

## ABSTRACTS

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# ISEE 20th Annual Conference, Pasadena, California, October 12-16, 2008

## PLENARY SESSIONS

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### ISEE-1

#### California Perspectives on Environmental Policy and Protection

*Opening Plenary Sunday Evening, October 12, 2008*

**Abstract:** California has often been the proving ground for new environmental policies and approaches, from motor vehicle emission reduction programs to Prop 65 warnings. The large and diverse population and economy has led to novel approaches to environmental quality, public health issues identification, and environmental protection. The Conference Opening Plenary showcases three aspects of California's progressive efforts in environmental health and protection: The State's perspectives, beliefs, concerns, and approaches to dealing with Climate Change; the evolution of chemical policy through the State's Green Chemistry Initiative; and the awareness of biological pathways receptor exposures through the Environmental Contaminant Biomonitoring Program.

### ISEE-2

#### Climate Change

Mary D. Nichols, *Chairman, California Air Resources Board.*

**Abstract:** This presentation will explore the impacts of land use, growth and transportation on efforts to control climate change. It looked at the need for communities throughout California to re-think decades-old planning and land use protocols if we are to have success in controlling and reducing the state's greenhouse gas emissions.

### ISEE-3

#### Green Chemistry

Maureen F. Gorsen, *Director, California Department of Toxic Substances Control.*

**Abstract:** Every day, news reports warn us that the consumer products, children's toys, jewelry, pet food, and other common goods may be unsafe or could contain hazardous chemicals. The public assumes that the government tests products for chemical safety, but that is not true for most items. Consumers, businesses, and manufacturers often lack information about chemicals in supply chains and finished products. These information gaps prevent the free market from working properly to stimulate the development of safer substitutes. Green Chemistry is a way to make products using less toxic materials, less energy, and less waste—by design. Renewable feedstocks, recycling, sustainability, and other life-cycle attributes are incorporated into the design of new products and processes. This “cradle-to-cradle” approach of Green Chemistry means fewer hazardous substances along with improved air quality, cleaner drinking water, and a safer workplace.

### ISEE-4

#### The California Biomonitoring Program

Mark Horton, MD, MSPH, *Director, California Department of Public Health.*

**Abstract:** Scientific studies have identified a multitude of environmental chemicals as toxic to humans, but with few exceptions, relatively little is known about the presence or levels of these chemicals in people or the extent to which they contribute to risks of disease. We do know, however, that exposure to many chemical substances is widespread.

The California Environmental Contaminants Biomonitoring Program was created through shared vision and broad stakeholder collaboration. It is based upon scientifically sound methods to facilitate the development of information about chemical exposures. The program will determine baseline levels of environmental contaminants in a representative sample of Californians, establish temporal trends in contaminant levels, and assess effectiveness of public health and regulatory programs to reduce exposures of Californians to specific chemical contaminants.

### ISEE-5

#### Environmental Health Policies—How Societies Decide What to do About Problems Unearthed by Epidemiologists and Exposure Scientists

*Monday Plenary, October 13, 2008*

**Abstract:** Environmental epidemiologists and exposure scientists tend to assume that excessive exposures that occur to only a small proportion of the population are not as important as exposures that are widespread. They follow the utilitarian principle of the “most good for the most people at the least cost”. Yet most citizens support the “duty ethics” rule that the majority has the duty to protect the minority from unfair exposures regardless of cost. Such clashes of ethical worldview and stakeholder interest have no technical solution and ultimately require a political solution.

This plenary examined how environmental epidemiologists and exposure scientists can influence who will be the local and global “winners and losers” by packaging information in an informative and philosophically neutral way to increase the chance of comprehensiveness in the ultimate policy discussions. It looked at environmental exposure and health problems around the world; how ethical frameworks and methods, such as cost benefit analysis, influence the policy discussion; and how to assure that relevant stakeholders are at the table as these problems are prioritized and solutions chosen.

*Convenor*

Raymond Neutra, MD, DrPH, *Chief emeritus, Division of Environmental & Occupational Disease Control, California State Department of Public Health.*

### ISEE-6

#### Poisoned for Pennies: Costs, Benefits, and Chemicals Policies

Frank Ackerman, PhD, *Director of Research and Policy Program, Global Development and the Environment Institute, Tufts University, USA.*

**Abstract:** It is often claimed that cost-benefit analysis is needed to determine whether proposed environmental policies are affordable. Such analysis, however, is both impossible, because crucial benefits have no meaningful prices, and also unnecessary, because most policy proposals (with the possible exception of climate change measures) are very inexpensive. Empirical examples include US policy toward arsenic, the debate over atrazine, and the new European chemicals policy.

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**ISEE-7****How Differences in Power, World View and Styles of Decision Making Impact Decisions About Third World Environment**

Indira Nair, PhD, *Vice Provost of Education; Professor, Engineering and Public Policy, Carnegie Mellon University.*

**Abstract:** Decisions about responses to exposures of industrializing countries are made by a multiplicity of parties explicitly and implicitly, often closely intertwined with and even ruled by, economic interests of parties who are not real stakeholders in the ultimate consequences of the exposure. Cultural beliefs, practices and actions depend heavily on local cultures while decisions may be made or coerced by people with little understanding of local cultures and ways and heavily invested in an ethic of rationality and individualism. This talk discussed the ethics of inclusion, transfer of knowledge and practice using a framework of the ethic of care.

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**ISEE-8****Decision Analysis Under Uncertainty: To Help the Dialogue Between Stakeholders with Different Interests and Ideologies**

Detlof von Winterfeldt, PhD, *Professor, School of Policy, Planning, and Development Director, Homeland Security Center for Risk and Economic Analysis of Terrorism Events University of Southern California.*

**Abstract:** How certain must one be of how much exposure and disease before different stakeholders would decide to move from the status quo to cheap and expensive exposure mitigation? How decision analysis can help stakeholder policy dialogue from an informed point of view.

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**ISEE-9****The Rise and Fall of Environmental Health Issues—Provoking Innovation in Environmental Health Sciences**

*Closing Plenary Thursday, October 16, 2008.*

**Abstract:** A major challenge in the management of environmental health issues is prioritization and resource allocation. Traditionally a ‘central’ government or system has been responsible for identifying and prioritizing environmental health issues. This system, typically regulatory, has been the driver for which issues are prioritized, acknowledged, and addressed by the public, industry, politicians, and others. This process also determined how resources were allocated to these issues for research and advocacy. Increasingly, however, other drivers—well-funded foundations, strategic activism, and celebrities, for example—are playing a greater role in how environmental and public health issues rise to prominence and receive attention. The challenge of harnessing this new momentum to effect a net improvement in human and environmental health is the focus of this session. The plenary included three presentations followed by audience discussion to provoke innovative thinking in addressing environmental health issues.

*Convener*

Tina Bahaduri, DSc, *Managing Director, American Chemistry Council Long-Range Research Initiative.*

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**ISEE-10****Ecological Health Paradigm, Vectors of Interest, and Influence of Issue Market Forces on Public Health Protection**

Michael Lerner, *President, Commonweal.*

**Abstract:** The science is clear that some chemical contaminants degrade human and ecosystem health. An historic struggle is underway to achieve a global precautionary approach to chemical management. The global environmental health movement integrates market campaigns, media strategies, policy initiatives, constituency development and other approaches. Specific issues compete for funding, attention, and allegiance. Low-dose effects on fetal development, the ecological health paradigm of health, biomonitoring, and the promise of green chemistry are four key science and technology issues driving the field.

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**ISEE-11****Activating Research and Putting Research into Action: California Breast Cancer Research Program**

Marion (Mhel) Kavanaugh-Lynch, *Director, California Breast Cancer Research Program.*

**Abstract:** Disease-specific research can be criticized for its singular body-part focus. It can serve as an illustrative example of global issues. In this presentation, the process and results of a multi-year plan to develop an initiative on disparities and environment in breast cancer will be presented. The advantages and challenges of channeling resources into such an initiative, and the potential for impact outside breast cancer was discussed along with the question where do we go from here?

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**ISEE-12****Through the Cacophony: Enabling Improved Public Health**

Gina Solomon, MD, MPH, *Senior Scientist, Natural Resources Defense Council.*

**Abstract:** The fundamental purpose of environmental health research is to provide information so that people can make better choices about their health and the environment, and to provide a scientific basis for improved public policy. Scientists and public policy experts are generally focused either on investigating environmental agents, or on investigating diseases. Connecting the ends of the exposure-disease spectrum is the ‘holy grail’ of environmental health research. New scientific tools that better connect “upstream” markers of exposure and biological perturbations with “downstream” health effects are a key area of investigation. Yet these new tools must be deployed on the foundation of a strong public health system.

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**SYMPOSIUM ABSTRACTS**

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**ISEE-S01****Global Food Safety and Environmental Health**

**Abstract:** Objectives of the symposium on Global Food Safety and Environmental Health include:

- Raise awareness on the impacts of Global Food Production Systems, International Agriculture and Trade Policies, and other food related emerging issues on Health and the Environment.
- Address the role of environmental health epidemiologists in the provision of information for dietary exposure assessment (to chemical, microbiological and emerging food risks) for adequate risk management and risk communication.
- Offer a platform to scientists to discuss the road map for the ISEE Conference on Environment, Food and Global Health in 2009.

Proposed sessions include: 1) Global Food Safety and Environmental Health Cristina Tirado, UCLA School of Public Health, USA This session will be provide an overview of the main global environmental health issues related to food production systems (e.g. feed production, animal farming, aquaculture, fisheries, etc.) and the impacts of international agriculture and trade policies on environmental and health. Data on chemical, microbiological and emerging food and environmental risks from new technologies, climate change, etc. will be presented. Current needs for risk assessment by international bodies to protect health and facilitate trade will be discussed. 2) Exposure assessment to chemical contaminants in food. Giovanni Leonardi, UK Health Protection Agency, UK. Exposure measurement of chemical contaminants in food is complex. Information from nutritional surveys of food intake needs to be combined with estimates of contaminant concentration in food items, to produce valid assessment of overall chemical exposure via food. These principles have been applied to a number of chemical contaminants of food, such as metals and persistent organic pollutants. Recent methodological advances in assessment of exposure to chemical contaminants via food are relevant to overall assessment of food safety, and will be presented in this session. 3) Industrial food animal production: food safety, socioeconomic, and environmental health concerns. Ellen K. Silbergeld, Bloomberg School of Public Health, USA Animal feeds may contain drugs and other additives, as well as recycled materials from slaughterhouses and animal wastes. The use of antimicrobials in animal feeds is associated with increasing prevalence of drug resistant pathogenic and commensal bacterial in the food supply. Farmers and farm workers are exposed to these bacteria in animal houses, and rural communities are exposed via environmental pathways of release, including air, soils, and water. Results indicate the importance of re-evaluating methods of food animal production in terms of risks beyond but including the food supply. 4) Food Risk and Benefit Analysis: Case study—Fish Consumption. Cristina Tirado, UCLA School of Public Health, USA Risk and benefits for health and the environment of food production and consumption such as fish, genetically modified foods, organic foods etc. have not been properly addressed. The assessment of risk to human health of food substances or nutrients is usually conducted independently of possible health benefits. International risk assessment bodies have been urged to develop guidelines on methodology for risk-benefit assessment. Approaches for conducting a quantitative risk-benefit analysis for food and food ingredients will be presented using fish consumption as a case study.

#### ISEE-S01-01

##### Global Food Safety and Environmental Health

Tirado-von der Pahlen MC, UCLA School of Public Health, Los Angeles, CA, USA.

**Abstract:** The “farm to the fork” approach to address food safety issues has been recently evolving into an “environment to consumer” approach. There many environmental factors that affect food and feed safety, such as soil, air and water pollution from industrial emissions/effluents, contamination with urban/farm sewage, chemicals used in agriculture, etc. Food can also be contaminated during storage, processing, distribution, commercialization, handling and consumption. At the same time, current food production systems (agriculture, animal farming, aquaculture, fisheries, etc.) have an impact on environmental health and emerging zoonosis. Global issues such as climate change and international agriculture and trade policies further determine global food safety. This session will present current trends on foodborne diseases and updated data on chemical and microbiological food contamination worldwide. Emerging food and environmental risks from new technologies such as biotechnology or nanotechnology, will be addressed considering risk and benefit issues. Current needs of data for food microbiological and chemical risk assessment and safety assessment of new technologies by international bodies to protect health and the environment and facilitate trade will be discussed.

#### ISEE-S01-02

##### Exposure Assessments to Chemical Contaminants in Food

Leonardi GS,\* Fletcher T,† Gnagnarella P,‡ and Duarte-Davidson R,\* \*Health Protection Agency, Didcot, United Kingdom; †London School of Hygiene and Tropical Medicine, London, United Kingdom; and ‡European Institute of Oncology, Milan, Italy.

**Abstract:** A main route of exposure to chemical contaminants is via food ingestion. Quantitative information on this at individual level would provide key information for estimation of health effects, and for monitoring of policies regulating human exposure to chemicals. However, there is a wide gap between information needed for estimation of chemical contaminant exposure via food, and information currently available. One of the reasons is that exposure measurement of chemical contaminants in food is complex: information from nutritional surveys of food intake needs to be combined with estimates of contaminant concentration in food items, to produce valid assessment of overall chemical exposure via food. These principles have been applied to a number of chemical contaminants of food, such as metals and persistent organic pollutants. In the Arsenic Risk Assessment and Molecular Epidemiology (ASHRAM) in Central Europe, a Food Frequency Questionnaire (FFQ) was used to estimate dietary intake of water and other nutrients. Repeatability and validity studies for the ASHRAM FFQ were conducted in 85 volunteers in counties of the Slovak republic. As part of the validation, a study of fluid vessels volume was conducted that showed the average size of a glass for drinking water was 231.7 ml SD 7.7 in this population. Overall water intake will be estimated by adding volumes and frequencies for all fluids consumed per year. In consideration of the expected dietary differences before and after political and social changes in 1989, the FFQ included sections estimating nutrient intake in both periods. Estimates of arsenic content in drinking water and food items, both from ASHRAM study and preceding surveys, will be used to estimate exposure via water and food. An effort to reconstruct exposure to perfluorooctanoic acid (PFOA) in food items is ongoing in a community study in West Virginia, and has provided an opportunity to extend the methods outlined above to the case of a persistent organic pollutant. Recent methodological advances in assessment of exposure to chemical contaminants via food are relevant to overall assessment of food safety, and will be presented in this session.

#### ISEE-S01-03

##### Industrial Food Animal Production: Food Safety, Socioeconomic, and Environmental Health Concerns

Silbergeld EK, Graham J, Price L, Liebler J, Evans S, Vailles R, Lackey L, Peterson A, Davis M, Arriola CS, and Resnick C, Johns Hopkins University Bloomberg School of Public Health, Department of Environmental Health Sciences, Baltimore, MD, USA.

**Abstract:** Over the past 50 years, the organization and methods of food animal production have been transformed significantly in economic organization, intensity and localization, and animal husbandry. This process began in the US in the 1940s and now is being adopted worldwide, including production of poultry, swine, cattle, and aquatic species (finfish and crustaceans). Some of these changes have reduced food costs to consumers (with high subsidies) and improved food safety through economies of scale and centralization of slaughterhouse practices, which can facilitate regulatory oversight of food processing, storage, and preparation. Other changes have created new problems not limited to food safety. These include the use of drugs as feed additives, high throughput processing methods, and confinement of thousands of animals in one site, leading to the concentration of millions of animals in some geographic areas. Addition of antimicrobials to feeds results in selection for and increased prevalence of antimicrobial resistant microbial populations

within the farm environment and on consumer meat and poultry products; the confinement of thousands of animals in one site impairs animal welfare and increases the problems of waste management and the risks of zoonotic disease outbreaks, and high throughput processing methods increase risks of cross contamination and occupational injuries to production workers. Moreover, industrial food animal production destabilizes rural communities and abrogates the autonomy of farmers, who become contractors to large producers, and in some cases multinational corporations. These large corporations often allocate costs to contractors and outsource negative impacts of intensive practices, including as waste management, and responses to zoonotic disease outbreaks, such as avian influenza. Our research has focused on the health impacts of the use of arsenicals and antimicrobials in animal feeds, which include consumer exposure to antimicrobial resistant pathogens in the food supply, occupational exposures of farmers and workers to resistant pathogens, and contamination of environmental pathways (air, water, and soils) by drugs and resistant pathogens. While some changes have been legislated in the European Union regarding animal feeds and conditions of animal production, because of the international nature of the food supply, the development of global policies remains critical to ensure the safety of the food supply as well as protection of the environment.

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**ISEE-S01-04****Food Risk and Benefit Analysis: Case Study—Fish Consumption**

Tirado-von der Pahlen MC, UCLA School of Public Health, Los Angeles, CA, USA.

**Abstract:** Risk and benefits for health and the environment of food production systems and foods such as fish, genetically modified foods, organic foods etc. have not been properly addressed. The assessment of risk to human health of food substances or nutrients is usually conducted independently of possible health benefits. International risk assessment bodies have been urged to develop guidelines on methodology for risk-benefit assessment. Approaches for conducting a quantitative risk-benefit analysis for food and food ingredients will be presented using fish consumption as a case study.

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**ISEE-S02****Environmental Justice at the U.S.-Mexico border: California/Baja California Region**

**Abstract:** The California/Baja California border is a region characterized by a growing manufacturing and trade base, extensive agriculture that relies heavily on migrant workers, significant in-migration, and rapid and poorly planned urbanization. The San Diego-Tijuana region near the Pacific Ocean has a transborder metropolitan population of some 4.5 million. The Imperial Valley-Mexicali Valley region, with its desert agricultural cities, has a binational population of nearly 1 million. The most pressing environmental issues in the region include poor air and water quality, and inappropriate use and disposal of toxic chemicals. The EPA Border 2012 report details the environmental goals for the USMexico border area, which include improved water and air quality, reduced land contamination, reduced exposure to chemicals, and improved compliance, enforcement and pollution prevention. Exacerbating the difficulties of improving environmental quality of the border area are differing levels of economic development and differing legal and regulatory systems for environmental quality and occupational health across the region. Significant disparities in exposures to pollutants and in access to clean water remain. The goal of environmental justice is to ensure that all people have the right to safe, secure and sustainable livelihoods free of toxic pollution, and a voice in the decision-making that affects them. An example of an environmental justice issue faced in this border region is the maquiladora program, designed to bring jobs and

prosperity to northern Mexico cities while at the same time providing cheap labor for foreign-owned manufacturers. Although the program has produced jobs, the work typically involves low wages, few benefits, little job security, and high exposure to toxics. Nor is heavy exposure to toxics limited to workers. The maquiladoras produce large quantities of hazardous waste, little of which finds its way back to the country of origin for proper disposal. The symposium will present several case studies in the border region that illustrate the environmental problems facing disadvantaged communities, and cultural and community factors important in taking action to remediate environmental problems. One case study will cover the cleanup of the abandoned Tijuana battery recycling plant/lead smelter known as Metales y Derivados, representing a binational environmental and public health victory. Shut down by the Mexican government in 1994 for repeated violations of environmental law, Metales y Derivados continued to pollute nearby communities. Another presentation focuses on the environmental issues faced by tribal populations in the California/Baja California area, specifically, cultural and environmental issues surrounding access to clean drinking water. The next presentation will outline air quality problems in the agricultural Mexicali area, and discuss binational solutions. Following the presentations, the panel and audience will discuss environmental justice in the border region: priority areas, barriers faced when addressing these problems, policy changes that would enhance environmental justice, and culturally appropriate, community-based solutions.

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**ISEE-S02-01****NAFTA's Failure to Protect Public Health and the Environment: The Case of Metales y Derivados, Tijuana, Mexico**

Simpson A, Environmental Health Coalition, National City, CA, USA.

**Abstract:** For more than 20 years, the U.S.-based New Frontier Trading Corporation recycled batteries in Tijuana. In 1986, operations moved from the La Gloria neighborhood to the Metales y Derivados site on the Mesa de Otay, above the community of Colonia Chilpancingo. In 1994, the Mexican government permanently shut down Metales y Derivados. The owner fled across the border to San Diego after a warrant was issued for his arrest for alleged environmental crimes. He left behind 7,000 metric tons of lead slag, along with other hazardous waste. No cleanup was proposed by the owner, or mandated by the U.S. or Mexican government. Residents of Colonia Chilpancingo and the Environmental Health Coalition began organizing and took actions including filing a citizen's petition with the North American Free Trade Agreement's Commission for Environmental Cooperation (CEC) to address the urgent need for cleanup of the toxic site. After much advocacy, the site is now being cleaned up, with independent community monitoring, representing a binational environmental and public health victory.

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**ISEE-S02-02****Case Study: Community Monitoring for Water Quality and Environmental Health in Baja California Indigenous Communities**

Stigler P, The San Diego Foundation, San Diego, CA, USA.

**Abstract:** The majority of indigenous communities in Baja California are located less than one-hundred miles south of the United States-Mexico border. In 2003, a study was conducted to document environmental health practices and linkages between drinking water infrastructure, quality and health in seven Kumeyaay and Pai Pai indigenous communities in Baja California, Mexico. Community health workers (Promotoras) were trained to collect water samples ( $n = 53$ ) and administer health surveys ( $n = 821$ ) to assess existing drinking water sources, basic sanitation, and illnesses within the communities. Water quality analysis showed widespread contamination of drinking water with total and fecal coliforms. Based on these findings, water infrastructure assessments were carried out

for the communities. Two of the communities were selected to receive new drinking water systems, based on level of contamination, number of persons in community and infrastructure already in place (i.e. electricity). These communities received their new systems in 2006 and an operation and maintenance capacity building project was carried out in order to ensure sustainability and community buy-in. A PAHO- funded 18 month follow-up study began in 1/2007 to examine the correlation between improved drinking water systems and decreased rates of gastrointestinal illnesses in order to demonstrate the applicability of water quality as an environmental health indicator. The project was designed to implement the same sanitary surveys by Promotoras in the two communities that received new water infrastructure systems with concurrent water sample analysis. Both surveys and water quality are to be compared to previous study results completed with the older infrastructure in place. The result should be a decrease in the amount of gastrointestinal illnesses and improved health within the communities after the installation of a new drinking water infrastructure. This project has been highlighted in the most recent U.S.-Mexico Border 2012 Program report as a major milestone in addressing the needs of the most at risk communities along the border and demonstrates the results of community monitoring by community members and the impacts improved environmental health has on rural indigenous communities.

**ISEE-S02-03****Air Quality in Mexicali, Baja California**

Reyna M, *Universidad Autónoma de Baja California, Mexicali, Mexico.*

**Abstract:** Mexicali, Baja California, close neighbor to the wealthy State of California, USA, plays an important demographic, urban, industrial, and business role in the regional economy, both domestically and binationally. All this dynamism in the region has generated important economic benefits; nevertheless the lack of attention to the care of environment have entailed severe situations of contamination, especially in regional air quality. The increase in industrial, commercial, and service activities—as well as a steep rise in vehicles in poor condition—have degraded air quality in the cross-border airshed, especially on the Mexican side. In addition, the situation is exacerbated by particle and dust emissions from illegal urban burns, agricultural burns, farming, industrial activities, and unpaved roads. In addition, the emission sources by energy generation (i.e., geothermal a fossil fuel-fired power plants in Mexicali) are more and more important. The construction of natural gas –fired power plants in the Mexicali area are exclusively to serve the California energy market has occurred and is likely to continue. These power plants are among the largest single sources of air pollution in the Ca-BC border region. The airshed is in non-attainment of federal standards on both sides of the border for PM-10, ozone and CO among others. Also, cardio-respiratory morbidity and mortality rates are one of highest in this binational zone. Recommendations discussed including the need for the harmonization of data, designation of binational airsheds, harmonization of vehicle inspection and maintenance programs, and consideration of policies regarding energy production. Also to improve air quality in the Mexicali-Imperial Valley region, resources are needed to build technological infrastructure as well as human capacity and understanding, and for programs in pollution reduction. In addition, the lack of local, binationally standardized agreements and procedures are important issues that impedes the collection, ordering, reliability, and compatibility of the medical/clinical data needed in order to do local, in-depth epidemiological studies, and hinders to a great degree the opportunity to study and propose indicators that assess the region's environmental health from a cross-border perspective.

**ISEE-S02-04****Pesticide Exposures in Imperial County**

Al-Delaimy WK, *University of California, San Diego, CA, USA.*

**Abstract:** Pesticides are a ubiquitous component of our environment. Over 1 billion pounds of pesticides are applied in the United States each year. Pesticide use in agricultural communities is much higher than urban and non-agricultural communities. Higher pesticide use has been linked to higher exposure to these chemicals and most cases of pesticide poisoning occur among farmers and workers in farms. Imperial County east of San Diego is a small agriculture community on the California/Baja California border. It is mostly composed of Latinos/Hispanics and has a lower than average family income and education. Imperial County has been shown to be one of the highest areas of use of pesticide in southern most area of California and up to 8.5 times higher use than San Diego. All use of pesticides is recorded with the California Department of Pesticide Regulation and therefore we can predict what types of pesticides are used in a certain community such as Imperial County. Soil sampling and analyses for different pesticides in the county revealed 5 pesticides to be consistently present (DDD, DDE, chlorthal-dimethyl, diazinon, and trifluralin). Trifluralin was the highest in terms of level of detection in soil samples. Trifluralin has been listed by the EPA as a carcinogen. However, it is still not known how these environmental exposures are related to human exposure among the population living in this county. The literature is inconsistent but suggestive of an association between pesticide exposure and cancer risk. In more than 30 studies from the literature, the majority indicate an association between pesticides and/or farming and Non-Hodgkins Lymphoma and Leukemia. However, these studies only rely on the type of occupation or on ecological studies to assess exposure to pesticides, leading to poor assessment of exposure. Poor exposure measures lead to attenuation of the true associations and can explain the inconsistent and weak findings. The use of biomarkers in epidemiology are expected to improve our estimation of true associations because of more accurate measurement of exposure. The risk of pesticide exposure in Imperial County, a disadvantaged community on Southern California's border, is not well addressed and needs further investigation.

**ISEE-S03****"Fishing For Solutions": Issues in Estimating Fish Consumption Rates for Exposure Assessment**

**Abstract:** Consumption of fish and shellfish and their impact on human health have remained a notable health concern because fish tissue can bioaccumulate environmental pollutants and it also offers important dietary benefits. Knowledge regarding the amount, type, and preparation (etc.) of the fish and shellfish consumed by a population is critical for estimating consumption rates regardless of whether the information is used to assess risks or benefits to human health. This symposium will discuss topics that help assessors identify issues relating to fish consumption rate estimates and will discuss topics to help assessors improve fish consumption rate calculations. For example, some population groups have fish consumption rates that may differ from the general population. To address this issue, methods for targeting populations with high consumption rates for the purpose of exposure assessment will be presented. Consumption rates for exposure assessments should be derived from site-specific surveys that capture the fish consumption patterns and rates for the population targeted for assessment. However, when site-specific data on fish consumption are not available and conducting a consumption survey is not practical due to limited resources, assessor have relied on available fish consumption data from existing studies conducted in other areas and/or for other purposes (surrogate data) to derive consumption rates for their assessments. Thus, issues surrounding the use of surrogate data will also be discussed in this symposium. Several fish consumption issues are statistical in nature. For example,

assessors are asking "how can I combine consumption data from different data sets into one estimate", "how should I address uncertainty from use of surrogate data", or "how can I use short term data to best predict long term consumption rates"? The symposium will address some of these statistical issues by investigating the use of Bayesian models, expert elicitation and presenting models illustrating how chronic consumption was estimated using short-term survey instruments. Other talks will review methods which estimate body burdens from commercial fish and will compare estimates of biomarkers with data found in NHANES. In addition to discussing general and statistical concerns, case studies describing issues uncovered in 'real world' assessment situations will be presented along with the approaches taken to contend with them. The case studies provide a wealth of information and experience for addressing special population groups, fish species grouping, identification of fish sources, and other significant fish consumption related issues. The overall goal of this symposium is to generate the conversation necessary to begin addressing those fish consumption issues requiring further attention from researchers studying within the field.

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**ISEE-S03-01****Overview of Scenarios, Issues, Recommendations & Needs Pertaining to Estimating Fish Consumption Rates for Exposure Assessment**

Wilkins A, U.S. Environmental Protection Agency, Washington, DC, USA.

**Abstract:** Assessors face various scenarios when determining fish consumption rates for a population of concern. The scenario depends on the type of data available for estimating consumption rates. One scenario occurs when an 'ideal' dataset is available where key factors for determining consumption rates are known for a site-specific population. With such data in hand, assessors can plug the necessary variables into the average potential daily dose equation to calculate consumption rates in terms of mg/kg-day. Other scenarios arise when 'ideal' or site-specific data are not available, assessors may decide to conduct a survey to collect data for their target population or may opt to use surrogate data or modeling techniques. Assessors should be aware of several issues impacting consumption rates when preparing estimates for the purpose of exposure assessment. For example, assessors should consider whether the rate is based on cooked or uncooked fish portions, the appropriate edible portions are taken into account, and how the species are grouped and identified. Other considerations for estimating fish consumption rate estimates include suppression, fish advisories, cultural aspects, definition of consumer and non-consumers, identification of the fish source, and the impact of survey testing periods. Identification of subsistence fishing populations and high-end consumer populations are also relevant issues that need to be addressed when assessing fish consumption rates. The purpose of the panel is to highlight key fish consumption rate estimate issues, provide recommendations and to facilitate discussion to address issues that require further attention from experts within the field. In addition, salient data gaps (geographical, population based data, guidance and other) will also be presented.

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**ISEE-S03-02****Identifying High-End & Highly Impacted Fish Consumers: Methods for Assessing Exposure Risk for Populations with High Fish Consumption Rates**

Burger J,\* Harris S,† and Gochfeld M,‡ \*Rutgers University, Piscataway, NJ, USA; †Confederated Tribes Umatilla Indian Res, Pendleton, OR, USA; and ‡UMDNJ-Robert Wood Johnson Medical School, Piscataway, NJ, USA.

**Abstract:** Understanding consumption patterns is particularly important for high-end consumers, those who are outliers on the fish consumption distribution. Such information is necessary for the consumers themselves,

as well as for the determination and management of risk. Exposure assessment must include both consumption data (fish species, amounts, timing), as well as contaminant information. High-end consumers can include Native Americans, Asians, African Americans and Hispanics, health-conscious people, recreational fishers, and others with a subsistence lifestyle. While it is relatively easy to identify the high-end consumers, it is much more difficult to obtain the information necessary to determine if high-end consumers are at increased risk from contaminants, including methylmercury. Difficulties include: 1) problems of recall (fish species, frequency, and amounts consumed), 2) differences due to gender, age, and season, 3) variations that may impact individual meal sizes, 4) individual lifestage, vulnerability and susceptibility, 5) difficulty of finding individuals to interview, and 6) reluctance to talk to interviewers, or to talk about fish consumption patterns with interviewers. Methods of identifying high-end consumers, and consumption patterns of these "at risk" populations required familiarity with cultural morals and values, approaches and social structure, as well as accepted scientific practices of determining consumption patterns. Stakeholder involvement is crucial at every phase. For example, with Native American and Aleut communities, meetings with both elders and tribal councils are essential, as well as with village members themselves. Also, within any community it is essential to identify populations that might be increasing, potentially have high consumption rates, and might be otherwise unrecognized, due perhaps to changing immigration patterns. In the New York region, for example, Asian populations are increasing and many adapt their traditional fishing patterns to their adopted home. Finally, identifying high-end consumers among the majority population is equally important even though most obtain fish from markets. Identifying both high-end consumers, and identifying consumption behavior within these populations will be discussed in this talk.

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**ISEE-S03-03****Estimating Fish Consumption and Targeting High Risk Consumer Populations in NJ and NY: A Case Study**

O'Neill M, Lobdell D, and O'Shea M, U.S. Environmental Protection Agency, New York, NY, USA.

**Abstract:** An estimated 16.4% of US females of reproductive age eat fish at least once per day. While fish is a good source of protein, with some species high in the omega-3 fatty acids that are associated with cardiovascular health, studies also indicate some fish and shellfish can contain mercury, PCBs, pesticides or other harmful contaminants at levels that can result in pre- or postnatal impairments. New York City Department of Health and Mental Hygiene (NYCDMH) recently conducted a local version of the National Health and Nutrition Examination Survey (NYCHANES). The study revealed New Yorkers have over three times the national average of mercury in their blood, and one-quarter of the 1,811 New York residents tested had blood mercury concentrations at or above the 5 µg/L New York State reportable level. The study also found that foreign-born Chinese residents had blood mercury concentrations more than two and a half times that of the general population in the city. Although the fish commonly associated with the highest levels of mercury are not frequently seen in Chinese kitchens, the study found that Chinese-Americans ate fish three times more often than others in the city. In response to the NYCHANES findings, EPA has recently funded two projects which aim to better target public health outreach as well as educate the fish-eating consumer. The first project will develop a Geographic Information System (GIS) based tool to identify areas in New York and New Jersey where women of child-bearing years are at highest risk of eating contaminated fish; the second project will determine Hg and PCB levels in fish species most commonly sold in the New York City area. This tool will be used to provide an effective way for health care providers, as well as state and local health departments, to reach vulnerable populations. The second project involves fish testing at

the wholesale level. Each study is anticipated to improve spatial coverage for future, targeted outreach efforts. Information and data gathering to date indicate both the challenges and opportunities associated with each project. These include, data issues; difficulties with fish origin and species identification; cultural issues; and, the issues of engagement with our health care providers.

#### ISEE-S03-04

#### Considerations for Using Surrogate Data for Estimating Seafood Consumption Rates

Moya J, U.S. Environmental Protection Agency, Washington, DC, USA.

**Abstract:** Seafood consumption is linked to many health benefits for both adults and children. Fish and other seafood are low in saturated fat, contain many vitamins and minerals, and are high in healthy omega-3 fatty acids. The consumption of omega-3 fatty acids has been known to reduce risks of certain conditions, including heart disease (IOM, 2006).

Although there are many benefits associated with the consumption of fish, pollutants can accumulate in seafood and they may pose health risks to consumers, especially susceptible populations. According to the National Listing of Fish Advisories, in 2006, there were 3,852 advisories in 48 of the 50 states (U.S. EPA 2007). These advisories help inform the public about chemicals that have been found in local fish and provide recommendations to limit or avoid consumption of certain species or water bodies or specific water types (such as lakes and rivers), (U.S. EPA 2004).

Assessing exposure from the consumption of contaminated seafood requires knowledge about the levels of contaminants in seafood and seafood consumption rates for the populations of concern. Available seafood consumption data in the U.S. has been summarized in EPA's Exposure Factors Handbook and the Child-Specific Exposure Factors Handbook (U.S. EPA 1997, 2006). Data included in these handbooks include consumption rates estimated from national surveys, as well as, consumption rates estimated from state and local surveys. It is generally unfeasible to conduct a seafood consumption survey at every site where surface water or sediment contamination is a concern.

Alternatively, exposure assessors frequently use the available data as surrogate for other sites. However, comparing results from fish consumption studies to derive consumption rates for a specific population for use in exposure assessments present several challenges to exposure assessors. Factors such as the general survey design, population surveyed, type and size of water body, approach for the analysis of data, and interpretation of results are important considerations when deriving fish consumption rates. This presentation will examine these factors that assessors should consider to adequately interpret seafood consumption survey data and use them as surrogate for other areas.

#### ISEE-S03-05

#### Use of Bayesian Models & Expert Elicitation for Estimating Fish Consumption Rates

Schmitt KA,\* and Choi T,<sup>†</sup> \*Battelle, Columbus, OH; and <sup>†</sup>University of Maryland, College Park, MD, USA.

**Abstract:** Understanding rates and types of fish consumption is an important issue to policy makers and risk communicators. Often, risks accrue more heavily to certain groups (defined by age, geographic location, gender, ethnicity or occupational status) and policy makers wish to analyze exposures and risks or craft targeted communication for specific groups. While situations exist for which precise data is available for particular groups or time and funding is available to conduct a new study for the particular group of interest, more often existing data must be employed to estimate consumption rates for the population of interest.

This talk will address the use of Bayesian techniques in establishing fish consumption patterns and sharing information between related studies on seafood consumption rates, species preferences and geographic and ethnic variation. Models will be presented which pool information on related data sets using a variety of hierarchical structures. Further, the use of expert elicitation in seafood consumption modeling will be explored. In this application, expert elicitation can be used to directly estimate consumption rates in communities of interest, and more interestingly for a Bayesian hierarchical approach, can be used to estimate similarity in fish consumption rates among available data and communities of interest.

#### ISEE-S03-06

#### Exposure Assessment of Methylmercury from the Consumption of Commercial Fish and Shellfish

Bolger PM, and Carrington CD, U.S. Food and Drug Administration, College Park, MD, USA.

**Abstract:** The methylmercury (MeHg) exposure assessment model for U.S. consumers originally developed by the US Food Drug Administration over 15 years ago has been refined and updated with new data on numerous occasions. The current version, utilizes the most recent information from the USFDA, the Continuing Survey of Food Intakes by Individuals (CSFII), the National Health and Nutrition Survey (NHANES), and the National Marine Fisheries Service (NMFS). In addition, the model has been modified to more closely represent methylmercury concentrations, rather than total mercury. Outputs of the model include average daily seafood consumption, average daily methylmercury intake from seafood, average or steady-state methylmercury blood levels, and methylmercury hair levels. Population distributions are presented for four adult population groups: Women Aged 16–45; Women Aged 46 and over; Men Aged 16–45; and Men Aged 46 and over. Model predicted blood levels for all four population groups are compared to blood levels measured in NHANES. While all values are in close agreement to the values from NHANES for each of the four population groups, men are slightly over estimated while women are slightly under estimated relative to the survey values.

#### ISEE-S04

#### Space-time Statistics for Environmental Epidemiology

**Abstract:** A recurrent and challenging task in environmental epidemiology is the analysis and synthesis of data collected at different spatial scales and times. The integration of (geo)statistics into Geographical Information Systems (GIS) has enabled the incorporation of multiple layers of information and space-time correlation in the mapping of contaminant concentrations. However, there remain substantial hurdles when assessing the lifetime exposure to contaminants for individuals that move frequently and for pollution levels that change in time (e.g. air pollution). To protect patient privacy publicly available data are often aggregated to a sufficient extent to prevent the disclosure or reconstruction of patient identity. The information available for human health studies is thus restricted to mortality rates within areas, such as ZIP codes or counties. Associations can then be investigated between these areal data and environmental, socio-economic or demographic covariates. Traditional analysis of health data fails to account for the fact that mortality rates tend to be spatially correlated and are less reliable when computed for sparsely populated areas. Another weakness is that the association between rate data and covariates is assumed stationary or spatially invariant. This assumption is likely unrealistic for large regions that display substantial geographic variations in demographic, social, economic, and environmental conditions. The goal of this symposium is to bring together international experts in the conceptual development and application of spatial and space/time analysis methods and to encourage

their application for the joint analysis of exposure and health data. We have built on the expertise at Universities, Research and Development Companies and Agencies to put together a list with international expertise in spatial and space/time analysis. This symposium will offer a platform to foster interactions between modelers, software developers and health scientists that are critically needed to advance the field of space/time statistics in environmental epidemiology. The proposed format of this symposium is to have one session of two hours with four presenters, which should leave ample time for discussion.

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**ISEE-S04-01****Environmental Public Health Tracking: A Case Study from Florida**

Gotway C, *CDC, Atlanta, GA, USA*.

**Abstract:** The Centers for Disease Control and Prevention (CDC) created the Environmental Public Health Tracking (EPHT) Program to integrate hazard monitoring, exposure, and health effects surveillance into a cohesive tracking network. Part of Florida's effort to move toward implementation of EPHT is to develop models of the spatial and temporal association between myocardial infarctions (MIs) and ambient ozone levels in Florida. Existing data on hospital discharges and emergency room visits were obtained from Florida's Agency for Health Care Administration. Environmental data were obtained from Florida's Department of Environmental Protection, sociodemographic data were obtained from the U.S. Census Bureau, and data from CDC's Behavioral Risk Factor Surveillance System were used to provide additional information on other risk factors. In this presentation, we highlight the opportunities and challenges associated with combining disparate spatial data for EPHT analyses. We compare the results from two different approaches to data linkage, focusing on the need to account for spatial scale and the support of spatial data in the analysis. We discuss the challenges and identify key needs associated with routine reporting and analysis from EPHT programs.

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**ISEE-S04-02****Accounting for Residential Mobility in Studies of Cancer**

Jacquez G, *BioMedware, Inc, Ann Arbor, MI, USA*.

**Abstract:** Humans are mobile yet traditional techniques for assessing exposure and for evaluating relationships between human health and the environment typically assume people never move. Examples include the use of static spatial point distributions to represent place of diagnosis or death in spatial statistical studies of health outcomes; exposure metrics that ignore residential mobility; and the often complete failure of analyses to account for different aspects of human mobility such as daily commutes, the weekly work cycle, mobility in structured environments such as buildings, and residential history over a person's life course. This problem is particularly important for cancers, where latency can be long, of uncertain duration, and where causative environmental exposures might occur at places very different from where a person resides at time of diagnosis. This presentation gives a brief history of human mobility to illustrate how it has changed to the present day. Dimensions of human mobility in our current society are described, and potential impacts of ignoring mobility in spatial epidemiology are identified. A flexible approach to accounting for mobility and latency in cancer studies is outlined and illustrated using case-control studies of bladder cancer in Michigan and breast cancer in Marin County, California. The techniques introduced in this talk are useful for (1) reconstructing time-continuous individual-level exposures in a manner that accounts for residential mobility; and (2) assessing cancer clustering over the life course while accounting for residential history, relevant risk factors and covariates.

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**ISEE-S04-03****A Bayesian Maximum Entropy Approach to Adjust for the Sampling Variability of Space/Time Disease Data**

Serre M, *University of North Carolina, Chapel Hill, NC, USA*.

**Abstract:** The space/time analysis of diseases involves many challenges, including the space/time autocorrelation of the data, the need to aggregate cases over arbitrary areas to protect privacy, and the fact that rates calculated from aggregated cases are less reliable for areas with small at-risk population. This talk presents a framework to address these challenges using the Bayesian Maximum Entropy (BME) method of non-linear spatiotemporal geostatistics and illustrates its application in several case studies. We will first describe techniques used to protect privacy, including data aggregation and geomasking, and we discuss strategies to provide sufficient privacy protection through the concept of minimum k-anonymity while at the same time allowing adequate sensitivity and specificity in detecting clusters or outbreaks in the disease. We then present the overall BME framework. BME is able to process a wide variety of knowledge bases, including space/time statistical moments and soft data characterized by any arbitrary probability density function (pdf). Using this later property we introduce different probabilistic models describing the uncertainty caused by the observational noise due to sampling variability. We use three cases studies, consisting in the studies of Sexually Transmitted Infections (STIs) in North Carolina (NC), renal cancer in NC, and Cholera in Bangladesh, to illustrate the challenges of the space/time analysis of diseases and the application of the BME approach. We demonstrate the use of data aggregation and geomasking to protect privacy of renal cancer cases and STIs, respectively. Using the STIs data we then demonstrate the applicability of the BME framework to correct for the observational noise due to sampling variability using the interval model of the latent disease rate given crude observed rates, and we validate the approach using an asymptotic cross validation procedure. We then illustrate how this first approach can be expanded using a Bayesian model that accounts for prevalence as prior information to the interval model. Finally we demonstrate how the BME approach can be used to detect clusters of renal cancer cases in NC, or outbreaks of Cholera episodes in Bangladesh. In conclusion, our BME maps of latent disease rate are complementary to maps obtained using the Poisson model.

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**ISEE-S04-04****Geostatistical Analysis of Health and Exposure Data: State of the Art and Perspectives**

Goovaerts P, *BioMedware, Inc, Ann Arbor, MI, USA*.

**Abstract:** The analysis of health data and putative covariates is a promising application for geostatistics. The joint advancement of environmental geostatistics and GIS has allowed the incorporation of multiple layers of information and accounting for spatial correlation in the creation of maps of contaminant concentrations, resulting in more accurate exposure models and the availability of associated measures of uncertainty. In comparison, the field of health geostatistics is still in its infancy. Several methodological challenges arise from the fact that health data are typically aggregated over irregular spatial supports and consist of a numerator and a denominator (i.e. population size). Common geostatistical tools, such as semivariograms or kriging, thus cannot be blindly applied to health outcomes. Because of the loss of information induced by the aggregation process and the possible distortion of relationships between health outcomes and their possible causes (ecological fallacy), it is beneficial to process directly the point-based data. Once again, geostatistics offers tools that are well suited to the problem at hand, yet they have been seldom applied in health science. This paper presents an overview of recent developments in the field of environmental and health geostatistics, both for the analysis of aggregated

and individual-level data. Three main types of application will be covered: 1. Stochastic modeling of the spatial distribution of pollutant concentrations around a point source. A simulation-based approach is used to combine the detailed process-based modeling of atmospheric deposition from an incinerator with the probabilistic modeling of residual variability of field samples. 2. Filtering of noisy mortality rates and detection of geographic and racial disparities in health outcomes. Poisson kriging is applied to the detection of disparities in cervix and prostate cancer mortality between black and white populations, using data recorded over all US State Economic Areas. 3. Mapping of the risk for late stage cancer diagnosis and detection of racial disparities in health outcomes. Indicator kriging is used to identify hot spots and cool spots of rates of early/late stage diagnosis and survival for breast and prostate cancers across Michigan.

#### ISEE-S05

#### The Relationship among Surrogate Measures of Exposure to Air Pollution in Rapidly Developing Countries

**Abstract:** The relationship between personal and surrogate measures of exposure may be influenced by where and how people live. This symposium will focus on the dynamic relationship among surrogate measures of exposure to air pollution in rapidly developing countries of Africa and Asia (A complementary proposed symposium focuses on research in developed countries). The influence of social inequality, urbanization, and economic development on personal exposures to air pollution will be addressed. Methods and preliminary results from ongoing studies of human exposure and health effects in Vietnam, Ghana, and India will be highlighted. Jack Spengler will chair the session, and give a context setting overview talk.

#### ISEE-S05-01

#### Spatial and/or Temporal Patterns of Air Pollution in Two Low-income Neighborhoods of Accra, Ghana

Dionisio KL,\*† Arku RE,‡ Hughes AF,§ Vallarino J,\* Carmichael H,† Friedman AB,† Agyei-Mensah S,‡|| Spengler JD,\* and Ezzati M,\*† \*Harvard School of Public Health, Boston, MA, USA; †Initiative for Global Health, Harvard University, Cambridge, MA, USA; ‡Department of Geography and Resource Development, University of Ghana, Legon, Accra, Ghana; §Department of Physics, University of Ghana, Legon, Accra, Ghana; and ||Environmental Science Program, University of Ghana, Legon, Accra, Ghana.

**Abstract:** Although the population of sub-Saharan Africa (SSA) is still predominantly rural, urban population has grown faster than any other world region in recent decades. Despite this demographic shift, there has been very limited systematic measurement and monitoring of urban environmental health issues such as air pollution in SSA. The sources of air pollution in African cities are also different from those in many other regions. More than three quarters of the region's population, including a large fraction of the urban population, use biomass fuels for cooking and heating. Therefore, urban air pollution in Africa results, in part, from biomass combustion, in addition to transportation, industrial pollution, and non-combustion sources which are the common sources in more industrialized countries. Within each city, the levels of air pollution, and the contributions of biomass, transportation, and other combustion and non-combustion sources, may vary by a neighborhood's socio-demographic characteristics such as income and population density, the location of the neighborhood, and meteorological conditions. We report on a study that provides data on the levels, spatial and/or temporal patterns, and characteristics of multiple pollutants in the ambient air in four neighborhoods in Accra, Ghana.

#### ISEE-S05-02

#### Differential Exposure Misclassification by Socio-economic Position and Location of Residence in Ho Chi Minh City, Vietnam

Mehta S,\* Tuan ND,† Brauer M,‡ Dan VX,§ and Cohen AJ,\* \*Health Effects Institute, Boston, MA, USA; †HCMC EPA, HCMC, Viet Nam; ‡University of British Columbia, Vancouver, BC, Canada; and §Department of Health, HCMC, Viet Nam.

**Abstract:** Although many Asian cities now employ ambient air pollution monitoring networks, the utility of such networks for epidemiological analyses and health impacts assessment has not been investigated. Specifically, we hypothesize that exposures classified by ambient monitors may be misclassified due to differences in the composition and relative contribution of indoor and outdoor sources of exposure that are related to socioeconomic status and residential location. Further, the differential impacts of these exposures, and the influence of economic deprivation on those impacts, may lead to increased health risks for specific population sub-groups. Accordingly, an interdisciplinary team of local and international experts was established to assess the relationship between air pollution, poverty and health in Ho Chi Minh City (HCMC). The project has two complementary components—a hospital-based study and a household-based study. In the hospital study, we estimate the relationship between acute exposures to ambient air pollution on hospital admissions for acute lower respiratory infections in young children (<5 years) of HCMC, and compare the magnitude of the effect of air pollution on poor children vs. other children[1]. The household study was designed to evaluate whether differential exposure misclassification by socio-economic position and location of residence arises from the use of routinely collected ambient air quality data in the hospital study. We hypothesize that the poor routinely experience higher actual exposures to air pollution than the non-poor that is not be reflected by the ambient monitors. In the study, we assess determinants of personal exposure for the poor and non-poor, and explores whether the use of ambient monitors as a surrogate for personal exposures results in differential exposure misclassification by SES.

A household survey, including detailed questions on household assets and expenditure and the prevalence of chronic respiratory symptoms, was administered to 1000 households in Binh Thanh District and District 2 of HCMC (population = 6 million). 64 households from the lowest and fourth highest expenditure quintiles were selected for personal (primary caregivers of children <5 years) and household monitoring based on this survey.

Between July 2007 and March 2008, 9 repeated measurements of daily average personal exposures to PM<sub>2.5</sub>, PM<sub>10</sub>, NO, and NO<sub>2</sub> were made for each participant. Detailed information on exposure to potential sources of pollution, including traffic exposure, incense, cottage industries, and tobacco smoke, as well as time activity patterns, was collected during each measurement period. Personal monitoring equipment was collocated at ambient monitoring stations closest to the districts to enable a comparison of personal exposures and ambient concentrations.

Preliminary results suggest personal exposures to PM<sub>2.5</sub> do not vary substantially by district or SES, although the poor experience slightly higher exposures than the non-poor in District 2. Daily average concentrations of PM appear to be much better correlated ( $r = 0.74$ ) with personal exposures of the non-poor ( $r = 0.32$ ) than the poor.

[1] Preliminary results suggest that acute exposures to ambient air pollution do not differentially impact children of different socio-economic status (SES).

#### ISEE-S05-03

#### Addressing Exposure Misclassifications in Environmental Health Assessments in India

Balakrishnan K, Sri Ramachandra Medical College and RI, Chennai, India.

**Abstract:** Health effects studies for air pollutants have a relatively short history in India. While considerable information on exposures in the ambient and indoor environment has been generated over the last decade, few have attempted to use them in an epidemiological framework to enable estimation of associated health risks. Complexities of multiple hazards and competing microenvironments make accurate exposure assessments particularly challenging in most settings. Logistic and resource constraints in using high-resolution methods further contribute to exposure mis-classifications. We present results from on-going efforts in urban (time series analyses for criteria air pollutants), rural (modeling of exposures to indoor air pollutants related to solid fuel use) and some special (mixed occupational and environmental exposures in communities involved in small and medium sector industrial operations) settings. These studies have shown the need for new method development to capture not only the spatial and temporal variability but also the heterogeneity of exposure situations. Of particular importance, is the lack of accessibility and the relative un-usability of routinely collected secondary environmental data. Results of application of personal exposure assessment methods interfaced with geo-statistical approaches provide confirmatory evidence that such methods are more efficient despite the relative cost. The baseline data generated thus may provide the momentum imminently needed for both enhanced air quality management efforts and improved burden of disease estimations within the country.

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**ISEE-S06****Ethical Considerations in the Conduct of Epidemiological and Human Exposure Research: Privacy and Confidentiality**

**Abstract:** Epidemiological and human exposure research provide an important means to collect information that is critical to meeting the goal of protecting human health. Due to the nature of this type of research, there are many potential issues associated with the research participant's privacy and confidentiality that need to be addressed in the design and implementation of these studies. This symposium will open with a presentation on the ethical basis of privacy and confidentiality, a component of autonomy (a basic ethical principle for research involving human subjects). This will be followed by discussion on the implications of emerging technologies in observational exposure research on privacy and confidentiality and a review of the National Childrens Study as a case study on the practical considerations of privacy and confidentiality. The session will close with discussion on overall considerations of privacy and confidentiality to epidemiologists and human exposure researchers. A goal of the symposium is to provide a venue for exposure scientists and environmental epidemiologists to enhance their understanding and consideration of these important ethical considerations as part of their research. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S06-01****Ethical Principles of Privacy and Confidentiality**

Packman S, *University California, Los Angeles, CA, USA*.

**Abstract:** The ethical principles articulated almost 30 years ago in The Belmont Report, respect for persons, beneficence, and justice, inform research with human subjects and serve as the foundation for our federal regulations. The application of the ethical principles and federal regulations to epidemiological research raises questions regarding the autonomy and dignity of subjects through the process of informed consent as well as the potential risks to subjects, including the protection of individually identifiable private or confidential information. The National Bioethics Advisory Commission (NBAC) highlighted in their 2001 report that public health research has contributed greatly to the health and welfare of our society. The NBAC also noted long standing questions

about epidemiological research and its relationship to the federal regulations for the protection of human subjects and Institutional Review Board (IRB) review. This presentation will begin by highlighting ethical research principles and regulatory requirements for epidemiological research with human subjects addressing: what is research, who is a human subject, and what are the ethical principles that inform research with human subjects. This will be followed by discussing balancing ethical principles with the goals of epidemiological research and questions that arise about the protection of human research subjects in epidemiological research, specifically privacy and confidentiality.

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**ISEE-S06-02****Implications of Emerging Technologies in Observational Exposure Research on Privacy and Confidentiality**

Quackenboss J, *U.S. EPA, Las Vegas, NV, USA*.

**Abstract:** Environmental health research may impact the privacy of study participants. Observational exposure studies consider the frequency, magnitude and duration of contact between individuals and pollutants in the locations where they live and work. These studies often involve observing or measuring environmental conditions or pollutants in these locations, and combining this with information on activity patterns. In addition, some exposures may be measured through personal monitoring or assessed using biological samples.

Changes in technologies for these measures could increase or decrease the potential impact of the study on personal privacy. For example, personal monitors or GPS devices may record more information than the participant originally decided to share about their personal activities or the locations visited. Historically, these devices have been fairly obvious, which could identify study participants, especially if information about the research study has been released to the public. This could result in discomfort, especially for children and adolescents, or other concerns for study participants. Improved technologies, such as micro-sensors and GPS devices included on cell-phones, could reduce this disclosure risk. Collection and storage of environmental and biological samples, and of recordings from sensors or GPS devices, could be used for purposes other than those originally agreed to by the participant. Advances in analytical methods may allow for samples to be used to identify additional pollutants, or detect lower concentrations of these agents. Researchers may need to limit access to these data to protect confidentiality of information provided by the participant for specific purposes, and consider how to obtain approvals for secondary uses of such data and samples. Improved public access to research results and data could increase the risk of unintentional disclosure, given the desire to maximize the use of samples and data to answer important public health questions, and to share data and results with the scientific community and the public.

This presentation will provide examples of changing technologies that are becoming available for observational exposure studies, and discuss how these might increase or decrease potential impacts on individual privacy and confidentiality.

**Disclaimer:** Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S06-03****Practical Considerations of Privacy and Confidentiality: The National Childrens Study As A Case Study**

Fleischman A, *NIH National Childrens Study, Bethesda, MD, USA*.

**Abstract:** This presentation will discuss the policies and procedures that govern research practices for protection of human subjects for the National Children's Study. The National Children's Study is the largest and most ambitious study of the health and development of children ever to be undertaken in the United States. It is an observational longitudinal

study of 100,000 children and their families recruited as a probability sample from over 100 locations to examine the separate and combined effects of environmental exposures (chemical, biological, physical, psychosocial) as well as gene-environment interactions on pregnancy outcomes, child health and development, and precursors of adult disease. The Study is led by the U.S. Department of Health and Human Services—through the National Institutes of Health and the Centers for Disease Control and Prevention—and by the U.S. Environmental Protection Agency. Concern for privacy and confidentiality of individual participants and community engagement in all aspects of the Study are high priorities. Each research center will involve community representatives, organizations, and influential leaders as partners. Centers will develop strategies to inform local organizations and political leaders of relevant research findings that can affect the health of children. Individual participants will also receive confidential information about study findings that have clinical import. Relevant health information about the child participants including periodic assessments of growth and neurodevelopment will be shared with families and, with permission, given to their physicians. Families will also learn about the physical and chemical environment in which they live and be helped to understand the meaning of that information, as well as have the opportunity to learn about local resources that can assist in ameliorating any observed problems.

**ISEE-S06-04****Practicalities Addressing Confidentiality and Privacy in Environmental Epidemiology and Exposure Assessment Research**

Soskolne CL,\* and Al-Delaimy WK,† \*Department of Public Health Sciences, University of Alberta, Edmonton, AB, Canada; and †Family & Preventive Medicine, Cancer Prevention & Control Program, University of California, San Diego, CA, USA.

**Abstract:** As health researchers, we submit research proposals to Institutional Review Boards for review and approval prior to conducting research involving people or their records. According to ethics guidelines, we are expected to consider four bioethical principles: respect for personal autonomy, doing good, doing no harm, and distributive justice.

Respect for autonomy involves respecting the right to privacy of information collected from study participants who must be given sufficient prior knowledge about what they are being asked to do. Such knowledge relates specifically to potential harms and benefits associated with their participation in research. This information should be sufficient to enable potential participants to make a prior informed decision as to whether or not to consent. It is the responsibility of researchers rather than IRBs to ensure that participants can exercise their autonomy and that their long-term privacy is preserved.

Respecting autonomy is even more complex when dealing with stored data. The ability to store/freeze biological and other identifiable (linked or unlinked) samples from people for possible use in future research presents a different set of ethical considerations. Once sensitive and specific enough technological breakthroughs are developed for determining exposures and/or early markers of effect (clinical changes), researchers need to determine clinical significance. By exploiting pre-existing repositories of biological and other data, sensitivity and specificity of the technological advance can be examined cost-effectively. Public health advantage, can be derived from biological and related information stored for purposes beyond that for which consent had been granted. The researcher must, however, anticipate such work at the stage of securing initial consent, or the researcher must abide by normative standards locally for accessing stored data for purposes different from that for which consent had originally been obtained.

Further complexity arises through record linkage studies, facilitated by computerized records systems. However, concerns of data protectionists (i.e., people who value privacy over the uses to which data could be put)

need to be recognized when we consider large-scale population-based studies of potential public health importance. Our professional organizations need to work with data protectionists to better understand the need for researchers to protect privacy, and also to have data protectionists better appreciate health gains derivable from linkage studies. The Canadian Institutes of Health Research (CIHR, 2005) provided helpful guidelines for others to follow when proposing research using banked biological and related data.

**ISEE-S07****Reconstructing Lifetime Exposure to Low to Moderate Concentrations of Arsenic in Drinking Water in Case-Control Studies in USA and Europe**

**Abstract:** Arsenic is a pervasive contaminant in underground aquifers worldwide, with an estimated 100 million people exposed to elevated concentrations. Exposure to arsenic concentrations in drinking water in excess of 300 µg/L is strongly associated with diseases of the circulatory and respiratory system, several types of cancer, and diabetes; however, the health consequences of exposure to low-to-moderate levels of arsenic (<100 µg/L) is a topic of considerable debate. Three recent substantial studies have put much effort into methods for assessing individual study participants' exposure to arsenic in drinking water over time. These have been in different settings: Northern New England, USA (led by the National Cancer Institute), Michigan, USA (led by the University of Michigan), and in Central Europe (led by London School of Hygiene and Tropical Medicine). A key element of each of these studies is detailed assessment of lifetime exposure to arsenic in drinking water, accounting for residential mobility and changing concentrations of arsenic concentrations in water supplies, and dealing with water supplies and time periods where concentrations can not be directly measured. Accurate assessment of exposure is especially important when examining health effects from chronic low-level exposure. In this symposium, Jay Nuckols (representing the New England study), Jaymie Meliker (representing the Michigan study), and Tony Fletcher (representing the Central European ASHRAM study) will describe their efforts to reconstruct individual lifetime exposure to arsenic in drinking water. Each presenter will speak for approximately 20 minutes, after which Catterina Ferreccio will be a discussant, followed by questions and comments from the audience. This symposium, by exploring in some detail the similarities and differences in the approaches taken in these studies to addressing variability in time and space, along with uncertainty, will be of interest and relevance to people carrying out epidemiological and exposure assessment studies of drinking water contaminants.

**ISEE-S07-01****Arsenic Exposure Assessment in the New England Bladder Cancer Study**

Nuckols JR,\* Beane-Freeman L,\* Baris D,\* Lubin JH,\* Ayotte JD,† Schwenn M,‡ Johnson A,§ Karagas M,¶ Colt J,\* Silverman DT,\* and Cantor KP,\* \*National Cancer Institute, Bethesda, MD, USA; †U.S. Geological Survey, Pembroke, NH, USA; ‡Maine Cancer Registry, Augusta, ME, USA; §Vermont Cancer Registry, Burlington, VT, USA; and ¶Dartmouth Medical School, Hanover, NH, USA.

**Abstract:** Ingestion of inorganic arsenic in drinking water at levels higher than 150 µg/L causes skin, lung, bladder, and other cancers. However, the studies of lower exposures are inconsistent, possibly due to exposure misclassification and small study size, limiting the ability to detect small risks. Our participation in a large case-control study conducted in Maine, New Hampshire, and Vermont provided an opportunity to use innovative approaches to more accurately assess exposure to relatively low levels of drinking water arsenic.

We interviewed 1,213 cases and 1,418 population-based controls at home and measured arsenic in the drinking water of study participants.

The interview included lifetime residential history with water source(s) (private well/spring, public supply, bottled, etc.) and location of all lifetime residences, as well as questions on other known and suspected risk and confounding factors. Total daily tap water intake was calculated from usual adult intake of tap water, coffee, tea, and other beverages. We estimated arsenic level in drinking water for each year lived in a given home by each participant. The measured level was used to estimate water arsenic at the current home. Arsenic levels at past homes with private wells in New England were estimated either by sampling or by linkage to probability maps generated by one of two multivariate geologically-based models estimating the spatial distribution of arsenic in bedrock or unconsolidated aquifers. Arsenic levels in past homes with public supplies in the study area were estimated from abstracted historical data or by linkage with state data. For past residences outside of the study area, we used EPA, USGS, or state data, depending on type of water supply and data availability. Among the 1,123 controls having estimable levels of household drinking water arsenic for  $\geq 80\%$  lifetime years, the mean level was  $2.2 \mu\text{g/L}$  ( $sd = 4.9$ ), the median was  $0.9 \mu\text{g/L}$  (IQR = 0.5–2.2  $\mu\text{g/L}$ ), and the 95%ile was  $7.9 \mu\text{g/L}$ . The mean cumulative lifetime intake was  $80.2 \text{ mg}$  ( $sd = 207$ ), the median intake was  $30.7 \text{ mg}$  (IQR = 13.1–68.4), and the 95%ile was  $287 \text{ mg}$ .

In this large case-control study of bladder cancer, we were successful in estimating arsenic exposure for at least 80% of lifetime years for 80% of our study population, using several innovative approaches.

#### ISEE-S07-02

#### Addressing Space-Time Variability and Uncertainty in Reconstructing Exposure to Arsenic in Drinking Water in Michigan

Meliker JR,\* Slotnick MJ,† Avruskin GA,‡ Schottenfeld D,§ Kaufmann A,‡ Goovaerts P,‡ Wilson M,§ Jacquez GM,‡ and Nriagu JO,† \*Graduate Program in Public Health, Department of Preventive Medicine, Stony Brook University, Stony Brook, NY, USA; †Department of Environmental Health Sciences, School of Public Health, University of Michigan, Ann Arbor, MI, USA; ‡BioMedware, Inc., Ann Arbor, MI, USA; and §Department of Epidemiology, School of Public Health, University of Michigan, Ann Arbor, MI, USA.

**Abstract:** Exposure to arsenic in drinking water above  $300 \mu\text{g/L}$  is associated with bladder, skin, and lung cancer; however, health consequences of lower level exposure ( $<100 \mu\text{g/L}$ ) are equivocal. In southeastern Michigan, approximately 235,000 individuals are exposed to arsenic above  $10 \mu\text{g/L}$  (WHO and USEPA guideline) in their home drinking water. Lifetime exposure to arsenic in drinking water is reconstructed for a population-based bladder cancer case-control study. Cases ( $N = 421$ ), recruited from the Michigan Cancer Registry and controls ( $N = 573$ ), enrolled using random digit dialing of age-weighted lists, answered questionnaires about water and dietary consumption, residential and occupational histories, and historical sources of drinking water. Samples of drinking water were analyzed for arsenic at current residences, and arsenic was estimated at past residences using historical databases and a validated geostatistical model. Lifetime estimates of inorganic arsenic exposure were calculated in an automated fashion using space-time technology (STIS, TerraSeer, Inc.), incorporating residential mobility, changes in water consumption, the changing geography of municipal water supply districts, and arsenic concentrations in private and public water supplies over time. Quantitative estimates of time-varying uncertainty in exposure were also generated. Participants reported 8990 residences, accounting for 64,619 person-years (99% of total person-years), and reflecting an average 65 years of residential history per person. Approximately 33% of person-years were spent consuming private well water, and 64% served by a public water supply. Participants spent the majority of their lives in southeastern Michigan (83% of person-years); arsenic was estimated for 99% of person-years. Nearly 9% of person-years were spent drinking water with arsenic  $>10 \mu\text{g/L}$ ; 25% of participants

experienced a change in drinking water arsenic  $>10 \mu\text{g/L}$ . Results indicate considerable temporal variability in individual lifetime exposure to arsenic, confirming the need for a temporally-resolved exposure assessment. The automated STISbased exposure assessment method enables recalculation of lifetime exposure as datasets and models are validated and improved. Estimates of exposure and uncertainty are being incorporated into the epidemiologic study.

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#### ISEE-S07-03

#### Lifetime Exposure to Arsenic in Residential Drinking Water in Central Europe

Fletcher T,\* Leonardi G,† Hough R,‡ Goessler W,§ Gurzau E,¶ Koppova K,|| Kumar R,‡ Rudnai P,\*\* and Vahter M,†† \*PEHRRU, LSHTM, London, United Kingdom; †Division of Chemical Hazards & Poisons, Health Protection Agency, Chilton, United Kingdom; ‡The Macaulay Institute, Aberdeen, United Kingdom; §Institute für Chemie-Analytische Chemie, Karl-Franzens-Universität, Graz, Austria; ¶Environmental Health Centre, Cluj-Napoca, Romania; ||State Health Institute, Banska Bystrica, Slovakia; #Division of Molecular Genetic Epidemiology, German Cancer Research Centre, Heidelberg, Germany; \*\*National Institute of Environmental Health, Budapest, Hungary; and †††Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden.

**Background:** Control of water supplies to reduce arsenic intake is good for public health and offer the opportunity to study the health benefits of reducing arsenic intake, however it also complicates the task of accurate reconstruction of past exposures in the service of investigating exposure response relationships between arsenic and cancer. Classifying people based on the current drinking water concentrations would be an unsatisfactory option by ignoring individual differences in patterns of concentrations over time. Methods: For the ASHRAM study—a case-control study investigating arsenic in drinking water and cancer, in counties with arsenic exposure in Hungary, Romania and Slovakia—the exposure history of each person was constructed taking into account how much water was consumed (as water, in drinks and in food), sources of drinking water in their various residences over their lifetime and the concentrations of arsenic in the water supply, in many cases measured in the ASHRAM study, or from routine data based on measurements performed by the authorities in each country. Four indices of exposure were calculated: the current concentration of residential drinking water, the time weighted average concentration of residential drinking water, the highest daily dose of As derived from residential drinking water and the lifetime cumulative dose. Results: For 1392 participants, the assignment of concentrations to water supplies was very successful with 81% of the population lifetime residential person time being matched to an arsenic concentration. The exposure indices were all log-normally distributed and the median lifetime concentrations were in Hungary  $13.3 \mu\text{g/l}$ , Romania  $0.7 \mu\text{g/l}$  and in Slovakia  $0.8 \mu\text{g/l}$ . Overall 25% of the population has average concentrations over  $10 \mu\text{g/l}$  and 8% with exposure over  $50 \mu\text{g/l}$ . Classifying exposure by current rather than lifetime measures of arsenic exposure leads to an underestimate of the strength of relationship between arsenic and cancer.

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#### ISEE-S08

#### State-of-the-Science Probabilistic Aggregate and Cumulative Residential Exposure Models and Recent Residential Exposure Measurement Studies: How the Data and Models Compare

**Abstract:** The U.S. Food Quality Protection Act of 1996 (FQPA) mandates that the EPA consider aggregate (single chemical, multiple pathway) and cumulative (multiple chemical, multiple pathway) human exposure, particularly for infants and children, when making pesticide regulatory decisions about chemicals having a common mechanism of

toxicity. In the European Union, the Biocides Directive and Project REACH also necessitate conducting multiroute residential exposure assessments. Implementation of these laws required new methodologies beyond existing deterministic, screening-level approaches to assess aggregate exposures. At least five major models have been developed to probabilistically estimate human exposures to pesticides across various pathways and routes (e.g., inhalation exposure, oral exposure through hand or object mouthing, dermal exposure to indoor and outdoor surfaces, dietary ingestion of chemicals in food and water). These five models, Calendex (Exponent), CARES (ILSI), ConsExpo (RIVM), LifeLine (The Lifeline Group), and SHEDS (EPA/ORD), all simulate exposures to pesticides over time in a residential setting by probabilistically combining available data on human activity patterns, chemical concentrations in media contacted, and other exposure factors. Concurrent with the development of the models have been field investigations of residential exposure to pesticides. Observational measurement studies have been conducted by various universities and by the US EPA's Office of Research and Development, among others. These studies have collected much needed data, including environmental residues, personal measurements, and biological monitoring from occupants, to provide real-world inputs to the models, to compare the model results from one model to another, and to compare the model predictions to the real-world measurements. This symposium will include an overview presentation on five models for residential (consumer, non-dietary) pathways; the results of model predictions based on use patterns from selected residential exposure studies to the exposures measured in those studies; and a detailed discussion of the multimedia monitoring from selected residential exposure studies, including relationships between environmental residues and biological monitoring. This symposium will offer recommendations for future research based on the results of the comparison of the model outputs to the residential exposure study monitoring results. The symposium will be supplemented with poster presentations permitting more detailed discussions regarding the underlying residential exposure studies and models. Proposed Presentations Symposium Introduction: History of aggregate/cumulative risk assessment and future direction. (5 min) David Miller, Health Effects Division, US EPA Overview of the Five Probabilistic Pesticide Exposure Models. (20 minutes, including questions) Steve Nako and Jeff Evans, Health Effects Division, US EPA Dermal, Inhalation, and Incidental Exposure Results from the Models: How Did They Handle the Data? (20 minutes, including questions) Jeff Driver, infoscientific.com Relationships between Environmental Concentrations and Absorbed Dose Levels. (20 minutes, including questions) John Ross, infoscientific.com, Dave Barnekow, Dow AgroSciences Panel Discussion. (20 minutes) Jeff Evans, Health Effects Division, US EPA Symposium Conclusions and Recommendations. (5 minutes) David Miller, Health Effects Division, US EPA Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-S08-02****Overview of the Five Probabilistic Pesticide Exposure Models**

Evans J, U.S. EPA, Washington, DC, USA.

**Abstract:** The U.S. Food Quality Protection Act of 1996 (FQPA) mandated that the EPA consider aggregate (single chemical, multiple pathway) and cumulative (multiple chemical, multiple pathway) human exposure, particularly for infants and children, when making pesticide regulatory decisions about chemicals having a common mechanism of toxicity. Five aggregate exposure models have been developed to probabilistically estimate human exposures to pesticides across various pathways and routes (e.g., inhalation exposure, incidental oral exposure, dermal exposure to indoor and outdoor surfaces, and dietary ingestion of residues in food and water). The five models are Calendex (Exponent), CARES (ILSI), ConsExpo (RIVM), LifeLine (The Lifeline Group), and

SHEDS (EPA/ORD) and they are programmed to simulate exposures to pesticides over time in a residential setting by probabilistically combining available data on human activity patterns, chemical concentrations in media contacted, and other exposure factors. Although the models are programmed to estimate residential exposures from multiple pathways they differ in approach (emphasis on activity patterns or environmental concentrations) and in the underlying assumptions and algorithms. As part of this symposium, the models are being used to estimate exposure resulting from the use of a residential pesticide using similar use scenarios. Comparisons and an understanding of how the models handled the application scenarios will be presented during the symposium and the model assessments will be compared to observational exposure study data. This presentation provides an overview of the different approaches taken to model exposures by the five models.

**ISEE-S08-03****Dermal, Inhalation, and Incidental Exposure Results from the Models: How Did They Handle the Data?**

Driver J, infoscientific.com, Inc., Manassas, VA, USA.

**Abstract:** Predictive algorithms and associated chemical- and scenario-specific input variables underlie residential exposure assessment methods (e.g., U.S. Environmental Protection Agency's Residential Exposure Assessment Standard Operating Procedures). Predictive models (e.g., Calendex™, CARES®, ConsExpo, LifeLine™, and SHEDS) have been developed and used as the basis for deterministic, screening-level and higher "tier" (probabilistic) quantitative human health risk analyses for pesticide-containing products that are proposed for use in and around homes. Residential exposure monitoring studies (e.g., environmental measurements such as surface deposition and transferable residues) and human and residential exposure factor data have been used to inform the algorithms and input variable values. This presentation will provide an overview of comparative modeling results for selected exposure scenarios. Specifically, the comparison will highlight similarities and differences between the models in how they accommodate input data, and highlight common issues and areas of uncertainty. Posters for specific modeling efforts will be acknowledged.

**ISEE-S08-04****Relationships between Environmental Concentrations and Absorbed Dose Levels**

Ross J, infoscientific.com, Inc., Carmichael, CA, USA.

**Abstract:** Observational exposure measurement studies may collect a plethora of information, including environmental (indoor and outdoor air, transferable residues, dust, soil), biological (urine, saliva), and personal (cotton garments, duplicate diet) samples, as well as activity patterns and questionnaire information. Data from selected studies were analyzed individually and then combined and analyzed collectively to evaluate the relationships between various environmental, personal, and biological concentrations for selected pesticides and their corresponding urinary metabolites. In this presentation, observations will be made on the relationships between the environmental concentrations and the measured urinary metabolite concentrations for the individual and combined analyses. Individual and combined data were evaluated using regression models. Preliminary data analyses indicated associations between analyte concentrations on socks data and measured urinary 3-phenoxybenzoic acid (3-PBA) concentrations ( $r^2 = 0.95$ ) and the indoor air data and measured urinary 3-PBA concentrations ( $r^2 = 0.35$ ) for a subset of the individually analyzed data ( $n = 9$ ). Included in this presentation will be a discussion of the challenges often encountered when interpreting environmental and biological data, including variations in sample collection strategies, parent pesticide half-life, and presence of pesticide metabolites in environmental

media. We conclude by comparing our observations to the NHANES and GerES population studies. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S09****The Relationships Among Surrogate Measures of Exposure to Air Pollution in Developed Countries**

**Abstract:** Many studies have estimated personal exposures from surrogate measures of exposure. However, the relationship among personal and surrogate measures of exposure may be influenced by where and how people live. This symposium will focus on a broad range of measures of exposure, and evaluate their utility for estimating personal exposure in developed countries. (A complementary symposium focuses on research in rapidly developing countries). Surrogate measurements of personal exposure that are discussed will include: modeled estimates from US Environmental Protection Agency's Assessment System for Population Exposure Nationwide (ASPEN), central site monitoring data, and modeled estimates using microenvironment measurements and time-activity patterns. Debra Kaden (co-chair) will start the session with a brief overview, putting the session in context. John Spengler (co-chair) will conclude the session by looking across the different methods for estimating exposure, and their utility for understanding personal exposure.

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**ISEE-S09-01****A Comparative Analysis of Monitored Ambient Hazardous Air Pollutant Levels with Modeled Estimates from the Assessment System for Population Exposure Nationwide**

Lupo PJ, and Symanski E, University of Texas School of Public Health, Houston, TX, USA.

**Abstract:** Hazardous Air Pollutants (HAPs) are toxic substances commonly found in the air environment that are known or suspected to cause serious health effects. In population-based studies evaluating health risks associated with HAPs, researchers are unable to assess personal exposures and rely upon ecologic exposure measures. Two potential data sources are modeled estimates from the US Environmental Protection Agency's (EPA) Assessment System for Population Exposure Nationwide (ASPEN) and measured ambient air levels. ASPEN estimates at the census tract level and monitoring data for all HAPs throughout Texas were obtained for 1990, 1996, and 1999. Ambient concentrations of HAPs, along with data on location of monitor, sampling duration and collection frequency, were obtained from the US EPA Air Quality System. Monitoring sites were mapped to census tracts using US Census data. For each pollutant, annual ASPEN estimates were compared to annual ambient air concentrations using Spearman correlation coefficients and ratios of modeled-to-monitored annual levels. Comparisons for 1990 were not made due to insufficient monitoring data. Modeled estimates across census tracts were positively and significantly correlated with monitored levels (with hexane being the highest in 1996,  $R = 0.58$  and methyl tert-butyl ether being the highest in 1999,  $R = 0.85$ ). Medians of ratios were close to 1 (indicating favorable agreement) for dichloromethane and trichloroethylene in 1996 and for ethylbenzene and vinyl chloride in 1999. Pollutants with poor agreement included: ethylene dibromide and 1,1,2-trichloroethane, with medians close to 0. Agreement among 11 of the 14 pollutants common to both years (carbon tetrachloride, dichloromethane, and vinyl chloride) improved from 1996 to 1999 with a larger percentage of model-to-monitor ratios within a factor of 2. Agreement for 2 of the 14 pollutants (ethylene dichloride and trichloroethylene) was markedly worse from 1996 to 1999. Based on the median of model-to-monitor ratios, our findings indicate there is moderate agreement between modeled and monitored levels of annual ambient air

HAP levels with 59% of the median of ratios falling between 0.5 and 2. Generally, there was better agreement between modeled and monitored estimates for the 1999 ASPEN data as compared to 1996.

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**ISEE-S09-02****Assessing the Variability in Daily and Time-Averaged Exposure to Ambient PM: Results from Exposure Assessment Panel Studies in Four U.S. Cities**

Sarnat JA,\* Brown KW,† Bartell S,‡ Sarnat SE,\* Wheeler A,§ Suh HH,† and Koutrakis P,† \*Emory University, Department of Environmental and Occupational Health, Atlanta, GA, USA; †Harvard University, Department of Environmental Health, Boston, MA, USA; ‡University of California, Irvine, School of Medicine, Irvine, CA, USA; and §Health Canada, Ottawa, ON, Canada.

**Abstract:** Exposure assessment panel studies have investigated the relationships between ambient fine particulate matter ( $PM_{2.5}$ ) concentrations measured at central sites and corresponding personal  $PM_{2.5}$  exposures with the goal of evaluating the validity of the methods used in PM epidemiologic studies. These associations may exhibit considerable variability, suggesting that personal exposures to ambient  $PM_{2.5}$  may differ considerably for a given ambient  $PM_{2.5}$  concentration. Previous exposure assessment panel studies have generally shown strong day-to-day correlations between ambient  $PM_{2.5}$  and corresponding personal exposures to ambient  $PM_{2.5}$  exist, despite differences in the actual levels of amount of ambient  $PM_{2.5}$  to which individuals are exposed. Strong day-to-day correlations are the basis for the observation that time-series studies examining the longitudinal correlations between  $PM_{2.5}$  levels and adverse health are unbiased. For chronic health effects studies, average  $PM_{2.5}$  levels measured at central monitoring sites that differ substantially from true population averages may introduce bias into observed risk estimates if the personal-ambient relationship varies by city or geographic locale within a city. Despite the potential impact of this source of exposure error, the degree to which ambient  $PM_{2.5}$  contributes to personal exposures and how this factor varies is still poorly understood. The current presentation examines differences between measured ambient, indoor and personal particulate sulfate ( $SO_4^{2-}$ ) with the goal of understanding the impact of these differences on ambient PM contributions to personal exposures.  $SO_4^{2-}$  was used as a surrogate of ambient  $PM_{2.5}$ , since it exhibits infiltration behavior similar to other stable, ambient  $PM_{2.5}$  components in the accumulation mode. Data will be presented from four large studies conducted in Atlanta, Baltimore, Boston and Steubenville, OH. Questions concerning day-to-day, within-subject variability in exposure to ambient particles, the relative degree of within-versus between-subject variability in ambient contribution to personal exposure, and the implications of this variability on epidemiologic health effect estimates will be addressed.

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**ISEE-S09-03****Measurement and Modelling of Exposure to Air Toxic Concentrations for Health Effect Studies and Verification by Biomarker (MATCH Study)**

Saborit JMD,\* Aquilina N,\* Baker S,\* Meddings C,\* Harrad S,\* Matthews I,† Anderson R,‡ Vardoulakis S,§ and Harrison RM,\* \*Division of Environmental Health and Risk Management, School of Geography, Earth & Environmental Sciences, University of Birmingham, Birmingham, United Kingdom; †Department of Epidemiology, Statistics and Public Health, Cardiff University, Wales College of Medicine, Cardiff, United Kingdom; ‡Department of Community Health Sciences, St George's Hospital Medical School, London, United Kingdom; and §Public and Environmental Health Research Unit, London School of Hygiene and Tropical Medicine, London, United Kingdom.

**Abstract:** The overall aim of the MATCH study was to quantify the magnitude and range of individual personal exposures to a range of air toxics and to develop models for exposure prediction based upon time/activity diaries.

Personal exposures of volunteer subjects living in a wide range of residential environments were measured for air toxics including volatile organic compounds and polycyclic aromatic hydrocarbons. Samples of urine were also collected from the volunteers for analysis of biomarker concentrations. The volunteer subjects kept detailed time-activity diaries and information was also collected on the characteristics of their homes and workplaces. In parallel with personal exposure measurements, a substantial programme of measurements of the same air toxics was carried out in microenvironments relevant to the subjects. These included homes, workplaces, streets, vehicles, transport stations and various public indoor environments.

The variability of VOC and PAH personal exposure concentrations mainly reflects the range of activities the subjects engaged in during the sampling period, as well as the variability in ambient and indoor levels. The home microenvironment is the dominant individual contributor to personal exposure. Furthermore, personal exposure concentration remains consistently higher during days of the week associated with increased vehicle use and ETS exposure. Regarding microenvironment concentrations, indoor microenvironments generally show higher concentrations than outdoor microenvironments. The highest concentrations for both VOC and PAH are recorded in those microenvironments with ETS events. Outdoor and in-vehicle microenvironment concentrations reflect the effect of traffic.

A model based upon the microenvironment concentration data, together with factors designed to account for exposures not easily estimated through the microenvironment data has been constructed and explains a high proportion of the variance in the personal exposure data. This has been tested against an independent set of personal exposures which has confirmed the value of the model in accounting for measured exposures, giving confidence that a combination of microenvironment data and time-activity diaries can form the basis for classification of personal exposure within epidemiological studies.

#### ISEE-S10

##### Insulating Environmental Health Research from Conflicting Interests

**Abstract:** Financial interests impact the workings of many aspects of our public health system and these are often in conflict with the public health interest. Increasingly, editors of the leading biomedical journals are requiring disclosure of potential conflicts of interest; several leading journals will only publish papers in which the authors have the unfettered right to publish the results. Many governmental organizations that rely on panels of expert scientists for advice attempt to "manage" the pernicious effects of conflicting interests through disclosure and membership balance. Recently, the International Agency for Research on Cancer has successfully implemented a policy in which conflicted scientists cannot serve as members of their monograph. Similarly, the US Food and Drug Administration is now enacting policies barring many conflicted scientists from serving on advisory panels. In this session, we will examine the consequences of financial conflicts of interest and their effect on research integrity, the composition and conduct of expert panels and advisory committees, and on regulatory decision-making.

#### ISEE-S10-01

##### Doubt is Their Product: Public Health and Manufactured Uncertainty

Michaels D, George Washington University School Public Health, Washington, DC, USA.

**Abstract:** The title of this talk comes from a tobacco executive's memo: "Doubt is our product since it is the best means of competing with the

'body of fact' that exists in the minds of the general public. It is also the means of establishing a controversy." Although, Big Tobacco manufactured more uncertainty over a longer period and more effectively than any other industry, the strategy of "manufacturing uncertainty" has been used with great success by numerous polluters and manufacturers of dangerous products to oppose public health and environmental regulation. It is central to the debate on global warming, and arises often in considering the safety of drugs and medical devices, and of consumer products. The approach is now so common that it is unusual for the science not to be challenged by an industry facing increased regulation. Manufacturing uncertainty has become a business in itself; numerous technical consulting firms advertise "product defense" or "litigation support." The firms, and the scientists who own and operate them, sell not just their scientific expertise, but their knowledge of and access to regulatory agencies. The financial success of these firms depends on their ability to assist their clients avoid increased regulation. Not surprisingly, it is rare for these firms to produce a study whose results conflict with the needs of the study sponsor. It follows that these scientists' financial conflicts of interest are so severe that they should be barred from serving on federal science advisory panels that inform public health policy.

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#### ISEE-S10-02

##### Corruption of the Research Process

Soskolne CL, University of Alberta, Edmonton, AB, Canada.

**Abstract:** There is an implicit public trust in the integrity of the scientific enterprise, especially in protecting the public interest. However, corruption of the research process has been demonstrated to have become almost systemic. Biased interpretation for the purpose of protecting vested interests has been shown by the way funding is channeled.

The public trust expectation provides the motivation for science to be both publicly accountable and self-regulating. Peer review, training, mentoring, and institutional support are all intended to ensure integrity in science, guarding against conscious or subconscious bias. And, when the integrity of the scientist is negatively influenced, the integrity of that scientist's research must be questioned.

Bias can arise where conflicting interests exist. Depending on the circumstances, it arises through the conscious or subconscious pressure felt by the researcher from vested interests. Any bias, consciously or subconsciously driven, must be exposed if science is to remain objective. The former derives from external pressure (explicit or implicit) that can influence objectivity. The natural predisposition to please one's sponsor can result in bias, from the nature of the question being pursued, through the design, conduct, interpretation, reporting and dissemination of a study's findings.

Interest groups can hire consultant epidemiologists to support a particular argument. Such consultants have been labeled as being in the pocket of the interest group that has employed their services, causing potential harm to the work they have critiqued, and also to the public interest when science is derailed in the process. Tobacco is one example where a global industry has been shown to have worked tirelessly to make prostitutes of scientists who conduct biased research in support of the industry's relentless pursuit of greater markets. The intent behind such work is to protect the short-term business interests of the particular industry, or of an interest group's goals. By casting doubt on research, business-as-usual is able to be maintained.

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#### ISEE-S10-03

##### What the History of Epidemiology and Toxicology Teaches Us About Ethics

Davis DL, University of Pittsburgh Cancer Institute, Center for Environmental Oncology, Pittsburgh, PA, USA.

**Abstract:** The evolution of epidemiology cannot easily be separated from the social and economic controversies about tobacco, asbestos, and other toxic hazards. Toxicological evidence and clinical case reports on the risks of tobacco and other toxic hazards were relegated to a secondary status as the field of epidemiology evolved. The funding for epidemiological research often came directly and indirectly from affected industries. This has created some ethical paradoxes and challenges that will be discussed as part of this symposium, extending analyses found in *The Secret History of the War on Cancer* in original archival documents.

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**ISEE-S10-04****Poisoned Profits**

Shabecoff A, *Greater Boston Physicians for Social Responsibility, Brookline, MA, USA.*

**Abstract:** As climate change imperils the earth, so too the toxification of the environment threatens the future of its human inhabitants. The harm has begun to show up.

As we dump 42 billion pounds of synthetic chemicals into our lives every single day in the U.S., we maim and sometimes kill our children. Half of all pregnancies now result in a prenatal or postnatal death or a less than healthy child, according to the National Academy of Sciences. Of the country's 73 million children, about one-third suffer from chronic diseases such as cancer, asthma, birth defects and neurological problems. Americans face increasing difficulty conceiving.

We have gathered evidence linking the explosion of environmental toxicants after World War II, when our nation began its experiment with 'Better Living through Chemistry,' to the rise in childhood disease and infertility over the same decades. We understand that the science is considered still controversial (perhaps lending heightened interest in our presentation). Our investigation reveals the reasons why the controversy exists. We discuss corporations that knowingly pollute and then sabotage investigations. The way science has often been co-opted to serve as witnesses for polluters, and how 'proof' has been made unattainable. A government that subverts objective science, and legislators who, in proportion to their campaign contributions, craft lax legislation. The lack of testing requirements for chemicals. And a public relations industry that distracts and obfuscates.

If time permits, we will offer stories of communities across the country: of Dickson, Tennessee, where babies were born with cleft lips and palates after landfill chemicals seeped into the water; and Port Neches, Texas, where so many graduates of a high school near a petrochemical plant contracted cancer that it was nicknamed "Leukemia High." We would also welcome the opportunity to discuss solutions. Our presentation flows from journalistic research that took us a cumulative ten years. Our investigation was funded by the Ford, Heinz Family and other foundations, sponsored by Greater Boston Physicians for Social Responsibility, and guided by some of the nation's leading environmental health scientists. It has culminated in a book, *Poisoned Profits*, which Random House will publish in mid-2008.

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**ISEE-S10-05****The Contamination of Scientific Advisory Committees: A Case Study of Industry Influence on the Prevention of Childhood Lead Poisoning**

Lanphear B, *Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA.*

**Abstract:** Environmental lead exposure is among the most thoroughly studied and widely recognized environmental toxicants in humans. Despite considerable evidence that lead is toxic at blood lead levels below 10 µg/dL—the existing level of concern—the CDC elected not to lower it. The advisory committee cited three reasons for not lowering the level of concern: there is no evidence that *clinical* interventions will result in

reduced blood lead levels in children; the accuracy of blood lead assays are insufficient to reliably measure blood lead levels below 10 µg/dL and, because there is no evidence of a threshold, any downward revision of the level of concern would be arbitrary and of uncertain benefit. The role of the lead industry in altering the composition of the CDC Lead Advisory Committee and the resultant impact on environmental health policy is largely unrecognized. This case study will summarize the epidemiologic data implicating low-level lead exposure in IQ deficits and behavioral problems, the dismissal of CDC officials' nominees with experience in the epidemiology of childhood lead exposure, and the unprecedented approval of industry-nominated persons who had limited experience or clear conflicts of interest with the charge of the Committee. Key examples of the impact of the CDC's recommendations for environmental health policy will be described. The presentation will conclude with discussion about steps to ensure that future scientific advisory committees' will be able to objectively evaluate scientific evidence and make recommendations necessary to protect public health.

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**ISEE-S11****Factors Controlling the Absorption of Arsenic from Soil: Emerging Research, Policy, and Data Gaps**

Requirements for site remediation are frequently based on the potential for contaminants in soil to pose unacceptable health risks following human exposures. It is becoming widely recognized by the international research and regulatory community that site-specific factors may control the bioavailability of chemicals in soil and dust, and therefore adjustments to account for reduced absorption relative to chemicals in other media (e.g., water, food, or dosing media used in research) are becoming more accepted in risk assessment. Both animal models and in vitro bioaccessibility models have been used to estimate relative bioavailability of metals in soil and dust. Although animal models are often held out as the "gold standard," the financial requirements and timeframe for animal testing, as well as ethical issues surrounding the use of animals in research, may preclude wider application of such testing. Routine application of the bioaccessibility models in regulatory settings is being held up by different perceptions of what is required of these models in terms of validation. ISEA 2006 and 2007 provided opportunities for international experts to exchange their research and views on adjustments for relative bioavailability/bioaccessibility, and their application in risk assessments of residential environments and contaminated sites. In 2008, the symposium will build on this base, and the presentations and panel discussions will explore relevant questions, such as:

- At what point is the research database sufficient to support a default value for relative oral bioavailability lower than 100%?
- At what point is an in vivo research database adequate to support validation of in vitro methods?
- What is required to "validate" an in vitro method and how should data from methods not yet validated be treated in risk assessments?
- Does soil chemistry and/or mineralogy provide an adequate characterization of the controls on bioavailability so as to be predictive of RBA?

This symposium will focus on arsenic, summarizing the existing data regarding relative oral bioavailability of arsenic from soils, what is known regarding the geochemical controls on arsenic solubility, scientific and policy issues associated with regulatory approval of site-specific adjustments to arsenic bioavailability, and panel members will be tasked with identifying data gaps that limit broader application of bioavailability adjustments in risk assessment of arsenic in soil.

**ISEE-S11-01****In Vivo Database on the Relative Oral Bioavailability of Arsenic from Soils: What We Know Now**Lowney YW, *Exponent, Boulder, CO, USA.*

**Abstract:** It has long been theorized that soil-specific or other site-specific factors could control the solubility of arsenic from soils, such that total arsenic concentrations in soil do not provide a good estimate of the amount of arsenic that can be liberated from the soil under the physiological conditions of the gastrointestinal tract. Research in several species of laboratory animals now confirms that the oral bioavailability of arsenic in soil is reduced relative to soluble forms of arsenic. This presentation will provide a summary of the existing *in vivo* database regarding the relative oral bioavailability of arsenic from soils, discussing the nature of the animal models, the soil substrates researched to date, and results. No new research will be provided in this presentation. Rather this discussion is intended to provide a synthesis of existing information, which can then serve as a basis for identifying broad conclusions that might be drawn from the compiled database, and identifying data gaps for future research.

**ISEE-S11-02****A Calibrated-Validated In Vitro Method for Arsenic: What's been done—Where are we—what's Next?**

Drexler JW,\* Lowney YW,† and Griffen S,‡ \*Department of Geological Sciences, University of Colorado, Boulder, CO, USA; †Exponent, Boulder, CO, USA; and ‡U.S. EPA Region VIII, Denver, CO, USA.

**Abstract:** The incidental ingestion of contaminated media (soils, dust, process waste, or sediments) can be the most significant pathway of exposure by humans. However, even though an exposure pathway is established, uptake of ingested contaminants may be limited as a result of social, biological, or physicochemical factors. These chemical and physical properties may influence (usually decrease) the absorption (i.e. bioavailability) of the contaminants when ingested in soil. Thus, equal ingested doses of different forms of contaminants in various media may not be of equal health concern. Therefore, an accurate estimate of bioavailability, prior to the evaluation of potential human health risk is essential. Results from traditional animal models are often the defining factor, however, their use is time consuming and costly. Arsenic concentrations have been found at various sites across the country in concentrations ranging from <100 mg/kg to over 10,000 mg/kg. Typical sources for elevated arsenic concentrations have been shown to be pesticides/herbicides, CCA treated products, tanning pits, and mining/milling/smelting operations. Currently, the validity and reliability of a risk assessment is often limited by the absence of site-specific data on the physicochemical and environmental processes that may be a determinant of arsenic bioaccessibility/ bioavailability. These data may improve the accuracy of an exposure assessment and therefore a more reliable evaluation of the potential risk.

To date no *in vitro* method has been shown to routinely predict *in vivo* arsenic bioavailability across a diversity of soil types. This presentation will discuss the current status of our *in vitro* method for arsenic and its *in vitro/in vivo* correlation (IVIVC) to more than 30 soils tested in swine or primates. We will characterize apparent controls to *in vitro* bioaccessibility; pH, particle-size, speciation, and arsenic solubility, along with some new insight into the important role iron may play. We will review a number of other *in vitro* methods with an emphasis on improving IVIVC.

Finally, we will present our views and invite input on future research needs to establish a well characterized/validated *in vitro* method for arsenic that can be utilized with much greater confidence and reliability for risk assessment than is presently available.

**ISEE-S11-03****Soil Chemical Controls on Arsenic Bioaccessibility and Bioavailability**

Basta NT,\* Scheckel KG,† Bradham KD,‡ Richey JS,\* Dayton EA,\* Whitacre SW,\* and Casteel SW,§ \*Ohio State University, Columbus, OH, USA; †U.S. EPA NRMRL, Cincinnati, OH, USA; ‡U.S. EPA NERL, Research Triangle Park, NC, USA; and §University of Missouri, Columbia, MO, USA.

**Abstract:** Soil chemical extraction methods and spectroscopic methods are able to characterize various pools and species of arsenic in soil. Use of these methods to estimate bioavailable is desirable to support characterization of arsenic contaminated soil but their ability to measure oral bioaccessibility and oral bioavailability of arsenic is unknown. We will present findings showing relationships between the use of soil chemical and spectroscopic methods to characterize arsenic bioavailability in contaminated soils. Limitations of these methods will be discussed. Results from several studies will be summarized that feature soils that vary in contaminant source, contaminant concentration and soil matrix properties. The presentation will explore the highly relevant question of the "Factors controlling the absorption of chemicals from soil" symposium "Does soil chemistry and/or mineralogy provide an adequate characterization of the controls on bioavailability so as to be predictive of RBA"?

**ISEE-S11-04****Update on Bioaccessibility Testing of Inorganic Elements: Comparison of Methods and Reproducibility**

Reimer KJ, Royal Military College of Canada, Kingston, ON, Canada.

**Abstract:** A strong need has been recognized in Canada for a review and comparison of soil bioaccessibility methods which have been developed independently over the years and are being used by Canadian laboratories for risk assessment purposes. A mostly Canadian research consortium (Bioaccessibility Research Canada-BARC), which also includes international participation, is conducting an initial round robin study that will compare soil bioaccessibility data using a commonly sourced material. The primary objective of this initiative is to advance the science of soil bioaccessibility in Canada and improve confidence in the use of bioaccessibility data for human health risk assessment.

Specifically, reproducibility within and between methods is being compared. Sixteen groups are involved: eight of them are university groups, four are government groups, and the remaining four are consulting/commercial laboratories. Five non-Canadian groups from the US, UK and Netherlands are participating. The round robin experiment encompasses 19 methods with some similarities between methods. Each laboratory conducted bioaccessibility testing on 5 replicates of NIST 2710, a standard reference soil that is contaminated with lead, arsenic and zinc, among other elements. Additionally, each lab conducted testing on 3 spiked blanks and 3 blanks. All extracts were analyzed at a commercial lab as well as at each participating lab. An update on the experiment, including measures of reproducibility between replicates within a lab, and between results from the commercial and participating labs, will be presented. Additionally, any similarities between methods and associated results will be addressed.

**ISEE-S11-05****Use of Bioavailability Information in Site-Specific Risk Assessment**

Beringer M,\* and Yeow A,† \*U.S. EPA, Kansas City, KS, USA; and †U.S. EPA, Washington, DC, USA.

**Abstract:** Site-specific human health risk assessments are used to determine whether a contaminated site poses a current or future threat to human health that warrants remedial action. Incidental ingestion of soil is

typically the most important exposure pathway and bioavailability is a critical factor in determining the uptake of ingested soil-borne contaminants. U.S. EPA's "Risk Assessment Guidance for Superfund" supports the consideration of bioavailability in site-specific risk assessments; however, the use of bioavailability information has not been widespread due to a variety of factors, including limited data, uncertain methodologies, and the lack of validated methods. Another significant impediment to the broad use of bioavailability information in risk assessment and decision-making is the absence of rapid and inexpensive tools that can generate reliable bioavailability estimates in the receptors of concern. There has been a considerable effort over the last several years directed at developing validated laboratory methods (e.g., *in vitro* bioaccessibility tests) for estimating bioavailability of soil-borne lead, arsenic, and other metals. The availability of new methods has reinforced the need for additional U.S. EPA guidance on evaluating alternative bioavailability methods and incorporating this information into site-specific risk assessments. In July 2007, U.S. EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) issued additional guidance that, in part, provides general criteria the Agency normally will use to evaluate whether a specific bioavailability method has been validated for regulatory risk assessment purposes. U.S. EPA has used these criteria to evaluate an *in vitro* bioaccessibility assay for predicting the relative bioavailability of lead in soil and soil-like materials and determined the validation criteria have been sufficiently satisfied. Thus, U.S. EPA considers this particular *in vitro* bioaccessibility assay a validated methodology that is generally appropriate for estimating the relative bioavailability of lead in site-specific risk assessments. This presentation will discuss in greater detail the method validation and regulatory acceptance criteria outlined in U.S. EPA's bioavailability guidance document, as well as how these criteria apply to evaluating alternative bioavailability methods (e.g., *in vitro* bioaccessibility tests).

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#### ISEE-S11-06

#### What Regulators Look for in Adopting New Science into Regulatory Policy—the Case of Risk Assessment and Bioavailability/Bioaccessibility of Contaminants in Soil

Richardson M, *Risklogic Scientific Services Inc., Ottawa, ON, Canada.*

**Abstract:** Risk assessment is now perhaps the most common 'tool' used by environmental regulatory agencies to make decisions about environmental risks and risk management/remediation. However, risk assessment is not an exact science, and is driven as much by policy as it is by scientific investigation and analysis. Policy development by regulatory agencies, as a whole, follows scientific advancement rather than precedes it. This is understandable, given the desire to establish public policy (or policies that affect the health and safety of the public) on known rather than speculative science. However, once that science exists, regulatory agencies continue to suffer major problems in overcoming the inertia of past practice. Even when good science exists, regulators tend to adhere to the comfort of accepted past practice owing to the fact that "it has worked in the past and, therefore, will work in the future". An additional factor—the Precautionary Principle—also deters the adoption of new, refined or "better" science if that science suggests that less conservatism (rather than more) is appropriate. These problems are currently affecting the application of bioavailability/bioaccessibility considerations in the risk assessment of contaminated soil. The proposed talk will present a variety of assumptions and factors commonly employed in contaminated site risk assessment and compare the relative levels of uncertainty and conservatism offered by past practice versus that presented by the relatively new consideration of bioaccessibility of contaminants in soil. Examples will also be presented of the application of bioaccessibility adjustments by Canadian regulatory agencies, and finish with a discussion of the data requirements suggested by Health Canada as

being sufficient to support the application of bioaccessibility adjustments to contaminated site risk assessments in Canada.

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#### ISEE-S11-07

#### A Lines of Evidence Approach to the Assessment of the Bioaccessibility as in Soils in the UK

Cave M, Palumbo-Roe B, Klinck B, and Wragg J, *British Geological Survey, Nottingham, United Kingdom.*

**Abstract:** In the UK up to a third of the country exceeds the the UK soil guideline value of 20 mg/kg and areas such as the South West (Devon and Cornwall) the background values exceed 100 mg/kg. This presentation will put forward our approach which uses a combination of contaminant mapping, in-vitro bioaccessibility tests and geochemical characterisation including sequential leaching, in combination with spatial modelling of the potential hazard. We are trying to develop a 'lines of evidence' approach which allows us to build confidence on our risk assesment by using these different sources of information. This helps us to answer the questions relating to the magnitude of the potential hazard and why and how the hazard exists.

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#### ISEE-S12

#### Characterizing Global Exposures to Persistent Organic Pollutants (POPs): The Role of Models

**Abstract:** Many pesticides, combustion products, and chemicals in commerce are persistent organic pollutants (POPs) and subject to long-range environmental transport (LRT). These attributes give rise to pollutants that are distributed across regional, continental or even global scales and result in exposures and health impacts far from the point of emissions. There are both national and global conventions to identify and prioritize persistent pollutants. Of particular importance are United Nations Economic Commission for Europe (UNECE) long-range-transport protocol on Persistent Organic Pollutants (POPs), and the United Nations Environment Program (UNEP) Stockholm Convention on POPs. The criteria for evaluating Persistence (P), Bioaccumulation (B), and Toxicity (T) characteristics of substances under the various regulations are not harmonized, but nevertheless show large similarities. There are a number of important scientific and regulatory questions in this emerging area of concern. What can we learn from monitoring these POPs in air, water, soils, sediments and biota? How best can experimental and monitoring programs be integrated with models to characterize the significance of POPs? What are the existing and emerging modeling approaches that can help identify POPs, particularly those with LRT potential? What new or existing methods can be used to map source-to-dose relationships on the spatial scale matching the reach of any specific POP? This symposium will bring together a coordinated set of papers to explore these questions. There will be three paper presentations and a panel discussion.

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#### ISEE-S12-01

#### Tracking the Sources, Transport, and Fate of Persistent Pollutants at Regional, Continental, and Global Scales

MacLeod MJ,\* Arnot J,† McLachlan M,‡ and Wania F,§ \*Swiss Federal Institute of Technology, Zurich, Switzerland; †Trent University, Peterborough, ON, Canada; ‡Stockholm University, Stockholm, Sweden; and §University of Toronto, Scarborough, ON, Canada.

**Abstract:** This talk will address the modeling and experimental evidence for long range transport of persistent organic contaminants with an emphasis on the availability and credibility of models for addressing POPs. It will describe the use of models to explain historical and current patterns of environmental distribution of persistent pollutants, and the role of models as tools to identify unrecognized current and future problems.

Different modeling approaches will be compared and evaluated, with consideration given to the reliability and insight from models at different levels of complexity. Finally there will be discussion of how monitoring data can be combined with models to evaluate our understanding of the source-to-environmental concentration relationship for persistent pollutants, and to characterize source and receptor regions for POPs.

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**ISEE-S12-02**
**Characterizing Source-to-Dose Relationships for Persistent Pollutants**

McKone TE,\* Arnot J,† Sohn M,\* and Vallero D,‡ \*Lawrence Berkeley National Laboratory, Berkeley, CA, USA; †Trent University, Peterborough, ON, Canada; and ‡U.S. EPA, Research Triangle Park, NC, USA.

**Abstract:** POPs typically enter the human population through food—particularly foods with high lipid content such as meat, dairy products, fish, and foods derived from plant oils. Exposed populations are often far from the emissions source and the exposure pathways are complex. In this talk we will consider the use of environmental monitoring data, biomonitoring data, and models to identify and characterize POPs exposures for vulnerable populations. There will be a strong focus on transport and bioaccumulation through agricultural food webs and fisheries.

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**ISEE-S12-03**
**The Role of Models in an International Framework for Characterizing Persistence, Long-Range Transport and Exposure for POPs**

Cowan-Ellsberry C,\* McLachlan M,† MacLeod M,‡ and Arnot J,§ \*Procter & Gamble Company, Cincinnati, OH, USA; †Stockholm University, Stockholm, Sweden; ‡ETH, Zurich, Switzerland; and §Trent University, Peterborough, ON, Canada.

**Abstract:** Current national, regional and international regulations such as the Stockholm Protocol have defined processes for identifying candidate POP compounds using fairly strict criteria. These criteria were based on the state of the science in the late 1970s and early 1980s. A January 2008 Society of Environmental Toxicology and Chemistry (SETAC) Pellston workshop brought together scientists, regulators and industry scientists to discuss current criteria used under the UN Stockholm Protocol and other related PBT/POPs regulations and how these could be updated using current understanding. One working group within the workshop focused on how fate and exposure models can be used more effectively within the PBT and POPs identification process. Long-range transport from the site of emission to remote regions is a criterion that is used in the first stage of the POPs review process. Fate models that predict the potential for long-range transport are now used in this first stage. The second stage in POPs review includes evaluation of significant adverse effects. Fate and exposure models are not currently used in this evaluation. However, they can be very valuable. For example, these models can be used to estimate exposure concentrations in the environment and in biota including humans when fate, exposure and bioaccumulation models are linked. These exposure concentrations can either be calculated directly if the emission patterns and amounts are known or can be estimated by benchmarking the chemical to known POPs or PBT chemicals. Also these linked models can be used to identify those fate processes and chemical properties that most directly influence the exposures so that additional research can be targeted, if needed, to more accurately characterize them. This presentation will describe the various stages in the identification of POPs and PBTs and show specific examples of when these types of models can be used to gain greater understanding of POPs and PBT fate and exposure to inform regulatory decisions. This presentation will also briefly describe how to choose models for these types of assessments and to evaluate the final exposure assessment.

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**ISEE-S13**
**Advances and Challenges in Long-term Air Pollution Cohort Studies**

**Background:** Long-term exposure to air pollution has been associated with increased mortality and morbidity in cohort studies conducted in the United States. However, some studies have not been able to replicate others' findings or have argued that air pollution exposures in the more distant past were related to mortality but not so in more recent years. Exposure misclassification is a continuing major concern for inconsistent findings. Although exposure assignment in recent studies have progressed from central-site based measurements to spatial interpolation from numerous monitoring stations within an area, information is still lacking for within-city contrasts of long-term air pollution exposure and health endpoints. Recent advances in long-term air pollution epidemiological studies include the continuing follow-up of pre-existing cohorts for air pollution studies, with the addition of sensitive sub-clinical health endpoints and improved exposure estimates linking to individual subjects or their residences. Other cohorts not previously established for air pollution studies were utilized for assessment of air pollution effects, taking advantages of some retrospective exposure modeling techniques or recent advances in particle composition and source apportionment results. With insufficient and inconsistent findings of long-term health effects and regulatory dilemmas for particulate matter (PM), recent advances in exposure assessment to PM sources, PM components, and different size ranges of PM should be reviewed to greatly improve our knowledge of PM effects. Medical advances have also made possible sensitive sub-clinical health endpoints to be examined on a large scale. Meanwhile, more attention is being paid to compiling long-term cohorts across diverse populations. **Objectives:** This symposium will address issues and current knowledge regarding challenges involving with cohort maintenance, applications of advanced techniques in exposure assessment and health assessment, study design issues, and comparisons of health outcomes across diverse cohorts in the U.S. and Europe. **Format:** This symposium will involve four presentations of recent findings and advances from studies of major long-term air pollution cohorts in the U.S. and Europe. Each presentation will conclude with a list of challenges and provide provocative issues that involve at least one or more other studies also presented in other sessions of the conference for discussion. We then open floor for interactive panel and audience discussion. The panel includes the four speakers and two additional experts (Doug Dockery and Jim Gauderman). The chairs will provide a summary statement for state of the art, insights, and future directions.

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**ISEE-S13-01**
**Air Pollution Studies Using the Harvard Six-Cities and the ACS Cohorts: What we have Learned and what we Still Don't Know**

Pope C III, Brigham Young University, Provo, UT, USA.

**Abstract:** The Harvard Six-Cities and ACS prospective cohort studies have contributed much to our understanding of the mortality effects of chronic exposure to air pollution. Since the reporting of the original analyses in the mid-1990s, there have been various reanalyses and extended analyses. This presentation will outline the history of these studies and briefly review how their results suggest the following six conclusions: 1) Long-term exposures to air pollution, especially fine particulate matter (PM) and sulfur oxide-related pollution, are significantly associated with elevated risk of mortality. 2) Long-term exposures to fine PM pollution have larger, more persistent cumulative effects than short-term transient exposures. 3) Fine PM is associated with cardiopulmonary mortality generally, but most strongly associated with mortality attributable to ischemic heart disease, dysrhythmias, heart failure, cardiac arrest, and lung cancer. 4) In addition to cross-metropolitan area variability in long-term exposure, intra urban exposure gradients contribute to elevated mortality risks. 5) The shape of the concentration-

response function across the observed range of exposure is near linear or log-linear without a discernable threshold. 6) Reductions in fine PM exposures are associated with reductions in mortality risk and, for cardiopulmonary deaths (excluding lung cancer), mortality effects are at least partially reversible within a time frame of just a few years. Uncertainties regarding these conclusions and various unanswered questions regarding the health effects of long-term air pollution exposure will also be discussed.

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**ISEE-S13-02****Advances and Challenges in the Swiss Long-term Air Pollution Cohort Study (SAPALDIA)**

Liu, LJS, *University of Basel, Basel, Switzerland*.

**Abstract:** SAPALDIA (Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults) is a multi-center study started in 8 areas representing the range of environmental, meteorological and socio-demographic conditions in Switzerland. It was initiated in 1991 with 9651 subjects, aged 18 to 60 years, recruited for a detailed interview and more than 90% of them underwent spirometry and atopy tests. A follow-up assessment was performed in 2002 in which 8047 participants provided health information, 6528 underwent lung function tests, 6345 participants provided blood samples, and 1813 subjects aged 50 and older participated in 24h-ECG monitoring. Major exposure assessment includes a dispersion model for predicting individual exposure to total and source-specific PM<sub>10</sub> and land-use regression models for predicting individual exposure to traffic-related NO<sub>2</sub> over the 11 years of follow up. Major health findings include: 1. For the first time in a longitudinal study, we demonstrated that gradual decreases in outdoor air pollution were associated with an attenuated age-related decline in lung function and with decreases in respiratory symptoms in adults. 2. We found associations between long-term exposure to traffic related NO<sub>2</sub> and cardiac autonomic dysfunction in women and in subjects with cardiovascular disease of the general population. 3. We confirmed hypothesized associations of single nucleotide polymorphisms with the long term evolution of lung function parameters and respiratory health in the Swiss population. We are exploring further associations including environmental factors, in particular outdoor and indoor air pollution. In addition, the SAPALDIA cohort represents a unique opportunity to study a wide range of other determinants of respiratory and cardio-vascular health in the Swiss population, including second-hand smoke and the interaction between obesity, cardiac and respiratory parameters at the population level. Challenges in long-term air pollution cohort studies include selection bias due to loss of follow-up, maintaining the address database of the participants, evolving techniques for health and exposure measures, assessing exposure in different environments, research issues regarding gene-environment interactions, and modifications of socio-economic and gender factors in health effects.

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**ISEE-S13-03****The Multi-Ethnic Study of Atherosclerosis and Air Pollution: An Update**

Kaufman J, *University of Washington, Seattle, WA, USA*.

**Abstract:** The "MESA Air" study is a major new multi-center prospective U.S. cohort study, with detailed individual-level air pollution exposure estimation, health and covariate assessment in a multi-ethnic cohort, launched in 2004. By leveraging the investment of the NIH/NHLBI in the Multi-Ethnic Study of Atherosclerosis (MESA) cohort (which began in 1999) and adding exposure assessment activities, new subjects to enhance exposure heterogeneity, and additional health testing, the EPA-funded MESA Air project will allow a prospective assessment of whether air pollution accelerates atherosclerosis and the occurrence of clinical cardiovascular disease. The study employs sophisticated measures of

atherosclerosis progression (coronary artery and aortic calcification, carotid wall intima-media thickness), and detailed assessment of clinical and subclinical cardiovascular disease. It also provides a platform for a wide variety of special studies. While the main MESA Air study characterizes PM<sub>2.5</sub>, traffic and regional pollution, ancillary studies will allow us to explore health effects by source type and particle size. Additional ancillary studies are planned assessing gene-environment interactions in the cohort, and assessing whether state-of-the-art air quality modeling techniques further informs this research. MESA Air has several advantages that should provide important new information on the relation between long-term exposure to air pollution and cardiovascular diseases, though the multi-city organization poses challenges as well. This presentation will discuss the progress to date, early results, and opportunities for additional collaborations.

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**ISEE-S13-04****Design of a Multi-cohort Study of Air Pollution Effects in Europe: The ESCAPE Study**

Brunekreef B, *Universiteit Utrecht, Utrecht, Netherlands*.

**Abstract:** Current European assessments of the long-term health impact of air pollution are largely based on non-European epidemiological studies. ESCAPE is a collaboration of European cohort studies for quantification of effects of long-term exposure to outdoor air pollution on human health. Several new hypotheses regarding specific health effects of air pollution have been formulated in recent years, and the ESCAPE project will test the most important of these. Last, the ESCAPE project will largely focus on effects of within-city contrasts in air pollution. Methods to do this have been largely pioneered in Europe in the last decade, and the project will be at the methodological cutting edge worldwide for this. ESCAPE will develop a single methodology for assessing within-city or within-area contrasts in long-term average concentrations of airborne particulate matter and nitrogen oxides. Airborne particulate matter will be characterized as PM<sub>10</sub> and PM<sub>2.5</sub> particles as well as 'soot' and elemental composition. Both NO and NO<sub>2</sub> will be measured in view of changing NO/NO<sub>2</sub> ratios in primary traffic emissions which may affect compliance with the European legislation with respect to NO<sub>2</sub> which will come into force in 2010. ESCAPE is organised into four main categories of cohort studies. One category is pregnancy outcomes and birth cohort studies. The second is on respiratory disease outcomes in adults. The third is on cardiovascular disease outcomes in adults. And the final is cohort studies on cancer incidence and cause specific mortality. It includes some 30 major European multicenter studies contributing to at least one of the aforementioned categories. Within each of the four main categories of studies, four or five study hypotheses have been formulated which the ESCAPE project will seek to address. In addition, investigators contributing cohorts to the ESCAPE study are encouraged to use the air pollution exposure data generated by the project to produce single-study papers which will be able to address additional hypotheses and/or local study questions in more detail.

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**ISEE-S14****Epigenomic Changes Related to Environmental Exposures in Children**

**Abstract:** A substantial amount of research effort has been directed to understanding how variants in the DNA sequence influence susceptibility to environmental stressors. Recently, increasing attention has been focused on the disease pathogenesis contribution of epigenetic changes i.e. those that result in stably maintained changes in gene transcription without changes in DNA sequence. A rapidly emerging body of evidence indicates that epigenetic changes in response to environmental exposures can have long lasting effects on intermediate biomarkers and disease occurrence. This symposium would provide an integrated summary of new

studies of the relationship between the environment and epigenetics in children conducted by investigators from the Children's Environmental Health Centers: Introduction to Environmental Epigenetics, Allen Yang MD, Norris Comprehensive Cancer, Keck School of Medicine, University of Southern California; Epigenetic Alterations Induced by Prenatal Environmental Exposures in Children, Frederica Perera Dr. P.H., Columbia University School of Public Health; Role of Epigenetics in Environmental Neuroepidemiology, Robert O. Wright MD MPH, Departments of Pediatrics and Environmental Health, Harvard Medical School and School of Public Health; Genetic and Environmental Determinants of Global Methylation in Children's Respiratory System, Frank Gilliland M.D., Ph.D., Department of Preventive Medicine, Keck School of Medicine, University of Southern California; and Panel Discussion with audience participation on the importance of environmental epigenetics and future research directions (Gilliland, Wright, Perera, Yang).

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**ISEE-S14-01**
**Introduction to Environmental Epigenetics**

Yang A, *University of Southern California, Los Angeles, CA, USA.*

**Abstract:** Epigenetics is a rapidly developing field that focuses on heritable information that is not coded for in the sequence of the DNA. The vast majority of epigenetic research focuses on DNA methylation, histone modifications and chromatin structure. DNA methylation is the post-replicative chemical modification of DNA. Cytosine can be methylated to 5-methylcytosine at the palindromic CpG dinucleotide. This chemical modification of the DNA can be maintained and inherited due to an enzyme DNA methyltransferase I, which faithfully copies the DNA methylation pattern from the parent to the daughter strand of DNA. DNA methylation is associated with transcriptional silencing of genes. Although the chemical methylation of DNA in itself does not inhibit transcription of mRNA, DNA methylation recruits methyl-binding proteins that are associated with histone modifying enzymes such as histone deacetylases. DNA methylation and histone deacetylation lead to compaction of DNA tightly around histones and a compaction of chromatin, which leads to transcriptional silencing. Aberrant epigenetic changes are a common finding in all cancers. Hypermethylation of normally unmethylated CpG rich areas referred to CpG islands seems to be the most prevalent event described in cancer. These CpG islands usually associated with the promoter region of genes leads to the aberrant silencing of numerous genes including a number of tumor suppressor genes. The importance of epigenetic changes in cancer is underscored by the development and use of drugs that inhibit DNA methylation and histone modifications. Recently there is growing evidence that the environment can effect have epigenetic effects. Environmental exposures have been linked to changes in the DNA methylation pattern to a number of environmental exposures. This presentation will give a brief overview of the biology of DNA methylation and histone modifications; review the epigenetic changes seen in cancer and discuss how the environment may play a role in these changes.

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**ISEE-S14-02**
**Genetic and Environmental Determinants of Global and CpG Methylation in Children's Respiratory System**

Gilliland F, *University of Southern California, Los Angeles, CA, USA.*

**Abstract:** The study of environmental contributions to alterations in the epigenome is a rapidly developing field. In this presentation, the focus is on environmental contribution to different patterns of DNA methylation among children who have participated in the Children's Health Study, a 15 year longitudinal study of children's respiratory health. We present ongoing work about the effects of tobacco smoke and air pollutants on

respiratory track global DNA methylation, hypermethylation of the p16 promoter regions, and methylation status of 1505 specific CpGs. Preliminary analyses suggest that common environmental exposures during growth and development may influence epigenetic patterns in children.

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**ISEE-S14-03**
**Prenatal Exposure to Airborne PAHs and Alterations in DNA Methylation in Cord Blood in Prospective Cohort Studies**

Perera F, *Columbia University School of Public Health, New York, NY, USA.*

**Objective:** First, to examine the relationships between prenatal polycyclic aromatic hydrocarbon (PAH) exposures and epigenetic alterations in two prospective cohort studies of children followed since they were in utero: New York City (African-American and Dominican); Krakow, Poland (Caucasian). Second, to test hypotheses about relationships between specific gene alterations associated with prenatal PAH exposures and adverse birth, developmental and respiratory outcomes. Methods and Results: The initial study in the NYC cohort hypothesized that epigenetic marks associated with in utero PAH exposure could be identified in cord blood DNA with confirmed expression in fetal tissue and would be associated with childhood asthma risk. Using methylation sensitive restriction fingerprinting (MSRF), we analyzed umbilical cord white blood cell DNA of a subset of NYC cohort children for CpG-rich sequences with aberrant methylation status. Six DNA sequences whose methylation status was dependent on the levels of prenatal PAH exposure and that were homologous to known genes having one or more 5'-CpG island(s) (5'-CGI) were identified. Of these, acyl-CoA synthetase long-chain family member 3 (ACSL3) exhibited the highest concordance between the degree of methylation of its 5'-CGI and the level of gene expression in matched fetal placental tissues. Hypermethylation of ACSL3 5'-CGI was found to be associated with prenatal airborne PAH exposure exceeding 2.3 ng/m<sup>3</sup> (OR = 10.8;  $P < 0.001$ , n = 60) and with parental report of asthma in children at age 2, 3 or 5 years (OR = 3.7;  $P = 0.05$ , n = 57). Thus, ACSL3 is the first candidate epigenetic marker that, if validated, could be used to predict asthma risk in children living in traffic-polluted areas. Further study is ongoing to identify additional epigenetic alterations on the pathway between PAH exposure and childhood asthma. A second collaborative project (with D.A. Bell, G.S. Pittman, NIEHS) involves our ongoing parallel cohort study in Poland and is using the Illumina method to analyze epigenetic alterations in mothers and newborns with varying prenatal PAH exposure levels. The method assays 1500 loci in 700 genes. This early work suggests that identifying aberrant methylation status associated with prenatal PAH exposure and adverse health effects may be possible.

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**ISEE-S14-04**
**Role of Epigenetics in Environmental Neuroepidemiology**

Wright R, *Harvard Medical School and School of Public Health, Boston, MA, USA.*

**Abstract:** Factors which determine neurodevelopmental phenotypes begin to occur in the early years of life. The observed phenomenon of fetal origins of disease suggests that early life environmental exposures, such as stress or metals, program later life gene expression. One possible mechanistic pathway which has yet to be fully explored in humans is via epigenetics. Psychological stress and chemicals such as metals may be important environmental factors driving epigenetic processes. Although this is only beginning to be explored in relation to neurologic disorders, there is considerable animal data that suggest that stress and metals can alter DNA methylation and that this process may be a mechanism by which these factors program neurobehavior. For example, effects of

parenting on subsequent adult animal behaviors suggest that DNA methylation patterns may be involved in determining neurobehavioral phenotypes. The memory enhancing effect of the "handling paradigm" in which investigator handling of pups stimulates maternal Licking/Grooming(L/G) behavior, observed in mice involves a brief separation of the pups from the dam. Handling during infancy increases maternal L/G which then decreases the magnitude of both behavioral and HPA responses to stress in adulthood. Furthermore, maternal L/G has been shown to correlate with changes in epigenetic marks within the offspring glucocorticoid receptor gene of hippocampal cells as adults, suggesting that behavioral programming occurs via epigenetics. While measures of DNA methylation hold substantial promise as a biomarker for toxic environmental exposures, the key unanswered question for non-cancer clinical and epidemiologic research is whether measures of gene methylation (global or gene specific) obtained from leukocyte DNA correlate with measures within the target organ. Obviously, measuring target organ DNA methylation is ideal. However, whether the changes in DNA methylation from environmental exposures within target organs and peripheral leukocytes correlate is unknown. To date, there are no studies of DNA methylation patterns as predictors of neurodevelopment.

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**ISEE-S15****Global Goods Movement, Local Environmental Health**

**Abstract:** The global goods movement is a major consequence of the increasingly inter-connected world market and just-in-time-production. Southern California is a major hub of container transport and goods movement across the entire Pacific region and a primary entry and transfer point for Pacific Rim products to the U.S. and Europe. This session presents the global goods movement in a local and regional environmental health context from four complimentary viewpoints: (1) the goods movement trend's and pressures on local and regional domains; (2) an economic assessment of the social, environmental, and health impacts; (3) the local and regional health and environmental issues in a world-sized port operation (Los Angeles and Long Beach CA); (4) the European perspective on environmental health impacts, from a leading Dutch port (Rotterdam). Session speakers will discuss the opportunities and challenges in the environmental and public health sectors as the pressures and policies of a global goods movement intersects with communities, regions, public health, and the environment.

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**ISEE-S15-01****Global Trade Comes Home: The Impacts of International Trade and Goods Movement**

Hricko A, University of Southern California Keck School of Medicine, Los Angeles, CA, USA.

**Abstract:** Globalization is profoundly changing the world's economy. In the U.S., the enactment of new free trade agreements, the downsizing of the American manufacturing base, and consumer demand for inexpensive products, coupled with the industrialization of China, have resulted in a dramatic increase in international trade, particularly from Asia to southern California. This affects the economy, employment options, transportation infrastructure, land use planning, environment and health.

As this shift in the world and U.S. economies occurs, environmental and health concerns are increasing, because moving imported goods from ports of entry to final destinations involves diesel-powered vehicles and equipment every step of the way, creating significant exposures and health impacts along the distribution corridors—impacts that are just beginning to be assessed.

Residents from California port, rail yard and distribution center communities have actively mobilized over the past 5 years to reduce the impacts of air pollution, demanding local, regional and state policy

actions. Increasingly, residents in other communities (such as Vancouver, British Columbia Canada; Johnson County, KS; and Charleston, SC) have rallied to seek emissions reductions as well. More than 500 residents and non-profit group leaders from impacted communities, along with university scientists and others, came together at the "Moving Forward Conference" in Los Angeles in late 2007, where they formed a national/international network to share information on the impacts of ports and goods movement. Attendees voiced specific concern over the explosion of pending infrastructure projects to support growing international trade (marine terminals, highways, truck lanes, truck expressways, bridges, rail lines, and rail yards).

As we consider the current trends in international trade and goods movement from the Pacific Rim, we must also consider the need for improved information about impacts on both worker and community health, quality of life issues, disproportionate burdens leading to environmental justice scenarios, and the increasing tension between ever-increasing economic growth and finite infrastructural support.

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**ISEE-S15-02****The Economic Perspective: Local Facts and Fiction**

Haveman J, Beacon Economics, San Rafael, CA, USA.

**Abstract:** The global goods movement has unleashed a powerful economic force, but how do we interpret its effects on communities, the environment, and regions? Today, the world is more tightly linked economically than at any time in history. These goods move by air, land, and sea, with the magnitude of each growing significantly. As a consequence, the global footprint of goods movement services has also grown. Though these three modes of transport have been growing roughly in proportionate value terms, goods moved by air have a much smaller footprint than does the same value of goods moved by either sea or land; it is generally more expensive, time sensitive, and higher value added goods that travel by air. Internationally, goods movement has served to increase the linkages between northern (rich) countries and southern (poor) countries. This trend has characterized the evolution of international trade for the last 25 years and has important implications for both rich and poor. For the rich countries, increased trade with poorer countries is a source of competitive pressures, not only lowering wages of some workers, but lowering prices for all consumers. For the poorer countries, it provides an important path to development. Regardless of its broader economic implications, the increasing importance of sea-based trade is having a significant but mixed impact on particular local economies, especially in immediately surrounding seaport communities. Impacts range from increased jobs handling the movement of goods, to increased tax revenues and competition for locally produced goods, to increased pollution, to highway congestion, and to assorted aesthetic and security impacts. Local economic development organizations frequently view increased goods movement in a region to be beneficial. This calculation seldom incorporates an assessment of the deleterious impact on public health and the quality of life in these regions. Of crucial importance to the facilitation of greater trade flows in a region is an understanding of both the net benefits to the local communities and of policies that ensure an equitable maximization of those net benefits.

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**ISEE-S15-03****The Environmental Health Perspective: A Closer Look at Ports**

Avol E, University of Southern California Keck School of Medicine, Los Angeles, CA, USA.

**Abstract:** The adjacent ports of Los Angeles and Long Beach are the largest marine port complex in the US (based on cargo throughput), one of the largest in the world, and the main US entry point for Pacific Rim trade; almost half of US imports enter the country through this Southern

California complex. Over the past decade, aggressive port growth has been challenged by increasingly vocal, strident, and successful calls for equally aggressive emission reduction strategies for all sectors of port-related emissions. Innovative emission reduction strategies for ocean-going vessels, on-road heavy-duty diesel trucks, off-road yard equipment, harbor craft, and rail have been or are in varying stages of development, in the face of repeatedly modeled and continuing determinations of unacceptably elevated health risks for the surrounding communities. Effective emission control strategies have been somewhat stymied by interstate and international implications of local regulatory emission reduction attempts. Diesel Particulate Matter (DPM) and nitrogen oxides (NOx) emissions remain the most contentious and persistent issues, with the port complex contributing a substantial portion of daily regional emissions to a region struggling to achieve Federal Clean Air Act compliance. DPM emissions continue to raise health concerns, and NOx emissions provide fuel for downwind regional photochemical formation of both particles and gases. The rampant growth of off-site re-distribution centers for received cargo and the radiating exposure of emissions associated with local goods movement have contributed to the regionalization of exposures, effects, and likely health impacts. Countering these environmental and health concerns are increasing economic pressures, job growth opportunities, and promised lucrative expansion of the local, regional, and national goods movement economy. Unless and until these issues are directly addressed with objective, realistic, and transparent markers of progress and approach, business desires, community relations, economic vitality, environmental quality, and public health will continue to clash in the courtroom and community, with increasingly frustrating and acrid results.

**ISEE-S15-04****Environmental Health Challenges of Ports—a Dutch Perspective**

Lebret E,\* and van Doorn R,† \*National Institute of Public Health and the Environment (RIVM), Bilthoven, Netherlands; and †Rotterdam-Rijnmond Public Health Authority, Rotterdam, Netherlands.

**Abstract:** Rotterdam and associated (petrol-chemical) industries in the Rijnmond area form one of the biggest ports in the world. The port and industrial area stretches over a length of 40 kilometres and covers 10,000 hectares.

Together with the Schiphol Airport, Rotterdam Harbour is considered a mainport to the country and vital to the Dutch trade and economy by the Dutch government. More than 500 scheduled services link Rotterdam with over 1000 ports worldwide. The European market is accessible from Rotterdam via five competing modalities: road, rail, inland shipping, coastal shipping and pipeline. Goods which arrive in Rotterdam in the morning can be in, for example, Germany, Belgium, France or Great Britain the same afternoon. One of the main advantages of Rotterdam is its location on the estuary of the rivers Rhine and Maas. As a result, efficient and economical transport by inland vessel is possible deep into the heart of Europe.

The continued growth of the goods movements has led to increasing land use in an already densely populated country. This precludes good separation of functions in land use, even under the elaborate Dutch physical planning regulations. Multifaceted activities of shipping, handling, storing, downland transportation, industrial production of goods and associated waste production and handling lead to a complex set of emissions and safety risks, at the local level, as well as nationally and even supranationally. This complexity of environmental health risks and impacts and include SO<sub>2</sub> and particulate matter emissions from ships, pesticide emissions (e.g. methylbromide) from consumer products due to pest control in container transports, accidental spills of chemicals, introduction of foreign insects and vector-born diseases, and (illegal) dumping of waste in developing countries (e.g. Proba Koala) associated with the goods movement. These environmental health risks are routinely managed at the Rotterdam port as we work to integrate health issues into

the regulatory process and in physical planning and environmental impact assessments.

**ISEE-S16****Infectious Diseases in the Global Environment**

**Abstract:** Objectives of the symposium on Infectious diseases in the Global Environment include:

- Address the importance of preventing infectious diseases through healthy environments and discuss the role of environmental health and disease epidemiologists in the prevention and control of infectious diseases.
- Raise awareness on the impacts of global environmental changes on infectious diseases worldwide.
- Offer a platform to discuss the road map for the ISEE Conference on Environment, Food and Global Health in 2009.

Proposed sessions include: 1) THE RISE OF ENVIRONMENTAL INFLUENCES ON INFECTIOUS DISEASES: IMPLICATIONS FOR PREVENTION Anthony J McMichael, National Centre for Epidemiology and Population Health The Australian National University Canberra, Australia The long history of human infectious diseases has experienced a recent accelerated change. This changing pattern of infectious diseases reflects diverse increases in the intensity and scale of human activity, allied with rapid microbial genetic evolution and ecological opportunism. There is a need to develop a more 'ecological' systems-based approach to this topic. We must understand better how the interplay of environmental, ecological and social processes, along with microbial evolution, influences infectious disease patterns. Epidemiologists should apply this perspective, to improve our understanding, anticipation and effective response to these diseases in today's increasingly human-dominated, environmentally-stressed world. 2) CLIMATE CHANGE AND EMERGING INFECTIOUS DISEASES—PRESENT SITUATION AND RESEARCH NEEDS. Kristie L. Ebi, Independent Consultant, Washington DC, USA. Climate is a primary determinant of whether a particular location has environmental conditions suitable for the transmission of several vector-, rodent-, and tick-borne diseases, including malaria, dengue, meningitis, West Nile virus, tick-borne encephalitis, and leishmaniasis. A change in temperature may hinder or enhance vector and parasite development and survival, thus lengthening or shortening the season during which vectors and parasites can survive. Evidence from a variety of countries suggests that climate change is providing opportunities for diseases to alter their geographic range and the intensity of disease transmission. However, disentangling the impacts of climate change from those of land use change, changes in human behaviors, and other driving factors is complex, requiring the use of systems-based approaches. 3) IMPACTS OF ANIMAL FARMING SYSTEMS ON FOOD BORNE INFECTIOUS DISEASES AND ENVIRONMENTAL HEALTH—THE WAY FORWARD. Cristina Tirado-von der Pahlen, UCLA School of Public Health, USA Animal farming and aquaculture systems have an impact on foodborne diseases and on environmental health. Intensive animal farming and aquaculture have been associated the misuse of antibiotics and this has lead to the increase of multi-drug resistant strains on animals, humans and the environment. Emerging zoonosis such as Bovine Spongiform Encephalopathy have been due to agriculture systems which were looking for maximizing revenues. On the other hand extensive livestock production systems are detrimental for climate change and the environment. Data on emerging infectious foodborne diseases and zoonosis will be presented and current strategies to improve animal farming systems will be discussed. 4) THE GLOBAL EMERGENCE AND SPREAD OF HIGHLY-PATHOGENIC H5N1 AVIAN INFLUENZA—HOW CAN ENVIRONMENTAL AND INFECTIOUS DISEASE EPIDEMIOLOGISTS JOIN FORCES TO DEAL WITH THE THREAT? Scott Layne, UCLA School of Public Health, Los Angeles,

USA We face unpredictable and unprecedented threats from influenza viruses with pandemic potential, most recently from rapidly evolving avian H5N1 strains. We are living in a new kind of global incubator that includes over 6 billion people worldwide, demands 100 times more food animals than just fifty years ago, and requires close monitoring.

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#### ISEE-S16-01

#### The Rise of Environmental Influences on Infectious Diseases: Implications for Prevention

McMichael AJ, *The Australian National University, Canberra, Australia*.

**Abstract:** The long, kaleidoscopic, history of human infectious diseases has experienced a recent accelerated change. Since the mid-1970s there has been much discussion about the global ‘emergence and resurgence’ of infectious diseases. In particular, over the past 15 years various animal-generated human epidemics have emerged—hanta virus in the USA (1993), plague in India and deadly Ebola virus in Zaire (1994), West Nile virus in Africa (1999), Rift Valley fever in Africa (2000) and severe acute respiratory syndrome in Asia and Canada (2003). At issue, however, is not only the emergence of new diseases, but the recent increases in various ancient scourges such as tuberculosis, malaria and cholera. Others that may have quietly circulated for some time (e.g. cryptosporidiosis, hepatitis C and Lyme disease) have only recently increased to the point of being noticed. Meanwhile, in the background lurks the increasingly ominous rise of antimicrobial-resistance.

This changing pattern of infectious diseases reflects diverse increases in the intensity and scale of human activity, allied with rapid microbial genetic evolution and ecological opportunism. Amplified influences include: human travel, extended trade, altered social relations (sexual networks, drug use), intensified livestock production, extensive land clearance and other environmental incursions, biodiversity losses, and climate change. Many climate-sensitive infectious diseases (particularly insect-borne infections and those spread via food and water) will be affected by climate change.

Much recent literature has focused on (apparently) new, ‘emerging’, diseases. Meanwhile, globally, recent upturns in malaria, dengue, cholera and food-borne infections are of particular concern. They and HIV/AIDS are a key focus of the Millennium Development Goals. This upturn reflects the interplay of the above factors, along with ill-judged relaxation of prior control programs and weakening of public health capacity in many regions.

This increased liability of infectious diseases focuses new attention on the need to develop a more ‘ecological’ systems-based approach to this topic. An instructive example of the prevention of infectious diseases through healthy environments is the program of sustainable alternatives to DDT for malaria vector control in Mexico and South America. We must understand better how the interplay of environmental, ecological and social processes, along with microbial evolution, influences infectious disease patterns. Epidemiologists should apply this perspective, to improve our understanding, anticipation and effective response to these diseases in today’s increasingly human-dominated, environmentally-stressed, world.

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#### ISEE-S16-02

#### Climate Change and Emerging Infectious Diseases—Present Situation and Research Needs

Ebi KL, *Independent Consultant, Washington, DC, USA*.

**Abstract:** Climate is a primary determinant of whether a particular location has environmental conditions suitable for the transmission of several vector-, rodent-, and tick-borne diseases, including malaria, dengue, cholera, meningitis, Japanese encephalitis, St. Louis encephalitis, West Nile virus, tick-borne encephalitis, Rift Valley Fever, schistosomiasis, and leishmaniasis. A change in temperature may hinder

or enhance vector and parasite development and survival, thus lengthening or shortening the season during which vectors and parasites can survive. Small changes in temperature or precipitation may cause previously inhospitable altitudes or ecosystems to become conducive to disease transmission (or cause currently hospitable conditions to become inhospitable). Evidence from a variety of countries suggests that climate change is providing opportunities for diseases to alter their geographic range and the intensity of disease transmission.

While climate is an important driver of malaria and other diseases, it is not the only one. The many determinants of infectious diseases often form an interconnected web with positive feedbacks between transmission dynamics and other factors. For example, the non-climatic socioeconomic and biological drivers of malaria include drug and pesticide resistance, deterioration of health care, deterioration of public health infrastructure (including vector control efforts), demographic change, and changes in land use.

Malaria is a complex disease to model, and current models have not completely parameterized the key factors that influence transmission. Given this limitation, models suggest that, in Africa, climate change may be associated with both expansions and contractions of the geographic area suitable for transmission of stable *Plasmodium falciparum* malaria, with expansion projected to be larger than contraction. These projections are consistent with experiences with malaria control officers in the field. Some projections suggest that the season of transmission may be extended, which may be as important for disease burdens (and vector control programs) as geographical expansion.

Several food- and waterborne diseases are climate sensitive, suggesting that climate change could affect their incidence and distribution. For example, studies report an approximately linear association between temperature and common forms of food poisoning such as salmonellosis.

Disentangling the impacts of climate change from changes in land use change, human behaviors, and other driving factors is complex. Systems-based research is needed to identify the primary factors affecting disease incidence, and the degree to which changes in those factors can alter the burden of climate-sensitive diseases.

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#### ISEE-S16-03

#### Impacts of Animal Farming Systems on Food Borne Infectious Diseases and Environmental Health—The Way Forward

Tirado-von der Pahlen MC, *UCLA School of Public Health, Los Angeles, CA, USA*.

**Abstract:** Animal farming and aquaculture systems have an impact on foodborne diseases and on environmental health. Intensive animal farming and aquaculture have been associated with the misuse of antibiotics and this has led to the increase of multi-drug resistant strains on animals, humans and the environment. Emerging zoonosis such as Bovine Spongiform Encephalopathy have been due to agriculture systems which were looking for maximizing revenues. On the other hand extensive livestock production systems are detrimental for climate change and the environment. Data on emerging infectious foodborne diseases and zoonosis will be presented and current strategies to improve animal farming systems will be discussed.

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#### ISEE-S16-04

#### The Global Emergence and Spread Of Highly-Pathogenic H5N1 Avian Influenza—How Can Environmental and Infectious Disease Epidemiologists Join Forces

Layne S, *UCLA School of Public Health, Los Angeles, CA, USA*.

**Abstract:** We face unpredictable and unprecedented threats from influenza viruses with pandemic potential, most recently from rapidly evolving avian H5N1 strains. We are living in a new kind of global incubator that

includes over 6 billion people worldwide, demands 100 times more food animals than just fifty years ago, and requires close monitoring for signs of threatening influenza outbreaks. This talk will present innovative approaches, methods and technologies for near-real time surveillance of influenza viruses, and the new era of global infectious disease and environmental stewardship. It will overview efforts pertaining to the new UCLA High Speed, High Volume Laboratory Network for Infectious Diseases and efforts pertaining to preparedness for seasonal epidemic influenza and sporadic pandemic influenza.

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**ISEE-S17**
**Enhancing Exposure Assessment for Air Pollution Health Studies**

**Abstract:** The objective of this symposium is to explore and discuss the development and application emerging exposure assessment techniques for PM, ozone and co-pollutant epidemiological studies. Since direct personal exposure measurements on all or most of the health study subjects cannot be practically obtained, it is important to consider various alternative surrogates or indicators of exposures—ranging from simple to more complex (e.g., GISbased kriging or land-use regression modeling, intake fractions, exposure factors or time-activity adjusted ambient measurements, probabilistic exposure models, etc.), depending on the particulars of the epidemiologic study design and availability of exposure-related information. However, the use of exposure surrogates in health studies introduces issues associated with exposure misclassification. These exposure misclassification issues may be minimized by improving the exposure assessment technique. A number of different surrogates of personal exposures have already been used in criteria air pollution epidemiology studies and new tools and approaches for estimating exposures are emerging. The joint ISEE/ISEA Conference provides an excellent opportunity for the exposure and epidemiological communities to discuss the advantages and limitations of various exposure assessment techniques. This 90-minute symposium will follow a poster-platform format. It will begin with a series of six 5 minute mini-presentations followed by 30-minutes of poster viewing. The symposium will then conclude with a 30-minute panel discussion. The initial 5-minute overview presentations will set the stage for further discussions during the poster viewing period. The symposium will start with a review of the methodological issues associated with exposure error in epidemiological studies through an application of spatial exposure predictions issues in PM health effects. This will then be followed by two presentations that describe various exposure assessment techniques that are being developed for the purposes of air pollution health effects analysis and interpretation of land-use model results in the context of air pollution health effects studies. The final three presentations will then describe different approaches for the development and application of various exposure indicators during the course of air pollution health studies, including air pollution epidemiology and accountability analyses. Lessons-learned from these studies and how the results provide insights into future exposure and health effects studies will be emphasized. During the final 30-minute panel discussion period, four invited exposure and health researchers will address overarching issues dealing with the utility of available methods and how they may be improved or tested further in the future. In light of the presentations made during the symposium, the panellists will respond to the following charge questions: 1) Where do you see the greatest potential benefit for applying more refined exposure surrogates or exposure prediction methods in the analysis of air pollution health effects? 2) What opportunities exist, for: a) Improving the exposure metrics for PM, ozone and co-pollutants that support air pollution health studies? b) Evaluating alternative exposure metrics using existing health data? 3) What are some critical gaps in knowledge or information that limit our ability to improve exposure assignment in air pollution health studies, and how can we address them?

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**ISEE-S17-01**
**The Use of Spatial Exposure Predictions in Health Effects Models: An Application to PM Epidemiology**

Coull B, Gryparis A, Paciorek C, Suh H, and Schwartz J, *Department of Biostatistics, Harvard School of Public Health, Boston, MA, USA.*

**Abstract:** Predictions from spatial exposure models are increasingly used to assess health effects of environmental exposures. Use of such predictions involves measurement error, caused by spatial misalignment. We provide a framework for spatial measurement error modeling, showing that smoothing induces a Berkson-type measurement error with non-diagonal error structure. From this viewpoint, we review existing approaches to estimation in a linear regression health model, including direct use of the spatial predictions, weighted least squares exposure simulation, and Bayesian approaches. We also illustrate the gains that can be made by incorporating in-home validation exposures into a unified modeling framework. We then consider the analogous procedures in non-linear models for non-normal responses, such as dichotomous outcomes. We illustrate the relative performances of the various methods by applying them to data on the association between estimated traffic particles and cardiovascular outcomes in the Normative Aging Study cohort in the greater Boston area.

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**ISEE-S17-02**
**The Use of Improved Exposure Factors in the Interpretation of Air Pollution Epidemiological Results**

Baxter L, Neas L, and Schultz B, *U.S. EPA, Research Triangle Park, NC, USA.*

**Abstract:** Numerous studies have reported significant associations between ambient PM<sub>2.5</sub> levels and increased mortality. A recent mortality study conducted by Franklin et al. 2007 in 27 U.S. cities reported significant heterogeneity among city-specific effect estimates. This city-to-city heterogeneity may reflect effect modification related to varied individuals behaviors, residential characteristics, and other community-specific factors. For instance, differences in home air exchange rates can affect personal-ambient relationships, since individuals spend a majority of their time indoors and ambient PM<sub>2.5</sub> penetrates fairly efficiently indoors. In addition, community co-pollutant concentrations (e.g., O<sub>3</sub>) may also be a factor, depending on the correlations among the various exposure metrics. We evaluate whether variations in the personal-ambient relationships and community characteristics can explain part of the variability seen in the PM<sub>2.5</sub> health effect estimates among different cities. We use the health effects estimated from the Franklin et al. 2007 multi-city study that examined the association between PM<sub>2.5</sub> and both total and cause-specific mortality in 27 U.S. communities from 1997–2002. Using inverse variance weighted least-squares regression, we examine the effect of home ventilation and O<sub>3</sub> to analyze whether differences in exposure factors may account for some of the variability observed across study sites. Home ventilation will be estimated using the Lawrence Berkeley National Laboratory equation for normalized leakage (NL), an indicator of the tightness of the building, determined by the year built and the area of houses. Using the distribution of these factors, we will determine a distribution of NLs for each community. Using the medians for each community, we calculated that the maximum NL was 30% higher than the minimum. Preliminary results indicate that differences in community-specific housing characteristics may explain part of the heterogeneity seen among city-specific PM<sub>2.5</sub> mortality effect estimates. We outline additional studies to improve our understanding of various factors which could have a measurable influence on the magnitude of the PM-mortality relationships. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-S17-03****On the Use and Interpretation of Land Use Regression Estimates in Chronic Air Pollution Epidemiology**

Jerrett M, University of California, Berkeley, CA, USA.

**Abstract:** Land use regression (LUR) has emerged as an effective means of estimating exposures for epidemiological studies. The LUR method relies on saturation monitoring over many spatial sampling points for short periods, usually one to two weeks, sometimes with two to four repeated samples. The monitored pollution values are then used as the dependent variable in a regression model with proximate traffic, land use, population, and physical geography variables as predictors. Drawing on research in the Netherlands, Canada, and the United States, I will evaluate the use of LUR estimates for mortality, respiratory, and cardiovascular endpoints. The comparative evaluation reveals that LUR models are often associated with health effects to a greater extent than proximity buffers, inverse distance weighting, and kriging interpolators. However, the use of surrogate pollutants such as nitrogen dioxide based on only short-term monitoring campaigns raises many questions in the assessment of health effects, which will be evaluated in this presentation. For example: 1) how well short-term monitoring capture the longer-term spatial gradient in exposure, which is usually the focus of interest in an epidemiological study? 2) can direct temporal measurements be used to assess the likely spatial patterns of exposure retrospectively? 3) which sources other than the assumed traffic are the likely cause of the spatial variation? 4) do the predictors used for traffic and on the locations of subjects in geographic information systems allow for the evaluation of near source impacts with sufficient precision? 5) are certain predictor variables (e.g., population density) associated with likely confounders of health effects such as socioeconomic status? Funded by the California Air Resources Board; the Office for Environmental Health Hazards Assessment, California Environmental Protection Agency; the Canadian Institutes of Health Research Grant MOP-64463; Health Canada; the Program of Energy Research and Development, Natural Resources Canada; and the U.S. Environmental Protection Agency Grant RD-83184501-0 EPA-2003STAR K-1.

**ISEE-S17-04****Development of Alternative PM and Ozone Exposure Prediction Methodologies for Environmental Epidemiology and Public Health Tracking Studies**Garcia V,\* Özkaynak H,\* Dimmick F,\* Holland D,\* Hall E,\* and Linn S,<sup>†</sup> \*U.S. EPA, Research Triangle Park, NC, USA; and <sup>†</sup>New York State Dept. of Health, Albany, NY, USA.

**Abstract:** This presentation will describe the exposure prediction techniques employed by EPA in collaborative projects involving the States and CDC. EPA is supplementing ground-based observations with CMAQ modeled outputs by statistically combining the data sets. Bayesian hierarchical space-time models are used to give more weight to accurate monitoring data in areas where monitoring data exists, and relies on bias-adjusted model output in non-monitored areas. This approach is being developed into an operational system such that EPA can deliver the statistically combined estimates for the CDC's Environmental Public Health Tracking program for use in associating ozone and PM<sub>2.5</sub> with various health outcomes. In addition, EPA is collaborating with New York State to apply these combined ambient ozone and PM concentration surfaces and exposure probability estimates in the evaluation of air pollution health effects (e.g., respiratory-related hospital admissions). An interesting component of this study will be the evaluation of using ambient pollutant concentrations as a surrogate of exposure versus calculated probability factors of exposure in the risk and health assessments.

**ISEE-S17-05****Enhancing Spatial Aspects of Air Pollution Epidemiological Studies**Marshall JD,\* Setton E,<sup>†</sup> Brauer M, and the Border Air Quality Study Team,<sup>†</sup> \*University of Minnesota, Minneapolis, MN, USA; and <sup>†</sup>University of British Columbia, Vancouver, BC, Canada.

**Abstract:** This presentation will examine three approaches for enhancing spatial aspects of exposure models in air pollution epidemiological studies. We will compare several exposure surfaces for total and source-specific pollutant concentrations, including land-use regression, the CMAQ air dispersion model, spatial interpolation of monitoring data, and proximity to industrial emissions. We explore how those surfaces yield different dose-response estimates for effects such as premature birth, low birth-weight, and childhood respiratory disease. The presentation will also discuss two other models that account for people's daily travel patterns. We quantify the exposure error induced by assuming people are exposed only to ambient concentrations at their residential location.

**ISEE-S17-06****Applying Alternative Approaches to Characterizing Air Pollution Exposure in An Epidemiologic Study in Atlanta**Sarnat SE,\* Sarnat JA,\* Klein M,\* Goldman G,<sup>†</sup> Mulholland J,<sup>†</sup> Russell AG,<sup>†</sup> Flanders WD,\* Waller LA,\* and Tolbert PE,\* \*Emory University, Atlanta, GA, USA; and <sup>†</sup>Georgia Institute of Technology, Atlanta, GA, USA.

**Abstract:** This presentation will explore a variety of alternative exposure metrics for ambient traffic-related and regional pollutants that we are developing for use in two of our ongoing epidemiologic studies examining ambient air pollution and acute morbidity in Atlanta, GA. Our studies include a time-series study of emergency department visits, with data on >10 million visits from 41 of 42 hospitals for the period 1993–2004, and a case-crossover study of cardiac events in patients with implantable cardioverter defibrillators, with data on 884 patients contributing 13,108 events between 1993 and 2002. Our exposure metrics address various tiers of exposure refinement, including the use of 1) ambient receptor data, 2) emissions data, and 3) exposure factors data. Under the first tier of refinement, we use existing ambient fixed-site monitoring data, spatially-interpolated ambient monitoring data and daily population-weighted average air pollution concentrations. Within this tier, we also consider geographic subpopulation analyses, which model visits from populations that reside within specified capture areas around monitors. Under the second tier of refinement, we use two air quality emissions models, including the Community Multiscale Air Quality model and a vehicle emissions impact model, to obtain spatially-resolved estimates of ambient concentrations. For the final tier of exposure refinement, we include spatially- and temporally-resolved surrogates of air exchange rates in our epidemiologic models to estimate personal exposures to our pollutants of interest. Health risk estimates from models using the various exposure metrics are compared and evaluated by pollutant and health outcome. In this presentation, results of several analyses will be discussed, and plans for future analyses will be described. We will use our results to examine the added benefits of increasingly detailed exposure assessment approaches. We will also discuss interpretations and limitations of each approach.

**ISEE-S18****Environmental Factors Associated with Development Delays and Disorders Among Children and Adolescents**

**Abstract:** There is evidence to suggest that there are environmental effects on mental disorders, most notably an increased rise in many types of mental disorders in young people in the last 50 years. The cause for the rapid rise in rates remains unknown. However few genetic links have been

identified and replicated, and this lends support to a substantial role of the environment in these complex disease. In the past ten years, the NIEHS and US EPA Children's Centers have reported a link between early exposure to environmental chemicals and neurobehavioral and cognitive impairment in infants and children. Exposure can occur early during fetal development via transplacental delivery, postnatally via breast milk or directly through the child's environment. We will explore the scientific data to support long-term changes in neurodevelopment associated with early exposures as well as new animal data to support potential mechanistic pathways of importance and as well as new measures of sub-clinical phenotypes and potential confounding effects of current therapies. This symposium would provide an integrated summary of new studies exploring the relationship between the environment and development delays in children conducted by investigators from the Children's Environmental Health Centers. Panel Discussion with audience participation on the importance of environmental exposures and persistent developmental disorders in young children.

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**ISEE-S18-01**
**PCBs and PCBEs & Attention and Impulsivity: Mechanistic Studies in Animals**

Schantz S, *University of Illinois, Champaign, IL, USA*.

**Abstract:** Polychlorinated biphenyls (PCBs) are industrial chemicals that are no longer in use, but are still prevalent in the environment. Previous research in animal models and humans has revealed deficits in response inhibition following PCB exposure. Perinatally PCB-exposed animals show increased perseverative responding on several types of learning tasks that require inhibitory control for their successful execution. PCB-exposed rats and monkeys also perform more poorly on schedule-controlled operant tasks where low rates of responding are optimal, including fixed interval and differential reinforcement of low rate (DRL) schedules. We have previously reported increased perseverative responding on both reversal learning and delayed spatial alternation tasks in PCB-exposed rats. More recently we have observed that rats exposed to an environmentally relevant PCB mixture during the perinatal period had shorter inter-response times and earned fewer reinforcers than control rats on a DRL task. Drug challenges with amphetamine disrupted the performance of PCB-exposed rats to a lesser extent than control rats, which is suggestive of reduced brain dopamine function. The deficits in response inhibition and the altered response to amphetamine seen following early PCB exposure show similarities to patterns observed in children with attention deficit hyperactivity disorder (ADHD). The effects of PCBs on attentional processes—which are also deficient in ADHD—are not as clear. Our future studies will focus on further elucidating the effects of PCBs on both attention and inhibitory control, as well as investigating the role of altered brain dopamine function in mediating these effects. Because of the similarities between the cognitive deficits resulting from early PCB exposure and those observed in ADHD, these studies have the potential to contribute to our understanding of this common childhood disorder. Supported by ES11263 and ES015687 from NIEHS and R82939001 from USEPA.

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**ISEE-S18-02**
**Neurodevelopmental Health Effects of Organopesticides and Organochlorine Pesticide Exposure in Mexican-American Young Children**

Eskenazi B, *University of California, Berkeley, CA, USA*.

**Abstract:** Despite animal evidence suggesting neurotoxic effects of organophosphate (OP) and organochlorine (OC) pesticides, few published studies have investigated the neurodevelopmental toxicity of pesticides in humans. This study investigates exposure to OP and OC pesticides and

neurodevelopment of children from low-income Mexican farmworker families living in California. These children are participants in the CHAMACOS birth cohort study. Six non-specific dialkylphosphate (DAP) metabolites of OP pesticides were measured in urine collected from over 400 mothers twice during pregnancy and from children at the time of the neurodevelopmental assessments. We also measured DDT and DDE in maternal serums during pregnancy. We found pregnancy DAP levels were associated with abnormal reflexes on the Brazelton Neonatal Assessment Scale (BNAS) and were negatively associated with the Bayley Mental Development Index. At 24 months of age, these associations reached statistical significance [per 10-fold increase in prenatal DAPs: beta = -3.5 points; child DAPs: beta = 2.4 points]. Maternal and child DAPs were associated with odds of maternal report of pervasive developmental disorder when the child was 24 months old [per 10-fold increase in prenatal DAPs: OR= 2.3,  $P = 0.05$ ; child DAPs OR = 1.7,  $P = 0.04$ ]. Paraoxanase (PON1 enzyme) metabolizes OP pesticides and the PON1 gene is located on chromosome 7. The detoxifying efficiency depends on SNP PON1 192 and the enzyme quantity on PON1 -108. We will also present our results for the relation of PON1 genotype and cognitive and behavior endpoints and whether these genotypes modify the relation of exposure and cognitive and behavior endpoints. We will also present our results on the association in this cohort between maternal DDT and DDE levels and neurodevelopment. We found no association between maternal DDT or DDE levels and neonatal performance on the BNAS. We did find an approximately 2-point decrease in Psychomotor Developmental Index scores with each 10-fold increase in p,p'-DDT levels at 6 and 12 months (but not 24 months) and p,p'-DDE levels at 6 months only. Additional follow-up of the children has been completed and results from 3.5 and 5 years will be presented. Results will also be compared to those from other studies currently being conducted.

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**ISEE-S18-03**
**Effects Of Prenatal Chlorpyrifos Exposure On 5 and 7-year Neuropsychological Functioning**

Rauh VA, *Columbia University, New York City, NY, USA*.

**Abstract:** Concerns about the harmful neurodevelopmental effects of prenatal exposure to organophosphate pesticides, in particular chlorpyrifos (CPF), are growing. CPF is a known neurodevelopmental teratogen in animals, and it is likely that adverse effects on human development have gone undetected because of the absence of overt signs of toxicity. Despite a recent regulatory ban on residential use, agricultural applications continue in the U.S. and abroad. As part of a prospective cohort study in a non-smoking inner-city minority population, neurotoxic effects of prenatal exposure to CPF have been evaluated in 228 children through the first 5 years of life. Previous reports showed widespread prenatal exposure in New York City households, significant adverse impact of high prenatal exposure on birth weight and birth length (Whyatt et al, 2004), and increased risk of developmental delay and symptoms of attentional and ADHD-like problems at three years of age (Rauh et al., 2006). This report examines neuropsychological functioning at 5 and 7 years of age in this same cohort. After adjustment for race/ethnicity, sex, maternal education, maternal IQ, prenatal secondhand smoke exposure, and measures of poverty, CPF was significantly and positively related to attentional problems (distractibility and concentration difficulties) on the Behavioral Assessment Scale for Children-Second Edition and hyperactivity (restlessness, fidgeting, and difficulty sitting still) on the Conners' Rating Scales-Revised at 5 years of age. Measures of inattention and hyperactive symptoms were highly stable from 3-5 years of age. In addition, high prenatal exposure was associated with significantly lower scores on working memory, digit span, and block design on the Wechsler Scales of Intelligence for Children at 7 years of age. The addition of birth weight, birth length and head circumference to the models did not alter the effects of CPF. This suggests that the neuropsychological effects reported here

may involve different mechanisms than those underlying previously reported fetal growth effects. This work was supported by NIH ES09600, EPA RD83214101, and NIEHS R01 ES08977.

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**ISEE-S18-04****Introduction to Environmental influence on Psychiatric Disorders in Children and Adolescents**

Hertz-Pannier I, University of California, Davis, CA, USA.

**Background:** Little is known about the environmental causes of autism. Pesticides affect numerous targets in the CNS, and cross the placenta. One previous report linked autistic symptoms to personal organophosphate pesticide exposures; another found an association with residential proximity to ganochlorine pesticide applications.

**Objectives:** To compare early life exposures to household pesticides in young children with autism vs. typically developing controls.

**Methods:** Participants were from the CHARGE (Childhood Autism Risks from Genetics and the Environment) study, a large population-based case-control study in California, a central project within the UC Davis Center for Children's Environmental Health. Autism spectrum disorders (ASD) were confirmed using the Autism Diagnostic Inventory, an interview with the mother, and the Autism Diagnostic Observation Scale, a structured play activity session with the child. Mothers were interviewed regarding demographics, lifestyle, and prenatal and early postnatal exposures of the child. Questions addressed use of numerous household products, including insecticides for flies and ants, pet shampoos, and weed control products. Interview data were available for 333 ASD cases and 198 confirmed typically developing controls. Logistic regression models were adjusted for family socioeconomic status. An index exposure period was defined as three months prior to conception through the child's first year of life.

**Results:** Mothers of ASD children were twice as likely to report using pet shampoos for fleas or ticks during the index period as compared with control mothers: adjusted Odds Ratio (aOR) = 2.0, 95% Confidence Interval (CI) = [1.2, 3.6]. When examined by trimester, the strongest association was during the second trimester: aOR = 2.6, 95%CI = [1.3, 6.0].

**Conclusions:** The higher prevalence of pet shampoo use by mothers of children with ASD could be due to reporting bias, although many other products did not show differences. Pyrethrins have largely replaced organophosphates for flea control on pets. Early life exposure to pyrethrins has been shown to compromise the blood-brain barrier in rodents, raising concern about prenatal and early postnatal exposures.

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**ISEE-S19****Individual-level Interventions to Reduce Exposure to Pesticides and Other Household Contaminants**

**Abstract:** Intervention studies provide a unique opportunity to evaluate the effectiveness of exposure reduction strategies, to infer a potential cause-effect relationship between sources and exposure levels, and to understand the relative impact of different sources on total exposure. Individual-level intervention studies, specifically, are those studies focused on changes in individual-level behavior and exposure patterns. Individual-level interventions are particularly useful for studying exposures to pesticides and other semi-volatile organic compounds (SVOCs) due to the wide variety of sources of these compounds, particularly within the indoor environment, and relationship between personal choices, uses, and behaviors and sources. For example, products with fragrances may contain phthalates, many of which are considered endocrine disruptors; therefore, by reducing the use of fragranced products or substituting them with products without or with lower concentrations of phthalates, exposure to these compounds can be reduced at an individual level. The potential success of an intervention study was observed in a study in which

elementary school-age children's diets were switched from a conventional diet to an organic food diet over a 5 day period. Using a longitudinal approach, the investigators observed a decrease in the urinary concentrations of several organophosphorus pesticides shortly after the switch to an organic diet and then an increase in concentrations once the children returned to the conventional diet. Intervention studies, however, may not always lead to reductions in exposure or may potentially result in unintended changes in exposure due to substitution. Providing alternatives and understanding the potential impact of alternatives on exposure is necessary in an effective intervention study aimed at reducing overall exposures and potential adverse health effects. This symposium on individual-level interventions related to pesticide and other SVOCs will: 1) explore issues related to the development of effective intervention studies; 2) evaluate the efficacy of intervention studies to reduce exposures; 3) discuss potential unintended consequences of interventions due to substitutions; 4) share results from longer-term follow-up after; and 5) highlight issues related to sharing results with study participants.

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**ISEE-S19-01****Development of an Evidence-based Intervention Study to Reduce Exposures to Contaminants in Consumer Products**

Dodson RE, Standley LJ, Brody JG, and Rudel RA, Silent Spring Institute, Newton, MA, USA.

**Abstract:** In response to public demand for information to guide consumer product choices to reduce exposures to chemicals of concern, Silent Spring Institute has launched a new project to develop evidence-based recommendations for exposure reduction. Informed by our previous research characterizing varied classes of endocrine disrupting compounds (EDCs) in indoor air and house dust, we have now tested 186 products for over 65 chemicals, including phthalates, fragrances, antimicrobials, parabens, and perfluorinated compounds. Both alternative and conventional products were included in the analysis. Products were categorized either as "conventional" or "alternative" depending on advertising terminology, including "greener", "organic" or "safer"; and ingredients lists, such as being free of phthalates, parabens, and fragrances. For each product type, Silent Spring Institute submitted three to five conventional products, which were combined into a composite sample by the analytical laboratory based on approximate market share, and one alternative product, if it was available. Antimicrobials triclosan and triclocarban were detected in conventional bar soaps, hand soaps and toothpastes. DEHP (bis(2-ethylhexyl)phthalate) was found in a vinyl shower curtain (almost 28% by weight), conventional deodorants, lip products, and nail products. Parabens, which are often used as preservatives, were found at substantially higher levels in conventional body lotions, face lotions, hand soaps, lip products, some cosmetics and hair products than in alternative products. Using these data, we have developed a protocol for household exposure reduction to be tested in an intervention study involving 20 participants who will be asked to use alternative cleaning products for 2–3 months and alternative personal care products for the final 2 weeks of the study. Samples of air, dust and urine will be collected prior, during and after product switch and used to quantify the relationship between product use and exposure.

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**ISEE-S19-02****The Attribution of Urban and Suburban Children's Exposures to Common Pesticides Present in the Environment**

Lu C,\* Barr D,† Pearson M,\* Waller L,\* and Brovo R,† \*Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA; and †National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA.

**Abstract:** Despite the widespread use of common pesticides such as organophosphorus (OP) and synthetic pyrethroid (SP) insecticides that led to common exposure in the population, few studies have been conducted to quantitatively assess human, particularly children's, long term exposures to those pesticides. The Children Pesticide Exposure Study (CPES) was designed to establish the longitudinal daily pesticide exposure profiles in a cohort of children living in two urban and suburban communities, one in Seattle WA (CPESWA) and the other in Atlanta GA (CPESGA), using urinary metabolites as exposure biomarkers. Twenty-three children ages 3–11 who only consumed conventional diets were enrolled in the CPESWA in which two daily urine samples, daily dietary consumption and residential pesticides use information were collected from each participant for multiple consecutive days (7 to 15 days) in each of the four seasons. Children switched to organic diets for 5 consecutive days in the summer and fall sampling seasons, and their daily urine samples were analyzed for selected metabolites of OP and SP. We observed a measurable effect of reducing malathion and chlorpyrifos exposure by substituting children's conventional diets with organic food items. We also observed a seasonal effect on the OP urinary metabolite concentrations in children, which is correspondent to the consumption of fresh produce throughout the year. However, when we took into account season, age, sex, diet, and self-reported use of pesticides in a linear mixed effects model, results suggested that the combination of the use of pyrethroids in the household, dietary intake, and seasonal differences play a significant role in predicting children's exposure to synthetic pyrethroids. The findings from CPESWA support the conclusion made by the NRC's 1993 report that dietary intake of OP pesticides represents the major source of exposure in infants and young children. We also found that while CPESWA children continuously exposed to pyrethroids through their diets all year long, the exposure pattern for pyrethroids was periodically modified by episodes of relatively high exposures resulting from residential uses. The results from the CPES provide opportunities to implement effective intervention measure to further reduce pesticide exposure among children.

#### ISEE-S19-03

##### A Case Study Examining the Effects of Integrated Pest Management on Pesticide Residues and Residents' Pest Control Practices

Julien R,\* Adamkiewicz G,† Levy JI,† Hynes HP,‡ and Spengler JD,† \*U.S. EPA, Boston, MA, USA; †Harvard School of Public Health, Boston, MA, USA; and ‡Boston University School of Public Health, Boston, MA, USA.

**Abstract:** Pesticide exposures may be elevated among residents of low-income multi-unit dwellings due to severe pest infestation and resulting misapplication of pesticides. Structural Integrated Pest Management (IPM) is focused on modifying pest habitats while relying on little or no pesticides. Studies which have evaluated IPM effectiveness have not routinely examined its impact on pesticide reductions indoors. In this study, we looked at the effect of the interventions on both resident pest control practices as well as pesticide residues by comparing both pre- and post-intervention measurements of the representative pesticide residues (chlorpyrifos, diazinon, permethrin, cypermethrin and cyfluthrin) in kitchen floor wipes. The IPM interventions included resident education, professional house cleaning and the application of low impact pesticides (e.g., gels and roach baits) by a professional pesticide applicator. It was conducted in 42 households in Boston Public Housing developments. There was a reduction in families reporting cockroach infestation (52% to 21%), as well as those reporting the use of chemical pesticides including sprays (38% to 0%) and smoke bombs (27% to 0%). Good housekeeping practices also improved (19% to 38%). With the exception of diazinon ( $P$ -value = 0.04 for reduction), mean concentration changes for the other prevalent pesticides were not significantly different from zero at the 0.05 level. Certain household attributes, however, were found to be associated

with concentration change. For example, IPM training was associated with both a decrease in cyfluthrin concentrations and an increase in permethrin concentration, which may be suggestive of a pesticide substitution. In general, homes with poor housekeeping were found to have higher baseline pesticide concentrations than homes with good housekeeping and achieved greater reductions in pesticide residues, suggesting that dust reservoirs may be important sources of exposure. Public health implications: Need effective interventions to prevent residents' potential exposures to pesticides in the home. Substitutes may also be harmful.

#### ISEE-S19-04

##### Residential Pesticide Use Patterns Among an Inner-City Cohort in New York City and the Impact of an Intervention to Reduce Pesticide Use and Exposure

Williams MK,\* Barr DB,† Camann DE,‡ Evans D,\* Kinney P,\* Rundle AG,\* Perera FP,\* and Whyatt RM,\* \*Columbia Center for Children's Environmental Health (CCCEH), Mailman School of Public Health, Columbia University, New York, NY, USA; †Center for Disease Control and Prevention, Atlanta, GA, USA; and ‡Southwest Research Institute, San Antonio, TX, USA.

**Abstract:** We report results of a pilot intervention designed to test the efficacy of integrated pest management (IMP) at reducing pest infestation and residential pesticide exposure during pregnancy among women in NYC as well as cross-sectional and longitudinal data collected on pesticide use patterns in the CCCEH Mother's and Newborn's study. For the intervention pilot, baseline samples including a pest sighting and pesticide use questionnaire, 2-week indoor air sample and pest infestation assessment were collected from cases and controls upon enrollment. In cases, the intervention began after baseline and consisted of three main components: extensive cleaning, low-toxicity pesticide application and behavioral/health education plan. Indoor air monitoring and pest infestation assessments were repeated for cases and controls 6–8 weeks following baseline. Maternal and cord blood samples were collected upon delivery. For the CCCEH study, a questionnaire including items on reported pest sightings and pesticide use during pregnancy was administered at enrollment. Participants are also asked about pesticide use annually until the child reaches age 36 months and biannually until the child reaches age 9 years. In the intervention pilot, there was a 59% decrease in total cockroach infestation among intervention households following the intervention ( $P$  = 0.016). Non-intervention households showed no significant cockroach reduction. Air levels of piperonyl butoxide were significantly reduced following the intervention ( $P$  = 0.016). Levels of cis- and trans-permethrin decreased marginally in post-intervention compared to pre-intervention air samples in the majority of homes, and increased slightly in non-intervention homes. Levels of three pesticides in plasma were significantly lower among intervention cases (1-isopropoxyphenol,  $P$  = 0.04, cis-permethrin,  $P$  = 0.03, and trans-permethrin,  $P$  = 0.003). In the CCCEH cohort, cross-sectional analysis suggests overall pesticide use in the cohort remains consistent over time (88% of subjects report use during pregnancy), and high toxicity pesticide use has increased (from 47% in 2000 to 74% in 2006). Results indicate that IMP can be successful at reducing pest infestations and residential pesticide exposure; however, they are an ongoing problem in this cohort.

#### ISEE-S19-05

##### Reporting Individual-level Exposure Measurements to Participants in Intervention Studies for Emerging Contaminants

Brody JG,\* Altman RG,† Morello-Frosch R,‡ Brown P,† Adams C,† and Rudel RA,\* \*Silent Spring Institute, Newton, MA, USA; †Brown University, Providence, RI, USA; and ‡University of California, Berkeley, CA, USA.

**Abstract:** Individual-level intervention studies pose particular challenges for researchers to report results to study participants. In the past, researchers typically reported individual results only when a finding was judged clinically significant: when there was an established safety criterion and health recommendation for findings above the criterion. Increasingly, community research contexts draw on “right to know” principles that call for more complete reporting of individual results. Planning report-back in these studies requires new informed consent protocols and communications that address scientific uncertainty about relationships between exposure and health and about options for exposure reduction. We report on our methods and experience reporting individual results for 89 endocrine disruptors in air, dust, and urine; interviews with 30 of our participants who received their own results; and 25 interviews with other researchers who have conducted individual exposure report-back. Well-designed individual report-back methods in intervention studies can be an important motivator for study participation and exposure reduction behavior and improve science literacy more generally.

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**ISEE-S20****New Approaches for Addressing Microbial Exposure Assessment**

**Purpose:** A 1 ½ hour symposium describing improved methods for assessing exposure to waterborne pathogens which could also be used for epidemiological investigations. Co-sponsored by the International Society for Environmental Epidemiology (ISEE) and the International Society of Exposure Analysis (ISEA).

**Abstract:** Recent research developments have led to more meaningful procedures for conducting microbial exposure assessments. There is a growing trend to define exposure to microbial pathogens in terms a host response rather than the highly uncertain approach of detecting and identifying pathogens in water matrices. Techniques for using non-invasive specimens, such as saliva in place of sera, have provided access to larger and broader study populations because of the ease of obtaining specimens. Highly discriminating cellular immune systems for identifying contact between host and pathogens may support or sometimes replace the antibody based immune systems in common use. The process of identifying pathogens in water by determining the presence of microbial genes that code for virulence may soon be replaced by cell culture systems that identify pathogens by the profiles they elicit in human cells. This session will describe some of the new approaches that are being developed and evaluated for assessing human exposure to pathogenic microbes. One of these approaches substitutes analyses of saliva for secretory antibodies for the traditional, more invasive, serum antibody analyses. Another approach is the measurement of interferon gamma to determine previous exposure to waterborne pathogens. Whole blood specimens are challenged with specific antigens to determine previous exposure to that antigen. This approach lends itself to the measurement of multiple of antigens with a single blood specimen. Another new approach is the measurement of gene expression by host cells exposed to a suspected pathogen. Gene expression profiles used in conjunction with occurrence studies may result in more meaningful data on microbial pathogenicity and the differentiation of virulent and non-virulent strains of the same microbial species. This approach provides meaningful results without resorting to a battery of tests for known virulence factors or use of animal models. The concept of initiating microbial exposure assessment with the populations at risk will provide a higher degree of certainty than the traditional approach of assessing human exposure to microbes. The final approach to be discussed is a DNA sequence-based technique that can establish or refute a putative epidemiologic link between pathogens isolated from patients and organisms isolated from the environment. The presentations of this symposium will add to the armamentarium for measuring exposure to microbial hazards. These methods are suitable for use in epidemiological investigations as well as exposure assessments.

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**ISEE-S20-01****Application of a Multiplex Immunoassay for Detection of Salivary Antibody Responses to Selected Potentially Waterborne Pathogens**

Hunt S,\* Fout GS,\* Chen I,\* Wade TJ,† and Egorov A,\* \*U.S. EPA, Cincinnati, OH, USA; and †U.S. EPA, Research Triangle Park, NC, USA.

**Abstract:** Pathogen-specific antibodies in saliva can be used as bioindicators of recent or ongoing infection. Because collection of saliva is easy and painless, immunoassays designed to detect antibodies in oral fluid can be used in prospective studies. This project involves the development and validation of a multiplex microbead immunoassay for salivary IgA and IgG responses to Cryptosporidium, noroviruses (VA387 and Norwalk), rotaviruses (WA and DS1), Toxoplasma gondii, Helicobacter pylori, and Giardia lamblia. Paired saliva and serum samples from EPA volunteers were analyzed for antibody responses to T. gondii and H. pylori using this salivary assay and diagnostic serological ELISAs. The results demonstrated that salivary antibodies could be used for detection of these infections. The prospective analysis also identified immunoconversions to noroviruses that followed episodes of vomiting and diarrhea. Total antibody and protein concentrations were measured to control for variability in saliva composition. This multiplex assay is being used in an ongoing study in Massachusetts to characterize the incidence of potentially waterborne infections before and after the introduction of improved drinking water treatment.

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**ISEE-S20-02****Development and Evaluation of Salivary Antibody Assays for Enteric Viruses**

Moe CL, Leon JS, and Liu PB, *Hubert Department of Global Health, Emory University, Atlanta, GA, USA*.

**Abstract:** Simple diagnostic tests are needed to identify enteric virus infections in population-based studies. Because of the difficulties and risks associated with collecting serum and stool samples, salivary antibody assays provide an attractive alternative to studying viral infections—especially in susceptible pediatric populations. We will describe the development of a salivary antibody assay for Norwalk virus that we successfully applied to a norovirus outbreak investigation in an elementary school. We have also collected and tested serial salivary samples from human volunteers in norovirus challenge studies, infants with lab-confirmed rotavirus infection and students who received hepatitis A virus vaccines from the student health clinic. Saliva collection and processing methods, enzyme immunoassay formats, antigen sources and results from these experiments will be presented.

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**ISEE-S20-03****Interferon Gamma as a Biomarker of Exposure to Enteric Viruses**

Dufour AP, and Li L, *U.S. EPA, Cincinnati, OH, USA*.

**Abstract:** Interferon gamma (IFN- $\gamma$ ) was selected as a biomarker for viral exposure. Twelve-week-old BALB/c mice were intraperitoneally injected with Coxsackievirus B3 or B4 diluted in phosphate-buffered saline (PBS). Control mice were injected with PBS only. Four months after viral infection, T lymphocytes were isolated from mouse thymus and spleen. T lymphocyte release of IFN- $\gamma$  was examined after *in vitro* incubation with viral antigens, a mitogen, PHA and PBS respectively. The level of IFN- $\gamma$  released by T lymphocytes was examined by antibody-capture chemiluminescent ELISA. A marked increase in level of IFN- $\gamma$  was observed when T cells from Coxsackievirus B3-infected mice were incubated with B3 virus but not B4 or PBS. This indicated that Coxsackievirus B3-sensitized T cell receptor recognized only T cell epitope from B3 virus not B4. Coxsackievirus B4 primed mouse T cells did not release IFN- $\gamma$  when they were incubated with B3 virus or PBS.

Our results showed that IFN- $\gamma$  produced by primed memory T cells is virus-specific. The data also show that memory T cells can distinguish very structurally related Coxsackievirus B3 and B4 when the sensitized T cells were directly stimulated by the viruses *in vitro*. The results of this study may be extended to human exposure studies related to microbial pathogens.

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**ISEE-S20-04**
**Evaluating Virulence of Waterborne Bacteria Isolates Using Gene Expression**

Hayes S, U.S. EPA, Cincinnati, OH, USA.

**Abstract:** If a goal is to someday replace animal models for determining virulence of waterborne pathogens, then any developed approach will likely be multifaceted. To assess the virulence of *Aeromonas* spp. using animal (murine) and cell tissue (murine and human) models, artificial infections with a variety of *Aeromonas* spp. were performed. After five hours, mRNA extracts from each test system were processed and hybridized to murine and/or human microarrays to determine host gene response. Virulence was first defined based on host mRNA response in murine neonatal intestinal tissue and on animal mortality. After a virulence designation was given to each strain based on neonate testing, infections of mouse intestinal cell cultures were then performed to determine whether this simpler model system's mRNA responses correlated to neonatal results and therefore be predictive of virulence of *Aeromonas* spp. Virulent aeromonads up-regulated transcripts in both models including multiple host defense gene products (chemokines, regulation of transcription and apoptosis, cell signaling). Avirulent species exhibited little or no host response in neonates. Mortality results correlated well with both bacterial dose and average fold change of up-regulated transcripts in the neonatal mice. Cell culture results were less discriminating but showed promise as potentially being able to be predictive of virulence. Jun oncogene up-regulation in murine cell culture is potentially predictive of *Aeromonas* virulence. Once a correlation was established between the murine cell culture and live animals in terms of mRNA response, the next step was to infect a human cell line. Cell culture data were collected after infecting a human adenocarcinoma cell line (Caco-2) that represented colonic epithelial cells. Jun transcripts were also upregulated in human cell cultures infected with virulent *Aeromonas* spp. Having the ability to determine virulence of waterborne pathogens quickly would potentially assist public health officials to rapidly assess exposure risks.

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**ISEE-S20-05**
**Molecular Tools for Typing *Mycobacterium Avium-intracellulare* Organisms**

Behr MA, McGill University, Montreal, QC, Canada.

**Abstract:** Molecular methods for typing pathogenic Mycobacteria can be divided between classification and tracking tools. Classification tools permit one to assign an unambiguous species, sub-species or lineage, providing a stand-alone designation for an isolate. This designation can be employed directly in an analytic framework, such as assessing for virulence as a function of the genotype. In contrast, tracking tools rely on mobile genetic markers, but provide only comparative results. The output, such as an RFLP pattern, is only useful when compared to others, from which one draws the conclusion that the isolate is matched with another in the dataset or unique, hence epidemiologically unrelated. Different *M. avium-intracellulare* tracking methods are available to compare small numbers of organisms. However, in the absence of an overall population structure, it is difficult to infer whether organisms should be compared, and assignments of sub-species are based on confusing combinations of

PCR reactions potentially leading to unreliable designations. Our laboratory became interested *M. avium-intracellulare* typing to derive a foundation to overlay the extensive genomic variability detected by microarrays. Turning to a more conventional genetic approach, we uncovered a number of polymorphisms in housekeeping genes that provided a phylogenetic portrait of these organisms and informed on the nature of genetic variability. We found that *M. intracellulare* is genetically distinct from *M. avium*, which is comprised of three principal lineages. *M. avium hominissuis* is genetically heterogeneous and represents the diverse collection of *M. avium* typically encountered in environmental settings. In contrast, *M. avium paratuberculosis* and *M. avium avium* have restricted genetic diversity and appear to represent host-associated pathogens (livestock and birds respectively). The polymorphisms we found permit a rapid unambiguous classification of isolates through a sequence-based approach that lends itself readily to inter-laboratory comparisons. Given the high degree of genetic diversity in these organisms, sequence-based typing should help establish or refute a putative epidemiologic link. A direct comparison between this method and others is now indicated to assess their relative strengths as epidemiologic tools.

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**ISEE-S21**
**Challenges and Opportunities for the Use of Source Apportionment Methods in Air Pollution Epidemiology**

**Abstract:** Ambient particulate matter (PM) is a complex mixture of chemicals derived from multiple sources. More specifically, PM is comprised of both inorganic and organic materials of natural and anthropogenic origin. Given this complexity, attempting to determine which sources and components may be of most concern from a health standpoint is challenging. Source apportionment (SA) can be of great value in attempting to link health endpoints with specific pollutant sources. "Source apportionment" broadly refers to a number of methods, including positive matrix factorization (PMF), chemical mass balance (CMB), inorganic and organic tracer methods, and the consideration of specific components to qualitatively represent sources. This symposium brings together environmental exposure assessors, epidemiologists and air pollution modelers. The first two speakers will focus on the use and limitations of several SA methodologies with a specific emphasis on their potential application in air pollution epidemiological models. Schauer will discuss the use of tracer methods in epidemiological settings, covering both organic and inorganic species. Russell will present data describing a novel method for apportioning PM from traffic sources and using results from this approach in an ongoing time series analysis. The next four speakers in the session will highlight results from some of the few epidemiological analyses that have used SA techniques and lessons learned from these efforts. Sarnat will present results from Atlanta, GA, where PMF, CMB, and tracer techniques were applied to emergency department visit data for respiratory and cardiovascular disease. Ito will explore the issues associated with the analysis and interpretation of results from studies utilizing speciated PM data. Ostro will then present findings from the CALFINE study, which looked at health effects in six California counties and linked them to PM components. Finally, Wyzga will present results from mortality studies in Phoenix, AZ and St. Louis, MO, comparing and contrasting the component and PMF approaches. Participants in this symposium will be provided with varied and novel perspectives on the application of SA methodologies in air pollution epidemiology, and will be presented with recent epidemiological results employing these methods. Importantly, all of the speakers will be asked to address areas of greatest uncertainty and promise in the use of SA methods in epidemiologic analyses.

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**ISEE-S21-01****Strategies for Integrating Advanced Chemical Analysis Measurements into Epidemiological Studies**

Schauer JJ, University of Wisconsin, Madison, WI, USA.

**Abstract:** The opportunities for integrating advanced chemical measurements of particulate matter into exposure assessment and epidemiology studies will be presented. The presentation will focus on opportunities for using molecular markers, particle-phase organic compounds that serve as source tracers, and metals speciation techniques in health studies. Epidemiological studies can use these measurements using two basic strategies: 1) as primary metrics of source impacts, which can be used to assess the relationships between sources and health outcomes; and 2) as input to source apportionment models that can generate more formal source impact data that can be used as inputs to epidemiological analyses. Examples of how these analytical tools have been used in the past to quantify human exposures to particulate matter and how they have been adapted to make long time series of measurements that can support epidemiological studies will be presented. Such examples include the generation of daily concentrations of molecular markers for a two year time series at the St. Louis Midwest Supersite, which was made possible by the development of lower cost methods for molecular marker analysis including thermal desorption gas chromatography mass spectrometry (TD-GC/MS). The over 700 daily measurements of select molecular markers have been used in source apportionment models and will be used in the near future for an epidemiological study. In another study, daily water-soluble metals were measured for a full year in Denver and used in a source apportionment model. The results of source apportionment models were shown to correlate with reactive oxygen species generation from a cellular macrophage assay used to assay the same extracts used for the water-soluble metals analysis. Additional examples will be presented that include the adaptation of molecular marker measurements to personal exposure samples and the use of wet chemical methods to measure the oxidation states of select metals in personal exposure samples. The goal of the talk will be to present new opportunities for integrating source specific measurements. The opportunity to directly integrate these same chemical measurements into toxicological assays, which can provide linkages between future epidemiological studies and toxicological studies, will also be presented.

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**ISEE-S21-02****Development of Novel Source Indicators for Linking Air Quality Data with Health Endpoints**

Russell A, Georgia Institute of Technology, Atlanta, GA, USA.

**Abstract:** There are a number of reasons to elucidate the link between health endpoints with specific sources of air pollution, in addition to establishing associations with atmospheric pollutant concentrations. First, we control sources, so such knowledge is directly applicable to air quality management. A second reason is the inability to fully characterize the range of pollutants present in routine ambient measurements. This is especially true for particulate matter (PM) species, including individual organics and the metal oxides. The primary etiologic agents may not even be quantified, particularly by routine measurements. Our studies indicate a stronger association between PM from mobile sources with cardiovascular disease outcomes compared to other PM sources in Atlanta, GA (e.g., the RR for CVD from mobile sources are 1.02–1.03 per IQR, while for soil and sulfate it is about 1), though they also suggest that current approaches to source apportionment of air pollutants may introduce additional issues. In our analyses, “other organic aerosol” concentrations found from source apportionment behaves similar to that expected for SOA (e.g., association with other photochemical species), and has an elevated association with

CVD (RR~1.015). However, the methods are not currently available to measure SOA directly. We are developing a series of novel indicators that blend various measures of emissions estimates, air quality and health outcomes to assess the impacts of sources. Approaches such as ensemble averaging and optimal profile development are being applied to provide more realistic day-to-day source impacts. Ensembling results are correlated with source apportionment results from traditional approaches ( $r^2\sim 0.9$ ), but decreases the tendency to suggest that some sources have no contribution on some days. This presentation will discuss limitations in apportionment methods as applied to health association studies, the development of indicators of motor vehicle air quality and health impacts and how ensemble methods impact day-to-day source impact quantification. Such new methods are designed to be used in future health studies, both to provide improved estimates of source-health associations and levels of uncertainty introduced by using alternative indicator and source apportionment results.

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**ISEE-S21-03****Fine Particle Sources and Cardiorespiratory Morbidity: An Application of Chemical Mass Balance and Factor Analytical Source Apportionment Methods**

Sarnat JA, Emory University, Atlanta, GA, USA.

**Abstract:** Interest in PM health effects has focused on identifying sources of particulate matter (PM) that may be associated with adverse health. Few epidemiologic studies, however, have included source apportionment estimates in their examinations of PM health effects. We analyzed a time-series of chemically-speciated PM measurements in Atlanta, GA, and conducted an epidemiologic analysis using data from three distinct source apportionment methods. Atlanta is a unique location for conducting this type of health effects study given the existence of an extensive time-series of daily speciated  $\text{PM}_{2.5}$  measurements and corresponding hospital records. The key objective of this analysis was to compare epidemiologic findings generated using both factor analysis and mass balance source apportionment methods. We analyzed data collected between November 1998 and December 2002 using positive-matrix factorization (PMF), modified chemical mass balance (CMB-LGO), and a tracer approach. Emergency department (ED) visits for a combined cardiovascular (CVD) and respiratory disease (RD) group were assessed as endpoints. Results. There were significant, positive associations between  $\text{PM}_{2.5}$  concentrations to mobile sources (RR range: 1.018–1.025) and biomass combustion, (RR range: 1.024–1.033) source categories and CVD-related ED visits. Associations between the source categories and RD visits were not significant for all models with the exception of sulfate-rich secondary  $\text{PM}_{2.5}$  (RR range: 1.012–1.020). Generally, the epidemiologic results were robust to the selection of source apportionment method. Conclusions. Despite differences among the source apportionment methods, these findings suggest that modeled source apportioned data can produce robust estimates of acute health risk. In Atlanta, there were consistent associations across methods between  $\text{PM}_{2.5}$  from mobile sources and biomass burning with both cardiovascular and respiratory ED visits and between sulfate-rich secondary  $\text{PM}_{2.5}$  with respiratory visits. Moreover, combining multiple source apportionment methods adds information that compensates for limitations of relying on any single method. The implications of using one or several methods for understanding the sources of  $\text{PM}_{2.5}$ -mediated health risks will also be addressed.

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**ISEE-S21-04****Issues in the Interpretation of PM Components' Associations with Health Outcomes**

Ito K, New York University School of Medicine, Tuxedo, NY, USA.

**Background:** Uncertainty remains as to which component(s) of particulate matter (PM) are most responsible for observed associations between PM and various health outcomes. However, estimating and interpreting each PM component's individual risk is not straightforward because these components can have varying extents of spatial and temporal variations across cities. Also, the extent of correlation between these components and other covariates in the health effects regression models can vary. These issues need further evaluation. Objective: To systematically characterize the factors that influence risk estimates of individual PM components.

**Methods:** We retrieved US Environmental Protection Agency's nationwide fine PM ( $PM_{2.5}$ ) chemical speciation data for the years 2000 through 2006. We examined 15 key  $PM_{2.5}$  components (As, Cr, Cu, Fe, Pb, Mn, Ni, Se, V, Si, Zn, organic carbon, elemental carbon, nitrate, and sulfate) in 30 candidate cities for characteristics including their analytical uncertainties, signal-to-noise ratios, within-city spatial variation and monitor-to-monitor temporal correlation where multiple monitors were available, and day-of-week, and seasonal pattern.

**Results:** We found that the ranges of these characteristics varied across  $PM_{2.5}$  components, and for some components, they also varied across cities. For example, in the 17 cities where multiple monitors existed, monitor-to-monitor temporal correlations (computed when at least 100 days of overlapping observations were available) for some  $PM_{2.5}$  components (e.g., sulfate and nitrate) were consistently high (median  $r > 0.9$ ), consistently low for others (e.g., Cr with median  $r < 0.1$ ), whereas for other components (e.g., Zn), the correlations varied greatly across cities. Some of these patterns are consistent with their corresponding differences in signal-to-noise ratios, whereas others appear to be due to the influence of local source impacts. Likewise, we found varying extent day-of-week and seasonal pattern across  $PM_{2.5}$  components, and for some components, across cities.

**Discussion:** These spatial and temporal variations in characteristics across PM components complicate a comparison of relative strength their associations with health outcomes, but they also provide important information to aid in the interpretation of association causalities.

#### ISEE-S21-05

##### The Acute Effects of Fine Particle Species on Cardiovascular Hospital Admissions in California

Ostro B, *California OEHHA, Oakland, CA, USA*.

**Abstract:** Epidemiological studies have demonstrated an association between acute exposures to particulate matter less than 2.5 microns in diameter ( $PM_{2.5}$ ) and daily mortality. Few, however, have examined fine particles and hospitalization. In addition, little is known about the relative impacts of the specific constituents of the particle mix and whether differential impacts occur by race/ethnicity. We examined associations between 11 components of  $PM_{2.5}$  and hospital admissions in six California counties. We obtained daily hospitalization counts for cardiovascular disease from 1999–2003, as well as data on  $PM_{2.5}$  and its constituents, including elemental and organic carbon (EC and OC), nitrates, sulfates, and several metals. Relationships of these constituents were examined for all cardiovascular disease and several disease-specific outcomes. In addition, several disease categories were stratified by race/ethnicity to investigate potentially sensitive subgroups. A time series analysis using Poisson multiple regression models incorporating natural splines were used to control for time-varying covariates. County-specific estimates were obtained and then combined in meta-analyses using random effects models. Pollutant lags of 0 and 3 days were considered. Concentrations of  $PM_{2.5}$  and several of its components including OC, EC, nitrates, sulfates, iron and zinc, were associated with one or more of the outcomes including all cardiovascular hospital admissions, ischemia and MIs, but not with stroke, heart failure or dysrhythmias. In addition, there was evidence of some sensitivity by race/ethnicity. For example, exposure

to unlagged nitrates, which make up about 30 percent of the fine particulate mass in our study sample, was associated with cardiovascular admissions for Blacks and Hispanics, but not Whites. The excess risks per interquartile range of  $6 \mu\text{g}/\text{m}^3$  for these groups at lag 0 were 4.2% (95%CI = 1.1, 7.4;  $P < 0.05$ ), 2.0% (95%CI = -0.2, 4.2;  $P = 0.07$ ) and 0.6% (95%CI = -0.7, 1.8;  $P > 0.10$ ), respectively. This multi-county analysis provides new evidence of adverse effects of specific components of particulate air pollution. Many of the components associated with hospital admissions are associated with combustion sources. In addition, there is evidence of differential effects by race and ethnicity.

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#### ISEE-S21-06

##### Comparison of Source Apportionment Approaches for Mortality Data for St. Louis, MO and Phoenix, AZ

Wyzga RE, *Electric Power Research Institute, Palo Alto, CA, USA*.

**Abstract:** In the epidemiological setting there are two general approaches to consider multiple pollutants: direct consideration of measured components and the definition of pollution indices. Both approaches can be used to examine the relationship between pollutants and health endpoints. In an effort to understand how to exploit and utilize these two approaches, they were applied to two geographic areas where extensive air quality data are available, St. Louis and Phoenix. The Phoenix data were analyzed by undertaking Poisson regression analysis to evaluate associations between daily mortality and pollution levels, adjusting for time trend, temperature, dew point and day of week. Analyses were undertaken for total non-accidental mortality 1995–1997 as well as major cases of death. The most sensitive results were for cardiovascular deaths among the 65+ age group. Several components of air pollution were considered in the analyses. In single pollutant models,  $PM_{2.5}$ ,  $PM_{10}$ ,  $PM_{coarse}$ , CO,  $SO_2$ ,  $NO_2$ , OC, and Ca showed significant positive associations with cardiovascular mortality. Two-pollutant models were run in an effort to see if any particular pollutants dominated the results. When PM measures were considered with gases, the PM measures, especially coarse PM, dominated. Two major methods were then used to obtain pollution indices often referred to as source factors: UNMIX and PMF. For UNMIX none of the factors were associated significantly with daily mortality. The PMF approach identified two possible factors, one of which gave inconsistent results, leaving one factor as being significantly associated with cardiovascular mortality. Examination of the factor loadings indicated that the major components were Na, Cl, and EC. These individual components were examined singly as predictors of cardiovascular mortality; results suggested that the factor results were driven by the chloride ion. It is not clear what the source of the chloride ion is, if chloride itself is the agent of interest, if it is a surrogate for some unmeasured component, or if the result is an analytical artifact. The component-based and source-based approaches suggest different concerns vis-à-vis air pollution and health. Both approaches, applied in concert, can provide additional clues about those pollutants that are responsible for health concerns.

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#### ISEE-S22

##### Addressing Challenges in Study Design and Methods for the National Children's Study

**Abstract:** The National Children's Study (NCS) will examine the effects of environmental influences on the health and development of more than 100,000 children across the United States, following them from before birth until age 21. Because a key study objective is to assess the impact of exposures that occur early in pregnancy, the study was designed as a prospective birth cohort study in which women who become pregnant will be recruited early in pregnancy. The Study plan is to select a sample of women of child-bearing age, to request that each eligible woman

participate in the Study, and to follow these women over four to five years. If an eligible woman becomes pregnant, information will be collected during her pregnancy. The collection of mother's information will begin as early in the pregnancy as possible and, at the time of birth, her child will be enrolled in the sample of children. The Study will be based on a national probability sample utilizing a multi-stage cluster sampling design. Eligibility for the study will be determined based on the woman's residence within defined geographic areas within counties, called segments. Recruitment will primarily be through household sampling in the sampled segments or neighborhoods. Because of the neighborhood based sampling design, the Study investigators will have to undertake extensive and effective community outreach and engagement in order to achieve high recruitment and retention rates over the course of the longitudinal study. The Study will involve collection of questionnaires, diaries, physical measures, biological specimens, and environmental specimens at multiple points in time during pregnancy, at the time of birth, and periodically until the child is 21 years of age. Data collection will take place in the participants' homes and neighborhoods, and in clinics and the birthing hospitals. Because the Study is the largest and complex study of its kind ever undertaken in the United States, the Study has presented many unique challenges in developing the study design and methods. This symposium will discuss some of the key challenges in epidemiology and exposure assessment being addressed by the National Children's Study. Following an overview of the NCS, the presenters will discuss the strategy and methods used for the multi-stage cluster sampling of neighborhoods (segments); the strategy, methods, and initial lessons learned for community outreach and engagement; the rationale, strategies, and methods for exposure assessment; and the strategies and challenges for outcome measurement.

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**ISEE-S22-01****Overview and Current Status of the National Children's Study**

Quackenboss J, U.S. Environmental Protection Agency, Las Vegas, NV, USA.

**Abstract:** The National Children's Study (NCS) will examine the effects of environmental influences on the health and development of more than 100,000 children across the United States. The NCS will be based on a national probability sample, utilizing a multi-stage cluster sampling design. In the first stage, 105 primary sampling units (PSUs)—generally single counties—were selected. The second stage will select smaller geographic areas—segments—within each PSU. The Study will identify and follow eligible women in the sampled segments over four to five years. If a woman becomes pregnant, she will be asked to enroll in the cohort study. Study hypotheses were used to guide development of the design and sample size, and for selection of measures. The NCS will involve collection of questionnaires, diaries, physical measures, biological specimens, and environmental samples at multiple points in time during (or before) pregnancy, at the time of birth, and periodically until the child is 21 years of age. Data collection will take place in the participants' homes and neighborhoods, in clinics and the birthing hospitals, and through telephone or other communications. Planning for the NCS had taken many years. The NCS Program Office (PO) is based within the Eunice Kennedy Shriver National Institute for Child Health and Development (NICHD). The Inter-agency Coordinating Committee (ICC) includes representatives from the EPA, the CDC, and the NIEHS. The NCS Program Office selected seven initial Study Centers (called Vanguard Centers) and the Coordinating Center in 2005. The PO, ICC, Coordinating Center, and Vanguard Centers have collaborated in revising the hypotheses and finalizing the protocol and operational plans. In 2007, the number of study centers was expanded by 17 to conduct the Study in 40 additional locations. In 2008, the NCS plans to select additional Study Centers. The NCS Research Plan has been peer-reviewed by the National Academy of Sciences, the ICC agencies, and the Office of Management

and Budget. This presentation will describe challenges encountered in planning and implementing the Study, and provide an update on the Study's current status. Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy. \*On behalf of the NCS Interagency Coordinating Committee and the NCS Program Office.

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**ISEE-S22-02****Strategies and Methods for Population-based Sampling in the National Children's Study**

Baker D, University of California, Irvine, CA, USA.

**Abstract:** The National Children's Study will be based on a national probability sample using a multi-stage cluster sampling design. The first stage of sampling was the selection of primary sampling units (PSUs), which correspond to single counties or groups of contiguous counties. The second stage is the selection of smaller geographic areas (segments) from within the PSU. The segments are "clusters" of households based on US census blocks. Prior to the formation of segments, a target number of sampled segments is established. This number is primarily based on operational considerations and varies between PSUs. For most PSUs, the number of sampled segments will be between 10 and 15. In general, a smaller number of segments are targeted in more rural, less densely populated PSUs that cover large areas; in more densely populated PSUs with larger numbers of births, the number of sampled segments may be larger. Prior to segment sampling, the PSUs are divided into strata (or grouping of segments) that represent natural spatial-political subdivisions of the PSU (e.g., a city within a county). The Coordinating Center and Study Centers will use data such as expected number of births by block and major geographical or regional characteristics such as health regions to determine the stratification scheme. Within a stratum, the segments will be created by the Coordinating Center such that the number of expected births is as equal as possible in all segments included in that stratum. An equal probability sample of segments will be selected by the Coordinating Center. The Study Centers play an essential role in the segment formation. The initial segments will be created by the Coordinating Center, but the Study Centers will review and comment on the segments prior to sampling of the segments by the Coordinating Center. The purpose of the Study Center review is to utilize their knowledge of the local area to make sure the segment boundaries are as consistent as possible with natural neighborhood boundaries and to ensure that the segments are approximately equal in expected number of births. Once the Coordinating Center and the Study Center accept the segment definitions, the Coordinating Center will select the sample of segments and provide it to the Study Center.

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**ISEE-S22-03****Community Outreach and Engagement for the National Children's Study**

Winseck K, National Children's Study, NICHD, Bethesda, MD, USA.

**Abstract:** The National Children's Study is a community-based prospective cohort study that will require substantial respondent burden over many years. Eligibility is based on the woman's residence within sampled geographic areas, called segments, within 105 primary sampling units (PSU) across the country. Because of this sampling design, the Study must conduct extensive community outreach and engagement in order to achieve high recruitment and retention rates. Since the beginning of planning, the NCS has undertaken a range of community engagement activities to lay the groundwork for Study Center activities. Between 2000 and 2005, the NCS conducted many focus groups to obtain community perspectives on informing communities about the NCS, gaining the support of communities, recruiting and retaining participants, and NCS

sampling and visits. Additionally, the establishment of working groups, the Study Assembly, and the Federal Advisory Committee allowed ongoing community input into the Study plans. The Vanguard Centers are working within local communities to prepare for recruitment. Study Centers will continually share experiences with and learn from each other in implementing community engagement plans. To build trust, enhance the credibility of the Study, and ensure community engagement on the local level, during the initial years of the Study Center investigators have conducted community needs assessments to identify children's environmental health issues in the target community. These assessments have focus on community concerns regarding the core NCS protocol and additional concerns that may be considered for inclusion in the study protocol. Community activities include identification of community representatives and resources and recruitment of community partners to facilitate engagement. Examples include advance contact with community leaders to gather information about the community, town meetings, and listening sessions. Reliance on secondary data sources like environmental and geographic data can enhance these activities. Previous studies have shown the importance of involving community members, either in the actual data collection for the study or as liaisons to special populations such as the medically underserved. These approaches will be utilized at the Study Centers to the extent possible.

**ISEE-S22-04****Challenges and Strategies for Exposure Measurement in the National Children's Study**

Dellarco M,\* and Viet S,† \*National Children's Study, NICHD, Bethesda, MD, USA; and †WESTAT, Rockville, MD, USA.

**Abstract:** The National Children's Study will examine relationships between environmental exposures and various health and developmental outcomes at specific points in a child's life. Therefore, the exposure assessment must consider how to measure or estimate exposures of varying kinds during the child's different developmental phases. Environmental effects could result from exposures either prior to, or concurrent with, outcomes. Furthermore, there may be times in children's development when they are differentially susceptible to the effects of an exposure. Because of the prospective study design, the NCS can examine both the overall effects of exposure and susceptibility within each life stage. Many aspects of the NCS have important implications for the collection of exposure measures. These include the Study's size, scope, and duration; geographic dispersion and timing of visits; and the varied socioeconomic and demographic characteristics of the study population. These characteristics present challenges in the selection and collection of environmental and biological media, necessitating consideration for the type, performance characteristics, burden and cost of biological and environmental sampling devices; the stability of biological and environmental samples; acceptability of sample collection procedures to various segments of the study population; and, availability and suitability of local environmental data to complement environmental measurements. Perhaps most challenging is combining these data with other information such as questionnaires, diary reports, and physical and visual assessments of the neighborhood to estimate exposures and to assess their significance to both psychosocial development and health outcomes in study participants. Many of the environmental samples and biospecimens will be stored so they can be analyzed later in targeted NCS population segments or in nested case-control studies. This practice maximizes the efficient use of finite samples for future analyses that will be driven by the evolution of research questions, advances in analytic techniques, and availability of funding.

**ISEE-S22-05****Challenges and Strategies for Outcome Measurement in the National Children's Study**

Fields NA, U.S. Environmental Protection Agency, Washington, DC, USA.

**Abstract:** The NCS is designed to address many of the complex chronic illnesses and common injuries that afflict children across the United States. There is mounting concern that overall, children in the US are developing susceptibilities and chronic illnesses early in life, potentially modifying their health and development trajectories. The Study's 21 year, longitudinal design will allow investigators and community partners to develop a clearer understanding of how genetic, environmental and societal factors shape the health, wellness or illness of children. An interconnected framework of core hypotheses helps focus the NCS around a set of priority exposures and priority health outcomes. These outcomes stretch across the developmental stages of children from birth through late adolescence. Priority outcomes include preterm births, asthma, injuries, obesity, type-2 diabetes, neurodevelopmental disorders—such as mental retardation, ADHD, schizophrenia, and autism—and birth defects such as hypospadias and cardiac defects. The priority outcome areas were chosen because of their importance to public health, and because a study with the scope and magnitude of the NCS is required to understand their origins and course. There are several key challenges in conducting health assessments and ascertaining diseases in a cohort of 100,000 children assessed in decentralized clinical and household settings. For instance, given the Study's large scope, there is a need to minimize participant burden and measurement costs. Medical records and physician diagnosis, though reliable, will likely present considerable variation in recorded ascertainment, particularly for diseases which develop progressively and which present multiple phenotypes. Medical records may also prove incongruent with the assessments and indicators collected by the Study over the course of multiple visits. For some outcomes (e.g., physical maturation and social and emotional development), multiple batteries will be needed to assess the health and development of the child over time. The NCS will also incorporate the use of validated early biological markers of disease, though their analyses may follow the onset of disease in nested case-control designs. The NCS will encounter similar challenges in meeting other aims of the overall Study. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-S23****Global Assessment Lessons from Environmental Health Disasters**

**Abstract:** Across the globe, environmental health disasters do happen. Such events are both public health challenges and scientific opportunities. Although the initial focus of the public health community should always be on simply helping those affected by the unfortunate event, it is often possible to advance scientific knowledge even in the midst of assisting communities in chaos. However, too often this is not attempted except in the largest of environmental health disasters. Comprehensive human health effects of most industrial chemicals are poorly understood, primarily because it is unethical to perform medical research on humans which requires intentionally inflicting harm. Therefore, much of what we know about the health effects of hazardous chemicals comes from either observational epidemiological studies or toxicological studies in animal models or human tissues *in vitro*. Environmental health disasters, however, may provide a laboratory for observing health effects over a range of doses. Therefore, environmental health disasters can be studied as 'quasi-experiments' which, if done ethically and methodologically well, can generate scientific knowledge that is equitably as robust as a true experiment. This symposium will provide an innovative look at the common methodological issues in exposure assessment and outcome measurement within the environmental epidemiological study of different

types of environmental health disasters in Asia, Europe, and North America. First, Dr. V. Ramana Dhara will share how these issues came to play in the study of the Bhopal, India disaster of 1984 that impacted over 500,000 people. Second, Dr. Marina Naboka will discuss these issues in the context of her collaborative work studying an at-risk community severely exposed to residual radiation by the Chernobyl nuclear accident of 1986 which impacted millions. Lastly, Dr. Shao Lin will present the more recent work of the New York State Department of Health in their study of the communities impacted by the collapse of the World Trade Center. A better understanding of these common methodological issues will allow environmental epidemiologists and exposure assessors to leverage sound science from the more frequent smaller environmental health events and greatly broaden our knowledge of the human health effects of industrial chemicals.

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**ISEE-S23-01****Lessons in Outcome and Exposure Assessment from the Bhopal Gas Disaster**

Dhara VR, Rollins School of Public Health, Atlanta, GA, USA.

**Abstract:** The methyl isocyanate (MIC) gas leak from the Union Carbide plant at Bhopal, India in 1984 was the worst industrial disaster in history. Over 500,000 people were exposed and compensated for death and injuries from the gas leak. There were many methodological challenges to assessing the health effects of MIC in this population. Examination of the effects of exposures from the disaster after 10 years was undertaken among a cross-section of current residents. Factors contributing to variability in exposure include exposure duration, activity during exposure, and amount of protection their housing provided. Individual exposure estimation was done for gas victims by developing exposure indices based on activity, exposure duration, and distance of residence from the plant. Exposure-response relationships were examined using the exposure indices to determine which of these most strongly predicted health outcomes of respiratory and non-respiratory symptoms, and pulmonary function. Many of the exposed victims requested testing as part of the survey. The IMCB explained that selecting a random sample would satisfy scientific requirements by using a simple example (checking a single rice grain to determine if the whole pot was cooked). When a subject was selected for questionnaire administration, other members of the family wanted to enroll, also. The surveyor had to explain that only the selected subject could be the respondent to avoid a self-selection bias. Since our subjects were questioned 9 years after the accident, recall bias is certainly a major potential cause of exposure misclassification. Even though our interviewers emphasized to the victims that there was no link between our questions and compensation, factors such as lack of access to health care, psychological strain, and disappointment with official policies may have led to an increase in felt or reported symptoms. However, the observed decrease in symptoms with distance seen in the first IMCB study leads us to believe that disease misclassification from over-reporting, if any, was likely to be mostly non-differential. The strategies that we used to address the many methodological challenges within this study could easily help guide the exposure and epidemiological assessment of future environmental health disasters.

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**ISEE-S23-02****Influence of Local Environmental Conditions on Exposure and Child Morbidity after the Chernobyl Accident**

Naboka MV, Scientific Centre for Radiation Medicine, Kyiv, Ukraine.

**Abstract:** After the Chernobyl accident the Ukrainian population continued to receive substantial radiation doses due to their consumption of contaminated locally grown food, even in communities with relatively low levels of radioactive soil contamination. Many Ukrainian, Russian and

Belarusian scientists have shown increases of chronic gastritis and gastroduodenitis, ulcers of the stomach and duodenum, liver diseases, disorders of the gall-bladder and of biliary tracts, diseases of the pancreas, and dental caries in children consuming locally grown food in contaminated areas. Atrophy of stomach mucous was found 5 times and intestinal metaplasia 2 times more frequent in the residents of the exposed group than in the control group. One of the most debatable issues following the publication of the Chernobyl forum was an attempt to limit the medical consequences after the Chernobyl accident to only the mortality from cancers, practically ignoring the publications citing the excess of non-cancer morbidity in the populations of children residing in the territories contaminated after the Chernobyl accident. We studied the influence of soil-geochemical conditions on food dose and it's associated non-cancer morbidity during the 20 year period after the radiation accident. In our studies, we found that the coefficient of  $^{137}\text{Cs}$  food migration in acidic soils was 3 to 5 times higher than in neutral-alkaline soils. However, the total soil concentrations for the settlements located in territories with acid and neutral-alkaline soils essentially did not differ. In two independent studies we found linear relationships between increased gastrointestinal morbidity in children and cesium dose in different radio-contaminated territories where soils facilitate radioactive cesium migration into plants. This indicates that radiation exposure after the Chernobyl accident was directly associated with non-cancer gastrointestinal morbidity in children. This study, also, showed that the existing models to calculate dose need the correction for soil-geochemical conditions.

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**ISEE-S23-03****Methodology Challenges and Strategies on Assessing Respiratory Health Among the Residents Living Near the Former World Trade Center**

Lin S, NY State Department of Health, Albany, NY, USA.

**Abstract:** We investigated changes in respiratory health after September 11, 2001 (9/11) among the residents of the area near the former World Trade Center (WTC) in New York City. However, there were considerable challenges to conducting this study including a lack of existing baseline health data and objective exposure data for participants, possible selection biases due to community concerns regarding health and residents' mobility patterns after 9/11, recall bias due to self-reported health information, and potential unmeasured confounding effects. We anticipated and attempted to address these issues either by design or in the analysis. The eligible study population for this retrospective cohort study included ~9,200 residences within 1.5km of the former WTC (affected area), and ~1,000 residences in upper Manhattan more than 9km from the site (control area). Because no direct exposure measurements were available, an exposure proxy was used (residential distance from the WTC site). To minimize selection bias and improve response rate, participation was encouraged among individuals with or without breathing problems, demographics between the respondents and the underlying population were compared, and exclusion criteria was used to minimize differential selection by study area. Recruitment was also intensified in specific 'target' areas to improve response in order to evaluate participation bias. Information bias due to recall was minimized by asking symptoms quantitatively, assessing relatively objective measures, and examining WTC-unrelated variables. The response rate was similar in both the affected and control areas. Target area analyses showed that diseases were consistently higher in both the targeted and non-targeted affected areas, reducing concerns about selection bias. This is one of the largest among the few studies to investigate respiratory health among the residents of lower Manhattan after 9/11. The methodological problems encountered in examining such an unprecedented event and the strategies used to address various biases in the design, outcome, and exposure assessment phases of this study may help public health practitioners in disaster preparedness and planning of future epidemiologic studies which assess health impacts in the event of a similar environmental hazard.

**ISEE-S24****Assessing Seasonality for Environmental Epidemiology**

**Abstract:** The importance of seasonality is well recognized by infectious disease epidemiologists and this perspective is gaining attention in the fields of environmental sciences. Accompanied with advanced computational techniques and ever-evolving research designs, time series analysis allows researchers to better understand the complex relationship between human health and the environment. In recent years the use of novel analytical techniques has become important skill that epidemiologists should master. However, detection and interpretation of meaningful patterns in time series data are challenging. Many environmental exposures such as extreme temperature, heavy precipitation, air pollution and water contamination have complex cyclical patterns which can drive the periodic fluctuations of disease. Strategies to minimize exposure to environmental factors or to prevent and control the spread of environmentally sensitive infections in this rapidly changing world demand deeper insights into the cyclic nature of health outcomes and their risk factors. This symposium aims to discuss the multitude of dimensions associated with periodic fluctuations in health outcomes and environmental factors; the need for seasonality assessment in understanding environmental drivers of infectious diseases; and the importance of this aspect of environmental epidemiology for policy making and public health professionals.

**ISEE-S24-01****Principles of Seasonality Assessment**

Naumova E, Tufts University School of Medicine, Boston, MA, USA.

**Abstract:** Diseases which are climate and environment sensitive such as waterborne or food-borne enteric infections alternate periods of low endemic levels with outbreaks, forming a typical seasonal pattern. For example, in temperate climates illness caused by thermo-sensitive bacteria rises in the summer and declines in the winter whereas enteric infections caused by protozoa exhibit a peak in the fall. Temporal pattern of diseases may be governed by precipitation or associated factors related to increases in the probability of pathogen spread, transmission, and viability.

Consistent temporal fluctuations for diseases with similar sources of exposure or routes of transmission suggest the presence of environmental factors that synchronize seasonal variation. Deviation from an established seasonal pattern may provide important clues to the factors that influence disease occurrence such as changes in the sources of exposure, spread, affected population, or differences in the pathogen itself. Increased temperatures and extreme precipitation have also shown to have a short-term effect on health outcomes. It is plausible that temporal patterns in ambient temperature may determine, in part, the timing and magnitude of the peak of a disease incidence curve for enteric diseases.

Although seasonal variation is a well-known phenomenon in the epidemiology of enteric infections, analytical tools for examination, evaluation, and comparison of seasonal patterns are insufficient limiting analysis of factors associated with seasonal variations. We offer a framework for seasonality assessment, and a parametric approach for seasonality evaluation. We contrast our approach with non-parametric modeling and demonstrate this methodology on hospitalization data for environmentally driven diseases using examples related to the effect of extreme temperature and precipitation. This requires a reasonable and quantifiable definition of seasonality and analytic tools concordant to the proposed definition and suitable for routine use by public health practitioners. An understanding of how specific environmental factors influence human disease may improve disease forecasting, improve the design of integrated warning systems, and advance the development of efficient outbreak detection algorithms.

**ISEE-S24-02****Seasonality of Rotavirus Diarrhea: A Call for Interdisciplinary Approach**

Kang G, Christian Medical College, Vellore, India.

**Abstract:** Enteric infectious diseases are a major cause of morbidity and mortality worldwide and rotavirus is one of the most common causes of diarrhea in children. A review of global data reveals geographic and temporal variations in the seasonality of rotavirus infection. In temperate regions distinct peaks tend to occur in winter, with autumn and spring peaks also observed, whereas in tropical climates the seasonality is less pronounced.

There is no consistency in the observed relationship between the rotavirus incidence and meteorological indicators. For example, in India, one study found high prevalence of rotavirus diarrhea during cold months but no association with rainfall or humidity. Another study found negative correlation between disease incidence and humidity and no relationship with temperature. A study of hospitalizations for rotavirus detected distinct winter peaks in north India but no seasonal peaks in the south. In our own community-based study in Vellore we saw peaks in incidence of rotavirus diarrhea during the rainy season.

We conduct multi-disciplinary, comprehensive, and complementary studies on the description, prevention, and control of diarrheal disease using state of the art tools in the laboratory, hospital and field. The patterns of disease are changing, with bacterial pathogens becoming less common in non-outbreak settings, but viral and parasitic pathogens detected in larger proportions. Both cross-sectional and longitudinal studies investigate the relative importance of enteric pathogens and monitor responses to rotavirus infections. Molecular genotyping techniques enable us to identify bovine-human rotavirus reservoirs. This potential transmission of animal viruses to humans has public health significance. Additional projects investigate the utility of point of use water disinfection methods in diarrhea prevention and the application of geographic information systems for spatial analysis of the relationship between environmental conditions and enteric infections.

Larger interdisciplinary studies integrating molecular, epidemiological, analytical, and geospatial techniques will considerably enhance our understanding of epidemiology of diarrhea, ecology of pathogen reservoirs, and the impact of environmental factors on the seasonality of infection at the local and global scale.

**ISEE-S24-03****Variations in Seasonal Patterns of Gastrointestinal Infections within a Watershed**

Jagai J, Tufts University School of Medicine, Boston, MA, USA.

**Abstract:** Epidemiologic analysis of waterborne diseases typically considers socio-economic, demographic characteristics and parameters of the infectious disease. However, hydrological parameters need to be considered as well. Increases in waterborne diseases have been associated with water quality characteristics such as turbidity and river flow. Each watershed has unique characteristics, such as streamflow, water temperature and turbidity which may predict the rates of waterborne diseases within a particular watershed. It is hypothesized that attributes of the watershed will predict the rates of waterborne disease throughout the watershed.

This preliminary analysis explores seasonal patterns of waterborne diseases along two watersheds in the U.S. using elderly hospitalization records from the Center for Medicare and Medicaid Services (CMS) from 1991 to 2004. We considered diagnoses of various gastrointestinal infections including, cryptosporidiosis (ICD 007.2, 007.4, 007.8), giardiasis (ICD 007.1), and GI Symptoms (ICD 558.9, 787), Ill-defined GI infections (ICD 008.5, 008.8, 009) and all GI infections without *Clostridium difficile* (ICD 001–009 W/O 008.45). Cases were aggregated

according to diagnosis code, location, and date of admission. Preliminary analysis of disease rates has been conducted for the Upper and Lower Mississippi River watersheds and the Ohio River watershed. Cities and counties within a 10-mile buffer of the rivers were selected using GIS. Annual disease rates by county were calculated using linearly interpolated elderly population for 1997 (midpoint of data timeframe) from 1990 and 2000 census as the denominator. Seasonal patterns of disease rates were assessed using an annual harmonic regression controlling for hydrological parameters. This is a first attempt at modeling rates of waterborne diseases associated with river characteristics and water quality within a watershed. An understanding of the relationship of watershed characteristics to health outcomes will allow for evaluation of drinking water regulations and policies in the U.S.

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**ISEE-S24-04****Temporal Variations in *Salmonella* Infections in the U.S. Elderly, 1991–2004**

Chui KKH, Tufts University School of Medicine, Boston, MA, USA.

**Abstract:** Evaluation of new policies in environmental sciences validates cost-effectiveness of decisions and informs future ones. However, there are caveats in such evaluation when the outcome shows trend and seasonality. Improper modeling of long-term trend may undermine associations between the outcome and the policy, while failing to account for the seasonal pattern of the outcome can lead to biases. We used *Salmonella* infections (SI) to demonstrate the use of time series analysis as a policy evaluation tool. In 1997, USDA started the Pathogen Reduction and Hazard Analysis and Critical Control Points Systems (HACCP), which demands regular testing for *Salmonella* in the chicken broiler industry however a temporally and geographically focused prevention strategy may improve cost-effectiveness. Using nationally representative data, we evaluated the trend and seasonality before and after the start of the HACCP and identified potential areas for preventive service.

Weekly hospitalizations in US elderly involving SI (ICD 9-CM 003) in 1991–2004 ( $n = 27,790$ ) were obtained from the Center of Medicare and Medicaid Services. To assess long-term changes, we fit a broken-stick model with the first week of 1997 as the inflection point, adjusted for annual seasonality. To assess seasonal patterns, we applied annual harmonic regression and annual oscillations were compared. Analysis was conducted for the nine Census divisions in the contiguous US.

Overall, there was a decrease in SI hospitalization rates. Changes before and after HACCP varied, e.g. New England had a decrease before HACCP and a significantly steeper decrease after HACCP; whereas, East South Central had a decrease in the pre-HACCP period, and then remained stable. Regarding seasonality, West South Central, East South Central, and South Atlantic could be potential foci of targeted interventions due to higher rates, and consistent annual oscillation.

The effect of interventions and regulations targeting outcomes with strong seasonality should be examined in three ways: (i) change of overall rate regardless of seasonality, (ii) change of seasonal patterns with respect to time and (iii) with respect to rate of the outcome. We suggested applying time series analysis to assess the proposed effects of the policy and provide useful feedbacks to the policy makers and health professionals for further improvement.

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**ISEE-S24-05****Visualization of Spatial and Temporal Data with Dynamic Maps**

Castronovo D, Mapping Sustainability, LLC, Jupiter, FL, USA.

**Abstract:** Recent advances in Geographic Information Systems (GIS) and visualization software allow for the representation of public health data over space and time through dynamic maps. Animation has potential to

show the spread of infectious disease in relation to climatic factors at various spatial and temporal scales. However, dynamic maps represent a delicate balance between usefulness and incomprehensible information overload. We develop a conceptual framework for building informative dynamic maps using data on waterborne diseases and extreme weather events.

Designing dynamic maps requires several considerations beyond the traditional static maps including: choice of a temporal scale, cartographic representation of environmental covariates with disease outcomes, appropriate symbolization of disease outcome data, selection of the duration and rate of change for each map frame, and tools to direct the audience's attention to space-time variations and anomalies. Monthly waterborne disease hospitalization data for the U.S. elderly were abstracted from the Centers for Medicare and Medicaid Services (CMS) for a 5-year period (1998–2002). Monthly rates were calculated for each county and mapped using graduated dots that represent the entire distribution of the data over the entire time period. Hospitalization rates for each month were overlaid on average monthly maximum precipitation data from the PRISM climate data set. The resulting dynamic map reveals seasonal patterns in waterborne disease hospitalization and suggests that dynamic mapping is informative for displaying the spread of infectious disease through time and space.

The study of spatiotemporal processes such as the spread of infectious disease requires researchers to recognize and track changes in complex systems. Studying the spread of infectious disease poses a large challenge due to the number and scale of interactions that occur within environmental-health systems. Dynamic maps have the capability to help visualize, hypothesize, and decipher change factors in large spatial and temporal data sets, but there are several factors one must consider to make dynamic maps useful. This presentation will teach the audience about key cartographic and visualization elements that contribute to successful dynamic maps of complex environmental-health systems.

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**ISEE-S25****Near-Roadway Exposures and Childhood Allergies and Asthma**

**Abstract:** Childhood asthma is a major health problem among children throughout the world. The apparent association of childhood allergies and asthma with near-roadway exposures to mobile source emissions is a growing concern to public health professionals, regulatory authorities, school administrators, urban planners, and the general public. The proposed symposium is based on four major international studies of the association of childhood asthma with near-roadway exposures:

- Joachim Heinrich—Germany—Traffic Related Air Pollution and Childhood Asthma in two Munich birth cohorts
- Gerard Hoek—The Netherlands—Traffic Related Air Pollution and Childhood Asthma in a Dutch birth cohort
- Lucas Neas, Alan Vette—United States—Detroit-area studies, including the Detroit Exposure Aerosol Research Study, the Detroit Children's Health Study, and the Mechanistic Indicators of Childhood Asthma Study
- Amanda Wheeler—Canada—School-age children in Windsor, Ontario (proposed). These four speakers will provide a clearer understanding of current developments in the relevant research methods, including:
  - Ambient air quality monitoring using both active and passive monitors;
  - Participant-based monitoring of indoor and outdoor air quality;
  - Indices of proximity of schools and residences to the near-roadway environment;
  - Geographic information systems (GIS) for spatial exposure gradients;
  - Land-use regression models for exposure assessment;
  - Questionnaire-based and diary methods of health outcome ascertainment;

- Biological indicators of exposure, early effect, and susceptibility; and
- Advanced epidemiologic models for the assessment of clustered measurements.

All of the above topics will be clearly illustrated with recent, unpublished results derived ongoing research. The symposium is geared both towards public health practitioners interested in the etiology of childhood allergies and asthma and toward technology transfers to other research groups interested in research on the association of near-roadway exposures and childhood respiratory effects. Since these talks will cover new developments in exposure assessment and in environmental epidemiology, the symposium is relevant to both ISEE and ISEA members. The organization of the symposium talks will allow for considerable audience involvement with short presentations and ample opportunity for discussion. The talks will foster discussion on future research related to near-roadway exposures and effects. Depending on the available facilities, the symposium will also provide an opportunity for attendees to examine the actual devices used for air quality monitoring and physiological assessment.

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**ISEE-S25-02**
**Overview of Near-Roadway Studies of Childhood Asthma and Allergies in Germany**

Heinrich J, Helmholtz Zentrum München, National Research Center for Environmental Health, Munich, Germany.

**Introduction:** While toxicological experiments on traffic-related particulates—in particular diesel particles—have consistently shown an increased risk for developing an allergy and for exacerbation of symptoms, the evidence from population studies that support this conclusion was inconsistent. One reason for inconsistent findings of epidemiological studies was the weakness in the exposure assessment and in particular the lack of individualized exposure assessment strategies. Studies, which used GISbased distances between a residential address and busy roads could improve the exposure assessment to traffic-related air pollutants (TAP). We will provide an overview of near-roadway studies on asthma and allergies with specific emphasis on GISbased distances to major roads in Germany.

**Methods:** As part of the German birth cohorts GINI and LISA approximately 4000 newborns were recruited in Munich and approximately 3000 were followed for 6 years. The geo-coded residential address was used to calculate distance to busy roads in addition to an individualized exposure assessment to TAP by a land use regression model.

**Results:** Strong positive associations were found between the distance to the nearest main road and asthmatic bronchitis, hay fever, eczema and allergic sensitization to common inhalant allergens. A distance-dependent relationship could be identified with the highest odds ratio for children living less than 50 m from busy streets.

**Discussion:** The simple distance to major roads revealed as a promising exposure proxy for TAP. A small distance of 50 m to a busy road might indicate breathing of a fresh aerosol. It serves as a valid exposure surrogate in particular in young children, who stayed mostly at home and possibly also in advanced age population. However, the exposure surrogate has also several limitations such as the impossibility to be “regulated”.

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**ISEE-S25-03**
**Assigning Air Pollution Estimates to Traffic Related Pollutants—An Application to School-based Respiratory Health Studies**

Wheeler AJ,\* Nethery E,\* MacNeill M,\* Van Ryswyk K,\* Grgicak-Mannion A,† Smith-Doiron M,\* Mahmud M,\* Liu L,\* Xu X,† Rasmussen P,\* Brook JR,‡ and Dales R,\* \*Health Canada, Ottawa, ON, Canada; †University of Windsor, Windsor, ON, Canada; and ‡Environment Canada, Toronto, ON, Canada.

**Abstract:** As part of the Border Air Quality Strategy, Health Canada conducted a series of studies investigating the relationship between air pollution and respiratory health of all elementary school-aged children living in Windsor, Ontario. In 2004, a self-reported questionnaire was administered to 12,694 children in Windsor to investigate the prevalence of asthma, along with other symptom data and information regarding SES, medication use, housing characteristics and family medical history. In early 2005, 2402 of these children also participated in a cross-sectional study of lung function testing which included spirometry, exhaled nitric oxide, and in a subset of the children, exhaled breath condensate. Later in 2005, 184 of these children with self-reported asthma were included in a month long assessment of their day to day changes in lung function, where the children conducted morning and evening daily peak flow measures and completed symptom questionnaires under supervision from their parents.

To evaluate different air pollution exposure sources and respiratory health, 51 of these asthmatics participated in a personal-indoor-outdoor air

pollution exposure monitoring study which was conducted during winter and summer of 2006. This study included morning and evening peak flow measures and daily exhaled breath condensate samples.

Air pollution estimates for the majority of the school children have been modeled using fixed-site monitors, land-use regression (LUR) models and proximity to roads. These different methods have not always shown consistent, or hypothesized, relationships with air pollution and health effects. It is anticipated that some of this inconsistency could be explained by measurement error and this will be investigated further by evaluating how estimates of personal exposure derived using LUR and fixed-site monitoring data differ from actual personal exposure measurements.

Initial NO<sub>2</sub> results from the personal, indoor and outdoor exposure phase indicate that personal measures (geometric mean (GM) = 8.7 ppb) were highly correlated with indoor measurements ( $\rho = 0.69$ ; GM = 7.9 ppb) and only moderately correlated with outdoor measures ( $\rho = 0.45$ ; GM = 13.8 ppb). Given the data collected using time activity patterns of these children this is not unexpected, as the children spend approximately 73% of their day indoors and 7.5% of their day outdoors. Initial regression analyses investigating predictors of personal exposure to NO<sub>2</sub> include presence of a gas stove, land use, and proximity to roadways, with the models estimating between 48.7%–60.8% of the variability in personal exposures.

LUR models were developed to provide seasonal estimates of outdoor air pollution exposure at each residence and then compared to actual outdoor measurements made at the same residence to ensure the reliability of the estimates. There were stronger correlations between the estimates from the LUR model and actual outdoor measurements in the summer (NO<sub>2</sub>:  $\rho = 0.42$ ; Outdoor GM = 10.0 ppb; LUR GM = 12.2 ppb) than the winter (NO<sub>2</sub>:  $\rho = 0.17$ ; Outdoor GM = 19.2 ppb; LUR GM = 12.2 ppb).

Having actual personal exposure study results from a subset of the larger survey provides an opportunity to quantify the impact of measurement error which typically occurs when modeling estimates of exposure to air pollution using fixed site monitors or LUR methods.

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#### ISEE-S25-04

#### Near-Roadway Studies in a Northern, Industrial U.S. Metropolitan Area: Exposures and Health Outcomes

Neas LM,\* Vette A,† Williams R,† Gallagher J,\* Mukerjee S,† Hudgens E,\* Johnson M,\* Barzyk T,† Baxter L,† and Williams A,\* \*U.S. Environmental Protection Agency, Chapel Hill, NC, USA; and †U.S. Environmental Protection Agency, Research Triangle Park, NC, USA.

**Introduction:** Residential exposures to the near-roadway environment have previously been associated with respiratory outcomes in children and with cardiovascular outcome in adults. These earlier exposure and epidemiologic studies have largely been conducted in metropolitan areas dominated by mobile-source emissions. We will provide an overview of recent collaborative work conducted in the Detroit metropolitan area by EPA's National Exposure Research Laboratory (NERL) and National Health and Environmental Effects Research Laboratory (NHEERL).

**Methods:** The NERL Detroit Exposure Aerosol Research Study (DEARS) used a repeated-measures design to examine detailed exposure information (outdoor/indoor/personal) for adults in two seasons across seven clustered areas within the Detroit metropolitan area. Participants in three of the seven DEARS areas lived within 200 m of a major roadway. The Detroit Children's Health Study (DCHS) used a case-cohort design to examine respiratory symptoms, pulmonary function, and exhaled breath for children. The air-component of DCHS developed a land-use regression model to estimate residential exposures for the DCHS children. The Mechanistic Indicators of Childhood Asthma (MICA) study used a cross-sectional design to examine biological markers of exposure, early effect, and susceptibility for children in the DCHS sample. An air-related sub-

study used a participant-based approach to examine indoor/outdoor relationships for children in the MICA study.

**Results:** DEARS successfully completed week-long monitoring in approximately 120 homes over three years. DCHS obtained questionnaires for 1,157 children and completed measurements of pulmonary function and exhaled nitric oxide for 702 children. The air-component of DCHS completed a six-week monitoring at 25 elementary schools and developed a land-use regression model. MICA obtained complete clinical samples for 166 children. The air-related sub-study successfully obtained passive air-quality samples from 92 residences. The specific results from these EPA studies will be presented in a series of posters and presentations at this conference. This presentation will provide an overview of the EPA collaboration and new results for the health analyses.

**Discussion:** The successful conduct of near-roadway research depends upon the close and collegial collaboration of both epidemiologists and exposure scientists and upon the integration of a variety of exposure measurements and models with a broad suite of health outcome measurements. This abstract of a proposed presentation does not necessarily represent EPA policy.

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#### ISEE-S26

#### Personal Exposure Assessment Tools for use in Large Scale Epidemiologic Studies

**Abstract:** Environmental epidemiologists need simple tools for collection of environmental exposures from all participants. The planning of environmental epidemiological studies is a delicate balance between obtaining as many relevant physical and biologic measures as possible, while at the same time, limiting the burden on the participant and study staff. More and more tools are available that can be shipped to participants and returned to researchers without technician assistance. The recent technological advances in sensors and other measurement devices have created an opportunity where it is possible to combine these technologies to create an environment where researchers can collect more data, more reliably, and do so with reduced participant burden. Currently, these have been employed as mailable collection devices in large scale epidemiologic studies. In this symposium, researchers will speak of their experiences first hand in identifying and assessing the utility of these devices in large scale epidemiologic studies in three primary areas: (1) Measurement and analysis of exposure; (2) Measurement and analysis of health/medical characteristics/biomarker of effect; (3) Collection of questionnaire/diary data. This symposium will focus on evaluating devices that can be mailed to study participants; be used to collect measures; and shipped back to study organizers for analysis. Some of these may collect samples stored for future use; others provide the necessary quantitative information needed to construct more accurate exposure characterization and thus, a better estimate of risk for potential health effects in large scale epidemiologic studies. SESSION OUTLINE: (1) Overview of challenges and opportunities of remote data collection devices in large scale epidemiologic studies—Dale Sandler (NIEHS). (2) Presentation of the device/tool/method used in epidemiologic studies and a practical assessment of what worked, didn't work, what investigators would change next time. These include the following 5 studies: (i) Measurement of Gaseous PAHs with an Innovative Passive Sampler in Community Exposure Studies—Tina Fan (Rutgers); (ii) Characterizing Exposure in Community Health Studies: A Participant-Based Approach to Indoor/Outdoor Air Monitoring—Markay Johnson (EPA); (iii) Use of an Electrostatic Dust Cloth for Self-administered Home Allergen Collection—Wendy Cozen (USC); (iv) Remote Exposure Monitoring Strategy for Use in Longitudinal Cohort Studies—Jim Raymer (RTI); (v) Use of Ultraviolet Radiation Dosimetry in Epidemiologic Studies of Skin Cancer—Richard Kwok (RTI). (3) The symposium will conclude with a panel discussion by the presenters and a question and answer period with audience.

**ISEE-S26-01****Remote Data Collection Devices for Exposure Measurement in Large Scale Epidemiologic Studies**

Sandler DP, NIEHS, Research Triangle Park, NC, USA.

**Abstract:** Exposure assessment is often the “weak link” in large scale epidemiologic studies of the role of environmental exposures and gene-environment interactions in risk for disease. The development of validated simple to use tools for measuring environmental exposures has lagged behind rapid advances in other areas of biotechnology such as molecular genetics. The cost and feasibility of field placement of measurement devices have so far limited the ability of investigators to include measurement in study protocols. Recent developments may make it feasible for large scale studies to incorporate environmental measurements. To be useful in a case-control study, tools would ideally assess exposures that occurred in the past or that could be shown to reflect exposures during a relevant time period. For prospective studies, tools should provide a snapshot of exposure that is reflective of exposures over a reasonably long time window. Before using such tools, investigators will need to demonstrate that they can be used correctly by following simple mailed instructions, that exposures are high enough and varied enough to be measured with precision, that participants are willing to deploy them and return them as required, and that measurements are repeatable and reflective of relevant exposures. Experience with mail-out detection devices such as saliva collection kits for extracting DNA, residential radon detectors, hand-held GPS tools, nitrate test strips, vacuum cleaner hose attachments for collecting dust samples, and alcohol wipes for collecting dust particles from household surfaces will be used to illustrate some of the problems that must be overcome before launching such devices for large-scale studies.

**ISEE-S26-02****Measurement of Gaseous PAHs with an Innovative Passive Sampler in Community Exposure Studies**

Fan Z, Environ. &amp; Occupational Health Science Institute, Piscataway, NJ, USA.

**Abstract:** A sensitive, simple, and cost-effective passive sampling methodology was developed to quantify gaseous PAH in personal, indoor and outdoor air. A Fan-Lioy passive PAH sampler (FL-PPS) is constructed from 320 1-cm long SPB-5 GC columns (0.75-mm ID and 7- $\mu$ m film thickness), similar to a mini-honeycomb denuder. Given the unique feature of the GC column stationary phase, gaseous PAH are collected on the inner surfaces of the columns by molecular diffusion and can be either thermally desorbed or liquid extracted during subsequent analysis by GC/MS. Laboratory tests were conducted to evaluate the performance of the sampler for the measurement of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, and pyrene for a range of face velocity, temperature, humidity, and PAH concentration. Except naphthalene, the sampling rate was stable for the 7 PAH over a sampling duration of 8–48 hours. The naphthalene sampling rate was stable for an 8-h sampling period but decreased along with increase of sampling time. The effects of other parameters on the sampling rate were not significant for all the compounds tested. Further evaluation was performed in two community exposure studies conducted in two locations with different environmental conditions, Detroit vs. Mexico. The sampler was deployed by subject (42 asthma homes) to measure indoor and outdoor PAH in Detroit. All samplers were recovered, with only 7% invalid and 7% suspicious samples. In the Mexico study, only 1 out of 47 samplers was lost. The average recovery of PAH from both studies ranged from 61–89% and the method precision (CV%) ranged from 30–51%. PAH concentrations were found to be 5–40 times higher in Mexico than in Detroit, varying by

species, but naphthalene was underestimated in Mexico due to potential saturation of the sampler. In summary, the FL-PPS is suitable for airborne PAH measurement in community settings. It is small and light weight, can be worn by small children, and deployed by participant. The sampler is a cost-effective device and can be reused for ~10 times after a simple baking process. Improvement is needed to reduce the sampler background. Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-S26-03****Characterizing Exposure in Community Health Studies: A Participant-Based Approach to Indoor/Outdoor Air Monitoring**

Johnson M, U.S. EPA, Research Triangle Park, NC, USA.

**Introduction:** Traffic-related air pollution has been associated with numerous adverse outcomes. However, community health studies of traffic-related air pollution have been hampered by the cost and participant burden associated with estimating household-level exposure through technician-based air monitoring or advanced modeling. This study utilized a participant-based approach to collect indoor and outdoor air monitoring data for 92 asthmatic and non-asthmatic children enrolled in health studies in Detroit, Michigan.

**Methods:** Passive samplers were shipped to participating households and deployed by parents of study participants to collect indoor and outdoor measurements of NO<sub>2</sub>, VOC, and PAH. Half of the homes deployed VOC and NO<sub>2</sub> samplers for 7 days; the rest deployed NO<sub>2</sub> samplers for 2 days and PAH samplers for 1 and 2 days. Participants conducted air monitoring without assistance or oversight from trained technicians and returned samplers during a scheduled clinic visit.

**Results:** Of 114 households asked to conduct air sampling, 91% agreed to participate. Of those agreeing to participate, 88% completed air sampling, and 85% provided usable data. Compliance and providing usable data were higher among participants deploying all samplers for 7 days compared with those who deployed some samplers for 2 days and others for 1 day. Compliance and providing usable data did not vary by asthma status or among households deploying duplicate samplers. Variation between duplicates and percent below detection limit were low for NO<sub>2</sub> and BTEX. Measurements and trends were consistent with findings of technician-based studies.

**Conclusions:** Participation and compliance were high; there was no evidence of selection or information bias, suggesting that this participant-based approach could be successfully applied among diverse communities and would be appropriate for characterizing exposure in a health study. Furthermore, QA/QC and measurements analyses showed that participant-based sampling could provide reliable data. These results suggest that participant-based sampling may be a feasible and cost-effective alternative to traditional exposure assessment. Although this work was reviewed by EPA and approved for publication, it may not reflect official Agency policy.

**ISEE-S26-04****Use of an Electrostatic Dust Cloth for Self-administered Home Allergen Collection**

Cozen W, University of Southern California, Los Angeles, CA, USA.

**Abstract:** Most epidemiologic studies employ a vacuum cleaner used by a trained technician to collect household allergens. This approach is labor intensive, equipment dependent, and impractical if study subjects reside over a wide geographic area. We examined the feasibility of a self-administered dust collection method, using an electrostatic cloth sent by conventional mail, to obtain allergen measurements. Thirty-two non-asthmatic twins from the California Twin Program wiped areas in the family room, kitchen, and bedroom, according to standardized

instructions, and returned the cloths by mail. Allergen concentrations for Der-p-1, Der-f-1, Fel-d-1, and Bla-g-2 were determined using ELISA, and intrahouse and room-to-room concentrations were compared. Der-p-1 and Fel-d-1 were found in most homes, with highest concentrations in bedrooms and kitchens, respectively. Der-f-1 and Bla-g-2 were rarely found. Intrahouse Der-p-1 and Fel-d-1 concentrations were highly correlated and statistically significant (for Der-p-1, bedroom vs. kitchen,  $P = .0003$ , bedroom vs. family room,  $P = .0001$ , and family room vs. kitchen,  $P = .002$ ; for Fel-d-1, bedroom vs. kitchen,  $P = .0004$ , bedroom vs. family room,  $P < .0001$ , and family room vs. kitchen,  $P = .0001$ ). Reported cat ownership was strongly correlated with household Fel-d-1 concentrations ( $P < .005$ ). In another comparison from different homes of children enrolled in the La Casa atopy prevention study, allergen concentrations measured from dust collected by a single operator from the left and right half of the same room in 21 homes were compared. Levels of Bla-g-2, Der-p-1, and Fel-d-1 concentrations collected from right and left halves of the same room were highly correlated, with  $r^2$  ranging from .7 to .9, and were highly statistically significant (all  $P$ -values  $< .01$ ). We conclude that non-intrusive and self-administered dust collection, using commercially available electrostatic dust cloths, sent by conventional mail services, is a promising alternative to technician-collected vacuumed dust for measuring indoor allergens in population-based studies, although further validation of the method is necessary. Additional feasibility data from a large ongoing Southern California children's cohort study on asthma using the same wipe test method will also be presented.

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**ISEE-S26-05****Remote Exposure Monitoring Strategy for Use in Longitudinal Cohort Studies**

Raymer JH, RTI International, Research Triangle Park, NC, USA.

**Abstract:** The magnitude and expense of large environmental epidemiologic studies requires sample collection methods that are amenable to acquisition by the participants themselves followed by direct shipment to the analysis laboratory in order to provide a cost-wise alternative to technician-based sampling procedures. In a pilot study, we evaluated the ability of participants in three age cohorts to collect environmental and biological samples according to prescribed approaches over a 12 month period. The cohorts consisted of parents and their children in the ages of 0–1 year, 3–5 years, and 6–8 years old. Biological and environmental samples included urine, breast milk/duplicate diet for the 0–1 cohort; urine cotton sock dosimeters, hair, vacuum dust, and tap water for the 3–5 cohort; and saliva, dust wipe, volatile organic compounds, and humidity/temperature data for the 6–8 cohort. Collection approaches were chosen to represent a range of media and a range of collection difficulty in order to help to identify potential issues in a larger study. Sample collection instructions and materials were prepared and shipped to participants monthly over a 12-month period. Internet accessible video instructions were also prepared. Participants were requested to collect the samples, complete questionnaires, and return the samples to RTI within defined time periods, using pre-paid express mail. Upon receipt at RTI, the condition of the samples was assessed by visual inspection and the details of the receipt and evaluation were subsequently used to assess compliance. In some cases, chemical analysis was used to further evaluate sample integrity. A great deal was learned that supports optimism for the approach evaluated in this task, although the study brought forward a number of issues that can impact a large-scale study such as the NCS, and that deserve additional consideration. Potential limitations of participants should be taken into account, e.g., ability to read colors on pH strips. Other issues relate to the sample collection/monitoring methods that can be realistically fielded, given that the participants themselves are to collect samples. The development of simpler, participant-friendly measurement devices and methods are

anticipated in the future. This study was funded by EPA contract 68D-99-012, Task 014.

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**ISEE-S26-06****Use of Ultraviolet Radiation Dosimetry in Epidemiologic Studies of Skin Cancer**

Kwok RK, RTI International, Research Triangle Park, NC, USA.

**Abstract:** Exposure to ultraviolet radiation (UVR) from sunlight is the major environmental risk factor for skin cancer, and may also be linked with increased or reduced risk of other cancers and non-malignant serious medical conditions. However, the validity of self-reported sun exposure and time spent outdoors for epidemiological research has not been confirmed. The aims of the current study were to assess how well participants' self-reported time outdoors compares to objective measurements of personal UVR doses. We enrolled 124 volunteers who were identified from targeted subgroups of U.S. radiologic technologists, including approximately half residing in northern latitudes (Minnesota and Wisconsin) and half in southern latitudes (North Carolina and Georgia). Within each region, half of the volunteers selected were female and half male; half of each gender group were 40–59 years old and half were age 60 or older. Each volunteer was instructed to wear a polysulfone dosimeter to measure UVR on their left shoulder and to complete a daily activity diary, listing indoor and outdoor activities undertaken in each 30 minute interval between 9:00 AM and 5:00 PM during a seven-day period in September, 2004. In this presentation, we discuss the strengths and limitations of using these polysulphone dosimeters in this study to collect personal UVR dose measurements.

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**ISEE-S27****Health Effects Due to Human Impacts on the Global Nitrogen Cycle**

**Abstract:** Over the past 50 years, human inputs of nitrogen from fertilizers and fossil fuel combustion have exceeded natural sources. The result has been an increase in nitrate concentrations in many water resources worldwide. The U.S. Environmental Protection Agency and the World Health Organization maximum contaminant level (MCL) for nitrate in drinking water of 10 mg/liter (nitrate-nitrogen) and 50 mg/l (as nitrate), respectively, were promulgated to protect infants from developing methemoglobinemia, an acute health condition. Chronic health effects due to nitrate ingestion have not been as well-characterized. Nitrate ingestion from drinking water has been associated with an increased risk of specific cancers, adverse reproductive outcomes, diabetes, and thyroid conditions in animal and human studies. Nitrate ingestion can result in endogenous formation of carcinogenic N-nitroso compounds (NOC) and inhibition of iodide uptake by the thyroid. A few epidemiologic studies have shown adverse health outcomes at water nitrate levels below the MCL for specific cancers and neural tube defects. Presenters will provide an overview of the human studies of nitrate exposure and methemoglobinemia, cancer, and adverse reproductive outcomes, including results from recent studies. New exposure assessment efforts for epidemiologic studies which account for all sources of nitrate and nitrite ingestion and for factors affecting endogenous nitrosation will be presented. The adequacy of the current MCL for protecting the public health will also be addressed. Beyond its direct effects, nitrogen may indirectly influence human health via alteration of pathogen abundance and patterns of disease transmission. Agricultural runoff into nearby wetlands (eutrophication), for example, can alter the abundance of disease vectors, intermediate hosts, and harmful algae, potentially enhancing the risk of infectious and non-infectious diseases of humans and wildlife (e.g., West Nile virus, malaria, cholera). Forecasted changes in nutrient inputs will be discussed in relation to the likely influence on patterns of infectious and noninfectious diseases.

**ISEE-S27-01****Nitrate Exposure and Methemoglobin Levels among Infants in Washington State**

Vanderslice J, University of Utah, Salt Lake City, UT, USA.

**Abstract:** The role of ingested nitrate as a risk factor for methemoglobinemia has been a topic of controversy. Agricultural areas in central Washington State have groundwater nitrate levels often exceeding the health guideline levels of 10 mg NO<sub>3</sub>-N per liter, and health officials have had concerns regarding the risk to infants in the area. The purpose of this study was to examine the relationship between nitrate exposures from drinking water and methemoglobin levels among a sample of infants. Infants were recruited from all births to women using private wells or small water systems in the study area. Health status, 24-hour diet history and drinking water usage were gathered through a face-to-face interview. All water sources fed to the infant were tested for nitrate levels and the presence of total coliforms and E. coli. A blood sample from the infant was analyzed using a portable co-oximeter to determine the methemoglobin (MetHb) level. Just over half of the participants used private wells. 74% of the infants were given tap water or tap and bottled water, 18% were given bottled water exclusively, and 8% were not given any water. The mean nitrate level in tap water was 3.5 mg/L NO<sub>3</sub>-N; 9% of the samples were above 10 mg/liter, and the maximum was 35.5 mg/L. Bottled water levels were low (mean = 0.4 mg/L, max. = 10 mg/L). MetHb levels were obtained from 565 infants. Just over a third had less than 1% of their hemoglobin in the MetHb form, and just over half were between 1% and 2% MetHb. Almost 12% were >2% MetHb; 2% of the infants had readings above 3% MetHb. Based on a 24-hour diet recall (n = 611), 64% of the infants had some exposure to nitrate via drinking water. 5% of the infants had nitrate intakes >0.5 mg NO<sub>3</sub>-N per kg-day. Only 3% of the infants had been fed a food high in nitrate, typically carrots, and 3% had been given a medication containing benzocaine, a MetHb inducer. Using logistic regression both age less than 3 months (OR = 1.9, 95%CI = 1.14–3.28) and nitrate intake in the top quartile (OR = 2.44, 95%CI = 1.33–4.48) were significantly associated with having a MetHb level >2%. Having total coliforms in consumed water and having had diarrhea in the past 3 days were not significantly associated with MetHb >2%. However their presence in the model reduced the significance of the effect of nitrate intake.

**ISEE-S27-02****Nitrate Ingestion from Drinking Water and Diet and Cancer Risk**

Weyer PJ,\* Kantamneni JR,\* Lu X,\* Ward MH,† and Cerhan JR,‡ \*The University of Iowa Center for Health Effects of Environmental Contamination, Iowa City, IA, USA; †Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, USA; and ‡Mayo Clinic College of Medicine, Rochester, MN, USA.

**Abstract:** Nitrate ingested from drinking water and diet can contribute to the endogenous formation of carcinogenic N-nitroso compounds. Epidemiologic studies of nitrate and cancer have reported mixed findings; a brief overview will be given. We present an updated analysis of The Iowa Women's Health Study (IWHS), which in 2001 reported an increased risk for bladder cancer associated with long-term exposure to nitrate in municipal water supplies. Our reanalysis included an additional six years of bladder cancer cases and exposure assessment for both drinking water and diet nitrate. Nitrate intake was calculated for a cohort of 16,541 Iowa women (ages 55–69 at 1986 baseline) who used the same municipal drinking water supply for >10 years. A total of 112 incident bladder cancers were diagnosed in the cohort through 2004. Nitrate levels in finished (post-treatment) drinking water for all municipal supplies and nitrate levels in raw (pre-treatment) source water for supplies using alluvial groundwater were used to calculate mean nitrate levels (1955–88).

Dietary nitrate was estimated using a 126-item food frequency questionnaire. Dietary nitrate was not associated with bladder cancer risk. An increased bladder cancer risk was associated with the highest quartile of exposure to nitrate in drinking water (>2.23 mg/L nitrate-nitrogen, Relative Risk (RR) = 2.16, 95%CI 1.09–4.28); the risk was highest for women in the high water nitrate group who also had higher meat intake and lower vitamin C intake (RR = 4.17, 95%CI 1.46–11.88). Reanalysis of the IWHS showed an increase bladder cancer risk associated with long term exposure to drinking water nitrate levels below the regulatory limit. Other studies have found bladder cancer risk associated with exposure to trihalomethanes (THMs) and haloacetic acids (HAAs), common disinfection by-products (DBPs). We are estimating historical THM and HAA levels in Iowa municipal water supplies based in order to evaluate the separate contributions and possible interactions of nitrate and DBPs to bladder cancer risk. Recent studies on emerging nitrogenous DBPs (halonitromethanes, haloacetonitriles, N-nitrosodimethylamine) document cytotoxic and genotoxic effects in some mammalian species; therefore, research on drinking water exposures to these compounds in human populations is warranted.

**ISEE-S27-03****Estimating Exposure to N-nitroso Compounds in Studies of Adverse Reproductive Outcomes**

Brender JD,\* Griesenbeck JS,\* Steck M,\* Huber JC,\* Sharkey JR,\* Weyer PJ,† Werler MM,‡ and Mohanty B,§ \*Texas A&M Health Science Center School of Rural Public Health, College Station, TX, USA; †The University of Iowa Center of Health Effects of Environmental Contamination, Iowa City, IA, USA; ‡School of Public Health, Boston University School of Medicine, Boston, MA, USA; and §Texas A&M University Department of Biological and Agricultural Engineering, College Station, TX, USA.

**Abstract:** Amine- and amide-containing (nitrosatable) drugs and other compounds react with nitrite in the stomach to form N-nitroso compounds (NOC). NOC induce a variety of congenital malformations in animal models. Previous epidemiologic studies have primarily focused on the separate effects of nitrates, nitrites, and nitrosatable drugs without consideration of their interaction in the endogenous formation of NOC. We designed a case-control study to examine the separate and joint effects of prenatal exposures to nitrates, nitrites, and nitrosatable drugs on risk of selected congenital malformations (neural tube defects, limb malformations, oral clefts, heart defects). Cases and controls are from the National Birth Defects Prevention Study (NBDPS), a multi-center study in 10 states. We developed estimates of nitrate, nitrite, and nitrosamines for food items in the short Willet Food Frequency Questionnaire as adapted for the NBDPS, using means of values from the published literatures, weighted by study size. Our data sources included 35 published articles and 4 government reports. Twenty-nine articles included data from 1980 or later, but only nine included US or Canadian foods and no studies were published after 1990. Our findings demonstrate that more analyses of these compounds in foods are necessary in order to better estimate recent exposures. Medications taken preconception and during the first trimester are being classified by their nitrosatability. Periconceptional addresses of Iowa and Texas participants are being linked to pertinent nitrate monitoring data for community water supplies. For Texas participants on private wells, nitrate levels are being estimated with a multi-dimensional flow and transport model. Our analysis plan includes the evaluation of separate and joint effects of nitrosatable precursors on risk of selected malformations and the determination of interactive effects of dietary inhibitors of nitrosation (vitamins C and E) with exposures to nitrate/nitrite and nitrosatable drugs. This presentation will highlight exposure assessment needs and novel analysis methods that will help to clarify the potential role that NOC precursors have in the etiology of birth defects and other reproductive outcomes.

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**ISEE-S27-04****Nutrient Enrichment in Aquatic Ecosystems and Emergence of Human and Animal Diseases**

Johnson P, and Townsend A, *University of Colorado, Boulder, CO, USA.*

**Abstract:** Worldwide increases in the number of human and wildlife diseases have challenged ecologists and epidemiologists to understand how large-scale changes affect host-parasite interactions. This presentation will examine available evidence linking anthropogenic nitrogen inputs and diseases of humans and wildlife and will discuss how forecasted changes in nutrient inputs are likely to influence patterns of infectious and noninfectious diseases. We considered the consequences of eutrophication on macroparasitic-, microparasitic- and non-infectious diseases of humans and wildlife, including cholera, West Nile virus, malaria, harmful algal blooms, coral reef diseases and amphibian malformations. The objectives were threefold: first, to examine broad-scale patterns in the types of parasites and pathogens favored under eutrophic conditions and how these patterns vary with environment, degree of eutrophication, and type of disease. Second, we examined evidence for the ecological mechanisms underpinning relationships between nutrient enrichment and disease. And finally, we explored how forecasted changes in nutrient deposition are expected to affect the levels of pathogenic disease. Results derived from published and unpublished research indicate that nutrient enrichment has diverse effects on disease that depend on the type of pathogen, host species and condition, attributes of the aquatic system and the degree of enrichment. Human inputs of nitrogen into the environment can profoundly alter pathogen abundance and patterns of transmission. Agricultural runoff into nearby wetlands (eutrophication) can alter mosquito production and plant community composition, potentially enhancing the risk of mosquito-borne diseases such as West Nile virus and malaria. Eutrophication favors generalist or opportunistic parasites with simple life cycles, which can be particularly dangerous because they continue to cause mortality even as their hosts decline. Given that nutrient-loading will almost certainly become more severe and widespread in the coming decades, eutrophication will continue to be an important factor in the etiology of human and wildlife diseases and we emphasize the importance of integrating experiments and ecological modeling.

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**ISEE-S28****Impacts of and Adaptation to Extreme Weather Events in a Changing Climate**

**Abstract:** In 2007, the Intergovernmental Panel on Climate Change concluded that evidence is unequivocal that humans are affecting the global climate system, with consequences that are already affecting the burden of climate-sensitive health outcomes, including morbidity and mortality due to temperature extremes and other extreme weather events (i.e. floods, windstorms, and storm surges). Climate change is expected to increase the frequency, duration, and severity of several extreme events, including heatwaves, hurricanes, floods, windstorms, wild fires, and drought. The resulting changes will significantly affect human health and welfare directly and indirectly. Extreme events have immediate impacts on morbidity and mortality that increase with the event's intensity (i.e., the amount of energy the event releases). Extreme weather events that occur with little advance warning in particularly vulnerable regions are generally associated with higher morbidity and mortality. Impacts generally increase with the duration of an event (e.g. there are greater health risks with a heatwave that lasts several weeks to one that lasts a few days). Health risks also increase with the size of the population and the degree to which it is physically, mentally, or financially constrained in its ability to prepare for and respond to an extreme weather event. The impacts of these direct health risks are often quantified as lives lost, persons hospitalized, or persons left homeless. Extreme weather events also present indirect health risks as a result of their ability to disrupt normal routines and systems.

These risks are positively correlated with the size of the affected population and the intensity of the event. Unlike direct health risks, the health impacts associated with indirect risks are often less apparent because they can take time to develop and manifest themselves. Examples of public health impacts associated with indirect health risks include ecosystem disruptions that lead to the spread of vector- and waterborne diseases, and mental health impacts (e.g., post traumatic stress disorder). Indirect health impacts are likely to receive less public attention and therefore run the risk of being overlooked in the preparation for and response to extreme weather events. The severity of future impacts will be determined by changes in climate as well as by concurrent changes in nonclimatic factors and by the adaptation measures implemented to reduce negative impacts.

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**ISEE-S28-01****Impact of Climate Change on Vectorborne Disease: What are the Early Signs so Far?**

Tong S, *Queensland University of Technology, Brisbane, Australia.*

**Abstract:** An increasing consensus among scientists is that climate change will undoubtedly alter the relations among pathogens, insect vectors, animal reservoirs, and humans, with warmer temperatures and altered rainfall patterns likely to change the geographic range and global burden of vector-borne diseases. However, the direction and magnitude of the influence will likely be heterogeneous and vary with region. Malaria is the most common and widespread vector-borne disease in the world, with approximately 40% of the world's population living in a malarious area. Although malaria epidemics are driven by many factors including climatic (e.g. ENSO, temperature, rainfall, and humidity) and non-climate factors (e.g. land use change, drug resistance, disease control efforts, and other socio-demographic factors), there is evidence suggesting that indices of El Niño-related climate variability are associated with malaria risks. Malaria resurgence in the East African highlands may be partly related to a significant warming trend in these regions. In Southern Africa, annual malaria incidence was positively related to the El Niño Southern Oscillation (ENSO), especially where *Anopheles arabiensis* is a major vector. Dengue is an infectious disease of public health importance, with up to 100 million annual infections, and up to 25,000 annual deaths, mainly in children. There is evidence that an increase in ambient temperature driven by the ENSO had a marked influence on the increased transmission of dengue. ENSO and long-range weather forecasts might help health authorities better design and implement intervention strategies for epidemic control and disaster management. In recognition of this need, WHO and partners have been developing and implementing an integrated early warning system for malaria in Africa using routinely collected data, seasonal climate forecasting, environmental monitoring, and disease surveillance. It is envisaged that the development of early warning systems for vectorborne disease will advance rapidly once scientific and operational issues are resolved.

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**ISEE-S28-02****Predicting U.S. Health Outcomes Attributable to Climate Change for Extreme Weather Events—What Happens when the Uncertain Meets the Unknown**

Mills D, *Stratus Consulting, Boulder, CO, USA.*

**Abstract:** This presentation explores issues associated with estimating how climate change could affect U.S. public health through potential changes in the incidence and/or severity of floods/extreme precipitation, wildfires, and hurricanes. In a simplified view of meteorological systems, heat is an indication of energy. Climate change therefore is expected to load the meteorological system with energy that can be released now or in the future. These events also have a history of significant adverse human

health impacts. Available research provides strong theoretical arguments that climate change may increase the future incidence and/or severity of extreme precipitation/floods and wildfires in parts of the United States. For hurricanes, the conclusions are less clear. Increases in the frequency and severity of extreme weather events will increase the risks to human health, all else equal. However "all else" will not remain equal. Increasing awareness of the risks and the potential impacts of climate change will likely increase the demand for adaptation programs that could reduce future impacts. At the same time, continued economic growth should increase the resources available to address this issue. These positive indicators are somewhat balanced, however, noting the anticipated population growth and increase in the average age of the U.S. population will generally leave the population more vulnerable. Competing demands for scarce financial resources also make it uncertain that addressing potential climate change impacts will emerge as enough of a priority to ensure it is effectively addressed. Predicting the health impact of future extreme weather events is further complicated because health impacts are not equally distributed across events. Historically, total health impacts and annual averages are in fact extremely sensitive to the results of single exceptional events. It is uncertain how climate change will affect this subclass of exceptional extreme weather events. Responding to the increased health risks of climate change will require human and financial resources. However, even a substantial resource commitment is unlikely to eliminate the chance that a single future extreme weather event, which may or may not be influenced by climate change, could result in catastrophic health impacts.

**ISEE-S28-03****Improving Adaptation to Heatwaves in a Changing Climate**

Sheridan S, Kent State University, Kent, OH, USA.

**Abstract:** The relationship between heat and human mortality is complex, varying across space, time, and age, among other factors. Data will be presented showing temporal trends of heat-related mortality across 28 US metropolitan areas. Acute heat-related mortality on hot air mass days has generally decreased over recent decades. This decrease is most significant in eastern and Midwestern cities where heat vulnerability is generally largest. In some cities, heat-related mortality has fallen below the level of statistical significance. In most cities, acute mortality still represents a statistically significant increase, with rates that leveled off during the past decade. Although historic values were lower across warmer cities, acute heat-related mortality rates have been stable over time, with a number of cities showing statistically significant associations. A number of southern cities have experienced an increased frequency of hot air mass days. Most northeastern and Midwestern cities have their peak acute mortality rates from late spring through August; in warmer cities the peak seasonal acute mortality appears earlier, with peaks as early as February and March. Several surveys across diverse metropolitan areas have been conducted regarding the perception of heat warnings. In much of the survey work, the elderly were sampled as their mortality rates during heat events far outpace the general population. Respondents were queried about their perception of their own vulnerability, changes in daily activities, and knowledge of their municipality's recommendations for how to deal with the oppressive weather. Results suggest that while the public is generally aware of the occurrence of heat warnings, only around half of all respondents modified their activities. Many did not recall specific advice, and the advice recalled varied significantly from city to city. Many did not feel that the recommendations for the elderly included them. Although most residents owned or had access to air conditioning, the cost of electricity was a significant factor for the duration of its use by almost half of respondents. In light of changing vulnerabilities, suggestions will be provided for how to improve the effectiveness of heat watch warning systems.

**ISEE-S28-04****Potential Impacts of Climate Change on Cold- Vs. Heat-Related Mortality**

Ebi KL, ESS, LLC, Alexandria, VA, USA.

**Abstract:** There is increasing interest in whether a warming climate could reduce deaths attributable to cold weather, thus offsetting some of the projected increased mortality from future heatwaves. Determining whether climate change could alter the nature of temperature-mortality relationships is complex, due to the multiple interacting drivers of these relationships. Two patterns are of importance: the annual association between ambient temperature and mortality, and the health impacts of extreme temperature events. Extreme temperature events are important in defining annual temperature-mortality relationships; they anchor the tail ends with relatively large impacts on mortality. Temperature-mortality relationships in temperate regions are U-shaped; mortality increases as temperatures increase and decrease from the minimum. The temperature at which mortality is at a minimum varies across geographic regions. The slope of the curve on either side of the minimum also varies, often with a steeper slope for cold-related mortality in regions with milder winters. Overall, more deaths occur during winter than summer months. Both extreme hot and cold temperatures lead to excess mortality. The health impacts of cold temperatures are less well appreciated by health practitioners and the general public. Cold stress stimulates a range of biological processes that result in the blood becoming thicker, increasing the likelihood of cardio- or cerebrovascular events. Colder air also induces bronchoconstriction, as well as suppressing the immune system, which can increase the likelihood of airborne infections. In regions with milder winters, colder temperatures have a greater impact on all-cause and respiratory disease mortality. The evidence suggests that reducing winter temperatures could increase cold-related mortality in the short-term if the populations in regions with newly milder winters do not maintain current environmental and behavioral practices. For climate to reduce temperature-mortality relationships, there would need to be a fundamental shift in current U-shaped relationships. Assuming no change in the degree to which temperature-related deaths are prevented, then climate change is likely to alter the balance of deaths between winters and summers, without changing overall mortality rates.

**ISEE-S29****The Southern California Children's Health Study: 15 Years of Air Pollution Epidemiology and New Results**

**Abstract:** Southern California is an ideal laboratory for studying health effects of traffic-related air pollution. Decades of unplanned urban sprawl and stunning growth in a port complex that is the principal gateway for goods imported into the United States has resulted in dense truck and automobile traffic corridors in close proximity to homes and schools. Because less densely populated coastal areas have pristine air quality, concentrations of regulated air pollutants in the region span the range present across the entire United States. The Children's Health Study (CHS) has examined respiratory effects of exposure to air pollution in a series of 6 cohorts of almost 15,000 school children during the last 15 years. New associations of primary and secondary traffic-related pollution with lung function growth, clinically relevant deficits in lung function, and asthma prevalence, incidence and severity have been influential in the recent development of regulatory policy. Study of genetic susceptibility to regional and local pollutants has increased both our understanding of the biological basis for these effects and our confidence in the causal nature of the associations. Susceptibility to outdoor pollutant exposure based on sex, socioeconomic characteristics and stress, and housing characteristics, has identified new research questions that merit further investigation. The development of new exposure assessment strategies and novel statistical methodologies in the CHS has promoted scientific progress in

understanding of air pollution health effects. This symposium will synthesize the results from the CHS. New results will be presented on effects of regional pollutants and traffic-related exposure at schools and homes, and on susceptibility based on personal characteristics and from a new genome wide association study of CHS participants.

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**ISEE-S29-01****Synthesis of Scientific Results and Policy Implications from the Children's Health Study**

Peters J, *University of Southern California, Los Angeles, CA, USA*.

**Abstract:** Epidemiological results from the CHS have demonstrated robust associations of particulate pollutants with lung function levels and growth, and with asthma exacerbation across the range of exposure in study communities. Ozone was associated with school absence and with asthma incidence. Exposure to local traffic was associated with effects on lung function additive to regional exposure and with prevalence of asthma and asthma severity. Susceptible groups based on gender, socioeconomic status and genetic variants have been identified. These findings have been influential both scientifically and in the development of U.S. standards for NO<sub>2</sub>, ozone and particulate matter.

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**ISEE-S29-02****Early Diagnosis of Asthma Modifies the Effect of Air Pollution on Lung Development in Children**

Berhane K, *University of Southern California, Los Angeles, CA, USA*.

**Abstract:** Children's Health Study cohorts of 2078 fourth (recruited in 1993 and 1996) and 750 seventh (recruited in 1993) graders were evaluated yearly until high school graduation. Based on these longitudinal data, we examined whether the effect of ambient air pollution on children's lung growth was modified by physician diagnosed asthma. A novel spline based multi-level mixed effects model was used to characterize the nonlinear lung growth patterns during the rapid growth period of adolescence and also to allow for proper comparisons at various levels: within-individual (over time), between individuals (within community) and between communities, after adjustments for potential confounders and effect modifiers. Significant deficits in lung growth (as measured by FEV<sub>1</sub>, FVC and MMEF) were associated with between-community differences in long term levels of NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, acid vapor, elemental carbon and organic carbon, but not with ozone. Moreover, children whose asthma was diagnosed before age five had both the largest asthma-associated deficits in lung function and the largest effect of air pollution, compared to those who were never diagnosed with asthma or were diagnosed after age five. These results indicate that current levels of air pollution could lead to chronic impairment in children's lung development, especially in the highly susceptible group of children with early diagnosed asthma.

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**ISEE-S29-03****Asthma and Traffic-Related Exposure at Schools, Homes and on Roadways**

McConnell R, *University of Southern California, Los Angeles, CA, USA*.

**Abstract:** New CHS analyses show associations of measured and modeled local traffic-related exposure with incident asthma. Independent effects are observed with exposure at school and home. A novel metric representing time to school as a proxy for commuting time is also independently associated with asthma prevalence. These results have important public health policy implications, as they indicate that traffic related pollution may be a major contributor to childhood disease burden, and the current regulatory framework does not control these exposures.

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**ISEE-S29-04****The Role of Genetic Susceptibility to Air Pollutants in the Etiology of Asthma**

Gilliland F, *University of Southern California, Los Angeles, CA, USA*.

**Abstract:** Epidemiological results from the CHS have demonstrated associations of air pollutants and tobacco smoke with adverse respiratory health effects in children, especially those with susceptible genotypes. The effects of ozone and traffic on asthma will serve as illustrative examples of the role of genetic susceptibility to environmental exposures in the etiology of asthma. Although oxidative stress is a cardinal feature of asthma, the roles of ozone, an oxidant air pollutant, fresh traffic emissions, and antioxidant genes in asthma pathogenesis have yet to be determined. We hypothesized that functional variants of antioxidant genes are associated with new onset asthma and that the effects of these variants vary by exposure to ozone and traffic proximity. In the first illustrative study, we investigated variants of HMOX1 ((GT)n repeat), CAT (-262C>T) and MNSOD-(Ala-9Val). HMOX1 'short' alleles (<23 repeats) were associated with reduced risk for new onset asthma in non-Hispanic whites (Hazard ratio (HR) 0.64, 95% CI 0.41–0.99). The protective effect was largest in children residing in low-ozone communities. Little evidence for an association with HMOX1 was observed in Hispanic children. In a second study, we hypothesized that GSTP1, GSTM1, exercise and ozone exposure have inter-related effects on asthma pathogenesis. A model of two functional SNPs best captured the association between GSTP1 and asthma. Compared to children with common alleles for both the SNPs, asthma risk was lower for the Val allele of Ile105Val (HR 0.60, 0.4, 0.8) and higher for the variant allele of rs6591255 (HR 1.40, 1.1–1.9). Risk increased with level of exercise in Ile homozygotes but not in those with at least one Val allele (interaction p 0.02). In those who participated in =3 sports in high-ozone communities, risk was higher in Ile homozygotes (HR: 6.15, 2.2–7.4) than in those with a Val allele (HR: 1.06, 0.3–4.1). GSTM1 null was independently associated with asthma, but showed no variation with air pollution or GSTP1 genotype. Additional examples are association studies with variants in TNF and EPHX1 metabolic phenotype and effect of tobacco smoke and GSTM2 null in association and challenge studies. Taken together, these studies strongly support the role of genetic susceptibility to air pollutants in the etiology of asthma.

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**ISEE-S29-05****A Genome Wide Search for Genetic Variants that Modify Air Pollution Effects on Respiratory Health**

Gauderman WJ, *University of Southern California, Los Angeles, CA, USA*.

**Abstract:** Recent CHS investigations have identified associations of childhood asthma and lung function development with regional air pollution, proximity to traffic, and tobacco smoke exposure. The CHS has also shown that genetic variation in specific candidate genes from oxidative stress and inflammatory pathways modify these pollutant effects. To further explore the genetic basis for these respiratory outcomes, we have conducted a genomewide association study (GWAS). Specifically, we have genotyped over 500,000 single-nucleotide polymorphisms (SNPs) on approximately 3,000 CHS study participants. We will describe the results to date of our search for novel genetic loci that contribute directly to asthma risk or lung function development, and for loci that modify the effects of air pollutants on these traits.

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**ISEE-S30****Exposure Assessment within the Frame of the European Union's Chemicals Policy REACH**

**Abstract:** Within the last two decades the science of exposure assessment has evolved and is now recognized as a full-grown science. The need for

scientific-sound methodologies is growing due to increasing public awareness towards exposure to chemical substances. The European Chemical Legislation REACH (Registration, Evaluation, Authorization and restriction of Chemicals) implemented the principle of exposure-based risk assessment and incorporates chemical safety assessment procedures that are based on exposure scenarios. This places the science of exposure assessment at the "heart" of an important legislative framework with a global impact. Consequently, major challenges are emerging in terms of data availability and data generation, communication in the supply chain, innovation and simplification in exposure assessment and modeling, harmonization of exposure assessment procedures. It is evident that further guidance needs to be developed and further training (programs and curricula) are essential. The objective of this symposium is to present and discuss the general context of REACH and its implications and challenges for the science of exposure assessment. Acknowledged experts from various organizations in Europe and the US (ECHA, TNO, RIVM and Exxonmobil) will be invited to present the REACH process and its exposure assessment related fields such as exposure scenarios, risk management measures and chemical safety assessment comprising occupational, consumer and environment exposure.

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**ISEE-S30-01**
**Introduction about Chemical Safety Assessment (CSA) under REACH**

Van Leeuwen K, TNO, Zeist, Netherlands.

**Abstract:** Substances manufactured in or imported into the EU in quantities of more than 10 tons/year, per registrant, and classified as dangerous for humans or the environment are subject to a Chemical Safety Assessment (CSA). A Chemical Safety Report (CSR) containing this assessment and including Exposure Scenarios (ESs) describing the safe manufacture and use (for all identified uses) of a given substance has to be provided as part of the registration dossier. After a short introduction about the formalities of REACH, this presentation will introduce the role of Exposure Scenarios (integrating environmental exposure and occupational, consumer and exposure of man via the environment) in the CSA process under REACH. Exposure scenarios are the first step in the safety evaluation of chemicals and play a crucial role in the exposure information exchange via Safety Data Sheets (SDS). The level of specificity needed for the Exposure Scenario depends on the hazard of the substances and the complexity of the use situation. A short overview will be given about the guidance and tools that are currently available.

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**ISEE-S30-02**
**Consumer Exposure Assessment**

van Engelen J, RIVM, Bilthoven, Netherlands.

**Abstract:** This presentation will provide an overview of the concept of consumer exposure and the models under REACH, both for the first tier and for the higher tier (e.g., ECETOC TRA, ConsExpo). Consumer exposure includes exposure to preparations as well as to articles and the information on exposure factors that are needed for consumer exposure are scarce and scattered. A case study will be given to illustrate the concept and current tools.

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**ISEE-S30-03**
**New Tools in Occupational Exposure Assessment**

Tielemans E, TNO, Zeist, Netherlands.

**Abstract:** This presentation will illustrate the current status of preliminary and refined occupational exposure assessment models under REACH. REACH requires a tiered exposure assessment approach in which the first tier is given by a conservative system and subsequent tier(s) providing

more refined exposure modeling for scenarios of concern. Such a system is required as a case-by-case in depth assessment requiring lots of exposure data for each scenario. These exposure data either exist or need to be generated involving costs. A core requirement of any screening (first tier) tool should be that it is simple, readily understood, and with appropriate level of conservatism. Higher tier models generate more refined and realistic exposure estimates. In general, one of the main weaknesses of the available screening tools is that only few have been validated. The consequences of this lack of validation in conjunction with available results from validation studies will be presented and discussed in this presentation. So far, a higher tier model that fulfills all REACH requirements is still missing. Therefore, a new exposure assessment framework is now proposed, incorporating both a mechanistic model and information from exposure databases. This framework is referred to as the REACH Advanced Tool project and first results will be discussed.

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**ISEE-S30-04**
**ECETOC Targeted Risk Assessment Screening Tool**

Zaleski R, ExxonMobil, Annandale, NJ, USA.

**Abstract:** The European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) developed a pragmatic approach in 2003/4 by which to evaluate and prioritize chemicals for which a more detailed safety analysis is required. The approach includes occupational, consumer and environmental exposure aspects and has been enabled in a web-based tool in order to provide wider access and facilitate consistent use across users. The approach combines aspects of established exposure models (EASE, EUSES), safety assessment practices (control banding), and standard exposure and risk concepts into a framework suitable for screening a broad range of chemicals and uses. Since 2004, several thousand risk assessments have been completed by users of the tool. Building from these experiences, ECETOC has been working with stakeholders during 2007/8 to examine how the tool's capabilities and scientific integrity can further be improved. This presentation will review these developments, with specific discussion of the approach's utility within the context of the EU REACH Regulation.

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**ISEE-S30-05**
**European Chemicals Agency's (ECHA) View for the Further Development of Exposure Tools for the Implementation of REACH**

Hansen B, European Chemicals Bureau, Helsinki, Finland.

**Abstract:** One of the challenges of REACH is that manufacturers and importers (M/I) are responsible for developing the Exposure Scenario. An Exposure Scenario is a description of the Operational Conditions (OC) and the Risk Management Measures (RMM) for a particular substance to ensure safe use for humans and the environment. This is then reported in the CSR. The focus on exposure in REACH is a real new element and, without any doubt, one of the real challenges of REACH. For each relevant chemical (see introductory presentation) M/I need to quantify the exposure of the different use patterns of each chemical in order to demonstrate safe use. The implementation requires adequate communication up and down the supply chain, simple and refined exposure models for occupational, consumer, and indirect human exposure as well as environmental exposure. For the practical implementation the following strategy has been chosen: start with generic exposure tools and only refine the exposure (including RMM and OC information) and hazard information, when necessary in order to demonstrate safe use. An overview will be presented what the ECHA (European Chemicals Agency) has done and will do to facilitate the implementation of ES and what is expected from industry.

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ISEE-S31**Research Perspectives on Community Environmental Health Assessment**

**Abstract:** PROBLEM. Each community has unique environmental exposures, activity patterns, and vulnerabilities that may affect their environmental health risks. Community environmental health assessment (CEHA) is a process to identify and communicate environmental health information and resources with a specific community in mind. CEHA can establish environmental health priorities, develop action plans to meet those priorities, and create community capacity by enhancing community participation in health decision-making. CEHA can be employed using a myriad of tools and approaches. CEHAs can provide a fresh perspective for the environmental health community to study risk assessment, but these research opportunities are not always developed. The goals of CEHA are not to establish exposure-outcome relationships, and many times the general participatory processes create an impediment to epidemiologic studies or risk assessments. Still, CEHA offers the unique opportunity for the environmental health research community to mitigate the normal limitations of traditional risk assessment: the use of a prototype community, assessment of single chemical agents, and lack of consideration of non-chemical stressors which affect individual and community health. However, sometimes community-academic partnerships fall short of their intended expectations. These collaborations can fail due to lack of resources or improper planning. Other times community-academic partnerships are unsuccessful due to communication issues or improper transparency and public input.

**SYMPOSIA OUTLINE.** We will briefly present the concepts and basic process of CEHA (10 minutes). Speakers will present their unique experiences (case studies) with CEHA and give advice/best practices for researchers working on similar project (60 minutes). Two speakers will discuss their involvement in urban CEHA efforts, and one speaker will present their activities with a rural, farmworking community. Then, the speakers will form a panel to entertain questions from the audience (20 minutes).

**OBJECTIVES.** At the end of the symposia, participants should be able to:

- Understand the value of CEHA
- Identify processes of CEHA activities
- Recognize different approaches and tools that could be appropriate for CEHA
- Distinguish elements that are important for successful community-academic activities
- Acknowledge challenges involved with community-academic collaboration

**CONCLUSIONS.** Community environmental health assessments (CEHA) have been noted as a useful approach for addressing community health needs. However, CEHA practitioners are faced with multiple challenges throughout the process, and many times CEHA efforts are not organized to facilitate epidemiological and risk assessment studies. Therefore, the environmental health research community may be missing important opportunities for environmental health research. The symposia will introduce CEHA to participants, present some experiences from the frontlines, and offer appropriate approaches and tools for successfully incorporating environmental health research into CEHA experiences. In addition, this symposium will facilitate networking among participants in hopes of instigating future partnerships or introducing collaborative colleagues.

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ISEE-S31-01**Community Environmental Health Assessment: What Is It? How Can I Participate as a Researcher?**

Sanchez YA, Association of Schools of Public Health, U.S. EPA, Washington, DC, USA.

**Abstract:** Community environmental health assessment (CEHA) is a systematic process to identify environmental health risks and create a practical action plan to address key environmental health issues within a target population. Many different approaches exist to employ CEHA. Efforts could be limited to public health and government officials. However, quality CEHAs alleviate some of the fragmentation of the public health system by allowing agencies, organizations, researchers and community members to work together. The involvement of environmental health researchers and community members can lead to successful CEHAs.

Among different approaches to employ CEHA, some trademark frameworks are available for broad use, such as: the Protocol for Assessing Community Excellence in Environmental Health (PACE EH), the Tool for Health and Resilience in Vulnerable Environments (THRIVE), and the Community Action for a Renewed Environment (CARE) Resource Guide. Each framework presents a roadmap for communities to follow to assess what environmental health means for the community and use community values to prioritize environmental health action. These frameworks address inherent challenges of CEHAs, such as gaps in scientific understanding of environmental exposures and health effects, data limitations, public perceptions of risk, and fragmentation of the public health system to address environmental health.

Environmental health researchers can enhance CEHA efforts by playing a role as technical advisors to environmental science issues. Researchers can improve CEHA efforts to gather environmental health data. Examples include environmental monitoring, biomonitoring measures in community members or food species, and assessment of behavior that may enhance exposure to environmental pollutants. Second, scholars can aid in gathering data on community perceptions of risk by carrying out, or advising CEHA participants to perform, key informant interviews or community surveys. Third, researchers can assess the magnitude of an environmental health risk through environmental risk assessment or interpret how large-scale scientific data may translate in the particular community. Finally, researchers can advise on evaluating progress toward reducing environmental health burden and improving community health. CEHA activities can also provide important scientific information that may compel researchers to publish information for the greater scientific community.

Enhancing community participation in CEHA increases the ability to effectively access the target community, efficiently “reach” that community for intervention efforts, and successfully advocate for public health funding to support CEHA objectives. Community members contribute valuable local knowledge to assess environmental health risks in the community. In addition, community involvement increases the understanding of community values and expectations leading to proper prioritization of environmental health risks. Second, community members have valuable skills to aid effective risk communication, such as cultural competency, knowledge of local customs, and understanding of local communication norms. Finally, unlike many government employees, community members can advocate in local politics, and they can lobby policy makers for adequate public health funding to support CEHA objectives.

Altogether, CEHA efforts aim to establish environmental health priorities, develop action plans to meet those priorities, and create community capacity. Collaboration with environmental health researchers and adequate participation of the local community can enhance CEHA activities.

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ISEE-S31-02**Urban Community Environmental Health Assessment: New York City**

Kinney P, Mailman School of Public Health, Columbia University, New York City, NY, USA.

**Abstract:** The South Bronx is a population dense, culturally diverse urban community. The geographical area has sparse capital investment and an abundance of noxious facilities. A myriad of subcommunities live in the densely populated urban area, each differing in their settlement history

and present status. In the South Bronx community the Columbia Center for Children's Environmental Health (CCCEH) has proposed to increase awareness of environmental health hazards by developing, implementing and evaluating community-wide intervention.

CCCEH works to protect children's health, by conducting scientific studies of links between common pollutants in the environment and certain health risks. CCEH has proposed to increase awareness of environmental health hazards by developing, implementing and evaluating community-wide intervention. One goal CCCEH is to carry out a comprehensive community-based assessment of urban environmental risks to infants and children living in Northern Manhattan-South Bronx.

Learning ways in which urban pollutants contribute to rising rates of asthma, developmental delay and cancer risk is guided by the notion that relationships between exposures and outcomes can be understood only through a multi-level approach. This approach incorporates molecular, individual and community sources of information on environmental, biological and social risk factors. Therefore, the focus is on a complex evaluation of the combined effects of pollutants over a range of susceptibilities, within the social context. Community involvement has become an essential component of a multi-level research approach. The Columbia Center has forged a successful partnership with West Harlem Environmental Action, Inc. and nine other community organizations to identify and prevent environmental causes of childhood disease in northern Manhattan and the South Bronx. Scientists draw on the knowledge of the community to design research projects that address the needs and concerns of community members. Community workshops and newsletters relay CCCEH findings back to neighborhood parents and other primary caretakers of young children. These caretakers can work toward reducing children's exposure to harmful pollutants that can impede their healthy growth and development. In addition, CCCEH and community partners are also conducting home interventions to help families minimize allergens using lower-toxic pest control methods.

This presentation will report on how a community-based environmental assessment of an urban community helped to inform environmental health research. Lessons learned from community-academic partnerships will be presented along with best practices on foraging future community-academic partnerships.

#### ISEE-S31-03

#### A Community Environmental Health Assessment in a Latino Farm Worker Community

Hoare L, Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA.

**Abstract:** The Yakima Valley is located in central Washington State, an agriculturally rich region that is among the leaders in the nation in the production of apples, hops, cherries, and grapes. Yakima County has an estimated population of 233,105, spread between the large urban center and smaller outlying rural towns. In 2006, approximately one third (39.3%) of the population in Yakima County was of Latino ethnicity, compared to 8.8% of the overall population in Washington State (US Census, 2006). This high concentration of Hispanics can be explained partially by the draw of the agricultural activity of the region with its high demand for farm laborers, many of whom migrate from Mexico.

El Proyecto Bienestar is a community based participatory research project (CBPR) in the Yakima Valley, Washington, that was formed in 2002 through a four year grant from NIEHS, with the aim of identifying and prioritizing environmental and occupational health concerns of Latino farm workers and their families. It is administered through a "Core" partnership between the four founding partners: Pacific Northwest Agricultural Safety and Health Center (PNASH) at the University of Washington, Northwest Communities Education Center (NCEC)/Radio KDWA, Yakima Valley Farm Workers Clinic, and Heritage University (a minority University located in the Yakima Valley). The agricultural

community is represented through the Community Advisory Board (CAB) which advises the Core on all activities. The CAB consists of community members that are or have been farm workers or people that work with this population in the Yakima Valley.

During the first four years, El Proyecto Bienestar used key informant interviews (24) with stakeholders in the agricultural community, annual community surveys (878 surveys total), and a Town Hall Meeting (65 voting participants) to get input from the farm worker community in the Yakima Valley in addition to the CAB. Key informant interviews provided a detailed "first look" at the environmental and occupational health issues faced by farm workers and their families in the Yakima Valley. The community surveys examined the prevalence of these concerns in the community. Approximately 40 environmental and/or occupational health concerns were identified through the data collection. The Town Hall Meeting was used as way to engage community members in prioritizing these health concerns. After the Town Hall meeting, the CAB reviewed all datasets and the results of the Town Hall meeting prioritization and endorsed these without modification. The top four priorities were identified as pesticides, workplace injuries, workplace illnesses, and abuse in the workplace.

El Proyecto Bienestar is currently in its fifth year and is supported through the Environmental Protection Agency's (EPA) Community Action for a Renewed Environment (CARE) program. In addition, the collaboration is searching for additional funds to carry out activities that address the four prioritized concerns.

This presentation will report on how a community-based environmental health assessment of a rural, farm worker community has helped inform environmental health research in the Yakima Valley. Lessons learned from community-academic partnerships will be presented along with best practices for forming future community-academic partnerships.

#### ISEE-S31-04

#### Community Environmental Health Assessment: Researchers Addressing "Real World" Problems

Hricko A,\* and Green E,† \*Keck School of Medicine of USC, Los Angeles, CA, USA; and †Long Beach Alliance for Children with Asthma, Long Beach, CA, USA.

**Abstract:** Southern California is a densely populated urban area with serious air pollution. The region is also home to the largest port complex in the U.S., with related highways, rail yards, and warehouses that contributing more than ¼ of the region's diesel particulate pollution.

Research results from the Children's Environmental Health Center (CEHC) based at Keck School of Medicine, University of Southern California (USC), have shown that children who live close to busy roads and freeways are more likely to have reduced lung function and asthma. As a core of the CEHC, the Community Outreach and Translation Core (COTC) was developed to facilitate community partnerships and relationships with the public. The COTC serves as a bridge between the Center's researchers (who are at both USC and UCLA) and members of the community, including elected officials and decision-makers.

To facilitate both the Center's Community Based Participatory Research (CBPR) project and the COTC's outreach efforts, formal partnerships were developed with two community-based groups concerned about respiratory illness and traffic emissions, the Long Beach Alliance for Children with Asthma and the Center for Community Action and Environmental Justice. This presentation will describe how, through these partnerships, the Center scientists have been able to draw upon community knowledge in conducting their studies and ensuring that their research is reflective of community concerns. From the partners' side, the presentation will describe how special training sessions and conferences ensure that the Center's findings are shared in an understandable way.

The presentation will also describe how the COTC has worked collaboratively with its community partners over the past three years to

develop and nurture Neighborhood Assessment Teams—or A-Teams—to conduct community assessments of environmental health problems.

Members of the A-Teams are bilingual community residents, often with limited formal education, who receive stipends for their neighborhood assessment activities. They are Latina mothers who are truly engaged in their community, and many of them have children with asthma.

The A-Teams have taken a specific interest in documenting traffic volume in communities frequented by trucks hauling containers to and from the local marine ports. A-Team members receive leadership training, classes in public health, and work jointly with university partners on developing protocols for counting traffic and monitoring air pollution. Following their field work, A-Team members are trained in making effective presentations at public meetings.

This presentation will report on how a community-based environmental health assessment approach can (1) empower community volunteers; (2) focus on a very specific issue of neighborhood concern—heavy duty diesel port truck traffic on residential streets; (3) enhance understanding of air pollution hot spots; (4) expand the capabilities of community groups to conduct their own research; (5) inform the university research effort; and (6) have an impact on the decision-making process. Successes and challenges will be discussed.

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#### ISEE-S32

#### NIH Genes, Environment, and Health Initiative: Tools for Enhancing Exposure Assessment

**Abstract:** The NIH established the Genes, Environment, and Health Initiative (GEI) in 2006 with a goal of establishing a foundation for large-scale Gene-Environment interaction studies. A central component of this Initiative is the Exposure Biology Program, lead by the National Institute of Environmental Health Sciences in collaboration with the National Cancer Institute, National Heart, Lung, and Blood Institute, National Institute for Drug Abuse and other NIH Institutes and Centers. The Exposure Biology Program aims to develop a new generation of tools for comprehensive exposure assessment. These tools stem from the efforts of four complementary program areas focused on improving detection of individual exposures to traditional environmental toxicants, assessing psychosocial stress and addictive substances, assessing diet and physical activity, and measuring biological responses to these factors. This activity is focused on the development and validation of new tools, approaches, and biomarkers that will enable fundamentally new directions in environmental epidemiology and the exploration of Gene-Environment Interactions. This session will present an overview of the GEI and the Exposure Biology Program and will include presentations by grantees of each of the four program areas. These presentations will focus on the evolution of these new tools and how they may be used to test novel hypotheses that could not be evaluated with currently available tools. Following the presentations we will engage in a dialog with the conference attendees to: 1) explore strategies of engaging the environmental epidemiology community, particularly early adopters, and 2) discuss barriers to the utilization of these tools in population-based studies.

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#### ISEE-S32-02

#### Nanosensor Array for Real-Time Monitoring of Diesel and Gasoline Exhaust Exposure

Mulchandani A,\* Myung NV,\* Deshusses MA,\* Cocker D,\* Wang J,† Bakkaloglu B,† and Spanias A,† \*University of California, Riverside, CA, USA; and †Arizona State University, Tempe, AZ, USA.

**Abstract:** Diesel and gasoline exhaust, produced when an engine burns fuel, is a complex mixture of gases and fine particles (commonly known as soot). It contains over 40 toxic air contaminants, including nitrous

oxide, nitrogen dioxide, hydrogen disulfide, sulfur dioxide, carbon monoxide, carbon dioxide, formaldehyde, benzene, toluene, naphthalene, polycyclic aromatic hydrocarbons, nitro-polycyclic aromatic hydrocarbons, acrolein, arsenic and 1,3-butadiene. Recent studies have linked respiratory diseases and cancer to exposure to gasoline and diesel exhaust. These diseases, however, are also attributed to genetic susceptibility. Establishing a direct linkage of these diseases to diesel and/or gasoline exhaust requires reliable and reproducible quantitative measure of exposure.

We are building an autonomous/self-contained wearable, approximately 4" by 4", sensor array for the real-time monitoring of exposure through inhalation to the gaseous components of internal combustion engine exhaust. The fully integrated light weight sensor that can be worn as badge similar to  $\gamma$ -radiation counter will comprise arrays of conductometric and amperometric sensors, and low-power fully integrated microelectronics for power management, data collection, and signal processing. Arrays of independent sensors can offer much more analytical information on personal exposure and thus hold a great potential for selective and accurate monitoring of low concentrations of mobile source air toxics and other relevant pollutants in real-time. Advanced data processing will be used for generating distinct response patterns and detecting the individual agents in vapor mixtures. Such judicious integration of two powerful detection schemes along with an intelligent data processing should dramatically increase the gathered information on personal exposure to offer remarkable reliability along with broad scope, while meeting the portability requirements of decentralized detection systems.

In this presentation, we will present our recent results on development of nanosensors based on using electrochemically functionalized single-walled carbon nanotubes (SWNTs) with either metal nanoparticles or metal oxide nanoparticles, and metal oxide nanowires and nanotubes for gases such as ammonia, NO<sub>x</sub> and volatile organics. The methods allow creation of high-density individually addressable nanosensor array that has application in assessment of exposure to gasoline and diesel combustion exhaust.

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#### ISEE-S32-03

#### Hemoglobin Adducts in Dried Blood Spots as Measures of Carcinogen Exposures

Rappaport SM,\* Funk WE,† and Chaing S,‡ \*School of Public Health, University of California, Berkeley, CA, USA; †School of Public Health, University of North Carolina, Chapel Hill, NC, USA; and ‡North Carolina State Laboratory of Public Health, Raleigh, NC, USA.

**Abstract:** Since carcinogens tend to be reactive electrophiles with short life spans in vivo, they are difficult to measure directly. However, these electrophiles react with nucleophilic sites on hemoglobin (Hb) to produce adducts that are stable over the residence time of the protein (63 d). Thus, Hb adducts provide convenient measures of the integrated doses of carcinogens over two months. Although dried blood spots (DBS) have been used to monitor protein biomarkers in infants and adults, they have not been used to measure Hb adducts of carcinogens in epidemiological studies. This is surprising because a single DBS contains sufficient Hb (about 8 mg) for measuring adducts, and DBS can be obtained and stored much more conveniently than conventional venous blood samples.

Because our laboratory has studied protein adducts from reactive metabolites of benzene, we conducted this project to determine whether we could detect adducts of benzene oxide (BO), in Hb isolated from adult and infant DBS. We performed experiments to selectively isolate Hb and, ultimately, globin from fresh DBS obtained either from archived adult-volunteer blood or from neonates screened by the State of North Carolina. Following a simple protocol, we successfully extracted globin in high purity, estimated at 96% by 2-D PAGE. The estimated mean quantities of

globin isolated from 9 adult and 9 newborn DBS were 6.4 mg (SD = 0.96) and 7.2 mg (SD = 2.20), respectively. We then conducted our standard GC-MS assay to detect cysteinyl adducts of BO (BO-Hb) using globin from adult and neonatal DBS and using globin that had been isolated conventionally from red blood cells in the same adult subjects. The geometric mean BO-Hb levels ranged from 27.7 to 33.1 pmol/g globin across the three sources of globin and the coefficient of variation of the assay was 15%. Neither of the comparisons of geometric mean BO-Hb levels between sources (adult conventional vs. adult DBS and adult DBS vs. newborn DBS) was significant at a *P*-value of 0.05. The (logged) BO-Hb levels in globin from DBS and conventional red blood cells were highly correlated in the 9 adult subjects ( $r = 0.732$ ).

We conclude that it is feasible to isolate globin from DBS in high purity and to detect Hb adducts of at least one prominent electrophile (BO) in DBS at levels comparable to those observed in conventional blood.

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provide information about the potential uses of this system in their research.

#### ISEE-S32-05

#### Characterizing the Impacts of Circadian Rhythm Alteration on Physiological Stress, and How these Alterations in Turn Impact How Environmental Exposures Affect Health

Rea MS,\* Figueiro MG,\* Lawless PA,† and Rodes CE,† \*Lighting Research Center, Rensselaer Polytechnic Institute, Troy, NY, USA; †RTI International, Research Triangle Park, NC, USA.

**Abstract:** Of growing scientific and medical interest is the importance of circadian (24-hour) temporal organization in biological systems. Patterns of light and dark are the primary exogenous stimuli that regulate these rhythms. In a natural environment, the light-dark cycle registered on the retina orchestrates our circadian rhythms with the local time on the planet. Modern society has altered the correspondence between natural solar time and our circadian time. The built environment shields us from daily sunlight exposure, and electric lighting has extended light exposure into the night. These lighting changes have muted and changed the periodicity of our light-dark patterns. A breakdown in the 24-hour light-dark rhythm has been shown to induce circadian disruption, which has been linked to a wide range of maladies, including sleep disorders, cardiovascular disease, diabetes, and breast cancer.

Of special interest, the efficacy of chemotherapy for breast cancer depends upon the circadian timing of drug administration: efficacy can vary by a factor of four over the circadian cycle. The impact of environmental exposures also varies with circadian time. Skin reactivity to histamines, for example, is much more prevalent in the evening than during the day. It is interesting to note that loss of circadian rhythmicity can be used as a predictor of malady onset. What is not known is whether restoration of these rhythms can reverse or delay the onset of symptoms. Since light and dark are the primary regulators of the timing and amplitude of circadian rhythms, it may be possible to use personal light exposure measurements to both diagnose the onset of symptoms and to delay their onset by corrective, non-pharmacological light treatments designed to reinstate circadian rhythmicity.

Personal exposures to pollutants are generally higher than background levels because individuals may be nearer to sources (cooking) or participate in generating their own exposures (cleaning, using sprays). These effects are noted even in 24-hour integrated samples. When real-time monitoring of exposures is performed, it becomes possible to relate exposure peaks to the individual's circadian cycle and explore relationships to health impacts.

The goal of this presentation is to lay the foundation for systematic studies of cohort stress, using personal light-dark exposure measurements together with techniques to quantify circadian disruption. By integrating circadian rhythm onto personal sensor platforms that have real-time capabilities for characterizing exposures, the degree of interactions with biological effects can be examined in previously unobtainable detail.

#### ISEE-S33

#### Exposure to Traffic-Related Pollutants: Continuous Monitoring and Future Directions

**Abstract:** Continuous air pollution monitoring has tremendous appeal for estimating exposure to traffic-related pollutants because its frequent sampling rate captures the intermittent nature of vehicular sources and other local combustion sources. Yet continuous monitoring poses a number of design and statistical issues that must be addressed. In particular, there is a tension between monitoring at fewer sites, which captures temporal trends but provides little insight about spatial patterns, versus monitoring at multiple sites, where disentangling spatial and

#### ISEE-S32-04

#### Geospatial Measurement & Analysis Of Physical Activity: Physical Activity Location Measurement System (PALMS)

Patrick K,\* Kerr J,\* Norman G,\* Ryan S,† Sallis J,† Krueger I,‡ Griswold W,\* Demchak B,\* Dietrich S,‡ Raab F,\* Lotspeich D,\* Matthews S,§ Wolf J,¶ and Ainsworth B,|| \*University of California, San Diego, CA, USA; †San Diego State University, San Diego, CA, USA; ‡California Institute for Telecommunications and Information Technology, La Jolla, CA, USA; §Pennsylvania State University, State College, PA, USA; ¶GeoStats, Atlanta, GA, USA; and ||Arizona State University, Tempe, AZ, USA.

**Abstract:** Understanding where physical activity-related energy expenditure (PAEE) occurs as a function of time and space is important in exposure biology research. The aim of the PALMS project is two-fold: a) develop a software-based system to collect over extended periods of time, through a variety of sensors and in free-living humans, PAEE and GPS data; and b) develop recommended modeling and analytical approaches for these data that researchers can use to link to other forms of information relevant to exposure biology. Data collected by PALMS, combined with optional concurrent ecological momentary assessment of psychosocial correlates of PA via a mobile phone will provide significant advantages over currently available approaches to understand how PAEE varies by location and context. This knowledge is essential to exposure biology researchers interested in gene-environment interactions as well as researchers exploring how environmental factors such as the built environment, crime, the availability of recreation facilities, or terrain influence PAEE. The PALMS project is one of seven GEI-funded studies with the objective of improving measures of diet and physical activity. The project is comprised of four phases: 1) Specify, adapt or build and bench test sensors for movement, heart rate, GPS, and mobile data collection via mobile phone and then develop data- and web-server software architecture that supports collecting, aggregating, storage and analyses of these data and their integration with existing GIS systems. 2) Usability and field data capture testing on the system among a multiethnic sample of adolescents (age 12–20), adults (21–60), and older adults (61+); n = 45 3) Use data captured in Phase II to develop new, and validate currently used, methods of data modeling and visualization appropriate to PAEE and geospatial research. Based on user feedback improve the tools and software for use in Phase IV 4) Field test the use of the entire system in free-living adolescents, adults, and older adults and test the utility of the system as a support to research on geospatial aspects of PAEE. This presentation will provide an update on the status of the development of PALMS and provide attendees and both gather and

temporal variability can be challenging. Accounting for the influence of local meteorology further complicates matters because statistical models must balance maximizing the explainable variability against adhering to the theoretical structure of atmospheric dispersion models. This symposium will consider recent studies utilizing continuous, real-time air pollution monitoring in a variety of observational frames—single-site, multi-site, and mobile monitoring—and review the various statistical techniques used to determine the contribution of local sources to measured concentrations. The primary question to be considered will be, “What do the results from these different approaches reveal about the overall nature of exposure to traffic-related pollutants and about the prospects for research in the near term?” To make the symposium maximally informative, the opening presentation will outline the focus of the symposium, invite the audience to participate freely in discussing the key issues, and review the current state of the literature. This will be followed by a series of 10-minute presentations highlighting study findings and methods relevant to the symposium themes; a wrap-up presentation; and a panel discussion involving all presenters. Presentation topics and speakers:  
\* Jonathan Levy, Harvard School of Public Health: Challenges in Evaluating Exposure to Traffic-Related Air Pollutants Using Continuous Monitoring Data. (10 minutes) \* Robin Dodson, Silent Spring Institute: An Analysis Of Continuous Black Carbon Concentrations In Proximity To An Airport And Major Roadways. (10 minutes) \* Rey deCastro, Westat: The Longitudinal Dependence Of Black Carbon Concentrations On Traffic Volume In An Urban “Hot Spot” Environment. (10 minutes) \* Jay Turner, Washington University in St. Louis: Aethalometer Black Carbon: Data Quality Issues and Data Analysis Methods. (10 minutes) \* Leonard Zwack, Harvard School of Public Health: Spatial and Temporal Heterogeneity in Mobile Source Air Pollutants in Complex Urban Terrain. (10 minutes) \* Timothy Buckley, Ohio State College of Public Health: Human Exposure to Mobile Source Related Air pollution: The Road Ahead. (10 minutes) \* Panel discussion and audience questions. (20 minutes)

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**ISEE-S33-01****Challenges in Evaluating Exposure to Traffic-Related Air Pollutants Using Continuous Monitoring Data**Levy J, *Harvard School of Public Health, Boston, MA, USA.*

**Abstract:** An increasing number of studies utilize continuous real-time air pollution monitors to determine exposure patterns to traffic-related air pollutants and to determine the marginal contribution of various sources. While these monitoring techniques have tremendous appeal given the intermittent nature of vehicular sources and anticipated variability in concentrations, interpretation of the outputs is complicated by a number of factors. Studies that collect measurements at a limited number of sites can potentially determine source contributions at those sites but cannot characterize spatial patterns in general. Conversely, monitoring at numerous sites or with mobile instrumentation can characterize spatial patterns but are challenged to disentangle spatial and temporal variability. In addition, the measurement instruments themselves have complex and dynamic biases for which adjustment is necessary. An evaluation of the literature confirms that many analytical challenges remain. This symposium addresses key issues related to evaluation of continuous monitoring data, including approaches to account for biases and autocorrelation of longitudinal concentration measures, utilizing continuous traffic data in a regression framework to facilitate source apportionment, appropriate incorporate of real-time meteorological data, and specific issues related to black carbon measurements with aethalometers.

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**ISEE-S33-02****An Analysis Of Continuous Black Carbon Concentrations In Proximity To An Airport And Major Roadways**Dodson R, *Silent Spring Institute, Boston, MA, USA.*

**Abstract:** In the vicinity of major airports, multiple source types may contribute to ambient pollutant concentrations, and determining the relative contributions of these sources is a key step in developing appropriate mitigation strategies. Regression analyses of continuous monitoring data can potentially provide these source contribution outputs, but only if real-time source and meteorological data can be incorporated. In this study, we conducted an analysis of continuous black carbon (BC) concentrations collected near T.F. Green Airport in Warwick, Rhode Island over a total of 14 months (July 2005 to September 2006). Sampling was conducted using aethalometers at five sites in Warwick, four in close proximity to the airport at various wind directions and a fifth site approximately three miles east-southeast of the airport. To determine predictors of BC concentrations, we considered both meteorological data and airport operations data, with data combined on an hourly basis. One-minute average BC concentration data were averaged and corrected for potential loading effects. To capture the joint effects of wind speed and direction, vectors of wind speed in the east-west direction and north-south direction were created. Since the temporal autocorrelation was rather high (one-hour lag Spearman correlation ( $\rho$ ) = 0.73), time-series bootstrap methods were used in combination with the LME models to obtain regression estimates. Conditional probability functions indicate that higher BC concentrations tend to occur during periods of low/calm wind speeds. Approximately 40% of the upper decile of the concentration distribution at each of the sampling locations proximate to the airport occurs during when the wind speeds drop below 3 m/s. Regression models indicate joint effects of wind speed and direction consistent with contributions from the airport and defined major roads, and demonstrate statistical significance for airport activities. Our statistical approach provides insight about the joint influence of source activities and meteorology on continuously measured concentrations and provides a template for analyses at complex urban sites.

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**ISEE-S33-03****The Longitudinal Dependence Of Black Carbon Concentrations On Traffic Volume In An Urban “Hot Spot” Environment**Decastro R, *Westat, Rockville, MD, USA.*

**Abstract:** This study evaluated the effect of traffic volume on ambient black carbon concentration in an inner-city neighborhood “hot spot” while accounting for modifying effects of weather and time. Continuous monitoring was conducted for 12 months at the Baltimore Traffic Study site surrounded by major urban streets that together carry over 150,000 vehicles per day. Outdoor black carbon concentration was measured with an Aethalometer<sup>TM</sup>; vehicles were counted pneumatically on two nearby streets; meteorologic data were also obtained. Missing data were imputed and all data were normalized to a 5-minute observational interval ( $n = 105,120$ ). Time-series modeling accounted for autoregressively (AR) correlated errors. Background neighborhood-level black carbon exposure was estimated to be 905 ng/m<sup>3</sup>, with additional exposure from traffic at a rate of 66 ng/m<sup>3</sup> per 100 vehicles every five minutes. Winds from the SW-SSE quarter are associated with the greatest increases in black carbon (376–612 ng/m<sup>3</sup>). These winds would have entrained black carbon from Baltimore’s densely trafficked central business district, as well as a nearby interstate highway. Dew point, mixing height, wind speed, season, and workday are also statistically significant predictors. The optimal, statistically significant representation of black carbon’s autocorrelation is AR([1:6])\*(288)\*(2016), where the short-term AR factor (lags 1–6) indicates that black carbon concentrations are correlated for up to 30 minutes, and the AR factors for lags 288 and 2016 indicate longer-term autocorrelations at diurnal and weekly cycles, respectively. Local exposure to black carbon from mobile sources is substantially modified by meteorologic and temporal conditions, including atmospheric transport processes. Black carbon concentration also demonstrates statistically significant autocorrelation at several timescales. Our quantitative characterization of the determinants of black carbon exposure may be

relevant to traffic-related pollutant exposures in other urban environments with similar fleet composition.

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**ISEE-S33-04**
**Aethalometer Black Carbon: Data Quality Issues and Data Analysis Methods**

Turner JR, *Washington University in St. Louis, St. Louis, MO, USA*.

**Abstract:** Magee Scientific's Aethalometer® is widely used for sustained measurement of aerosol "black carbon" mass concentration at high time resolution. The Aethalometer continuously collects particles onto a filter tape and measures the wavelength-dependent transmission of light through the deposit. A first principles model has been developed and published which shows the effective mass absorption efficiency of the deposited aerosol changes with the mass loading of absorbing particles onto the filter. This "optical saturation" effect is most-commonly observed as a step discontinuity in the reported concentration occurring when the filter tape is advanced to deposit aerosol onto a clean filter spot instead of a particle-laden filter spot. The implication is that while aerosol accumulates onto the same filter tape spot, the reported black carbon concentration will decrease with time while the actual sampled aerosol is constant. We have found the optical saturation effect to have a distinct climatology in both Boston and St. Louis, presumably due to the presence of high summertime sulfate concentrations which can suppress optical saturation. Various equations have been developed to compensate for this optical saturation effect, and one has been incorporated into Aethalometer data post-processing software distributed as freeware by the author. The approach relies on the concentration jump across tape advances and can be influenced by changes in the true black carbon concentration during such periods. Due to the noise inherent in estimating the tape advance-specific compensation parameter, it is necessary to perform time averaging on the compensation parameter. Estimation is further complicated because the minimum time scale for compensating for optical saturation is on the order of weeks, while changes in ambient aerosol composition are often on the order of days as synoptic weather fronts pass through an area that affect the mix absorbing and scattering aerosols. The presentation will demonstrate the nature of the optical saturation artifact in Aethalometer black carbon data and the influence of applied compensation factors on time series data. Data analysis methodologies to resolve emission source locations, such as frequency filtering of the data and nonparametric wind regression, also are briefly discussed.

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**ISEE-S33-05**
**Spatial and Temporal Heterogeneity in Mobile Source Air Pollutants in Complex Urban Terrain**

Zwack L, *Harvard School of Public Health, Boston, MA, USA*.

**Abstract:** Evaluation of the public health benefits of mobile source control strategies requires an understanding of the relationship between traffic emissions and ambient concentrations. In this study, part of the New York Metropolitan Exposure to Traffic Study (NYMETS), we continuously measured a suite of traffic-related air pollutants during a three-week campaign in June 2007 in the Williamsburg neighborhood of Brooklyn, NY. The monitoring included 24-hour continuous sampling at a stationary site within the domain and mobile monitoring during daytime hours throughout the neighborhood. A Global Positioning System (GPS) unit was used to record the exact spatial location of each of the one-minute concentration measurements. Each street in the sampling domain was visited on multiple occasions, which allowed for dense spatial coverage and was intended to facilitate separation of spatial and temporal factors. Traffic data were collected via continuous recording of vehicle number, class, and speed on the two hypothesized major sources of emissions. A weather station was also set up at the fixed site to collect

data on wind speed and direction at street and rooftop level. To predict both fixed-site and mobile concentrations, log-linear mixed effects models accounting for spatial and temporal autocorrelation were applied. Data from the fixed site indicate that both ultrafine particles and PAHs have diurnal concentration patterns that coincide with traffic patterns, with a peak during morning rush hour. Differences in patterns across these and other pollutants are indicative of differential contributions by vehicle type. Mobile monitoring suggests significant spatial and temporal heterogeneity in the concentrations measured, with patterns that vary by pollutant.

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**ISEE-S33-06**
**Human Exposure to Mobile Source Related Air pollution: The Road Ahead**

Buckley TJ, *Ohio State University School of Public Health, Columbus, OH, USA*.

**Abstract:** The complex spatial and temporal dynamics of human exposure to traffic-related air pollution is driven by highly variable patterns in vehicle patterns and fleet composition, meteorology, human activities, and in some cases by the measurement instruments. Understanding these complexities is critical in order to design and conduct epidemiologic studies that are efficient in detecting related health effects. And, yet, the recent explosion of remarkable work has achieved important advances in our understanding of the mechanisms and magnitudes of the underlying processes influencing exposure. Meaningful advances in risk assessment will continue to emerge from evolving air pollution monitoring technologies that enhance measurement sensitivity, specificity, and spatial and temporal resolution. These advances in monitoring technologies will need to be matched by innovative study design and biostatistical analysis methods like those discussed today. The road ahead is likely to have twists and turns as source emissions continue to change associated control technologies, use of alternative fuels, and changing driving patterns.

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**ISEE-S34**
**HEIMTSA-INTARESE—A European Center Stage for Developing Integrated Assessment Methodologies for Environmental Health Policy**

**Abstract:** Both HEIMTSA and INTARESE (6th European Framework Programme) individually bring together a team of internationally leading scientists in the areas of epidemiology, environmental science and biosciences, and health impact assessment to collaborate on developing and applying new, integrated approaches to the assessment of environmental health risks and consequences, in support of European policy on environmental health. This symposium discusses the complementary nature of the HEIMTSA and INTARESE project objectives, integrated assessment framework and methodology, exposure modeling- and health impact techniques and end products. Six sessions are listed under three headings: (i) introduction, (ii) methodology and (iii) end product. We hope that the Symposium will lead to useful discussion of how integrated methods can support the use of scientific evidence in the development of environmental policies that protect and enhance public health; and how this work may be further developed. Session 1–15 min: HEIMTSA-INTARESE—Bridging science and environmental policy through integrated environmental health assessments; Session 2–20 min: Integrated assessment for housing and climate policies (INTARESE); Session 3–10 min: Exposure scenarios for environmental health policy assessments (HEIMTSA, INTARESE); Session 4–10 min: A tool for health impact calculations (INTARESE); Session 5–10 min: Cost-benefit analysis and health economics in environmental assessments (HEIMTSA); Session 6–10 min: Guidance and tools for integrated assessments and their application (HEIMTSA, INTARESE); Discussion–15 minutes. INTARESE aims to create an integrated environmental health assessment system for assessing health-related problems deriving from the environment, and health-related impacts of policies that affect the

environment in ways that take account of the complexities, interdependencies and uncertainties of the real world. INTARESE will provide a conceptual and analytical framework for integrated assessment methods, tools, protocols, and indicators that can be applied across different environmental stressors, exposure pathways and policy areas. It will review, bring together and enhance the monitoring systems needed to support such analyses. Deliverables will include new, integrated methods and indicators for environmental health risk assessment and monitoring, an operational assessment guidance system, and a set of validated assessments that can directly inform policy. HEIMTSA aims to support the European Environment and Health Action Plan by extending health impact assessment and cost benefit analysis methods and tools so that environment and health impacts of policies can be evaluated better at the European level. HEIMTSA will use the impact pathway or full-chain approach, tracking the effects of pollutants from policies through emissions, changes in microenvironments and exposures, and health to monetary values. As well as covering a very wide range of pollutants, HEIMTSA will take account of mixtures and will incorporate uncertainty assessment integrally. A modular integrated assessment system will be developed to implement the methodology Europe-wide.

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**ISEE-S34-01****HEIMTSA-INTARESE—Bridging Science and Environmental Policy Through Integrated Environmental Health Assessments**

Lebret E,\* Hurley F,<sup>†</sup> and Briggs D,<sup>‡</sup> \*RIVM, Bilthoven, Netherlands; <sup>†</sup>IOM, Edinburgh, United Kingdom; and <sup>‡</sup>IC, London, United Kingdom.

**Abstract:** There is growing interest internationally in science-based environmental health policy. INTARESE and HEIMTSA are large-scale (20+ partners), long-term (4–5y) and largely concurrent multi-disciplinary collaborative research projects in Europe in this area. Both projects have similar aims: review and extend methods, and make available tools, for assessing those impacts on public health that are mediated via the environment, as a result of policies in various sectors such as transport, housing, agricultural landuse, water, chemicals in households, waste and climate. Both use a common methodological framework, briefly summarised as integrated environmental health impact assessment (IEHIA), using the full chain approach. EIHIA is a particular form of HIA “a combination of procedures, methods and tools by which policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within a population” with specific focus on health impacts mediated via the environment. For policies which affect emissions of environmental pollutants to air, soil and water, the full chain approach helps systematise efforts to track the fate of these emissions through environmental concentration, exposure, (internal) dose and consequent health effects. These impacts are summarised as disease burden (e.g. DALY's), in monetary terms, and in terms of policy deficits (e.g. degree of non-compliance) and perception and acceptance of risks. Thus, multiple perspectives from different stakeholders are covered in the description of impacts. Not all stages are needed for every pollutant; and policies may affect environmental health impacts in ways other than via emissions. Similarly, not all impacts need to be covered, depending on the issue framing of the particular assessment. The methodology aims to be integrated (i) across components of the full chain; and (ii) across pollutants and across stakeholder perspectives. This talk will introduce the projects, IEHIA and its relationship to other approaches; and challenges of implementing the EIHIA in support of policy developments (Europe-wide and local).

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**ISEE-S34-02****Integrated Assessment for Housing and Climate Policies**

Haverinen-Shaughnessy U,\* Fenn B,<sup>†</sup> Chalabi Z,<sup>†</sup> Kovats S,<sup>†</sup> Michelozzi P,<sup>‡</sup> and de Donato F,<sup>‡</sup> \*KTL, Kuopio, Finland; <sup>†</sup>LSHTM, London, United Kingdom; and <sup>‡</sup>ASL RM/E, Rome, Italy.

**Abstract:** As part of the INTARESE project, a mathematical modelling framework was developed to evaluate the health impacts of housing policies. The framework consists of a series of linked sub models, including building physics and indoor environment, exposure-health response and life table models. Initially, the framework was applied to determine the health impact of increasing energy efficiency by improving household insulation in an UK setting. The model is extended to determine the mortality and morbidity impacts associated with additional exposures: dampness/ mould, particulate matter, nitrogen dioxide, carbon monoxide. Parametric and structural uncertainty analysis is also included in the model. The resulting model will be applied to other European countries. The model may best be demonstrated using a set of case study houses from different countries with particular characteristics. In addition, the model may be tested with some existing housing intervention data sets. Preliminary results and testing of the Finnish case study will be presented at the symposium. Assessing future burdens from heat and cold in Europe Authors: S Kovats, P Michelozzi, F de Donato The INTARESE climate assessment will quantify the current burden due to heat and cold in Europe, using the full chain approach for three cities. City specific temperature-mortality relationships will be used to estimate cardio respiratory mortality due to temperature exposures above and below city-specific threshold values. Policies to reduce these burdens can be considered as adaptation response to climate change. Health interventions for heat include e.g. warning systems; interventions for cold are primarily related to home heating. Policies to reduce or prevent global climate change do not achieve the benefits to health for decades. The estimation of future burdens of heat and cold needs to include robust assumptions about changes in population growth and aging, acclimatization and adaptation. Scenarios of future climate are derived from global climate models but need to be downscaled to city level. Estimates of the impacts of climate change on health require new approaches to uncertainty assessment.

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**ISEE-S34-03****Exposure Scenarios for Environmental Health Policy Assessments**

Loh M, and Jantunen M, KTL, Kuopio, Finland.

**Abstract:** HEIMTSA's and INTARESE's efforts to develop a unified, integrated risk assessment framework for use in policy assessments focus on a “full-chain” assessment from sources to health effects. In particular, scenario-based assessments allow for the exploration of different policy options. Since exposure represents the interface and interaction between the environment and the human entity, appropriate development of exposure scenarios is necessary for determining the impact of interventions on health. A guiding framework and Exposure Platform has been created to assist in developing and modelling exposure scenarios. The exposure scenario guidance centres around two main components, which may be affected by policies: media concentrations and human factors (i.e. behaviour and characteristics that influence a person coming into contact with an agent of risk). To be applicable across regions, key areas of variation across time and space need to be identified and quantified. Consideration of such factors allows for a more holistic approach to population exposure and risk modelling. For example, if one is interested in controlling a certain agent, such as formaldehyde, with both indoor and outdoor sources, one needs to be able to quantify the contribution of these sources to exposure in different microenvironments to determine which policies would be most effective. Formaldehyde exposure may also vary by factors such as building type, dependent not only on climatic conditions but also on socioeconomic situation. Wherever possible, probabilistic modelling is encouraged, as it allows for incorporation of variability and uncertainty and the examination of the influence of different variables on modelling output.

**ISEE-S34-04****A Tool for Health Impact Calculations**

Knol A,\* Kunseler E,† and van Velze K,† \*RIVM, Bilthoven, Netherlands; and †MNP, Bilthoven, Netherlands.

**Abstract:** Triggered by the need to support decision making about a wide range of diverse environmental health problems, an emerging trend in the arena of environmental health research is the quantification of health impacts of environmental exposures. Environmental burden of disease measures such as DALYs (Disability Adjusted Life Years) give an indication of the (potential) number of healthy life years lost in a population due to exposure to environmental factors. Public health loss is defined as time spent with reduced quality of life, aggregated over the population involved, and combining years of life lost and years lived with disability, standardised by means of severity weights. This quantification enables comparison of dissimilar environmental health problems, thereby being an important tool for policy makers to prioritize such problems, or to evaluate the (potential) effectiveness of policies in terms of health gain or loss. Shortcomings of current DALY calculations While the arithmetic of burden of disease calculations is rather simple and the DALY measure can be quite appealing for policy makers, it should be interpreted with caution. Uncertainties and assumptions can become obscured when complex issues are represented in single numbers. In order to come to well-founded policy decisions, the various types of uncertainties (both quantitative and qualitative) should be well represented in both the ranges of the burden of disease estimates, as well as in the contextual presentation of these ranges. Besides, it is common practise to base calculations of the attributable number of people with a certain health effect on static life tables. Changes in birth and mortality rates can herewith not be accounted for. Features of health impact calculation tool We are developing an environmental burden of disease calculation tool which includes both dynamic life table analysis and extensive uncertainty analysis. The flexible nature of the tool and its user-friendly interface allow for it to be used by the wider environmental health research community. The tool can help to standardize burden of disease calculations, as well as raise awareness about the complexities, uses and limitations of burden of disease measures.

of use in value transfer. The review also serves to identify the health endpoints gaps remaining in the WTP literature. The evidence base of QALYs and DALYs are reviewed and compared with that for WTP. We also explore whether there is potential for value transfer between DALYs and WTP components. The HEIMTSA activity on CBA and health economics provides an overview of the issues and concepts that differentiate alternative valuation paradigms including: definitions of metrics appropriate to their use; treatment of time preferences (discounting), and treatment of equity. We survey experience of operationalising alternative valuation paradigms in non policy contexts before outlining recommendations as to how these valuation paradigms can practically be applied in policy analysis.

**ISEE-S34-06****Guidance and Tools for Integrated Assessments and Their Application**

Friedrich R,\* Kuhn A,† Tuomisto J,‡ and Sabel C,§ \*University of Stuttgart, Stuttgart, Germany; †USTUTT, Stuttgart, Germany; ‡KTL, Kuopio, Finland; and §JC, London, United Kingdom.

**Abstract:** Although single enhancements in methodologies regarding health (impact) assessment deserve high merit, the coherence and integration of those developments are of great importance, too. A Guidance System, developed in INTARESE, aims at providing a fundamental knowledge base and (specific) guidance to different user groups like assessors, policy makers and students. The information is provided in a structured and clearly arranged way. Methodologies are explained and put into context, describing their purpose, relevance, advantages and constraints. A complementing Resource Centre provides information on resources needed to perform an integrated assessment including fact sheets on data and models and a core data set. Some tools, like a health impact calculation tool and discussion and collaborative functionalities are also incorporated. In HEIMTSA, the system is expanded by including selected models and data for integrated assessment on a European scale including emission scenarios, dispersion models, exposure models and models for monetary valuation, within a tighter framework encompassing over-arching issues such as spatial integration and uncertainty handling. Integrated assessments will be conducted by applying a multi-pollutant, multi-pathway and multi-media approach, also taking into account other stressors like noise. Different scales and  $\mu$ -environments will be considered during exposure modelling. Example case-studies will include outdoor and indoor air pollution, noise and pollutants with strong internal dose aspects, including multiple-pathways. A preliminary example using tools for a European-wide integrated assessment was undertaken about the health impacts of heavy metal emissions. In addition to the improvement on the emission data calculation and spatial distribution, the external costs for exposure via inhalation and ingestion to As, Pb, Cd, Cr and Ni were estimated for a Business As Usual and a Maximum Feasible Technical Reduction Scenario in 2010. The overall damage costs were given per country and as country specific costs per t of heavy metal released.

**ISEE-S35****Community-Based Participatory Research: Approaches in Incorporating Cultural Factors in Environmental Exposure and Risk Reduction Research**

**Abstract:** In conducting population-based exposure assessments and risk reduction interventions, community-based participatory research (CBPR) represents a spectrum of methods, activities and perspectives which engage academia, local leaders, health advocates, and concerned citizens in research efforts. This research may investigate routes of chemical exposures, prevalence and perceptions of adverse health outcomes, or the complex relationships between exposure and disease in a community

setting. Key principles of CBPR include: (a) active and equal collaborations of stakeholders at every stage of the research; (b) co-learning and ensuring cultural appropriateness of the research and intervention strategies; (c) defining community as a unit of identity; and (d) rapid dissemination of findings to the stakeholders. CBPR methods have proven useful in addressing environmentally-driven health disparities, in assessing differential risk of exposure and in incorporating cultural frameworks in risk management approaches. The values which underscore CBPR principles may become increasingly important in dealing with global environmental issues—both chemical and biological—which transcend geographic boundaries or which cut across diverse population groups to varying degrees of effect. This symposium will feature qualitative case studies describing how exposure scientists, epidemiologists and risk assessors partner with ethnically and culturally diverse communities to mutually address socially and scientifically relevant issues faced by at-risk subpopulations (e.g., children of farmworkers, or traditional tribal hunters). Three case studies involving long-standing community-university partnerships will explore experiences in enacting each of the four aforementioned CBPR principles in exposure and intervention research. Each case will offer specific examples of the influence of cultural factors in designing and implementing their research, while highlighting their lessons learned in translating and disseminating the research results in culturally empowering ways. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S35-01****Addressing Cultural Factors Associated with Exposure, Biomonitoring and Intervention Research in the Yakima Valley of Washington State**

Coronado GD, *Fred Hutchinson Cancer Center, Seattle, WA, USA*.

**Abstract:** The theme of the University of Washington based Center for Child Environmental Health Risks Research (CHC) is to understand the biochemical, molecular and exposure mechanisms that define children's susceptibility to pesticides. As part of the CHC, the Community Intervention Project has conducted a number of intervention studies in the Lower Yakima Valley of Washington State. Working with a Community Advisory Board (CAB), the group has worked in a predominantly Mexican-American population. This case study will highlight some of the unique attitudes, beliefs, and behaviors that directly impact study design and the successful implementation of field research in an at-risk rural population. Twenty-four agricultural communities and eight labor camps were selected to participate in a study that aimed to interrupt the take-home pathway of pesticide exposure. Communities and labor camps were randomized to receive either a pesticide safety intervention or control condition. The intervention involved activities targeted at the community at large, at organizations within the communities, and among small groups. Several principles of Community Based Participatory Research were employed. At the study onset, a committee of the CAB interviewed and selected the project's field operations supervisor (equal collaboration of stakeholders). Based on feedback from the CAB, the study design was expanded to include the collection and analyses of dust samples from farmworkers' vehicles (relevancy of study design). An intervention was designed based on local input from the field staff and CAB (relevancy of intervention). The relevancy of the intervention was assured through ongoing staff reporting of experiences at CAB meetings. Reporting of research findings to study participants proved key for building trust among study participants and assuring integrity of research conduct (rapid dissemination of results). Effective implementation of the principles of Community Based Participatory Research might improve the quality of research methods and assure the relevance of intervention programs.

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**ISEE-S35-02****From Study Design to Translation of Research Findings: Methods for Community Engagement in a Migrant Farmworker Cohort**

Salvatore AL, *University of California, Berkeley, CA, USA*.

**Abstract:** For almost a decade the Children's Center at U.C. Berkeley together with community partners in the Salinas Valley, California, has studied a topic of community concern: pesticide exposure. The Center's longitudinal CHAMACOS study focuses on assessing pesticide exposure and its potential health effects on childhood growth, neurodevelopment and respiratory disease among a cohort of mothers and children from farmworker families. In accord with its Community Based Participatory Research orientation, the Center also has conducted in intervention research to reduce the take-home of occupational pesticides and a host of other culturally-relevant activities to communicate and translate research findings into actions that will protect the health of farmworker families. Drawing from several Center studies, we will discuss effective methods for involving a diverse group of partners, including farmworkers, growers, and health care professionals, in developing research studies, tailoring methods and tools, trouble-shooting ethical challenges, interpreting study findings, and developing programs and policies to translate research into action. We will also illustrate ways in which these studies and programs considered the culture and beliefs of farmworkers. Examples such as the development of a worksite intervention to reduce pesticide exposures targeting farmworkers' cultural beliefs about handwashing and the development of low-literacy educational tools such as the Prenatal Environmental Health Kiosk will be shared. Center research shows that Salinas Valley farmworkers and their families are affected by pesticide exposures. We have found significant exposures to organochlorine and organophosphate pesticides and adverse effects of both in utero organochlorine and organophosphate pesticide exposure on neurodevelopment in young children in the CHAMACOS cohort. Our experiences indicate that a partnership approach is valuable for both carrying out culturally-relevant research and for engaging a diverse group of stakeholders in translating research into policies and programs that benefit the community.

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**ISEE-S35-03****Bridging Western and Traditional Tribal Knowledge in Assessing Exposure in Subsistence Populations**

Harper BL, *Conf. Tribes of Umatilla Indian Reservation, Pendleton, OR, USA*.

**Abstract:** This case study focuses on tribal risk assessment methods that have been developed to represent subsistence or ecologically-based lifeways. Risk assessments need to reflect any Treaties and aboriginal rights, cultural practices, and tribal perspectives on health and well-being. This presentation describes an interdisciplinary and collaborative approach to understanding natural resource use and therefore potential exposure pathways that reflect traditional tribal cultural values and traditional environmental knowledge. This research may be applied to risk assessment (e.g. at Superfund sites), regulatory standards development (e.g. water quality standards or other tribal environmental codes), and identifying other stressors that impact overall health and well-being in tribal communities. The long-term goal is not to reduce risks by advising people to forego their culture (e.g., fish advisories), but to develop standards to make the culture safe to practice. An emerging application of this collaborative approach is to support tribal planning in anticipation of climate-driven changes in the natural resources available to tribes for food, medicine, educational, spiritual, economic, and cultural uses. The result is an understanding of local or regional subsistence diets that is culturally accurate, ecologically-based and nutritionally complete, as well as an understanding of other exposure pathways (inhalation, soil ingestion, and so on) that is grounded in the local ecosystem and traditional

lifeways. This approach takes community-based participation to the next level: community co-management and ultimate ownership of the project and the results. Tribes are not objects of study, but have the ultimate authority over the methods and data.

#### ISEE-S35-04

##### **Discussant: Lessons Learned in Reducing Risks of the Anishinaabe from Methylmercury**

Foran J, EHSI, LLC, Whitefish Bay, WI, USA.

**Abstract:** In partnership with the Great Lakes Indian Fish and Wildlife Commission, Dr. Foran has participated in tribally-led research, which incorporates traditional Anishinaabe walleye harvesting and consumption. As a discussant in this session, Dr. Foran will address the relevance of treaty rights, cultural practices and perceptions of risk in developing and translating results from methylmercury exposure and intervention research.

#### ISEE-S36

##### **Biomonitoring in a Global Environment—Collaborations, Challenges, and Opportunities**

**Abstract:** For assessing exposure to environmental contaminants, biomonitoring can play an important role in supporting and guiding environmental and public health programs. The potential utility of biomonitoring in improving public health has led to several new population-based biomonitoring initiatives in Canada, California, and elsewhere. Collaborations between these newer biomonitoring endeavors and more well established programs, such as those conducted by the German and U.S. governments, not only allow for transmission of experiential knowledge from the older to newer enterprises, but also facilitate more effective use of resources through shared development of cross-disciplinary approaches, methods, and tools. Improving the interpretation, use, and communication of biomonitoring data remains a particular area of interest, as does improved data comparability between countries. This symposium will focus on collaborations, challenges, and opportunities presented by biomonitoring programs operating in the United States, Canada, and Europe. Presenters will discuss their respective programs within this framework. Symposium attendees will have an opportunity to participate in discussion and through a survey addressing areas of interest for collaboration and priority chemicals for biomonitoring.

#### ISEE-S36-01

##### **Decreases in Human Concentrations of Selected Chemicals as Determined in U.S. NHANES**

Needham L, CDC, Atlanta, GA, USA.

**Abstract:** The National Health and Nutrition Examination Survey (NHANES) dates back to 1971; however, no environmental chemicals were measured in the NHANES I participants. NHANES II (1976–1980) measured blood lead, serum pesticides, and urine phenols. Since 1999, NHANES has been a continuous cross-sectional study of the U.S. civilian, noninstitutionalized general population; annually, there are approximately 5000 participants from 15 sites. In the 2003–2004 NHANES, more than 250 chemicals have been measured in blood and urine samples. Many of the chemicals were measured for the first time in the 2003–2004 samples. Many others have been analyzed multiple times. Based on data from NHANES and other studies, we have found that human concentrations of many environmental chemicals have decreased; these decreases are due to governmental regulations, voluntary withdrawals, and/or technological improvements. The chemicals include lead, polychlorinated dibenz-p-dioxins and biphenyls, organochlorine pesticides, organophosphate pesticides, polyfluoroalkyl compounds, nicotine, and most recently,

selected polybrominated diphenyl ethers. Each of these chemicals will be discussed in terms of sources and pathways leading to human exposure and ultimately how biomonitoring is used to evaluate and assess the exposure to humans and to validate these apparent decreases. Also, limitations of the NHANES, such as age of participants, will be described. In addition, a listing of chemicals measured for the first time in the most recent NHANES will be provided.

#### ISEE-S36-02

##### **Moving Towards Integrated Human Biomonitoring Programs in Europe—Contribution of Experience from German Environmental Surveys (GerES)**

Kolossa-Gehring M, Federal Environment Agency, Berlin, Germany.

**Abstract:** The European Commission supports the development of a coherent approach to human biomonitoring (HBM) in Europe in its Environment and Health Action Plan 2004–10. Based on expertise and experience in the member states a concept has been elaborated within ESBIO (Expert team to Support BIOMonitoring). With this approach better data comparability and accessibility will support European environment and health policies. A consistent database elucidates the presence of chemicals in humans and possible health effects. The joint development of scientific tools and strategies will also increase the effectiveness of resource allocation. As a next step, a harmonized approach for EU-HBM will be tested. Comparable exposure data will be generated in European countries to derive reference values and identify reference ranges for specific biomarkers. Two scenarios are planned: Sc. 1 focuses on well-validated methods and critical experience in the member states. Sc. 2 addresses pollutants of great societal concern but with less experience and methodological confidence. Sc. 1 includes Pb, Cd, cotinine and Hg, sc. 2 phthalates, to which some children (according to GerES results) are exposed to levels above the ADI, oxidative metabolites of PAH, organotins, As, BFRs, PFOS/PFOA, PBT/vPvBTs, organophosphates and pyrethroids. The German Federal Environment Agency (Umweltbundesamt) developed guidelines to be evaluated in a coordinated approach for HBM in the EU pilot project. Prerequisite was the experience from 20 years of German Environmental Surveys—representative population studies conducted within a health related environmental surveillance system. Objectives of GerES are to evaluate the influence of chemical, biological factors and noise on a representative sample of the general population. All chemicals of scenario 1 and most of scenario 2 have been evaluated intensely in GerES. Hence, information on sources, time trends, and variation of exposure may serve for improving test designs and increasing harmonisation. All GerESs comprise questionnaires covering information on indoor and vicinity environment, health, food consumption, socio-economic status, and exposure relevant habits. Exposure to more than 100 environmental pollutants has been evaluated by human and/or ambient monitoring.

#### ISEE-S36-03

##### **Population-based Biomonitoring Surveys in Canada—Reporting Results to Study Participants**

Haines D, Health Canada, Ottawa, ON, Canada.

**Abstract:** Canada is implementing two comprehensive population-based biomonitoring initiatives: The Canadian Health Measures Survey (CHMS) and the Maternal-Infant Research on Environmental Chemicals study (MIREC). The CHMS is a nationally-representative survey collecting information and biospecimens on 5000 Canadians ages 6–79 years while MIREC is a prospective study of 2000 pregnant women from 10 cities across Canada. Both initiatives are measuring a suite of environmental chemicals in one or more matrices. The absence of documented health effects, health-based tissue guidelines (HBTG), or established reference ranges for many environmental chemicals presents challenges to reporting individual biomonitoring results. In the CHMS, if the blood level for lead,

mercury or cadmium is below a HBTG, individual results are provided to participants in a general report. If the blood level is above a HBTG, a flag is indicated in the general report suggesting follow-up with the subject's physician. If the result is above a threshold identified as "critical", a medical advisor reviews the results, attempts to contact the individual and provides a written letter informing the subject of the results and recommending follow-up with his/her physician at the earliest opportunity. Results for chemicals without HBTG are made available upon request with the disclaimer that interpretation is not possible given current state of knowledge. In MIREC, differences among Health Department and Hospital Research Ethics Boards (REB) led to the decision that study participants would receive their results only if their level is above a HBTG and there are preventive measures or treatments available. Levels below HBTG or for chemicals that are without HBTG are not reported even if the participant requests her data. Each site investigator is responsible for reporting the results to participants through their health care provider. The reporting approaches adopted by CHMS and MIREC were developed under the recommendations of the governing REBs and are detailed in the consent form. Based on the experiences of these two initiatives, decisions on reporting results to participants depend on the availability of HBTG, method of participant recruitment (e.g. clinical-based vs randomized household) and decisions of the various REBs.

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**ISEE-S36-04****10 Americans**

Houlihan J, *Environmental Working Group, Washington, DC, USA.*

**Abstract:** The U.S. population is exposed to numerous chemicals throughout life, beginning in utero with chemicals that migrate across the placenta, passing from maternal to fetal blood. A growing number of biomonitoring studies document exposures throughout life, evidenced by chemicals detected in umbilical cord blood collected immediately after birth, in samples collected during infancy or early childhood, and in breast milk or other samples collected during adulthood. In rare cases biomonitoring data has been used to guide public health policy. For the vast majority of chemical pollutants, such information is unavailable when policymakers develop public health protections. Because the developing child is generally more sensitive than adults to many types of chemical pollutants, a number of new programs aim to collect data that would allow for a fuller consideration of fetal and childhood risks in the public health arena. In this symposium we report on the results of the analysis of samples from a series of studies testing 160 people for more than 550 pollutants. These included 10 whole blood samples from children born in the U.S. tested for 413 industrial chemicals, pesticides, and other pollutants. For this cohort we identified an average of 200 chemicals in the samples, spanning organochlorine pesticides (e.g., DDT and dieldrin), chemicals currently or formerly used in a wide range of consumer products (perfluorochemicals, brominated fire retardants, PCBs), and chemical pollutants from waste incineration and fossil fuel combustion (polyaromatic hydrocarbons, polychlorinated and polybrominated dioxins and furans, polychlorinated naphthalenes, mercury). The results of our investigations raise questions about the role of chemical exposures in the increasing incidence of some health problems that cannot be explained by genetic factors. In particular, the work raises questions about the role of early life exposures in a range of children's health problems and in diseases developed in adulthood that may have their origins in early life exposures; the studies also reinforce the importance of explicit consideration of fetal and childhood exposures in developing public health policies. Numerous examples in the U.S. demonstrate the success of federal chemical policy improvements in reducing exposures.

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**ISEE-S37****Community Noise, Air Pollution, and Cardiovascular Health**

**Abstract:** Epidemiologic evidence of a link between chronic exposure to community (i.e. non-occupational) noise and adverse cardiovascular health is accumulating. There is also substantial evidence of associations between long-term exposure to air pollution and cardiovascular diseases, and recent evidence suggests that traffic-generated air pollution may play an important role. Since noise and air pollution share traffic as a common source, their exposures may be correlated and there is the potential for confounding in cardiovascular epidemiology studies. Noise and air pollution have rarely been considered simultaneously, but recently exposure scientists and epidemiologists have begun to consider combined exposures and the potential for confounding. This important and timely issue will be the focus of this proposed symposium. This session will include presentations on a number of issues relevant to noise and air pollution research including the current body of epidemiologic evidence suggesting a link between noise and cardiovascular health, state of the art noise exposure assessment methods for cohort studies, and the opportunities and challenges involved in disentangling the cardiovascular health effects of noise and air pollution. It is our goal to stimulate discussion amongst exposure scientists and epidemiologists interested in both noise and air pollution as public health issues, and to facilitate the exchange of ideas between researchers focused primarily on noise and those interested primarily in air pollution. An additional strength of this symposium will be the broad perspectives provided by a diverse group of speakers from both North America and Europe.

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**ISEE-S37-01****State of the Evidence of an Association Between Environmental Noise and Cardiovascular Diseases**

Babisch W, *Germany Federal Environment Agency, Berlin, Germany.*

**Abstract:** The hypothesis that long-term exposure to environmental noise—including road and aircraft noise—causes adverse health effects is based on three major findings: 1) Laboratory studies show that exposure to acute noise affects the sympathetic and endocrine system, resulting in unspecific physiological responses (e. g. heart rate, blood pressure, vasoconstriction, stress hormones, EEG); 2) Noise-induced instantaneous autonomic responses not only occur in waking hours but also in sleeping subjects even when no EEG awakening is present; and 3) Epidemiological studies carried out in the occupational field have shown that employees working in high noise environments are at a higher risk for high blood pressure and myocardial infarction. This talk discusses the epidemiologic evidence that supports the hypothesis that long-term exposure to noise adversely affects the homeostasis of the human organism, including metabolic function and the cardiovascular system. Air pollutants have also shown to be associated with cardiovascular endpoints. Living in the vicinity of roads might represent a combination of factors such as noise and air pollution. Considering the impact of shielding and room orientation in studies could help to disentangle the effects.

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**ISEE-S37-02****Assessing Chronic Exposure to Noise and Air Pollution in Greater Vancouver, British Columbia, Canada**

Davies H, *University of British Columbia, Vancouver, BC, Canada.*

**Abstract:** Both air pollution and noise are believed to contribute considerably to the worldwide burden of CVD, and the major urban source of the two pollutants is the same (motor vehicles). We are extending an existing study of air pollution and CVD to evaluate the chronic health effects of co-exposure to these two pollutants. The existing study has enumerated an adult cohort in the Metro Vancouver region ( $n =$

800,000) who will be followed up for 5 years for CVD hospitalizations and deaths. This study has already estimated air pollution exposures. The extension, which we will report here will (1) develop a noise map for the Metro Vancouver region; (2) determine estimates of noise levels at residential building facades, and assign noise exposure levels to cohort members; (3) examine the relations between noise exposure and CVD mortality and morbidity; and (4) examine the interaction between noise and air pollution and CVD. We will discuss study design, report on progress and provide interim results from the exposure analysis phase.

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**ISEE-S37-03**
**Noise, Air Pollution, and Cardiovascular Mortality in the Netherlands**

Hoek G, *University of Utrecht, Utrecht, Netherlands*.

**Abstract:** This talk will present the results of a cohort study conducted to assess associations between traffic related air pollution and mortality in the Netherlands. The study involved some 120,000 subjects, and some 18,000 deaths including some 6,000 from CVD. Exposure to black smoke (BS), as well as the traffic intensity on the nearest road were assessed at the home address. Exposure to road traffic noise was modeled with a 25 x 25 m resolution. We conducted Cox proportional hazard analyses for the association between cardiovascular mortality and air pollution, traffic intensity and traffic noise exposure. BS concentrations, traffic intensity on the nearest road and high traffic noise were associated with some subcategories of cardiovascular mortality, but the associations for background BS concentrations and traffic intensity on the nearest road were more robust.

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**ISEE-S37-04**
**Residential Exposure to Road Traffic and Cardiovascular Events: The Role of Road Traffic Noise and Air Pollution**

de Kluizenaar Y, *TNO Built Environment and Geosciences, Delft, Netherlands*.

**Abstract:** Studies into potential mechanisms and epidemiological studies indicate that cardiovascular health effects may be related to both environmental noise and air pollution. Road traffic is an important source of both road traffic noise and air pollution. Therefore, when studying the cardiovascular effects of road traffic, both noise and air pollution should be taken into account. However few studies have considered both. We will present results of a large prospective study on cardiovascular effects of transportation noise, which is also analyzing the relative contribution of air pollution. We linked baseline questionnaire data to 13 years of follow-up on hospital admissions for ischemic heart disease or cerebrovascular disease, and detailed road traffic noise and air pollution exposure, for a large random sample (~18 000 subjects) of inhabitants of a large urban region in the Netherlands. Cox proportional hazard analysis was conducted. We will pay attention to combined exposure assessment of environmental noise and air pollution in the urban environment.

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**ISEE-S38**
**Creating a Better Science-Policy Interface: Practical Guidelines for Scientists and Research Organizations**

**Abstract:** In the 1990 Clean Air Act Amendments (CAA), Congress articulated air quality goals, including the National Ambient Air Quality Standards for criteria pollutants and technology-based standards for 189 hazardous air toxics to protect public health and welfare. The standard-development process relies heavily upon independent science and systematic scientific reviews. But, policies do not flow directly from scientific knowledge, and sometimes it appears as though government actions are unrelated to scientific understanding. The policy development process can fall short due to a disconnect between scientists and

policymakers: scientists may not address key policy-relevant questions or give adequate thought to how their planned research will be used in the policy context; or, conversely, policymakers may not clearly establish and articulate their needs to the research community. In addition, differences in the communication and perception of uncertainty in scientific studies complicate the interaction between scientists and policymakers. This symposium, co-sponsored by NUATRC (a public-private organization established by Congress in the CAAA to provide sound scientific information on the health impacts of urban air toxics for use in the regulatory process) and EPA, will address the interface between scientific research and the needs of decision makers, focusing on the air quality standard-setting process. The overall goal will be to provide advice to researchers and research organizations on how to plan, conduct, and organize research activities so that the results can more quickly and easily be transformed into usable information for policymaking. Although not all research is (or should be) focused on policy-relevant questions, such a dialogue can increase the impact of research on environmental policy.

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**ISEE-S38-01**
**Interactions of Science and Policy to Meet Societal Needs**

Henderson R, *Lovelace Respiratory Research Institute, Albuquerque, NM, USA*.

**Abstract:** It is to the benefit of all that science inform the policy decisions that are made to take care of societal needs. However, communications between scientists and policymakers are not always smooth. Scientists feel comfortable with uncertainty and enjoy describing it in great detail. Policymakers, however, do not always know how to deal with uncertainty and often interpret it as a lack of knowledge that prevents action. An example of this is the interaction of the members of a science advisory group with the management of the US Environmental Protection Agency (EPA) in providing advice and recommendations for the setting of health protective standards for criteria air pollutants. When the Clean Air Act was first written, our knowledge of the effects of air pollutants on public health was limited and there were concentrations of air pollutants, below which, we had observed no adverse effects. These were so-called threshold concentrations and scientists could provide that information to the policymakers, who understood the value as the "safe" concentration. With time, we have become much more knowledgeable about the health effects of air pollutants and can detect those effects, through clinical, toxicological, and epidemiologic studies, at lower and lower concentrations. The lower the concentration studied, the more uncertainty is associated with the incidence and/or severity of the health effect. There is sometimes uncertainty as to whether the effects are adverse or merely physiological. All of these uncertainties make the communication between scientists and policymakers more complex. It is essential that scientists learn to communicate uncertainty in a manner that is useful to policymakers. It is also essential that policymakers do not use uncertainty as an excuse for inaction.

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**ISEE-S38-02**
**Defining Policy-Relevant Research Questions: A U.S. Perspective**

Hubbell B, *U.S. EPA OAQPS, Research Triangle Park, NC, USA*.

**Abstract:** EPA is at a crossroads in the policy development process, having successfully promulgated major programs to reduce utility and mobile source emissions, and issued MACT standards covering many significant air toxics sources. EPA has also established new, more stringent PM<sub>2.5</sub> and O<sub>3</sub> standards that will require a more sophisticated understanding of the temporal and spatial nature of PM formation and innovative local control measures to enable urban areas to meet the many air quality challenges they face in the future. As we seek to further improve the effectiveness and efficiency of EPA's air programs, it is important to continue to work with the research community to develop

answers to critical policy-relevant science questions. Recent areas of policy interest include the desire for a multipollutant air quality management paradigm and the need for a more complete characterization of uncertainty in air pollution risk and benefit-cost analysis. These policy needs are driving many current research efforts and development of analytical tools. Policy-driven research questions are often about providing more focus or specific details, looking at how and why, rather than the more typical science question about whether the effect exists. In the case of potential multipollutant strategies, the questions may go on to ask "so what?". Research that incorporates multipollutant interactions may be appropriate and necessary for improved scientific understanding of air pollution phenomena, but from a policy perspective, the real question is: does a multipollutant approach result in increased effectiveness or efficiency in management? Multipollutant approaches also drive research questions such as how tradeoffs between pollutants can be modeled? This leads to research questions focused on interactions between pollutants, rather than focusing on identifying their impacts. An important challenge in improving the dialogue between researchers and the policy community lies in understanding the proper characterization and communication of uncertainty in highly complex integrated models. Communication between scientists and policy analysts and decisionmakers relies on understanding the analytical techniques and uncertainties as well as the impacts these results have on the decision making process.

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**ISEE-S38-03****Defining Policy-Relevant Research Questions: An International Perspective**

Brunekreef B, *University of Utrecht, Utrecht, Netherlands.*

**Abstract:** AIRNET was a three year effort (2002–2004) to improve communication between science and policy in the air pollution and health field. The project was centered around a series of EU-funded studies on air pollution and health, some epidemiological, some toxicological. A special effort was made to involve various stakeholders in meetings and workshops. Some stakeholder organisations from industry, environmental NGOs, and patient organisations acted as partners in the project. AIRNET produced 'user-friendly' reports on exposure assessment, toxicology, epidemiology, and health impact assessment of air pollution. In addition, it developed a science-policy interface report, and a model for stakeholder workshops focusing on national and regional problems rather than EU-level issues. AIRNET was funded by the Directorate General for Research. Policy directorates (notably DG Environment, DG SANCO = Health) generally kept some distance to AIRNET. DG Environment funded the WHO Systematic Review of the health effects of air pollution, which covered essentially the same ground as AIRNET but from a policy perspective. Massive overlap in persons involved in both activities produced a satisfactory level of harmonisation, but having to deal with two major science-policy activities in parallel put some strain on the "air pollution and health" research community in Europe.

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**ISEE-S39-03****Community-Based Participatory Research: Methods for Assessing and Reducing Risks from Dietary Exposures in North American Native Tribal Populations**

**Abstract:** Many traditional North American Native Tribal Populations maintain intricate and ecologically interdependent relationships with the natural environment. Though many of these relationships developed over centuries, with knowledge and skills accumulated and passed across scores of generations, the rapid emergence of industrial chemical pollution, the availability of refined, processed foods, and social and political isolation has severely threatened the health, wellness and way of life of individuals and entire tribal communities in the United States. Recently there has

been increased emphasis on encouraging traditional diets, religious practices and customs to restore and protect the health and knowledge base of tribal communities while concomitantly addressing issues of environmental pollution, social justice, and sovereignty. This symposium will feature academic-tribal partnerships conducting dietary exposure and risk reduction research which aim to quantify and reduce the risks of toxic exposures from the sequestration, preparation and digestion of foods which are major sources of proteins and nutrients in subsistence diets. Researchers conducting dietary surveys and food sampling in Alaska will report on their findings from collection and chemical analysis of whale, walrus, seal and reindeer tissues, including muscle, blubber, organ and rendered oil samples obtained through their partnerships with Saint Lawrence Island Yupiks. Emphasis will be placed on the interpretation of these results to the affected communities. A mercury intervention study in the Great Lakes Region demonstrated the use of GIS mapping to inform traditional Ojibwe spearfishers in reducing their risk of catching and consuming heavily contaminated fish. Investigators from the Puget Sound will report results from a tribally-led, culturally appropriate dietary interview process. The links between the dietary data, risk as defined by a tribal population, and concentrations of bioaccumulating toxics in local shellfish will be explored. The objectives of this symposium are to: (a) characterize the challenges, risks and opportunities of subsistence as a way of life in North American Tribal populations; (b) present data highlighting the various approaches for collecting dietary information in tribal populations; (c) present data highlighting approaches for collecting unprepared and prepared food samples for chemical analysis; and (d) describe approaches in translation of findings to the larger tribal community. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S39-01****Contaminants in the Traditional Foods of the Yupik People of St. Lawrence Island, Alaska-Exposure Pathways, Collaborative Interventions, and Prevention**

Welfiger-Smith G, *Institute for Health and the Environment, Rensselaer, NY, USA.*

**Abstract:** The Yupik people, who reside in the northern Bering Sea region of Alaska on St. Lawrence Island, have noted an increase in chronic diseases previously uncommon in their community. Recent studies demonstrated that Yupik serum contained PCB levels significantly above those of the general North American population. The Yupik people sustain traditional cultural ways of life that rely on a diet of marine mammals, fish, and reindeer. This study examined Yupik traditional foods for PCBs, chlorinated pesticides, and heavy metal concentrations. Community field researchers, working with traditional hunters and heads of households, collected approximately 500 samples of plants, berries, fish, crab and other invertebrates, birds, and marine mammals. Samples include organ and muscle tissues, blubber, and rendered oils from such species as reindeer, walrus, ringed seal, bearded seal, spotted seal, bowhead whale, and polar bear. The samples were homogenized and extracted with 1:1 hexane:acetone. The extracts were then analyzed using dual-column gas chromatography with electron capture detection. Preliminary results show most meat samples and plant species were near the EPA consumption limit for PCBs in fish of 1.5 ppb, with the exception of polar bear and glaucous gull, both of which were significantly higher. Blubber tissues of marine mammals ranged from 35 ppb in walrus to 450 ppb for PCBs in polar bear. Overall liver and skin samples showed higher levels of PCBs than the meat and plant samples, but were not as high as blubber/fat samples. The rendered oil samples contained the highest PCB concentrations of all samples tested other than polar bear blubber, ranging from 200 ppb in bearded seal to 450 ppb in ringed seal. This was also true for bowhead whale oil, despite their relatively low position in the food web. The fish eating birds also contained higher levels of PCBs than the non-fish eaters. Reindeer had

much lower PCBs levels than the omnivores and carnivores. We conclude that consumption of rendered oils and blubber are the major dietary sources of PCBs. Researchers are working with community leadership on St. Lawrence Island to analyze additional PCB, pesticide, and heavy metal data and develop collaborative interventions that will eliminate sources and reduce exposures.

#### ISEE-S39-02

#### Defining and Evaluating Risks from Contaminated Food in the Swinomish: Combining Data from a Risk Assessment, Consumption Survey, and Cultural Risk Evaluation Tool

Donatuto J, *Swinomish Indian Tribal Community, La Conner, WA, USA*.

**Abstract:** The Swinomish Indian Tribal Community is a federally recognized Native American Tribe located on the shores of Puget Sound, Washington State. A seafood-dependent people, shellfish are considered a “cultural keystone” species vital for physical, social, cultural and spiritual health. The Swinomish performed a risk assessment of toxics in shellfish and “seafood diet interviews”—a culturally appropriate consumption survey. Two species of clams, Dungeness crab and sediment were analyzed for PCBs, dioxin/furans, chlorinated pesticides, butyltins, heavy metals and PAHs. Modified risk calculation considered factors such as higher exposure durations. “Seafood diet interviews” were conducted to determine current consumption rates, desired consumption rates, seasonal variation, and whether rates are influenced by the presence of pollution. An evaluation tool was created from interview data to determine key aspects of non-physical health, current health status, and potential health impacts from contaminated shellfish. A descriptive scale was used to evaluate the findings. The three data sources were assessed together to better determine the range of risks, impacts and vulnerabilities in connection to the range of consumption rates. The contaminants that contributed the most to human health risks were PCBs, arsenic and dioxins/furans, with lesser contributions from heavy metals, chlorinated pesticides and PAHS. Risks from eating 100 g (3.5 oz) portions of each species daily (for a total of 300 g/day) for life are in the range of concern because non-cancer risks for adults and children are above 1 (ranging from 3–20), and lifetime cancer risks are in the range of 1 in a 1000. Risks from a fully subsistent level consumption rate would be higher. Cultural health evaluations determined that the following four nonphysical health factors were given top priority in relation to seafood at Swinomish: community cohesion, food security, ceremonial use and education. These four health factors were all impacted by contaminated seafood. Integrated analysis of the data from the risk assessment, seafood diet interviews and cultural risk evaluation tool enabled the Swinomish researchers and leaders to craft useful advice given the ranges and uncertainties, and to establish mitigation and restoration action.

#### ISEE-S39-03

#### Intervention Research and Probabilities of Risk in Walleye Harvesting Ojibwe Communities

Foran JA, *EHSI, LLC, Whitefish Bay, WI, USA*.

**Abstract:** The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has produced Ogaa (walleye-Sander vitreus) consumption advisories since 1996 for Anishinaabe from GLIFWC-member tribes in the 1837 and 1842 ceded territories of Wisconsin. GLIFWC's advisory maps were revised in 2005 to address cultural sensitivities (to protect tribal lifeways) and to incorporate changes in advisory levels for methylmercury. Lake-specific, risk-based, culturally sensitive consumption advice was provided on color-coded maps for two groups: children under age 15 years and females of childbearing age, and males 15 years and older and females beyond childbearing age. The maps were distributed to, and a behavioral intervention program developed for, the six GLIFWC-

member tribes in Wisconsin as well as member-tribes in the 1837 territory of Minnesota and the 1842 ceded territory of Michigan. Tribal fish harvesters, tribal health care providers, women of childbearing age or with young children, tribal leaders, elders, and children were targeted specifically for the behavioral intervention. The efficacy of the behavioral intervention was assessed using surveys of tribal fish harvesters and women of childbearing age. Significant changes in advisory awareness and Ogaa size preference occurred as a result of the intervention, while tribal lifeways associated with harvest and consumption of Ogaa were not adversely affected.

#### ISEE-S39-04

#### Discussion: Constructing Traditional Tribal Subsistence Exposure Scenarios

Harper BL, *Conf. Tribes of the Umatilla Indian Reservation, Pendleton, OR, USA*.

**Abstract:** In the case of determining tribal exposures, there are no tribal-specific databases of subsistence activities, resources, or diets as there are for the general United States population. Cross-sectional surveys of contemporary tribal populations will not generate that data because much resource use is currently suppressed due to loss of land and access, awareness of contamination, and other reasons. It is therefore necessary to reconstruct an original subsistence diet using multiple lines of evidence. This presentation describes how ecoregion-specific subsistence exposure scenarios integrate a combination of baseline ecological descriptions with anthropologically defined information on subsistence lifestyle and diet.

#### ISEE-S40

#### Use of Simple Approaches That Tie Body Burden to Dose

**Abstract:** Most efforts that attempt to link exposure dose and body fluid (blood or urine) concentrations take a forward calculation approach that starts with the dose and, with the use of pharmacokinetic (PK) models, predicts the concentration. Furthermore, these models are often complex and physiologically based, having on the order of 10–15 compartments and a similar number of rate constants. The focus on these physiologically-based pharmacokinetic (PBPK) models is on the prediction of a physiological response, such as the activation of the Ah receptor, which is the focus of dioxin PBPK models, or the inhibition of iodide uptake, which is the focus of perchlorate PBPK models. This session will instead focus on much simpler approaches whose primary focus is on an expanded study of the magnitude and patterns of external exposure, using both external (dose) and internal (biomonitoring) measures of exposure. One of the approaches discussed in this session is termed the “creatinine correction” approach. This approach is based on the measurement of both creatinine and a specific contaminant in spot urine samples, and then using that information to backcalculate a daily dose of the contaminant. This approach has been used successfully on contaminants to which an individual is exposed on a daily basis, which have a short half-life in the body, and which are fully (or mostly) excreted in urine. Perchlorate and pesticides are examples of contaminants studied with the creatinine correction approach, and both of these will be discussed during this session. The second approach that this session will study is the simple, 1-compartment pharmacokinetic model. This single compartment is the blood reservoir, and the contaminants for which this approach have been used most often are contaminants with a long half-life such as dioxin and PCBs whose appearance in blood is the result of long-term background or occupational exposures. However, this one-compartment model has recently been applied to perchlorate, and with the addition of a “bladder” reservoir, predictions of perchlorate in both blood and urine are made. This session will review these methods and show how their application can greatly expand the understanding of external

exposures. With the growing relevance and use of NHANES to characterize background exposures for an expanding list of contaminants, there is a concurrent need to determine the patterns of background intakes that lead to these concentrations. In short, these simple models are allowing for an expanded and more valid study of external patterns of exposure.

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**ISEE-S40-01****Introduction to Session, and Use of a Simple Pharmacokinetic Model to Characterize Exposures to Perchlorate**

Lorber M, U.S. EPA, Washington, DC, USA.

**Abstract:** The introduction will provide an overview of the creatinine correction approach and the simple 1st order single compartment PK model, and introduce the speakers and talk titles. Then, there will be a presentation on the use of the simple 1st order PK model to predict concentrations of perchlorate in urine and blood. A simple 2-compartment first-order pharmacokinetic model which predicts concentrations of perchlorate in blood and urine was constructed and validated. The model was validated using data from a high dose experiment in humans where doses and resulting concentrations of perchlorate in blood and urine were well documented. Specifically, data were available for individuals who had been dosed at 0.5, 0.1, and 0.02 mg/kg-day for 14 consecutive days, significantly higher than the average background dose which is less than 0.0001 mg/kg-day. The average measured urine concentration in the high dose regime during the experiment was 15.4 mg/L compared to an average prediction of 17.3 mg/L. In the medium dose regime, the average measured was 3.0 mg/L compared to 4.1 mg/L predicted, and in the low dose regime, the average measured was 0.53 mg/L compared to 0.68 mg/L predicted. For blood, the analogous results include: 0.51 mg/L measured compared to 0.54 mg/L predicted in the high dose regime and 0.12 mg/L measured versus 0.11 mg/L predicted in the medium dose regime. The model was then used to study background exposures to perchlorate. A national sampling of perchlorate in urine showed a median concentration of 0.0035 mg/L. Blount used a creatinine correction approach on this data to back calculate a dose of 0.000064 mg/kg-day. This finding was independently verified with the modeling structure of this paper, as use of that back calculated dose of 0.000064 mg/kg-day resulted in predictions of urine concentration with an average virtually identical at 0.0033 mg/L. An examination of data on the possible pathways of exposure suggests that the consumption of foods, rather than ingestion of water, dominates background exposures to perchlorate. Daily variation in urine concentration was studied with the model, and it was found that concentrations in the morning hours were lower than concentrations in the afternoon and evening hours, corresponding to the time when most exposure was assumed to occur.

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**ISEE-S40-02****Interpreting Human Biomonitoring Data for Acrylamide: Screening-level Modeling Approaches**

Aylward L, Summit Toxicology, Falls Church, VA, USA.

**Abstract:** Physiologically-based pharmacokinetic (PBPK) models provide a set of tools that can be used in the interpretation of human biomonitoring data. However, in many cases, simpler pharmacokinetic data and information can be used to evaluate measured blood or urine concentrations of environmental chemicals in the context of existing risk assessments without the need for a fully validated and developed PBPK model. This talk presents the findings from the development of a Biomonitoring Equivalent (BE) for acrylamide which applies elements of an internal dose-based risk assessment and key data on metabolism to estimate biomarker concentrations consistent with existing risk assessments for acrylamide. The draft USEPA IRIS risk assessment for

acrylamide identifies serum area under the curve (AUC) of acrylamide and glycidamide as the critical dose metrics for neurological and carcinogenic responses, respectively. In vivo data in rats provide data on serum AA and GA concentrations exposed at the point of departure for the risk assessment. In vivo and in vitro data in humans provide the basis for estimating hemoglobin adduct levels in humans consistent with the identified steady-state target serum concentrations of AA and GA. These data can be used to estimate BE values for hemoglobin adducts associated with the identified RfD and cancer risk-specific doses. Similarly, data regarding the urinary metabolites of AA in humans provide the basis for estimating urinary marker concentrations that are consistent with exposures at the RfD. The resulting BE values provide a means to perform a screening level evaluation of biomonitoring data for acrylamide in a public health risk context.

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**ISEE-S40-03****Creatinine Corrections for Obesity and Pregnancy to Pesticide Doses Estimated From NHANES Urinary Data**

Allen R, U.S. EPA, Washington, DC, USA.

**Abstract:** The Biological Equivalent of the USEPA reference dose (RfD) of a toxicant such as a pesticide can be expressed as the expected concentration of the compound in blood or urine. Blood concentration depends upon individually different pharmacokinetics of uptake and renal clearance, and the total blood volume of the subject. Because of such uncertainty, we have chosen to focus on the urinary analyses because the ratio of pesticide to creatinine (CR) concentration removes the effect of the dilution caused by fluid intake. A normal healthy subject's daily CR excretion rate is a function of age, gender, race, body surface area, height and weight, body mass index, dietary intake of red meat containing creatine, and female pregnancy status. All of that information is reported by NHANES for each subject. Multiplying the measured mg/g CR by the predicted mg CR/kg-day predicts the constant dosage of the parent pesticide that would equilibrate with that urinary concentration. If a metabolite is measured we multiply by the parent pesticide molecular weight/metabolite molecular weight and the mol parent intake per mol metabolite produced. Because adipose tissue contains no CR to metabolize to CR, obesity is a factor that needs to be considered. This is done by scaling subject's lean body mass (LBM) to the LBM corresponding to the median LBM of an individual of same age and gender. We estimate the subject's LBM using the equations developed by Eddy (1975) for British adults as a function of their weight (Wt) and BMI [Wt (kg)/Ht<sup>2</sup> (m<sup>2</sup>)]: Male LBM (kg) = Wt (1.10–0.0128 BMI); Female LBM (kg) = Wt (1.07–0.0148 BMI). Each term is divided by the LBM for the same Wt and Median BMI for the age (MBMI), so for example the male factor to correct for adiposity is thus: Male factor = (1.10–0.0128 BMI)/(1.10–0.0128 MBMI). If the subject has more adipose tissue than the MBMI, the factor is less than 1, and vice versa. Examination of the literature for CR excretion before and during pregnancy shows that there is an approximate increase of 20% for a woman from her pre-pregnant status. We model the woman's CR excretion by multiplying our published factor by the term (1 + 0.2 P) where P = 1 if pregnant and P = 0 if not pregnant. We apply these corrected CR equations to NHANES pesticide data and discuss the results.

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**ISEE-S40-04****Application of Pharmacokinetic Modeling to Relate PFOA Exposures and Blood Concentrations in Human Populations**

Clewel H, The Hamner Institutes for Health Science, Research Triangle Park, NC, USA.

**Abstract:** PFOA is a surfactant that has been used for various applications including fluoropolymer production. It is also a metabolic and

environmental degradation product of telomer alcohols. Due to its high environmental persistence, PFOA is found throughout the global ecosystem as well as in human blood from the general population. Determining the relationship between exposure to PFOA and measured concentrations in plasma has been hindered by the lack of pharmacokinetic data in humans. For convenience, the pharmacokinetics of PFOA has been described with one-compartment, first-order models; however, the observed kinetics in animals is clearly more complicated. During studies with daily oral dosing and extended post-exposure observation periods, cynomolgus monkeys have a rapid approach to steady-state plasma concentrations together with a very much slower terminal half-life. Moreover, changes in apparent elimination rates with increasing dose suggest that capacity-limited, saturable processes must be involved in the kinetic behavior of these compounds. We have developed a biologically motivated model for PFOA in the monkey and rat, and have performed an initial extrapolation of this model to the human. This presentation will describe the alternative approaches for modeling PFOA (simple and biologically motivated) and discuss their relative strengths and weaknesses for estimating the exposures likely to be associated with blood levels of PFOA measured in a population, and for comparing these exposures with health benchmarks from animal studies.

#### ISEE-S41

##### Brominated Flame Retardants: A New Health Threat

**Abstract:** Flame retardants provide a valuable service in that their use resists or inhibits the spread of fire. These flame retardants may be naturally occurring, such as asbestos, or synthetic, such as the brominated flame retardants (BFRs), which came into wide use in the 1970s. They are applied to prevent fire in electronics, carpets, and furniture. Some BFRs, including the polybrominated diphenyl ethers (PBDEs), are considered persistent organic pollutants (POPs) and are known to bioaccumulate and produce adverse effects to the ecosystem. There is reason for concern although their complete toxicologic profile has not been fully determined. In 1999, BFRs were applied to 2.5 million tons of polymers worldwide, with the annual use of PBDEs alone being in excess of 40,000 metric tons. North American industry used about 34,000 metric tons of PBDEs in 1999, making it the largest user of these additives globally; however, a significant portion of the flame-retarded products manufactured in North America is destined for international markets. Because of their wide use, their ability to be persistent in the environment and in humans, to bioaccumulate, to move in air trans-boundary, and their toxicity, selected PBDEs are being discussed for addition to many global treaties; e.g., Stockholm Convention on POPs. Hence, they are of global human health concern. As with most POPs they are ideal candidates for biomonitoring. Biomonitoring data from such studies as the U.S. National Health and Nutrition Examination Survey (NHANES) 2003–2004 (Sjodin and Needham et al ES&T. 2008) and other studies worldwide reveal that humans are being exposed to a wide array of PBDE congeners and that North Americans, specifically residents of the U.S., have the highest PBDE serum concentrations. Again, the long term health effects are mostly unknown although several of the proposed talks in this symposium will focus on epidemiological studies investigating the relation between human exposure and effects, such as thyroid function (Goldman), cancer (Windham), and autism (Hertz-Pannier). Other health oriented talks may focus on exposure based on the serum and milk concentrations, specifically of newborns (Goldman) and children (Needham; Windham; and Bradman, Sjodin and Eskenazi) and how their concentrations compare among various race/ethnicities and with other age groups. Unlike most POPs where the primary route of exposure is known to be dietary ingestion of animal lipid, this is not known for PBDEs. For these BFRs, the primary route appears to be either dietary ingestion or non-dietary ingestion of dust. Exposure to PBDEs via the dust could also involve inhalation and perhaps dermal absorption. The various pathways of

exposure among age groups from the US, UK, and Germany will be discussed in this symposium as well (Schecter, Webster, Pless-Mulloli, Huwe). Other talks will focus on the health endpoints via primarily toxicological animal studies (Staskal, DeVito). Finally, one of the talks will put exposure of PBDEs in perspective as related to similar chemicals by examining exposure, health endpoints, and the resulting risk in nursing infants (Lorber).

#### ISEE-S41-01

##### PBDE Exposure to Pregnant Women and Their Children Living in a United States Agricultural Community

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**Abstract:** The CHAMACOS longitudinal birth cohort study is examining prenatal and child exposures to environmental chemicals and potential health effects in 600 pregnant Latina women and their children up to age 7 years and beyond. In a pilot study of 24 women, the median concentration of the sum of the PBDE congeners was 21 ng/g lipid and ranged from 5.3 to 320 ng/g lipid. Consistent with other studies, 2,2',4,4'-tetrabromodiphenyl ether (BDE-47) was found at the highest concentration (median = 11 ng/g lipid ; range, 2.5–205) followed by 2,2',4,4',5-pentabromobiphenyl (BDE-99) (median = 2.9 ng/g lipid ; range, 0.5–54), 2,2',4,4',5-pentaBDE (BDE-100) (median = 1.8 ng/g lipid ; range, 0.6–44), and 2,2',4,4',5,5'-hexaBDE (BDE-153) (median = 1.5 ng/g lipid ; range, 0.4–35). Levels of PCB-153 (median = 4.4 ng/g lipid ; range, <2–75) were lower than U.S. averages and uncorrelated with PBDE levels, suggesting different exposure routes. In this presentation we will characterize PBDE levels and exposure risk-factors in approximately 400 CHAMACOS mothers and 285 of their children at 7 years of age. We will also compare levels in the U.S.-born children with levels in a cohort of 5 year old Mexican children living in the same regions of Mexico where the U.S. families emigrated from.

#### ISEE-S41-02

##### A Case Control Investigation of PBDEs and Autism in Children

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**Abstract:** Polybrominated diphenyl ethers (PBDEs), used extensively in consumer products because of their flame retardant properties, show neuro-developmental toxicity in rodents. This study examined PBDE concentrations in a case-control investigation of autism and developmental delay known as the CHARGE (Childhood Autism Risk from Genetics and the Environment) Study. We examined children aged 2–5 years from three groups: those with autism, those with developmental delay but not autism, and general population controls. Autism spectrum disorders were assessed and blood specimens were collected. PBDEs were measured, including congeners #28, #47, #66, #85, #99, #100, #153, #183, #197, #207 and #209. As compared with typically developing children, children with autism and children with developmental delay showed lower PBDE concentrations at ages 2–5, particularly the higher brominated congeners. Further research is needed to prospectively determine the levels of these compounds in early life and during gestation, to understand the role of metabolites in toxicity, and to characterize relationships between exposures during critical time windows and neurodevelopmental endpoints.

**ISEE-S41-03****PBDE and HBCD Brominated Flame Retardants in the USA, Update 2008: Levels in Human Milk and Blood, Food, and Environmental Samples**

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**Abstract:** Levels of PBDEs in nursing mothers' milk and human blood samples from the USA are orders of magnitude higher than in European countries which in turn are higher than levels in Vietnam. Blood and milk levels on a population basis and from the same persons are very similar. In our studies, milk levels for all measured PBDEs combined vary from 4 to 589 parts per billion (ppb), lipid. PBDE levels are very much higher in serum from 2003 than 1973. By way of contrast, dioxins, dibenzofurans and PCBs are much lower than in 1973. All US blood and milk samples had detectable levels of PBDEs with BDE 47 usually predominating. Distribution in humans is skewed with few levels above 100 ppb. BDE 209, from DecaBDE, the only PBDE currently manufactured and sold in the USA and Europe has been found in many but not all human samples. Fetal liver contains lower levels on a lipid basis than adults. Vegans' blood had lower levels compared to that found in the general population with levels being lower the longer the person had not eaten meat. While PBDE levels in the USA are markedly higher than European levels, the levels of HBCD in milk is similar to European levels, with median of 0.5, mean of 0.5 and range of 0.2–0.9 ppb lipid. Market basket surveys found fish with median of 616, meat 190, dairy 32 and vegetables median to be 12 ppb. However, US dietary consumption patterns show highest intake from meat, followed by fish and dairy products. Estimated total PBDE intake in adults from food, dust and air is estimated to be 1.2 ng/kg/day with 307 ng/kg/day in nursing infants. A major uncertainty is from estimates of dust intake which vary 200 fold in the literature. We used a middle value for our calculations. In a new study, paired milk and serum from the same mothers appear to have slightly higher levels in milk, about 1.4 fold for total PBDEs. Environmental samples showed higher levels of PBDEs in household dust than in lint and higher levels in both in the USA compared to German values. Computer surface wipe samples showed measurable levels on wipe tests from older computers with BDE 209 predominating in computer, dust and lint environmental samples.

**ISEE-S41-04****Tissue Distribution of Polybrominated Diphenyl Ethers in Rats Following Oral Exposure and the Relationship to Body Burdens**

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**Abstract:** Polybrominated diphenyl ethers (PBDEs) are a class of widely-used flame retardants which have been found to persist, bioaccumulate, and potentially affect development in animals. Humans are exposed to PBDEs through both their diet and indoor environment. In human exposure studies, blood, adipose tissue, and breast milk have generally been used to estimate total body burdens of PBDEs. Using rats as a model, we looked at the tissue distribution of PBDEs after oral administration and evaluated a suitable matrix for body burden estimation. Eight male Sprague-Dawley rats were fed a diet containing either PBDE-contaminated dust mixed into the feed or a PBDE formulation dissolved in oil and given with the feed for 21 days. Tissues and plasma from each rat were analyzed for PBDEs by high resolution GC/MS. PBDEs were found in all tissues including adipose, brain, kidney, liver, residual carcass, and plasma. Tri- to hexa-BDEs comprised >80% of the PBDEs

in the adipose, brain, kidney, and carcass; but <40% of the total PBDEs in the liver and plasma. On a lipid weight basis, the concentrations of tri- to hexa-BDEs in adipose tissue were similar to the concentrations in the residual carcass (adipose:carcass = 0.6–1.5). Plasma concentrations averaged slightly higher than the concentrations in the residual carcass (plasma:carcass = 1.2–3.7). For the hepta- to deca-BDEs, adipose tissue concentrations were lower than the residual carcass (adipose:carcass = 0.0 2–0.5), and plasma levels were generally higher (plasma:carcass = 0.8–12.9). The results show that the lower brominated congeners tend to distribute equally into lipids implying that both adipose tissue and plasma could provide adequate estimates of total body burdens. However, the higher brominated congeners (hepta- to deca-BDEs) were not as predictable; adipose tissue tended to under-estimate and plasma to over-estimate and the total body burdens. (This abstract does not reflect Agency policy.)

**ISEE-S41-05****Televisions as Sources of DecaBDE in House Dust**

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**Abstract:** The indoor environment is an important pathway of exposure to polybrominated diphenyl ethers (PBDEs), a class of fire retardants used in consumer products such as foam-containing furniture and electronics. While these products are thought to be the major sources of PBDEs in indoor dust and air, researchers have had little success in linking them. We hypothesize that previous attempts to associate PBDE concentrations in house dust to consumer products have been hampered by misclassification, the inability to determine the levels of PBDEs in otherwise similar products. Our strategy is to use portable X-ray fluorescence (XRF) to quantify the bromine content of consumer products, linking this surrogate to PBDE concentrations in house dust. We previously reported an association between pentaBDE concentrations in house dust and bromine levels in household furniture. Here we discuss the link between decaBDE concentrations in house dust and electronics. We collected house dust separately from the bedrooms and main living areas of 19 homes in the Boston, MA area using a standardized protocol. The dust was analyzed for PBDEs using GC/MS. We estimated the bromine content of furniture and electronics by making up to three XRF readings per item or sub-item for objects with multiple components. Multiplying by the surface area (or volume) of the items and summing over all items in the room produced a bromine index. We used correlation analysis and linear mixed effects models to examine the relationship between the concentrations of decaBDE in dust and the bromine loadings in furniture, electronics and televisions. We found an association between decaBDE levels in dust and bromine levels in electronics, largely driven by the bromine levels in televisions ( $r = 0.64, P = 0.003$  for bedrooms). For the main living area, predicting decaBDE in dust improved when we included an interaction effect between the bromine content of televisions and the number of persons in the house ( $P < 0.005$ ), a potential surrogate for television usage. These results suggest that televisions were a major contributor to the decaBDE concentrations in the dust from these homes. Additional work is necessary to determine how the relatively non-volatile decaBDE is released from products and enter the environment.

**ISEE-S41-06****Serum Levels of Poly-Brominated Diphenyl Ethers (PBDEs) in Girls in California and Ohio**

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USA; <sup>#</sup>Centers for Disease Control and Prevention, Atlanta, GA, USA; <sup>\$</sup>Impact Assessment Inc., San Diego, CA, USA; and <sup>¶</sup>Kaiser Permanente Northern California, Oakland, CA, USA.

**Background:** Environmental exposures may affect pubertal development. We are studying hormonally relevant agents, including PBDEs, for possible effects on endocrine control of reproductive maturation. Because of the paucity of information on exposure to these chemicals in young children, we conducted a pilot study to determine the degree of detectable concentrations and variability. Methods: Girls 6-to-8 years old are being followed for pubertal development in a multi-site, prospective study within the Breast Cancer and the Environment Centers (BCERC). At the baseline physical exam of the child, serum and urine samples were taken. About 30 serum samples from both the California and Ohio sites were assayed for polybrominated diphenylethers (PBDEs), polychlorinated biphenyls (PCBs), and other organo-chlorinated compounds. Their distributions were examined and compared across age, race, site and BMI categories in adjusted models. Results: Six of the eleven PBDE congeners measured were detected among greater than 80% of samples (BDE 28, 47, 99, 100, 153, and 154). BDE-47 had the highest concentration (median 42.5, range 7-346 ng/g lipid), which was four times greater than any PCB congener median level, followed by BDE-153, 99 and 100. Girls in CA generally had adjusted geometric mean (GM) PBDE levels double those in OH. Hispanics and Blacks had similar PBDE levels, both slightly greater than Whites and Asians. The only significant difference by race in adjusted GMs was a higher concentration of BDE-153 (23.4 ng/g lipid) in Blacks. PBDE levels did not generally vary by BMI in contrast to some of the other compounds. Conclusions: Many of these potentially hormonally active agents were detected in a large proportion of young girls, some at relatively high levels, with variation by geographic location and other demographic factors. Several of the PBDE congener levels we measured were higher than those reported in recent NHANES data for 12-19 year olds. We will examine predictors of PBDE levels from the questionnaire for the symposium. These results warrant future investigation of the relationship of these exposures to pubertal development.

#### ISEE-S42

#### Personal Measurements of Radio Frequency Electromagnetic Field Exposure and the Implications for Experimental and Epidemiological Studies

**Abstract:** In many countries throughout the world almost the whole population is exposed to different sources of radio frequency electromagnetic fields (RF-EMF). Typical sources in our daily life are mobile phones, mobile phone base station, broadcast transmitters, cordless phones, and Wireless Lan. There is increasing public concern that exposure to RF-EMF causes adverse health effects. However, the development of well designed epidemiologic studies is hampered by the lack of knowledge about the contribution of various sources to the total population exposure. Moreover, there is a need for methodologically sound RF-EMF exposure assessment methods. Recently, newly developed personal exposure meters (exposimeters) have become available and these are expected to be useful for determining personal RF-EMF exposure. Exposimeters are simple to handle and can be carried easily throughout a whole day. They can simultaneously measure different frequency bands, which allows to distinct between various RF-EMF sources. Currently, exposimeter measurements are performed in various studies in different countries. Each of these studies have developed their own design and methods according to their specific objectives. The aim of the proposed symposia is to discuss and compare the methods, experiences and results from various studies. The symposium will start with an introductory talk about challenges of personal RF-EMF exposure measurements. Subsequently four ongoing studies will present their methods and results. This allows evaluating differences between studies and identifies

knowledge gaps. For future research we will discuss requirements for handling of the exposimeters and for the data analysis.

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#### ISEE-S42-01

#### Challenges of Personal RF-EMF Exposure Measurements

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**Abstract:** Personal exposure meters (exposimeters) are increasingly applied in bioelectromagnetic research to determine personal radiofrequency electromagnetic field (RF-EMF) exposure. The main advantages of exposimeter measurements are their convenient handling for study participants and the large amount of personal exposure data, which can be obtained for several RF-EMF sources. However, there are a number of methodological issues about personal RF-EMF exposure measurements that are not completely solved yet. This talk gives an introduction about the most important challenges of personal RF-EMF exposure measurements: 1. The RF-EMF field is interacting with the body. Thus, the undisturbed RF-EMF can be underestimated by the exposimeter by several orders of magnitudes due to shielding of the body. This has implications for handling the exposimeters and for interpreting the data. 2. The detection limit of currently available exposimeters is relatively high compared with typical value in the everyday environment. Thus, exposimeter datasets contain a substantial proportion of nondetects. This has implication for the data analysis. 3. There are a number of sources for measurement uncertainty; e.g. out of band response, non-isotropy, non-linearity, time shifts and different signal modulations in the real world. This needs an adequate quality control of the measurement devices.

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#### ISEE-S42-02

#### Mobile Telecommunication Exposure and Well-Being in Children and Adolescents

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**Background:** During the last decade, there has been an increase in the number of mobile phone users worldwide. In Germany, nearly every household with children and 94% of the German adolescents own a mobile phone. Some concern arises whether the phones or their base stations might adversely affect health and well-being. In this context, children and adolescents are of special concern as a) they might potentially be more vulnerable to effects of mobile phone frequencies and b) the duration of exposure during their life-time exposure will be longer. We therefore designed a cross-sectional population-based study in Germany of possible acute health effects of mobile phone networks. For the first time, personal dosimetry was used as exposure proxy in this study.

**Methods:** Participants were randomly selected from the population registries of four Upper Bavarian (South of Germany) cities and towns with different population sizes. With a one page short questionnaire participants were invited to take part in the field phase of the study. During this field phase a personal interview data on participants' well-being, socio-demographic characteristics and potential confounders were collected.

Simultaneously, using personal dosimeters (Maschek dosimeter ESM-140), a 24-hour exposure profile for each study participant was recorded including exposure to mobile phones, their base stations, DECT cordless phones and wireless LAN. During the 24-hour measurement, subjects completed a symptom diary (in the morning, at noon and in the evening

before bedtime) and an exposure diary (use of mobile phones and cordless phones).

**Results:** The field-phase of the study started in February 2006 and was completed in December 2007. Seventy percent of those invited answered the short questionnaire. Overall, 1497 children (age 8–12 years) and 1516 adolescents (age 13–17 years) participated in the field phase which results in a response of 52%. The exposure to mobile phone frequencies was very low and ranged from a mean of 0.13% (all measurement values below the limit of determination) to a mean of 0.92% of the ICNIRP reference level per second during waking hours.

**Discussion:** Personal dosimetry is feasible in epidemiologic studies. Response in a population-based study including children and adolescents was reasonably high. Funded by the German Federal Office for Radiation Protection (BFS).

#### ISEE-S42-03

##### Assessment of the Radio Frequency Exposure in the General Population: Results of a French Pilot Study

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**Aim of the Work:** A population based survey has just been carried out in two regions of France (Besançon and Lyon areas) in order to characterize RF exposure levels on a general population basis using a recently developed RF exposure meter (the EME SPY, a portable device for measuring the level of 12 radio frequencies). Its goal were tow-fold: to evaluate the importance of different sources in our general environment, and to identify, if possible, the main factors which may predict exposure levels.

**Material and Methods:** The current study is of necessity a pilot study, as only 10 RF exposure meters were available at the time scale for using them in short (6 months). A stratified random sampling procedure (with an urban/rural ratio of 75%/25%, and an adult/youth ratio of 66%/33%) was followed.

**Results:** In each area, 220 volunteers (200 for 24 hour measurements and 20 for 1 week measurements) have been recruited. Each participant has completed a general questionnaire about his/her occupation and habits, and kept a diary (space-time budget) during the monitoring period. The effects on the measured exposures of various factors (location of individual -at home, and at work-, means of transports, use of various RP emitting devices-mobile phones, DECT phones, WiFi networks, microwave ovens, etc.) have been analysed. First results of the survey will be presented. It is anticipated that this study will be useful to assist in the planning of new, well-targeted exposure assessment studies and in the characterisation of exposure distributions for the planning and feasibility assessment of analytical epidemiological studies.

#### ISEE-S42-04

##### Personal Radio Frequency Electromagnetic Field Exposure in a Swiss Population Sample

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**Objectives:** Exposure to various sources of radio frequency electromagnetic fields (RF EMF) is common in our environment, for

example from mobile phone handsets or broadcast transmitters. We measured exposure to RF EMF in volunteers in Basel (Switzerland) to gain a better understanding of exposure levels in everyday life. Moreover, we wanted to study the reproducibility of weekly exposure measurements. **Methods:** Exposure was assessed using the EME SPY 120 personal exposure meter (Antennessa, Brest, France), which allows separate measurements of twelve different bands in the RF range. A total of 166 volunteers carried a personal exposure meter during one week and completed a diary of daily activities at the following locations: "at home", "at the working place", "on the way" (e.g. outdoor, train, shopping) and "other". 35 persons were specifically selected because they lived close to a mobile phone base station ( $n = 27$ ) or a radio/television transmitter ( $n = 8$ ). 32 volunteers participated twice in the study at two different weeks (separated by 21 weeks on average). Measurements were taken every 90 seconds. To allow for values below the detection limit of 0.05 V/m, mean values were calculated by means of the robust ROS method, which assumes that measurements below the detection limit follow a lognormal distribution. All calculations were done with values for the power flux density ( $\mu\text{W}/\text{cm}^2$ ).

**Results:** In our sample the mean exposure to RF EMF over the whole week was 0.24 V/m. The lowest weekly average was 0.08 V/m and the highest 0.58 V/m. On average, radio transmitters contributed 5%, television transmitters 5%, tetrapol 0%, mobile phone handsets 30%, mobile phone base stations 28%, cordless phones 28% and wireless LAN 4%. Exposure at daytime (6 am–22 pm) (mean 0.27 V/m) was higher compared to nighttime (mean 0.18 V/m). During daytime exposure was mainly due to mobile phone handsets (34%) and cordless phones (31%), whereas at night it was mainly due to mobile phone base stations (49%) and cordless phones (20%). Exposure levels and contributions of different sources at weekdays (mean 0.24 V/m) and weekends (mean 0.23 V/m) were similar. At home, mean exposure was 0.22 V/m, at the working place 0.26 V/m, on the way 0.34 V/m. The Pearson correlation coefficient of mean total exposure for first and secondary week measurements for the persons who participated twice was 0.74. When restricting the analysis to those who reported similar activities on both weeks, the coefficient increased to 0.87.

**Conclusions:** The mean total exposure (0.24 V/m) is well below the standard limits. Major sources include mobile phone base stations, mobile phone handsets and cordless phones. Weekly exposure measurements were reproducible and the most important predicting factors could be identified. The data will help to assess personal exposure in the large-scale QUALIFEX cohort study (see [www.qualifex.ch](http://www.qualifex.ch)), which will examine non specific symptoms of ill health and exposure to RF EMF.

#### ISEE-S42-05

##### The Dutch Exposimeter Study: Developing an Activity Exposure Matrix

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**Abstract:** The main goal of the study is to find a proper measure of exposure, characterizing the exposure to extremely low frequency (ELF) and radiofrequency (RF) electromagnetic fields (EMF), for usage in epidemiological studies to define highly vs. lowly exposed persons. The study aims to build an Activity Exposure Matrix (AEM), describing for about 30 common, everyday activities in 1 ELF and 12 RF frequency bands the estimate of the exposure level. In this way the exposure to EMF can be estimated based on the AEM and a questionnaire on activity patterns without the need to actually measure. In the Dutch Electromagnetic Fields and Health (EMF&H) Research Programme the "EMF exposure characterisation using personal exposimeters and an

Activity Exposure Matrix (EMF-AEM)" is one of the five first granted studies. The project started in 2007 and will finish by the end of 2009. The outcomes of the EMF-AEM study will be made available for the follow up studies in the EMF&H Research Programme.

In the first stage we have prepared all tools such as questionnaires, time-activity patterns, a diary format and a list of initial everyday activities to be measured. The main criteria for the activities are: contrasting in exposure, common under a substantial part of the population and distinguishable from the recorded time series. Since the power transmitted by the sources depends on the time of day and the surroundings, the activities will be layered, for example "Traveling by bike—Morning rush hour—City". For the ELF band we purchased 8 Emdex Lite exposimeters measuring in a frequency range 40–1000 Hz. For the RF bands we purchased 11 EME Spy 121, measuring 12 frequency bands: FM, TV3, TV4/5, uplink bands and downlink bands for GSM, DCS and UMTS, DECT, Tetra and WiFi. The EME Spy exposimeters have been tested in a GTEM to determine the measurement uncertainty per exposimeter and per frequency band. To estimate the measurement errors we tested for a.o. the isotropy, responses at different input field strengths and out of band responses.

In the second stage we have hired temporary workers and commissioned them to perform the preliminary identified list of activities included in AEM, while carrying the EME Spy 121 RF-exposimeter, the Emex Lite ELF-exposimeter, and a GPS. Based on these measurements and the characteristics of the exposure during the activities an exposure classification scale will be constructed. In the AEM per frequency band the relevant activity will be classified. Also spot and exposimeter measurements will be performed to characterize certain (indoor) activities. The GPS data will be used as a tool to point out locations with exceptionally high or low field strengths. At these locations spot measurements with more sensitive, exact measurement devices with a broader measurement range of frequencies can be performed. To validate the developed tools, in the last stage we will test the AEM and questionnaire on volunteers.

**Acknowledgements:** We thank the Netherlands Organisation for Health Research and Development (ZonMw) for funding this study (<http://www.zonmw.nl/en/programmes/all-programmes/electromagnetic-fields-and-health-research/>).

#### ISEE-S43

#### Recent Findings from the Agricultural Health Study: Pesticide Exposure Assessment, Cancer, and Neurologic Disease

**Abstract:** Pesticide exposure is a global concern, but little is known about the health effects of chronic low level exposures. Although farmers are generally regarded as being healthier than the general population, they are at increased risk for some diseases, including specific cancers such as lip, prostate, and non hodgkin lymphoma; neurological diseases; respiratory diseases; and reproductive outcomes. Farmers have different exposure patterns than the general public to a variety of agents that may be associated with these diseases, including pesticides, animals, well water, and sunlight. The Agricultural Health Study (AHS) was designed to better address risk factors for disease among farmers and their families. The study, conducted in Iowa and North Carolina by NCI, NIEHS, EPA, and NIOSH, enrolled ~52,000 private pesticide applicators (mainly farmers), ~32,000 farm spouses, and ~5000 commercial pesticide applicators from 1993–1997. The hallmarks of this study are its large size, the representation of farm women, and its commitment to exposure assessment. To date, researchers from the AHS have published over 90 peer-reviewed papers on topics related to pesticide exposure assessment, cancer, neurological outcomes, and other aspects of farming and health (see [www.aghealth.org/publications.html](http://www.aghealth.org/publications.html)). Given the AHS relevance to the topic of the meeting, we are proposing this symposium to provide a summary of recent results from the AHS focusing on exposure

assessment, cancer, and neurologic outcomes. Presenters will describe findings for specific chemicals, while summarizing the overall results to date.

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#### ISEE-S43-01

#### Cancer Risk Associated with Pesticide Exposure in the Agricultural Health Study: Introduction and Recent Findings

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**Abstract:** Currently, only arsenical insecticides and one pesticide contaminant, TCDD, are known human carcinogens, but many other pesticides used world-wide are suspected human carcinogens. The Agricultural Health Study (AHS) is a comprehensive effort designed to evaluate the health effects of pesticides and other agricultural exposures. Using a prospective study design with a large population of occupationally and non-occupationally exposed participants and detailed exposure assessment prior to the onset of disease eliminates limitations of earlier studies. The AHS also allows comparison of epidemiological results in two states and evaluation of health effects at different points in time. Cancer incidence data are obtained annually from population-based cancer registries in Iowa and North Carolina. Associations between pesticides and cancer risk are assessed in both case-control studies of specific cancers and in prospective analyses of cancer risk in subgroups of the cohort who report use of specific pesticides. DNA samples allow for studies of gene-environment interaction, epigenetic mechanisms, and biomarkers of early disease. These will aid in our understanding of carcinogenic mechanisms associated with specific pesticides. Twenty pesticides studied to date in the AHS show some exposure-response relationships with cancer. Organophosphate (OP) insecticides including chloryrifos, fonofos, phorate, and coumaphos showed exposure-response patterns with prostate and lung cancers and possibly with multiple myeloma. For many pesticides, the AHS provides the first large-scale human data to assess potential cancer risk. Many of the pesticides associated with cancer risk in this cohort are not thought to be genotoxic and have been classified as unlikely human carcinogens by the EPA. Repeating initial evaluations of the OP (and other) pesticides and incorporating molecular epidemiology within a prospective cohort of occupationally exposed pesticide applicators should help us identify the potential human carcinogenic pesticides and better understand their carcinogenic mode of action. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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#### ISEE-S43-02

#### AHS Exposure Assessment Strategies: Questionnaires, Intensity Metrics, and Validation Studies

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**Abstract:** At enrollment in the AHS, over 89,000 individuals provided use information for 50 specific pesticides using questionnaires. Farmers and commercial pesticide applicators provided detailed information, while farm spouses were asked only about ever use. Use of organophosphate (OP) insecticides was common; 87% of applicators and 26% of spouses reported use. Malathion, diazinon, and chloryrifos were the most commonly used OPs. Exposure assessment has been a key component since study onset in 1993. We have evaluated the accuracy and reliability of the exposure information. Comparing self-reported data from repeated administration of the questionnaire one year apart, we found that exact agreement for chloryrifos (81%) and malathion (81%) was high. We assessed the accuracy of reported duration of use with information regarding when specific pesticides were introduced to the market. For chloryrifos, introduced in 1965, only 12 of the over 21,000 users provided information that was inconsistent with market introduction. The data collected on mixing, application, and personal protective equipment was used to create an exposure intensity score. Higher weights are

assigned to pesticide handling practices with a higher exposure potential. The intensity score is combined with the lifetime days of pesticide use to create an intensity-adjusted lifetime days measure for dose-response evaluation. Specific AHS studies have assessed how well the algorithm intensity scores discriminate exposure levels among users of the same chemical, including two field studies during which exposures were directly measured. One study was conducted among applicators of 2,4-D and chloryprifos using boom, hand spray, or in-furrow application methods; a second was conducted among orchard growers using captan. These studies have generally demonstrated a gradient in pesticide exposure with increasing algorithm scores, using both environmental and biological measures. Additional information on pesticide use is being collected at 5-year intervals from all participants. We will update and refine exposure histories in order to strengthen our ability to evaluate health effects. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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**ISEE-S43-03****Organophosphate Insecticides and Neurologic Dysfunction in the Agricultural Health Study**

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**Abstract:** Acute high-level exposure to organophosphate insecticides (OPs) is neurotoxic, and poisoning can have long-term sequelae, but the effect of chronic OP exposure at lower levels is unclear. Moreover, little information is available on aspects of pesticide use that may influence exposure, such as application methods. We studied ~18,000 licensed private pesticide applicators in the AHS. At enrollment, applicators completed questionnaires that provided information on neurologic outcomes and detailed data on use of pesticides, including 10 specific OPs. A follow-up interview in 1999–2003 collected updated information. We evaluated several outcomes including neurologic symptoms, physician-diagnosed depression, hearing loss, and retinal degeneration in relation to OP use reported prior to, or concurrently with, the reported outcomes. We used logistic regression with adjustment for age, state, and other covariates. Symptom prevalence was associated with cumulative lifetime days of OP use, with an odds ratio (OR) for the highest category of use of 2.2 (95% confidence interval (CI) = 1.7–2.7); the association was independent of recent OP use. Hearing loss was weakly associated with cumulative days of OP use (OR = 1.2, 95%CI = 1.0–1.3). Depression was associated with ever use of OPs (OR = 1.7, 95%CI = 1.3–2.3), as was retinal degeneration in both cross-sectional (OR = 1.6, 95%CI = 0.9–2.9) and prospective (OR = 1.9, 95%CI = 1.0–3.4) analyses. High personal exposure events were associated with symptom prevalence (OR = 3.0, 95%CI = 2.7–3.5), depression (OR = 2.0, 95%CI = 1.6–2.5), hearing loss (OR = 1.4, 95%CI = 1.2–1.6), and incident retinal degeneration (OR = 2.3, 95%CI = 1.3–4.0). Similarly, diagnosed pesticide poisoning was associated with symptom prevalence (OR = 2.5, 95%CI = 2.0–3.1), depression (OR = 3.8, 95%CI = 2.6–5.3), and hearing loss (OR = 1.8, 95%CI = 1.4–2.3). Notably, associations with cumulative exposure were independent of both high pesticide exposure events and physician-diagnosed poisonings. Application methods likely to involve greater personal exposure were more strongly related to symptom prevalence than low-exposure methods. These results suggest that high-intensity exposures have a strong effect on neurologic outcomes, but that chronic OP exposure at lower levels is also independently associated with neurologic outcomes.

**CONTRIBUTED ABSTRACTS**

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**ISEE-75****Costs of Public Health Adaptation to Climate Change**

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**S80**

**Background:** Climate change has begun to negatively affect human health, with larger burdens projected in the future as weather patterns continue to change. The climate change-related health consequences of diarrhoeal diseases, malnutrition, and malaria are projected to pose the largest risks to future populations.

**Methods:** The costs of treating diarrhoeal diseases, malnutrition (stunting and wasting only), and malaria in 2030 were estimated under three climate scenarios using (1) the current numbers of cases; (2) the projected relative risks of these diseases in 2030; and (3) current treatment costs. The analysis assumed that the number of annual cases and costs of treatment would remain constant. There was limited consideration of socioeconomic development.

**Results:** Under a scenario assuming emissions reductions resulting in stabilization at 750 ppm CO<sub>2</sub> equivalent in 2210, the costs of treating diarrhoeal diseases, malnutrition, and malaria in 2030 were estimated to be \$4 to 12 billion. This is almost as much as current total annual overseas development assistance for health.

**Conclusion:** The investment needs in the health sector to address climate-sensitive health outcomes are large. Additional human and financial resources will be needed to prevent and control the projected increased burden of health outcomes due to climate change.

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**ISEE-76****Manganese Superoxide Dismutase and Catalase Genetic Polymorphisms and Risk of Asbestosis**

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**Background:** Both asbestos exposure and genetic factors influence the development of asbestosis. Reactive oxygen species (ROS) are known to be involved in the pathogenesis of this disease. Manganese superoxide dismutase (MnSOD) and catalase (CAT) are enzymes that play an important role in primary defense against ROS. The genes coding for MnSOD and CAT are polymorphic. The most common polymorphism of the *MnSOD* gene results in alanine (Ala) to valine (Val) substitution in the mitochondrial targeting sequence (Ala -9Val), and that of the *CAT* gene consists of a cytosine (C) to thymine (T) substitution at position -262 in the 5' region (-262C > T).

**Objective:** The aim of this study was to investigate whether *MnSOD* Ala -9Val and *CAT*-262C > T genetic polymorphisms represent risk factors for the development of asbestosis in workers exposed to asbestos.

**Methods:** The study cohort consisted of 262 cases with asbestosis and 265 controls with no asbestos disease. All subjects were occupationally exposed to asbestos. The cumulative asbestos exposure was calculated for each case and control. The data on smoking were collected in all subjects by a standardized questionnaire. A real time PCR assay was introduced for genotyping of the *MnSOD* Ala -9Val and *CAT*-262C > T promoter polymorphism. To estimate the risk of asbestosis in relation to genotypes, cumulative exposure and confounders, a logistic regression analysis was used.

**Results:** The average cumulative asbestos exposure was 37.67 fibres/cm<sup>3</sup>-years in the workers with asbestosis and 11.23 fibres/cm<sup>3</sup>-years in controls ( $t = 4.78$ ,  $P = 0.00$ ). No difference in smoking was observed between the cases and controls. In both groups, approximately 46.0% were ever smokers ( $\chi^2 = 0.01$ ,  $P = 0.91$ ). Three different *MnSOD* (Ala/Ala, Ala/Val and Val/Val) and three *CAT* (TT, CT and CC) genotypes were identified by genotyping. *MnSOD* Ala/Ala genotype was observed in 29.0% of cases and 21.4% of controls, Ala/Val genotype in 45.0% of cases and 53.3% of controls, and Val/Val genotype in 26.0% of cases and 25.3% of controls. *CAT* TT genotype was found in 8.6% of cases and 6.5% of controls, CT genotype in 41.8% of cases and 40.1% of controls, while CC genotype was observed in 49.6% of cases and 53.4% of

controls. The OR of asbestosis was 1.50 (CI 1.01–2.24) for *MnSOD* Ala/Ala genotype versus Ala/Val and Val/Val genotypes, and 1.36 (CI 0.70–2.62) for *CAT* TT genotype compared to CT and CC genotypes. The risk of asbestosis for *MnSOD* Ala/Ala genotype did not change considerably after adjustment by gender, age, smoking and cumulative asbestos exposure. The gender, age and smoking did not influence the risk of asbestosis for *CAT* TT genotype either, but the involvement of cumulative asbestos exposure changed OR from 1.36 (CI 0.70–2.62) to 1.91 (CI 0.93–3.91), suggesting a confounding effect.

**Conclusions:** The key finding of this study was that *MnSOD* Ala/Ala genotype significantly increases the risk of asbestosis. A slightly elevated risk of asbestosis was also observed for *CAT* TT genotype, but the results were not significant.

#### ISEE-77

#### School Building Conditions Potentially Related to Indoor Air Quality: A Summary of Data from the 2005 New York State Building Condition Survey

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**Background:** The New York State (NYS) Building Condition Survey (BCS) is conducted in NYS schools every five years by teams of local inspectors. This survey describes general building characteristics, rates building conditions and environmental comfort and health parameters, and identifies situations directly related to school indoor air quality (IAQ). This analysis describes and analyzes the most recent (2005) data for school buildings in NYS (excluding NYC), focusing on conditions potentially related to IAQ and respiratory disease, and compares these results to those from the 2000 BCS.

**Methods:** For 2005, building characteristics such as age, type of floor finishes, and recent renovations or construction were assessed. Ratings were summarized for individual building systems whose condition may impact school IAQ including roofing, chimneys, windows, floor finishes, ceilings, swimming pools, plumbing systems, and the heating and ventilation system. Parameters related to environmental comfort and health, including cleanliness, moisture/humidity, and ventilation/IAQ, and the proportion of buildings reporting problems with vermin, mold, humidity and moisture, and ventilation were assessed. Results common to both the 2000 and 2005 BCS were also compared among schools participating in both surveys.

**Results:** From the 2005 BCS database, 3,315 buildings designated as instructional use were identified for analysis. The average building age was 50 years, 34% reported renovation or construction during the past year, and carpets were reported in 66% of classrooms. Seventy-two percent of buildings rated at least one system potentially related to IAQ as less than satisfactory, with 25% reporting this for more than five systems. The most frequently reported included windows (19.6%), roofing (19.5%), and air handling and ventilation (19.4%). The most frequently-reported IAQ-related problems were moisture/humidity (39% of buildings), ventilation problems (35% of buildings) and active roof leaks (33% of buildings). The most frequently reported ventilation problem was diesel intrusion (15% of buildings), and 36% of buildings reported not knowing whether the system was providing enough fresh air. Seventy-two percent of buildings reported their district uses an IAQ management program. Problems with vermin, mold, moisture/humidity and the ventilation system were cited less frequently among those reporting an IAQ program than those reporting no program. Of the 2,541 buildings participating in both the 2000 and 2005 BCS, the percent of buildings rating one or more systems as less than satisfactory increased from 44% to 74% from 2000 to 2005.

**Conclusion:** Based on this data, most school buildings have IAQ-related problems with individual building systems, and problems with roofing, moisture, and ventilation systems exist in many schools. However, most report that their district has an IAQ management program, and the

existence of such programs appears to be inversely related to having IAQ-related problems. Building ratings for the 2005 BCS were less favorable than for the 2000 BCS, possibly due to differences in reporting between the two surveys. This data comprises a sustainable source of ongoing information about school environmental conditions that will be linked with socio-demographic data and data on hospitalizations and emergency room visits for respiratory disease among school-age children in NYS.

#### ISEE-198

#### The Effect of Urban Fine Particles on Lipid Peroxidation of Schoolchildren in Korea

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**Objective:** In this study, we investigated the association between exposure to ambient particulate matters ( $PM_{10}$ ,  $PM_{2.5}$ , Number concentration) and oxidative stress to lipids, as indicated by urinary MDA (Malondialdehyde) concentration, in a group of schoolchildren.

**Methods:** The study group consisted of 32 children in a school in northern Seoul, Korea. On the first day, we collected personal information by measuring weight, height, body composition, etc. Parents were administered questionnaires to obtain medical history, including respiratory symptoms and disease, passive smoking exposure and house environment. Ambient particulate mass concentrations ( $PM_{10}$  and  $PM_{2.5}$ ) by low volume air sampler, model FH95, Thermo electron corp.) and number concentration (by water-base condensation particle counter, model 3781, TSI) were measured everyday. Daily ambient gas pollutant concentrations ( $O_3$ ,  $NO_2$ ,  $CO$ ,  $SO_2$ ) were obtained from the Korea Ministry of Environment and weather conditions including temperature and relative humidity were obtained from the Korea Meteorological Administration. Urine samples were collected for 10 students daily, and for 22 students weekly during the 25-day study period. The measurement of urinary MDA was carried out by the thiobarbituric acid (TBA) test. Specifically, when heated under acidic conditions, TBA reacts with urinary MDA derived from lipid oxidation leading to the formation of thiobarbituric acid reactive substances (TBARS) which can be measured by HPLC/FLD (Agilent, 1200). The creatinine level in the urine sample was measured with a HITACHI 7600 (HITACHI, Japan) using the Jaffe reaction. The urinary MDA concentration was adjusted to the urinary concentration of creatinine ( $\mu\text{mol MDA/grams creatinine}$ ) to control for the variability in urine dilution. The urinary MDA concentration range was  $0.922 \pm 0.501 \mu\text{mol MDA/grams creatinine}$ . The association of oxidative stress in children with ambient fine particulate ( $PM_{10}$ ,  $PM_{2.5}$ , Number concentration) concentration was analyzed using a linear mixed model in SAS. In the analyses, each day was weighted by the number of children exposed before that day.

**Results:** For the increase of  $PM_{10}$ ,  $PM_{2.5}$  mean concentration on the exposure day (Lag 0) and 4 day mean, we found a significant increase of the urinary MDA concentration ( $P < 0.05$ ). The 4 day mean after exposure to coarse was significantly associated with increase of urinary MDA concentration. For particle number concentration, the 2 day and 3 day after exposure and 4 day mean were significantly associated with urinary MDA concentration ( $P < 0.05$ ).

#### ISEE-520

#### Concentration of Organochlorine Pesticides in Blood, Tumor and Adipose Tissue and Breast Cancer Risk: An Indian Study

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**Background:** Breast cancer is the most common cancer diagnosed in women not only in United States, but also in developing countries. In India, the most frequently reported malignancies were breast (22.7%), uterine cervix (17.5%), gallbladder (6.4%), and ovary (5.8%). Known risk factors for this disease do not account for a significant proportion of the overall incidences. Environmental exposure of chemicals, may behave as xeno-estrogen, which is thought to be involved in hormone-dependent malignancies. Organochlorine pesticides may serve as cancer promoters in the same fashion as steroid hormones.

**Methods:** A hospital-based case-control study was carried out among women scheduled for excision biopsy (malignant and benign) of the breast. The biopsy tissues, tumor and surrounding adipose, from both groups of patients (70 each) were collected after surgery with consent. Blood samples of 50 disease-free, age-matched women from the same area were collected as controls. All the samples were extracted with n-hexane and analyzed on a gas-liquid chromatograph equipped with an electron capture detector for organochlorine pesticide residue levels.

**Results:** The  $\alpha$ ,  $\beta$ ,  $\gamma$  &  $\delta$  isomers of hexachlorocyclohexane (HCH), p,p'-dichlorodiphenyltrichloroethane (DDT), o,p'-DDT, p,p'-dichlorodiphenyl-dichloroethylene, and p,p'-dichlorodiphenyldichloroethane were frequently detected in all specimens. Blood levels of  $\beta$ ,  $\gamma$ ,  $\delta$  and total HCH were detected significantly higher in the malignant group when compared to the benign and control groups ( $P < 0.05$  each). However, adipose tissue levels of p, p-DDE and total DDT were also found to be significantly higher in malignant group as compared to benign ( $P < 0.05$  each). The distribution of known confounders of breast cancer such as age, body mass index, age at menarche and menopause, duration of breast feeding and family history related to breast disease was not statistically different among the three groups.

**Conclusion:** The findings suggest some association of organochlorine pesticides with breast disease. Investigation of environmental contributions to breast cancer risk offers the potential for understanding more about the etiology of this complex disease and may also provide opportunities for prevention of the most common cancer among women in India.

#### ISEE-523

#### A Case-Crossover Analysis Identifying the Vulnerable Populations for Mortality Associated with Temperature Exposure in California

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**Background:** The association between ambient temperature and mortality has been established in the literature, including our prior study in California. Here, we examined cause-specific mortality, age, race/ethnicity, gender, and education level to further identify vulnerable subgroups of ambient temperature exposure.

**Methods:** We obtained data from nine California counties from May to September 1999 to 2003 provided by the National Climatic Data Center (weather) and the California Department of Health Services (mortality). Using a time-stratified case-crossover analysis approach, we obtained county-specific estimates of mortality, which were combined using meta-analytic methods. A total of 248,019 deaths were included.

**Results:** Each 10 degree Fahrenheit increase in mean daily apparent temperature corresponded to a 2.6 percent (95% confidence interval (CI): 1.3, 3.9) increase for cardiovascular mortality, with the highest risk found for congestive heart failure (5.4%, 95%CI: -8.2, 21.1). Elevated risks were also found for persons at least 65 years of age (2.2%, 95%CI: 0.04, 4.0), infants one year of age and under (4.9%, 95%CI: -1.8, 11.6), and black racial/ethnic group (4.9%, 95%CI: 2.0, 7.9). No differences were found by gender or education level.

**Conclusion:** To prevent mortality associated with ambient temperature, persons with cardiovascular disease, the elderly, infants, and Blacks should be targeted.

#### ISEE-532

#### Associations Between Personal, Indoor, and Residential Outdoor Pollutant Concentrations: Implications for Exposure Assessment to Size Fractionated PM

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**Objective:** In this study we examined the role of organic and elemental carbon (OC and EC, respectively), particle number (PN), ozone ( $O_3$ ), nitrogen oxides (NO,  $NO_2$ , NOx), and other important pollutants of both indoor and outdoor origin as surrogates of personal size-fractionated  $PM_{2.5}$  ( $PM_{10}$ ,  $PM_{2.5}$ , and  $PM_{0.25}$ ).

**Methods:** Samples/data were collected at four retirement communities of the Los Angeles Basin during the Cardiovascular Health and Air Pollution Study (CHAPS), a multi-disciplinary project whose goals are to investigate the effects of micro-environmental exposures to PM on cardiovascular outcomes in elderly retirees affected by coronary heart disease. Three of these communities were in the San Gabriel Valley and the fourth in Riverside, CA. Two 6-week sampling campaigns were conducted at each location from 2005 to 2007 to characterize the seasonal variations in indoor/outdoor/personal relationships between  $PM_{2.5}$  and its components. Mix model regression analysis and Spearman's correlation coefficients (R) were calculated, and the following four models used to study the relationships between pollutants concentrations and size segregated PM levels:

- Associations between outdoor co-pollutants concentrations and outdoor size fractionated PM levels ("outdoor-outdoor associations").
- Associations between indoor co-pollutants concentrations and indoor size fractionated PM levels ("indoor-indoor associations").
- Associations between outdoor particle and gaseous species concentrations and personal exposure to size fractionated PM ("outdoor-personal associations").
- Associations between indoor particle and gaseous species concentrations and personal exposures to size fractionated PM ("indoor-personal associations").

Spearman's correlation coefficients (R) values calculated at the San Gabriel Valley and Riverside sites were compared against those obtained by Sarnat et al. in Baltimore (2001) and Boston (2005).

**Results:** At all studied locations, personal  $PM_{2.5}$  was well correlated with outdoor/ambient  $PM_{2.5}$ , both in the summer and in the winter. Moderately strong associations were observed at all sites between personal  $PM_{2.5}$  and  $NO_2$  (in both summer and winter), personal  $PM_{2.5}$  and  $O_3$  (only in the summer), and  $PM_{2.5}$  and CO (only in the winter). This suggests that changes over time for some gaseous pollutants measured at central or outdoor residential sites reflected corresponding changes in the personal  $PM_{2.5}$  exposures for the subjects studied during CHAPS, as well as the Baltimore and Boston studies. In the summertime, a considerable fraction of personal exposure to  $PM_{2.5}$  might be related to particles originating from photochemical activities, while in the wintertime personal  $PM_{2.5}$  levels are predominantly influenced by combustion processes. Results from all studies indicate that outdoor/ambient  $NO_2$  and  $O_3$  (in the summer) and outdoor/ambient CO and  $NO_2$  (in the winter) are more strongly associated with personal  $PM_{2.5}$  exposure, than with their respective exposures.

**Discussion:** It might be incorrect to assume that outdoor/ambient gases and  $PM_{2.5}$  measurements are consistent surrogates for  $PM_{2.5}$  exposures, because correlations between personal  $PM_{2.5}$  and outdoor/ambient CO,  $NO_2$ , NOx, and  $O_3$  vary by season and location. Previous studies showed that  $O_3$  and  $NO_2$  exposures can have adverse health effects and, thus,

have the potential to act as confounders of personal exposure to PM<sub>2.5</sub>. Results from time-series epidemiologic studies that include both gaseous and particulate pollutant concentrations in the models should be interpreted with caution.

#### ISEE-539

#### **Impact of Particulate Matter of Diameter Less Than 2.5 Microns (PM<sub>2.5</sub>) Over Daily Hospital Admissions on Children in Madrid, Spain (2003–2005)**

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**Background:** The latest WHO Air Quality Guidelines establish 10 µg/m<sup>3</sup> as the guideline value for annual mean particulate concentration of PM<sub>2.5</sub>. However, in large cities such as Madrid, the actual concentrations may be twice this value. Consequently, the existence of an association between PM<sub>2.5</sub> values and effects over morbidity and mortality is to be expected.

**Objective:** The aim of this study is to analyze and quantify the influence of PM<sub>2.5</sub> concentrations over daily morbidity on children less than ten years of age in Madrid.

**Methods:** The dependent variable was the daily number of emergency hospital admissions to the Hospital General Universitario Gregorio Marañón of Madrid from 2003 to 2005. All causes (ICD-IX: 1-799), excluding traumas, were analyzed for the following age groups: 0–10 years and 0–1 year. A longitudinal ecological time series study was performed using Poisson Regression Models, controlling for seasonality, trend, weekly days and autocorrelation between morbidity series. Flu epidemics, other air pollutants, noise and pollen concentrations were utilized as control variables.

**Results:** PM<sub>2.5</sub> was the only primary pollutant with statistically significant results in the models. The Relative Risk (RR) for an increase of 10 µg/m<sup>3</sup> in PM<sub>2.5</sub> concentrations was 1.03 CI 95% (1.00 1.05), for children less than 10 years old, and the RR for children less 1 year old was 1.03 CI 95% (1.00 1.06). The Attributable Risks (AR) were 2.7%, and 2.8% respectively. These values were slightly higher than previous results obtained for PM<sub>10</sub> concentrations used as the indicator.

**Conclusions:** PM<sub>2.5</sub> concentrations were an excellent indicator of the impact on health by the primary pollutants in Madrid. The results obtained show the need to implement maximum standards to reduce the concentrations of PM<sub>2.5</sub> in the atmosphere of large cities.

#### ISEE-541

#### **An Examination of Methods to Estimate Personal Exposures to Ambient PM<sub>2.5</sub> through Data Analysis**

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**Objectives:** Several new and recently developed methods of estimating personal exposures to ambient PM<sub>2.5</sub> (personal ambient PM<sub>2.5</sub>) were compared by data analysis, using data from an EPA study in Denver. The ongoing air pollution and health study has involved children with moderate to severe asthma that attend school at the site (National Jewish Medical & Research Center), monitored during the winter months each year since 1999. Data used for these analyses were obtained from a subset of these years.

**Methods:** One class of methods to estimate personal ambient PM<sub>2.5</sub> involves use of a component of ambient PM<sub>2.5</sub> to extrapolate estimates that are not commonly emitted from indoor sources, such as sulfate. Several variations of the extrapolation method were investigated. One

method used sulfate to extrapolate values, another used both sulfate and iron, and the last used sulfate and iron in addition to incorporating temperature (as a dichotomous variable) into the analysis. All of these methods corrected for infiltration differences between the component used for extrapolation (e.g., sulfate) and ambient PM<sub>2.5</sub> itself. Without making this correction, estimates of exposure are not properly scaled, which results in associated health effect estimates that are biased. Estimates obtained by extrapolation methods were compared with those acquired by positive matrix factorization (PMF), a method based on a different set of assumptions and processes for obtaining estimates. Initial comparisons between methods were based on scatterplots, Pearson correlations and summary statistics such as means and standard deviations. Differences between methods were further assessed by comparing slopes obtained from linear mixed-effect regression models of estimated personal ambient PM<sub>2.5</sub> on ambient PM<sub>2.5</sub>. These slopes were then used in regression calibration to adjust and compare associated health effect estimates, using forced expiratory volume in 1 second (FEV<sub>1</sub>) as the health indicator.

**Results:** The average ambient PM<sub>2.5</sub> concentration during the study period was 13 µg/m<sup>3</sup>. The extrapolation methods yielded estimated individual (subject-day) personal ambient PM<sub>2.5</sub> concentrations that were moderately correlated with those obtained from PMF ( $r = 0.51$  to  $0.61$ ). The average estimated personal ambient PM<sub>2.5</sub> concentration based on PMF was 7.55 µg/m<sup>3</sup> ( $SD = 3.61$ , Min = 1.33, Max = 25.61), slightly higher than the mean value of 6.60 µg/m<sup>3</sup> for the extrapolation method based on sulfate and iron ( $SD = 3.30$ , Min = 0.23, Max = 25.11). The slopes for the regression of estimated personal ambient PM<sub>2.5</sub> on ambient PM<sub>2.5</sub> ranged from 0.46 to 0.51 for all methods; adjusted estimates of average decrease in FEV<sub>1</sub> per 10 µg/m<sup>3</sup> increase in exposure to ambient PM<sub>2.5</sub> ranged from 1.95 to 2.17%. The unadjusted estimate, obtained by simply regressing FEV<sub>1</sub> on ambient PM<sub>2.5</sub> measured from a fixed outdoor monitor, was 1.00%.

**Conclusions:** The results suggest that although different methods of estimating personal ambient PM<sub>2.5</sub> may not be consistent in terms of estimating individual (subject-day) concentrations of personal ambient PM<sub>2.5</sub>, they lead to health effect estimates that do not differ greatly when used in conjunction with regression calibration. However, the unadjusted estimate is substantially different and is biased when the magnitude of health effects of direct exposure to ambient PM<sub>2.5</sub> is of interest.

#### ISEE-543

#### **SENTIERI—Mortality in Italian Contaminated Sites**

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**Background:** Human health is intimately connected to the surrounding environment but it is usually very difficult to identify cause-and-effect relationships. However, linking environmental pollution to human health helps to redefine priorities (<http://www.eea.europa.eu/themes/human>). Soil contamination requiring clean up is present at approximately 250,000 sites in the European Environment Agency (EEA) member countries, and the number is estimated to grow by 50% by 2025 (<http://themes.eea.europa.eu/IMS/IMS/ISpecs/ISpecification20041007131746/IAssessment1152619898983>). Several thousands of these sites are located in Italy, where 52 qualify for remediation (Ministerial Decrees n. 486, 2001 and n. 308, 2006) because of contamination documented in qualitative and/or quantitative terms and of potential health impact.

**Objective:** The SENTIERI project, funded by the Ministry of Health, aims at illustrating sources of environmental pollution in Italian contaminated sites and at describing health status of resident populations using mortality data.

**Methods:** Forty four sites were selected for analyses (295 municipalities, 5,534,492 inhabitants, or about 10% of the total Italian population at 2001 census); 21 sites are located in Northern Italy, 8 in Central Italy and 15 in

Southern Italy. The sites are classified for the presence of one or more of the following *Exposures* asbestos/other mineral fibers (A), dockyard (D), production/use of chemical substances (C), production/use of a single chemical substance ( $C_s$ ), petrochemical plant (P), refinery (R), thermoelectric power plant (TE), steel industry (S), mines/quarries (MQ), landfill (L), incinerator (I), environmental radioactivity (Rad). A total of 57 groups of causes of death (ICD IX), were selected for analysis. For males and females a descriptive analysis (1995–2002) was carried out calculating SMR (Standardised Mortality Ratio) using the local population for comparison.

**Results:** Preliminary results are available for three sites. In the site named Laguna of Grado and Marano (D,  $C_s$ -cellulose production), males show an increased mortality for esophageal cancer (SMR 1.77; 95% Confidence Interval-95%CI 1.01–2.87; Obs-Observed 16), lung cancer (SMR 1.35; 95%CI 1.10–1.64; Obs 102) and acute myocardial infarction (SMR 1.31; 95%CI 1.03–1.64; Obs 75); for females, mortality is above expected for ovarian cancer (SMR 2.00; 95%CI 1.16–3.20; Obs 17). In Cengio and Saliceto ( $C_s$ -dye industry, landfill) stomach cancer is increased among males (SMR 1.41; 95%CI 1.10–1.79; Obs 69) and females (SMR 1.64; 95%CI 1.22–2.15; 52 Obs); females show a higher than expected mortality for diabetes (SMR 1.29; 95%CI 1.04–1.59) and dementia (SMR 1.34; 95%CI 1.08–1.64; 93 Obs). In Piombino (D, C, TE, S, L-landfills of industrial hazardous waste), observed mortality is above expected among males for pneumoconiosis (SMR 5.41; 95%CI 3.92–7.29; Obs 43) and among females for infectious diseases (SMR 1.80; 95%CI 1.10–2.77; 20 Obs) and kidney cancer (SMR 1.93; 95%CI 1.11–3.14; 16 Obs).

**Discussion:** The SENTIERI project is the first attempt to describe mortality in all contaminated sites located in one country adopting the *a priori* definition of a contaminated site. For a selection of causes/sites subsequent analyses include: a) the computation of SMR adjusted for an *ad hoc* built deprivation index b) bayesian analysis c) cluster analysis d) time trend analysis for the period 1970–2002.

#### ISEE-548

#### A Follow-Up of Respiratory Health Among Residents Living Near Ground Zero

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**Objective:** This study investigated whether residents living near the World Trade Center (WTC) continued to experience respiratory problems ~2 and ~4 years after September 11, 2001 (9/11), and what factors contributed to symptom persistence.

**Methods:** Among participants we originally surveyed after 9/11, 136 and 69 affected area residents (i.e., lived < 1 mile from the WTC) responded ~2 and ~4 years after 9/11, respectively. The follow-up surveys asked about upper and lower respiratory symptoms, symptom severity, unplanned medical visits, family history of asthma, psychological stress, access to care, and indoor environmental characteristics. At the final follow-up, we also measured a biomarker for airway inflammation, exhaled nitric oxide (eNO). Survey data from affected area residents at follow-up were compared with affected and control area data collected in the original survey. We evaluated the relationship between eNO and self-reported respiratory symptom data to validate self-reported information.

**Results:** We observed general declines in symptom rates, new lower respiratory diagnoses, unplanned medical visits, and steroid medication use over time. However, compared to the original rate in the control area (20.3%), the prevalence of lower respiratory symptoms in the affected area at both follow-up periods remained high (47.8% at both 2 and 4 years). The most common lower respiratory symptoms at follow-up, as in the original survey, were cough and shortness of breath. Stress, dust/odors, and moisture were significantly associated with persistent symptoms at follow-up. Preliminary analyses showed that after controlling

for age, gender, race/ethnicity, and asthma medication use, eNO level at follow-up was correlated with shortness of breath and chest tightness, but was not significantly associated with other lower respiratory symptoms (cough or wheeze).

**Conclusion:** We conclude that despite a general decline in lower respiratory disease, symptom rates in the affected area remained high 2 and even 4 years after 9/11 compared to original rates in the control area. Home conditions and psychological stress may be contributing to the persistence of symptoms in this population. Exhaled nitric oxide level may be an appropriate predictor of some lower respiratory symptoms, but in this study the associations were likely confounded by unmeasured factors.

#### ISEE-550

#### Study of the Current Status and Influence Factors of Indoor Air Pollution in Xi'an City

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**Objective:** To learn about the state of indoor air pollution in newly renovated apartments in Xi'an city, and to explore the relationship among the major pollutants and the relationship between the pollutants and the differences of seasons.

**Methods:** From January 15th, 2006 to May 1st, 2007, we randomly selected 138 newly renovated (3 months or less) apartments in the urban area of Xi'an city, tested their indoor (including bedrooms, living room, dining room, kitchen, bathrooms, study, a total of 597) content of formaldehyde, total volatile organic compounds (TVOC), ammonia, benzene, toluene and xylene.

**Results:** Among all of the pollutants detected, total volatile organic compounds (TVOC) and formaldehyde own the highest exceeding rates, respectively 69.8% and 60.8%. They are followed by ammonia, whose exceeding rate is 13.2%, and xylene, which has the highest exceeding rate among the benzene compounds, 8.7 percent. We did comparative analysis of the concentration in different types of rooms for the pollutants which are among the top four in exceeding rate ranks, and found that only for formaldehyde is there a significant difference in statistics ( $P < 0.05 >$ ) in the concentration among the living room, the bedroom and the study. Total volatile organic compounds (TVOC), formaldehyde, ammonia, and xylene have the relativity between the concentration and the time they were tested.

**Conclusion:** For the newly renovated apartments, total volatile organic compounds (TVOC) and formaldehyde are the most important pollutants. The concentration of formaldehyde in the living room is significantly higher than that in other types of rooms. In summer indoor pollutant concentration is at its fastigium; we should pay attention to ventilation and take other measures to prevent pollutants from damaging the human beings.

#### ISEE-552

#### Exposure Assessment of Children to Local Traffic-generated Air Pollution in Sao Paulo, Brazil

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**Background:** Sao Paulo is the largest city in Brazil and South America. It has almost 11 million inhabitants, 25% of the national fleet with around 2.5 millions of vehicles, and a unique fleet composition with about 16% vehicles powered by ethanol. Little is known at a local scale about the impact of traffic generated air pollutants on residents in the Metropolitan Region of Sao Paulo.

**Objective:** The aim of this study is to assess the exposure of children ages 0–18 to local traffic-generated pollutants (CO, NO<sub>x</sub> and PM<sub>10</sub>) in the area known as Expanded Center of Sao Paulo, where the highest level of traffic in the city of Sao Paulo occurred.

**Methods:** Detailed traffic counts by categories were measured on 32 roads. The traffic measurement data (provided by the CET/SP-Traffic Engineering Company of São Paulo) and a georeferenced street database were used to construct a fleet database on freeways and major arterials. The CALINE4 model, developed by U.S. California Department of Transportation, was used to estimate traffic dispersion from line sources in 2005. Emission factors by vehicle types were obtained from CETESB (Environmental Technology and Cleanup Agency of São Paulo State). Meteorological data were obtained from 4 stations in the study area. Mixing height information was obtained from B-RAMS (Brazilian Regional Atmospheric Modeling System) model output by season and hour. Air quality measurements at limited monitoring stations were used to determine the background concentrations of target pollutants and validate the model. CO, NO<sub>x</sub> and PM<sub>10</sub> concentrations from local traffic emissions were modeled for children in 2503 census districts based on 2000 Census data from IBGE (Brazilian Institute of Geography and Statistics).

**Results:** Preliminary results showed significant spatial variations of traffic activities in the study region. The average total vehicle count in peak hours was 6339 vehicles/hour, with a standard deviation of 3631 vehicles/hour. On average, the fleet had 90.6% light-duty vehicles (LDVs) and 9.4% heavy-duty vehicles (HDVs). The spatial distribution of HDVs was more heterogeneous than that of LDVs. HDVs had 60.3% buses, 34.1% trucks and 5.6% vans. LDVs had 71.5% gasoline powered vehicles, 13.1% ethanol powered vehicles, and 11.9% motorcycles and 3.5% hybrid vehicles that may be powered by either gasoline or ethanol.

**Conclusion:** The highly spatial variation of traffic activities will significantly affect levels of traffic generated air pollutants on a local scale. The results obtained from this study will be used to support an epidemiological study that examines the impact of traffic related air pollutants to childhood asthma.

#### ISEE-554

#### The Effect of Heatwaves on Mental Health in a Temperate Australian City

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**Background:** For physiological and behavioural reasons, persons with mental illnesses often experience poorer overall health than the general population and as such may be vulnerable to the effects of climate variation. Psychotropic medications that interfere with thermoregulation can contribute to susceptibility during periods of extreme heat. However, few studies have characterized those specific mental disorders that may be exacerbated by high ambient temperatures. With mental health placing an increasing burden on the public health system, understanding the epidemiology of heat-related psychiatric illness will assist in identifying populations at risk as global warming ensues.

**Objective:** To identify mental, behavioural and cognitive disorders which may be triggered or exacerbated during heatwaves, predisposing individuals to heat-related morbidity and mortality in an Australian temperate climatic region, and to provide policy suggestions to relevant government organizations.

**Methods:** Using health outcome data from Adelaide, South Australia for the period 1 July 1993 to 30 June 2006, the effect of heatwaves on daily counts of hospital admissions and mortalities attributed to mental, behavioural and cognitive disorders (MBDs) was estimated. As well as all mental and behavioural disorders (MBDs) eleven sub classifications in this category (ICD-10-AM F00-F99) were investigated, together with Alzheimer's disease (G30-G30.9), senile degeneration of the brain (G31.1), and senility (R54). Meteorological data were obtained from the Australian Bureau of Meteorology. Heatwaves were defined as being three or more consecutive days when daily maximum temperatures reached or

exceeded 35°C. Conditional fixed effects Poisson regression models controlling for season and long term trend were used to quantify the association between health outcomes and heatwaves, with the referent period being all non-heatwave days during the warm season. A goodness of fit test was applied to each model and if significant overdispersion was detected, negative binomial maximum-likelihood regression models were used. Threshold temperatures in the relationship between daily temperature and MBD hospital admissions were determined using a nonlinear least-squares estimation (hockey-stick method).

**Results:** Over the study period there were 31 heatwaves ranging in duration from three to eight days with the highest recorded maximum temperature being 44.3°C during an eight day heatwave in 2004. Above a threshold temperature of 26.7°C, a positive association between maximum temperature and hospital admissions for MBDs was observed. Compared to non-heatwave periods, daily hospital admissions for MBDs were increased by 7.3% during heatwaves. Specific disorders for which admissions were increased included: organic, including symptomatic mental disorders (IRR 1.21, 1.09–1.35); dementia (IRR 1.17, 1.02–1.36); mood (affective) disorders (IRR 1.09, 1.00–1.19); neurotic, stress related and somatoform disorders (IRR 1.10, 1.02–1.18); disorders of psychological development (IRR 1.64, 1.09–2.48); and senility (IRR 2.37, 1.20–4.67). Mortalities attributed to MBDs were increased during heatwaves in the 65–74 year age group and in persons with schizophrenia, schizotypal and delusional disorders. Dementia deaths were increased in those aged up to 65 years.

**Conclusion:** Our results suggest certain psychiatric disorders may be heat-sensitive and that higher temperatures due to climate change pose a salient risk to the health and wellbeing of the mentally ill in Australia.

#### ISEE-555

#### Modeling Air Pollution of Vehicular Traffic in Szeged, Southern Hungary

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**Background:** European Union (EU) urban areas host 80% of the population and generate 75 to 85% of gross national product. They play an essential role in the vitality and competitiveness of Europe. However, this vitality is today endangered by the impact of non-sustainable urban means of transport. Private car use generates pollution, high energy consumption, noise, congestion and accidents. Reducing emissions, improving air quality, reducing accidents and congestion, reducing social deprivation, and thus increasing the quality of life in urban areas, requires modal shift from private transport to public and sustainable transport.

**Objective:** The aim of the study is to analyse how air pollution of vehicular traffic changed on the main roads of the Szeged regions between 1995–2007.

**Methods:** The ambient air quality effects of the traffic emissions were evaluated using the CALINE4 dispersion model. CALINE4 is a Gaussian dispersion model specifically designed to evaluate air quality impacts of roadway projects. Each roadway link is treated as a separate emission source producing a plume of pollutants, which disperses downwind. Pollutant concentrations at any specific location are calculated using the total contribution from the overlapping pollution plumes originating from the sequence of roadway links. In CALINE4, a specific computational scheme called the Discrete Parcel Method is used to model NO<sub>2</sub> concentrations. A simplified set of controlling reactions is assumed. On the other hand, CO is considered as inert gaseous component.

**Results:** Annual mean concentrations, as means of all the receptors for both CO and NO<sub>2</sub> on the major roads of the Szeged region modelled in one meter height, show clear increasing trends. Annual mean CO and NO<sub>2</sub> concentrations on some major roads of the Szeged region, considered in the function of the receptors, indicate higher values in the downtown and lower ones towards the outskirts. Furthermore, they show slight (CO) and

definite ( $\text{NO}_2$ ) increasing trends. Annual mean CO and  $\text{NO}_2$  concentrations on the major roads of the Szeged region are indicated using CALINE4 model for each year between 1995–2007. However, CO load for the starting year (1995) and years 2006 and 2007 are only analysed. The annual mean concentrations clearly indicate the increase of CO levels and a much more definite increase of  $\text{NO}_2$  concentrations from the beginning by the end of the period examined. The difference of the concentrations is especially striking between years 2006 and 2007. This points to the highly increased traffic through Szeged from Romania and Bulgaria after they entered the European Union on January 1, 2007.

**Conclusions:** Vehicular traffic of Szeged is permanently increasing. However, in year 2007 an especially striking increase of vehicular traffic was experienced. Due to the EU membership of Romania and Bulgaria (January 1, 2007) the number of trucks and lorries going through Szeged from these new EU countries quadrupled in 2007 compared to that in 2006. This increased traffic means a remarkable load of the road no. E43. As a result, remarkably higher vehicle originated air pollution can be experienced, as is clearly indicated by CALINE4 dispersion model.

#### ISEE-557

#### The Role of Environmental and Genetic Host Factors in Cervical Cancer Development Among Women from Rio De Janeiro, Brazil

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**Background:** High-risk human papillomavirus (HR-HPV) is a necessary but not a sufficient event in the development of cervical cancer, and the host and environmental factors can interact, enabling the onset of carcinogenesis. The p53 gene polymorphism, which either encodes a proline or an arginine amino acid residue at codon 72, has been reported as a risk factor for this tumor.

**Objective:** This study evaluated the prevalence of p53 polymorphisms at codon 72 and their association with environmental risk factors in a sample of women requiring health care in an oncological reference center in Rio de Janeiro, Brazil.

**Methods:** A cross-sectional study was carried out with 304 women with histological diagnosis of negative, pre-cancerous and cancerous lesions ascertained between October 2004 and May 2006. Antecedents of exposure to possible environmental risk factors were ascertained through an interview-administered questionnaire, and whenever indicated, colposcopy tests and lesion excisions were carried out. Genomic DNA was extracted from leukocytes of peripheral blood, and genotyping of p53 polymorphism was conducted using polymerase chain reaction and restriction fragment-length polymorphism methods. Crude and adjusted odds ratio (OR), and their 95% confidence intervals, were ascertained for selected risk factors and allelic groups among Normal, Low-SIL, and High-SIL/Cancer strata using logistic regression analysis.

**Results:** The observed p53 polymorphisms distribution in this population was 64(21.1%) Arg/Arg, 55(18.1%)Pro/Pro, and 185(60.9%)Arg/Pro. Women who were heterozygous (Arg/Pro) showed an independent risk for cervical HSIL/Cancer (adjusted OR: 1.92, 95%CI: 1.03–1.59, controlling by age, ethnicity and age at menarche) when compared to Pro allelic homozygous cases. Age at sexual onset up to 16 years old (adjusted OR:1.97, 95%CI:1.18–3.30), current smoking (adjusted OR:2.32, 95%CI:1.31–4.13), lifelong 3–4 sexual partners (adjusted OR:2.38, 95%CI:1.32–4.28), and smoking over 10 years (adjusted OR:2.52, 95%CI:1.042–6.09), were found as independent risk factors to cervical HSIL/Cancer.

**Conclusions:** Women showing p53arg/pro72 profile have shown a higher risk of HSIL/cancer development when compared to p53/pro72 in the studied sample after control for selected confounders. Early sexual onset, current and past tobacco smoking and multiple sexual partners were independent risk factors to pre-cancer and cancer development in this study.

#### ISEE-558

#### Selenium and Lipids in Umbilical Cord Serum

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**Background:** Selenium is an essential element that acts in antioxidant reactions, thyroid metabolism, and immune function. To promote health, selenium levels need to be maintained within a narrow range; either deficiency or excess can result in adverse health effects. The US population is generally selenium-replete. Among US adults higher selenium levels have been associated with higher lipid levels. No information is available on the relationship of selenium levels with lipid levels in the fetus and child.

**Objective:** Our objective was to examine the relationship of umbilical cord serum selenium and lipid levels.

**Methods:** The Baltimore THREE Study is a cross-sectional study which collected umbilical cord blood, maternal and infant medical record data, and census tract data for births occurring within a 6-month period in 2004–5 at the Johns Hopkins Hospital in Baltimore, Maryland. We used multivariable regression analyses to evaluate the association of quartiles of umbilical cord serum selenium levels with umbilical cord serum triglyceride, total cholesterol, and total lipid levels among 285 births. Multivariable models were adjusted for maternal age, maternal race, infant gestational age, maternal smoking, maternal prepregnancy body mass index, maternal parity, chronic or pregnancy-related maternal hypertension, maternal chronic or pregnancy-related diabetes, and median household income at the neighborhood-level. For sensitivity analysis and to assess potential confounding by gestational age, we also conducted our analyses excluding preterm births.

**Results:** Mean umbilical cord selenium levels were 70.1  $\mu\text{g/L}$  (95% confidence interval: 68.6, 71.5). The mean umbilical cord levels of total cholesterol and total lipids were 67.3 mg/dL (64.9, 69.7) and 253.5 mg/dL (247.0, 260.1), respectively. Triglyceride levels were right-skewed and log-transformed for analyses. The geometric mean of triglyceride levels were 34.9 mg/dL (33.2, 36.7). Participants with the highest quartile of selenium exposure had elevated triglyceride, cholesterol and total lipid levels compared to participants in the lowest quartile. There was a 33% increase (95% confidence interval: 17%, 52%) in triglyceride levels among those in the fourth quartile of selenium compared to those in the first quartile. Comparing those in the fourth to the first quartile of serum selenium levels, total cholesterol and total lipid levels were increased 5.48 ( $-1.34$ , 12.30) mg/dL and 25.2 mg/dL (6.5, 43.9), respectively. Results were similar when limited to full-term infants.

**Conclusions:** Our cord serum selenium levels are consistent with prior reports: they are higher than cord selenium values reported outside the US. Our cholesterol values are also similar to prior reports among newborns; for triglycerides, our levels are within the lower end of a wide range of reported averages. We found a positive relationship of umbilical cord serum selenium levels with umbilical cord serum triglycerides, total cholesterol, and total lipid levels. The health implications of this variation in newborn lipid levels are unclear. To better understand the long-term consequences of this relationship, prospective studies evaluating the temporality of the association and the impact on maternal and infant health are needed.

#### ISEE-559

#### Inter- and Intra-Rater Reliability of Occupational Exposure to Nickel and Cobalt as Assessed Retrospectively

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**Background:** Retrospective assessment of occupational exposures for the study of birth defects in offspring presents many challenges with the validity and reliability of the assessment dependent on the method employed.

**Objective:** Within the Baltimore-Washington Infant Study (BWIS), a large population-based case-control study of cardiovascular malformations, we evaluated the inter- and intra-rater reliability associated with the retrospective assessment of parental occupational exposure to nickel and cobalt.

**Methods:** All case and control jobs ( $n = 2724$ ) were first screened by five professionals with expertise in retrospective assessment of occupational exposures for epidemiologic studies. Jobs for which at least one expert indicated the potential for exposure were further assessed by two industrial hygienists (IHs). The assessment included familiarity with the job, probability of direct and indirect exposure, and frequency, duration, and intensity of exposure. Each assessment was repeated by the same two IHs, three months later. A consensus panel of three IHs (including the two original IHs) reviewed all jobs for which disagreement existed on exposure parameters, as well as, those jobs for which one or both IHs had no familiarity. Percent agreement and Kappa statistic ( $K$ ) were used to assess reliability between and within IHs.  $K$  values of  $<0.40$ ,  $0.40-0.75$ ,  $>0.75$  are traditionally interpreted to represent poor, fair to good, and excellent reliability, respectively.

**Results:** The screening resulted in 468 and 496 jobs being evaluated by the IHs for potential cobalt and nickel exposure, respectively. Among jobs with which IHs were familiar, IH1 indicated that 55 jobs had potential cobalt exposure and 55 nickel exposure, while IH2 indicated 83 had potential cobalt exposure and 68 nickel exposure. Inter-rater reliability was poor for presence of cobalt exposure ( $K = 0.21$ ) and nickel ( $K = 0.27$ ) with IHs agreeing on exposure status for 80% (349/437) and 84% ( $n = 328/389$ ) of jobs, respectively. Among jobs for which both IHs indicated exposure, inter-rater reliability was excellent for probability of direct exposure ( $K = 0.79$  and  $0.83$ ) and good for indirect exposure ( $K = 0.61$  and  $0.73$ ) for cobalt and nickel, respectively. Inter-rater reliability was excellent for frequency, duration, and intensity of both direct cobalt and nickel exposures ( $K > 0.85$ ). Intra-rater agreement for the presence of cobalt exposure was poor ( $K = 0.35$ ) and good to excellent ( $K = 0.54-0.92$ ) for probability, frequency, duration and intensity of direct and indirect exposure. Intra-rater reliability for the presence of nickel exposure was fair ( $K = 0.42$ ) and fair to excellent ( $K = 0.43-0.88$ ) for probability, frequency, duration, and intensity of exposure. The consensus panel reviewed 140 and 185 jobs for cobalt and nickel exposure, respectively. Among the jobs assessed for cobalt, the consensus panel concluded that 6% had potential exposure to cobalt compared to 42% by IH1 and 59% by IH2. Among the jobs assessed for nickel, the panel concluded 22% had potential exposure compared to 30% by IH1 and 37% by IH2.

**Conclusions:** While inter- and intra-rater reliability varied by parameter assessed, exposure was overestimated when assessed by individual IHs as compared to the consensus panel. Further attempts need to be made to improve retrospective exposure assessment methods through the use of expert panels and standardization of methodology employed by individual hygienists.

#### ISEE-564

#### Prenatal Organochlorine Exposure and ADHD-like Behaviors in School-Aged Children Using a Psychometric Intelligence Test

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Laboratory, Brigham and Women's Hospital, Harvard Medical School & Harvard School of Public Health, Boston, MA.

**Objective:** Organochlorines are environmentally persistent compounds that cross the placenta during pregnancy and have been shown to impact neurodevelopment in early childhood. We previously reported an association between low-level cord serum PCBs and ADHD-like behaviors using a behavioral rating scale and a continuous performance test (CPT).

**Methods:** We assessed whether an association with organochlorines, including polychlorinated biphenyls (PCBs) and p,p'-dichlorodiphenyl dichloroethene (DDE), could be demonstrated for specific components of the Wechsler Intelligence Scale for Children-Third Edition (WISC-III), for which children with ADHD were found to score lowest, including Processing Speed (PS) and Freedom From Distractibility (FD). Each of these indices are age-standardized components of the WISC and integrate performance on 2 different WISC subtests. Participants came from a prospective cohort study of children born between 1993 and 1998 to mothers residing near a PCB-contaminated harbor and Superfund site in New Bedford, Massachusetts. Median (and range) cord serum levels for the sum of four prevalent PCB congeners (118, 138, 153, 180), the sum of mono-ortho dioxin-like (toxic equivalency factor weighted) congeners and DDE were 0.19 (0.01–4.41) ng/g serum, 4.45 (0–151.49) picograms/g lipid, and 0.31 (0–14.93) ng/g serum, respectively.

**Results:** 585 children were administered the WISC-III at 7 to 11 years of age (median = 8 years). A modest and non-statistically significant decline in FD (median = 98, range = 50–134) was detected for the highest vs. lowest quartile of prenatal DDE levels (difference in score =  $-1.7$  (95% confidence limits (CL):  $-4.9$ ,  $1.6$ )), adjusting for child's age and gender, and maternal age at the child's birth, intelligence and education at the time of exam, and smoking during pregnancy; a monotonic dose-response association was not observed across quartiles of exposure. Decline at high DDE levels was also observed for Digit Span (median = 10, range = 1–20), a subtest of FD (difference in score =  $-0.4$  (95% CL:  $-1.0$ ,  $0.2$ ) for the highest vs. lowest DDE quartile), but was not observed for Arithmetic, the other subtest of FD. There was no evidence for an association between PCBs and FD or either FD subtest (Digit Span or Arithmetic) in these data. In addition, PS was not associated with prenatal PCB or DDE cord serum levels.

**Conclusions:** These results do not support an association between prenatal PCB exposure and FD or PS indices of the WISC-III, poor performance on which is associated with clinical ADHD. There was weak evidence for decrements in FD, and the Digit Span subtest of this index, at higher levels of DDE, indicating a possible threshold effect for this contaminant. Low levels of organochlorines in this cohort may have limited our power to detect associations. However, we previously observed associations between low-level PCBs and ADHD-like behaviors using a behavioral rating scale for teachers, which assesses school behavior, and a CPT. This suggests that the WISC-III components assessed here may not be sufficiently sensitive to detect an effect with low-level exposure or that performance on these formal psychometric measures reflect different skills than those assessed with school behavioral ratings and CPT testing.

#### ISEE-565

#### Winter Mortality Modifies the Heat-Mortality Association the Following Summer

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**Background:** Warm temperature and heat episodes have been shown to have serious effects on public health, especially in groups of susceptible individuals. The majority of excess deaths occur among the older population. Excess mortality may be followed by lower mortality than expected, referred to as harvesting and mortality displacement. The extent of harvesting following heat exposure is inconsistent and varies between

heat waves and time periods studied. We hypothesize that the extent of harvesting as well as the heat effect depend on the cause-specific and total mortality in the previous winter, which when low leaves a greater pool of susceptible individuals.

**Methods:** We studied the association of warm temperatures and total mortality (excl. external causes) in greater Stockholm 1990–2002. Mortality data collected from the Environmental Administration and the Swedish National Board of Health and Welfare was stratified into a summer period of June–August and a winter period of October–April. Thereafter, we established general additive models for the summer data assuming a Poisson distribution of daily mortality rates and incorporated daily mean temperature and smooth functions to control for confounders such as calendar variables, air pollution and relative humidity. Further, we incorporated indicators of total, respiratory, cardiovascular and influenza mortality of the winter period as effect modifiers in the summer model. We also studied the temperature effects using distributed lags in groups of summers defined by the indicators for winter mortality.

**Results:** A high rate of respiratory as well as cardiovascular mortality in winter reduces the heat effect the following summer, and influenza mortality in winter showed a clear tendency to do so as well. The distributed lags for cardiovascular and respiratory mortality were similar, but differed to some extent after winters with high and low mortality. Harvesting seemed to confound the lagged effects more when winter mortality was low, while high mortality in winter was associated with a second wave of mortality 1 or 2 weeks after heat exposure. There was also a significant increase in the heat effect (temperature coefficients) over the study period.

**Conclusions:** To our knowledge, this is the first study that shows the dynamics between winter and summer mortality, and examines differences in the extent of harvesting and second wave effects depending on the size of the pool of fragile individuals. Moreover, we speculate whether the observed trend in the heat effect could be related to the growing proportion of people vaccinated for influenza during the study period. We found that influenza mortality is rather highly correlated with respiratory mortality and also correlated with cardiovascular mortality. This paper explains some of the causes of the variations between years in heat effect and harvesting, but also highlights the lack of knowledge of the mortality dynamics of winter and summer mortality which have implication far beyond the scope of heat effect studies.

#### ISEE-568

#### Perception of Risk to Communities in the Oil-Drilling Areas of Northern Chiapas, Mexico

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**Objectives:** To evaluate the perception of risk to society with respect to threats to health and the environment derived from the drilling, transportation and transformation processes undertaken by the petroleum industry in northern Chiapas.

**Materials and Methods:** We studied the perception of risk to communities in the municipality of Reforma, Chiapas, considering their exposure to threats related to the oil drilling, transportation and transformation processes in that area. Risk perception was assessed using a Likert-type scale with 13 items specifically designed for this purpose. The items were determined by considering threats to health, the environment and property related to the petrochemical industry: existence of oil wells and oil pipelines, highway transportation of hydrocarbons, water contamination by petroleum, air pollution by the oil wells, soil pollution by the industry, contamination of crops from the industry's activities, local accidents due to the industry, illegal tapping of pipelines,

using water contaminated by petrochemicals, using contaminated water for animal consumption, using contaminated water to bathe and, finally, wastes generated by the industry. Problems for the community which affect health and the environment were determined by a survey with 14 items with open and closed questions, which preceded the application of scales. The locations to be included in the study were determined and selected by locating those communities found within one kilometer of the petrochemical industry sites. A random sample of 192 households, (124) in urban areas and (68) in rural areas, was taken. A descriptive statistic analysis was conducted on this sample.

**Results:** In rural areas, the problems affecting health and the environment, as referred by the population, and in order of importance are the following: air pollution, proximity to oil wells and pipelines and water contamination. The most frequent health problems were colds and respiratory ailments, skin diseases, headaches and eye irritations. In urban areas, the main problems affecting health and the environment were air pollution, water contamination and garbage. The most frequent health problems reported were colds and respiratory ailments, skin problems and eye irritations. The effects of environmental pollution in both rural and urban areas, as perceived by their population, were sick plant life, death of animals and contaminated food.

**Conclusions:** The effects on the inhabitants' health coincide with the threats of air and water pollution present in these communities. People perceive themselves as being highly vulnerable to the existing risks and having little control over them and limited information in order to protect themselves and respond to these threats.

#### ISEE-569

#### Show me the Data: The Regulatory Needs for Better Data on Hand-to-Mouth Transfer of Lead

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**Background and Discussion:** Incidental ingestion of lead as a result of hand-to-mouth activities has been recognized as an important exposure pathway for both adults and children. However, there is little scientific guidance on how to accurately assess lead exposure via the hand-to-mouth pathway. In response to a request from a group of manufacturers and sellers of fishing tackle products, the Office of Environmental Health Hazard Assessment (OEHHA) has developed a guideline on determining the hand-to-mouth transfer of lead from fishing tackle products during recreational fishing. The guideline provides a framework—a series of equations and default parameters—for calculating lead intake as a consequence of handling the product. It can be used to calculate lead exposure from the use of fishing tackle via the hand-to-mouth pathway for purposes of compliance with California's Safe Drinking Water and Toxic Enforcement Act of 1986 (commonly known as Proposition 65). Lead is listed under Proposition 65 as causing developmental and male and female reproductive toxicity, and cancer. Lead may be present in fishing tackle products made of metal alloys or polyvinyl chloride plastics, or coated with lead-containing paints. OEHHA's guideline takes into account lead transfer from fishing tackle products as a result of both direct (e.g., nail-biting) and indirect (e.g., snacking using hands) hand-to-mouth activities that would be expected to occur during recreational fishing. Lead intake from hand-to-mouth activities is a function of: the lead loading on the hand; the surface area of the hand in contact with the mouth; the hand-to-mouth transfer factor for lead; the hand-to-mouth contact frequency; and duration of the fishing event. The guideline provides default values for several parameters necessary for calculating lead exposure from hand-to-mouth activities from fishing tackle. Data to inform the selection of these values were sparse. For example, no data on the amount of lead transferred from the hand to the mouth as a result of handling fishing tackle products, or any other type of objects, were identified in the scientific literature. Exposure scenarios were presented to estimate indirect

hand-to-mouth contact frequency due to lack of data. In selecting default values for the lead hand-to-mouth transfer factor, as well as other parameters, relevant data were evaluated and utilized, together with professional judgment. This guideline is helpful in assisting interested parties (e.g., attorneys and consultants from defendants and plaintiffs involved in Proposition 65 lawsuits) who may not be trained in exposure science. However, the limitation of this guideline is the lack of robust scientific data to inform the values selected for the lead transfer factor and adult hand-to-mouth contact frequency. These variables are important to quantify the average hand-to-mouth exposure of lead and other contaminants from the use of consumer products or from occupational exposure. More rigorous research is needed to better characterize hand-to-mouth exposure for adults.

#### ISEE-570

#### Factors Influencing the Spatial Associations Between Nitrogen Dioxide and Other Ambient Airborne Pollutants Across Four Seasons in Windsor, Ontario

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**Background:** Ambient levels of nitrogen dioxide ( $\text{NO}_2$ ) have been associated with adverse outcomes such as hospital admissions and non-accidental mortality. However, it is unclear whether  $\text{NO}_2$  may be acting as a surrogate for another airborne pollutant. The objective of this study is to measure the spatial associations of  $\text{NO}_2$  with other ambient pollutants in Windsor, Ontario, Canada.

**Methods:** Spatial sampling to investigate intra-urban variability occurred once per season in 2005 and 2006, for a total of eight sessions. Ninety-nine locations were used over the two year period. At each site,  $\text{NO}_2$ , fine and coarse particulate matter, acid vapour (nitric, formic and acetic), volatile organic compounds (VOCs) ( $n = 26$ ), and polycyclic aromatic hydrocarbons (PAHs) were measured ( $n = 24$ ).

**Results:** Initial results indicate that the median  $\text{NO}_2$  concentrations and temperatures for the four seasons were 20.1 ppb and 0.3°C in winter, 11.3 ppb and 13.0°C in spring, 12.1 ppb and 23.9°C in summer, and 13.6 ppb and 12.2°C in fall. The Spearman correlations between  $\text{NO}_2$  and PM were strongest in fall ( $r = 0.59$  for  $\text{PM}_{2.5}$ ;  $r = 0.67$  for  $\text{PM}_{2.5-10}$ ) and weakest in spring ( $r = 0.01$  for  $\text{PM}_{2.5}$ ;  $r = 0.04$  for  $\text{PM}_{2.5-10}$ ). VOCs were most strongly correlated with  $\text{NO}_2$  in fall with  $r \sim 0.5-0.6$  for hexane, o-xylene and toluene. In winter, VOCs were generally weakly and negatively correlated with  $\text{NO}_2$  except for toluene ( $r = 0.42$ ). Correlations between  $\text{NO}_2$  and PAHs were generally strongest in spring with  $r \sim 0.6-0.7$  for benzo[a]pyrene, benzo[c]phenanthrene, and benzo[k]fluoranthene. Acetic, formic and nitric acid were weakly correlated with  $\text{NO}_2$  in each season.

**Conclusions:** Preliminary results indicate that the mixture of airborne pollutants is not consistent temporally. Associations between  $\text{NO}_2$  and a variety of pollutants vary greatly according to season. Subsequent analysis will assess associations spatially according to factors such as proximity to major pollution sources such as high traffic areas and industrial point sources.

#### ISEE-572

#### Influence of GST Genotypes Polymorphisms and Prenatal Smoke Exposures on Children Atopic Dermatitis

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**Background:** The evidence that both genes and environment play etiologic roles suggests that the increase in atopic dermatitis (AD) prevalence is likely to involve changes in specific exposures among the population of genetically susceptible individuals.

**Objective:** The purpose of this study was to evaluate the effect of Glutathione S-transferase (GST) genotypes polymorphisms and gestational smoke exposure on pediatric AD on the basis of the cord blood cotinine.

**Methods:** We recruited 261 mother and newborn pairs in 2004. Cord blood and information on perinatal factors of children were gathered at birth. At 2 years of age, information about development of AD and environmental exposures were collected. We compared AD with non-AD children for GTM1 and GSTP1 polymorphisms stratified by the cotinine level. Multiple logistic regressions were performed to estimate the association of genotypes polymorphisms and cotinine levels with AD.

**Results:** The risk of AD was found to increase with cord blood cotinine levels in a dose-response manner ( $p$  for trend = 0.02). GSTM1 null and GSTP1 Ile/Ile genotypes showed a significant increase in the risk of AD with OR (95%CI) of 3.61 (1.40–9.31) and 3.11 (1.30–7.46) respectively. In children with cotinine level  $< 0.1$  ng/ml, the risk of AD increased for those carrying two GSTP1 Ile-105 alleles (OR = 6.63, 95%CI 1.46–30.18). In children with cotinine level  $\geq 0.1$  ng/ml, GSTM1 null genotype was significantly related to AD (OR = 5.21, 95%CI 1.32–20.58).

**Conclusion:** Genetic polymorphism in GSTM1 and GSTP1 may be responsible for children differences in susceptibility to AD with regard to gestational smoke exposure.

#### ISEE-574

#### The Characterization and Health Effects of Indoor Particulate Matter Pollution from Biomass Burning in Northeastern China

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**Background:** Biomass fuel is the primary source of domestic fuel in much of rural China. Previous studies have not characterized particle exposure through time-activity diaries or personal monitoring in mainland China.

**Objectives:** This study characterized indoor and personal particle exposure in six households in Northeastern China (three urban, three rural) and explored differences by location, cooking status, activity, and fuel type. Rural homes used biomass. Urban homes used a combination of electricity and natural gas.

**Methods:** Stationary monitors measured hourly indoor  $\text{PM}_{10}$  for rural and urban kitchens, urban sitting rooms, and the outdoors. Personal  $\text{PM}_{2.5}$  monitors were employed for 10 participants. Time-activity patterns in 30-minute intervals were recorded by researchers for each participant.

**Results:** Stationary monitoring results indicate that rural kitchen  $\text{PM}_{10}$  levels are three times higher than in urban kitchens during cooking.  $\text{PM}_{10}$  was 6.1 times higher during cooking times than non-cooking periods for rural kitchens. Personal  $\text{PM}_{2.5}$  levels for rural cooks were 2.8 to 3.6 times higher than for all other participant categories. The highest  $\text{PM}_{2.5}$  exposures occurred during cooking periods for urban and rural cooks. However, rural cooks had 5.4 times higher  $\text{PM}_{2.5}$  levels during cooking than urban cooks. Rural cooks spent 2.5 times more hours per day cooking than their urban counterparts.

**Conclusions:** These findings indicate that biomass burning for cooking contributes substantially to indoor particulate levels, and that this exposure is particularly elevated for cooks. Second-by-second personal  $\text{PM}_{2.5}$  exposures

revealed differences in exposures by population group and strong temporal heterogeneity that would be obscured by aggregate metrics.

#### ISEE-575

##### Outdoor Particulate Matter Monitoring with a Real Time Portable Analyzer: A Performance Comparison with a Network of Official Fixed Gravimetric Stations in the Area of Milan, Italy

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**Background:** Particulate matter (PM) pollution is a concern for its health consequences. Fixed monitoring stations based on gravimetric method offer standard reference data, but the equipment costs and their maintenance are very expensive, so that they are available only in a limited number of sites for a given geographic area, and their data are useful for modelling pollution over wide extensions. Real time portable instruments based on optical particle counter (OPC) technology are user-friendly and cheap, and also allow a quick assessment because of a sampling time as rapid as 2 minutes. In addition, they enable mobile recordings. However, the instruments are manufacturer calibrated for reference to artificial monodisperse aerosol that differ from real world particle pollution. Thus they need proper routine calibration with data from reference instruments used to measure outdoor PM concentrations.

**Objectives:** To evaluate how an OPC calibrated for a reference method compares to official fixed gravimetric stations in the monitoring of outdoor PM pollution.

**Methods:** A laser-operated portable OPC with temperature/relative humidity sensor (Aeroctet 531, MetOne, USA) was placed in the town of Bareggio, a residential area in the suburb of Milan, Italy, as a fixed station 2 m high for continuous  $PM_{2.5}$  and  $PM_{10}$  recording with a sampling time of 2 minutes for over 2 months. A correction factor (K) was applied to OPC recordings, as a result of a previous calibration of the instrument as compared with FRM. Official gravimetric 24 h  $PM_{2.5}$  and  $PM_{10}$  average data were obtained from the network of 7 official fixed gravimetric stations of ARPA (the Lombardy regional agency for environmental protection: Saronno, Città Studi, Cornale, Lodi, Casirate, Calusco, and Seriate), one of them located in the metropolitan area of Milan, and six in the outskirts, but all of them in residential areas. The OPC 24 h average data were calculated after compensation for relative humidity interference and compared with two-tail paired Student's t-test with each official station, and the linear correlation was analyzed for mean  $PM_{2.5}$  and  $PM_{10}$  values of the OPC and the fixed stations.

**Results:** No statistically significant difference was found between the different official stations, and between each official station and the OPC. The correlation coefficient between the fixed station and each of the official stations ranged 0.67–0.91 for  $PM_{2.5}$  and 0.77–0.92 for  $PM_{10}$ . The ranges of  $PM_{2.5}$  concentrations varied from 5 to 140  $\mu g/m^3$ , and for  $PM_{10}$  from 7.0 to 191  $\mu g/m^3$ .

**Conclusions:** In our study OPC precalibration against outdoor operating reference instruments, and with factory gravimetric factor K adjusted at about 3 for  $PM_{2.5}$  and 2 for  $PM_{10}$ , allowed reliable outdoor PM measurements and can be used for accurate real time monitoring of outdoor pollution. However, because of seasonal variations in PM chemical composition and optical properties, frequent OPC re-calibration is required to adjust K factor.

#### ISEE-576

##### The Effect of Chronic Lead Exposure on Brain Magnetic Resonance Spectroscopy

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**Background:** Lead has been known as a human health hazard for a long time. In particular, damages to the brain and nervous system are a main issue in lead toxicology. The goal of this study is to investigate the brain metabolism using a 3 T magnetic resonance spectroscopy (MRS) in a group of chronic lead-exposed workers and matched non-exposed controls.

**Method:** The lead-exposed subjects were from a lead paint manufactory, 22 workers were all included. They did not have any clinical syndromes. 18 age and sex matched non-exposed healthy controls voluntarily participated. Blood samples were sent to KMU hospital for blood lead concentrations and other biochemistry tests. Bone lead levels were measured by KXRF equipment. A 3T MRS was used to measure their brain N-acetyl aspartate (NAA), Choline (Cho), and creatine (Cr) levels. In addition, a structural questionnaire was used to collect their working and health histories, as well as smoking and alcohol consumption.

**Results:** In comparisons of NAA/Cr, the frontal gray, subcortical, and white matters of Lead-exposed group had significantly lower NAA/Cr ratio, comparing to the non-exposed group. In the occipital lobe, only NAA/Cr ratio of white matter in the lead-exposed group was significantly lower than those of the non-exposed group. The NAA/Cr ratio of basal ganglia were also lower in the exposed group than those of the non-exposed group. Similarly, in comparison of Cho/Cr ratio, the data of frontal gray, white matters in the exposed group were lower than those of the non-exposed. In the occipital lobe, all the gray, subcortical, and white matters in the exposed group had lower Cho/Cr ratio than those of the non-exposed.

**Conclusion:** Lead toxicity in the human brain is complex and not well recognized. However, this study found that brain metabolism, especially NAA/Cr and Cho/Cr, may be disturbed by lead. Brain NAA and choline were negatively correlated to blood and bone lead levels, which may mean that lead may induce neuronal and axonal damage or loss.

#### ISEE-577

##### Increased Risk of Urological Cancer in Chinese Herbalists: A Retrospective Cohort Study

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**Background:** Aristolochic acid (AA) is a strong carcinogen to urological organs and is found in many traditional Chinese herbs of genus *Aristolochia*. Chinese herbalists are the most people frequently taking herbal drugs in Taiwan and are suspected to be chronically exposed to AA.

**Objective:** To clarify whether Chinese herbalists have increased risks of urological cancer, we conducted a retrospective cohort study in Chinese herbalist.

**Methods:** This cohort study recruited 3,093 male and 3,457 female herbalists who joined the Chinese Herbs Manufacture Labor Union in Taiwan from 11 February 1985 to 15 June 2000. By record linkage between the Labor Insurance Databank and Taiwan National Cancer Registry, we followed the development of cancer in herbalists to the end of 2001.

**Results:** Results showed that cancer incidence for malignancy of kidney and other urinary organs (SIR = 4.24, 95%CI 2.47–6.80) and bladder (SIR = 2.86, 95%CI 1.52–4.89) were both significantly higher than general population in Taiwan, especially in female herbalists. They were largely transitional cell carcinoma in histology type (90%) and had increased proportion in upper urinary tract (47%). The mean age of diagnosis of transitional cell carcinoma was 51.6 years.

**Conclusion:** The high risk of urological cancer in Chinese herbalists deserves more attention.

**ISEE-578****Increased Risk of Out-of-Hospital Cardiac Arrest is Associated with Short-Term PM<sub>2.5</sub> Exposure**

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**Background:** In the last decade, several studies have associated exposure to airborne particulate matter (PM) with cardiac morbidity and mortality, as well as effects on cardiac rhythms and electrocardiography. Although the exact nature of the mechanism is uncertain, some studies suggest that at least part of the increased mortality is due to acute cardiac events triggered by high PM levels. Attention has especially focused on the fraction of PM consisting of particles less than 2.5 micrometers in aerodynamic diameter (PM<sub>2.5</sub>) which is potentially a leading actor in inducing cardiovascular risks.

**Objective:** This study aimed to determine whether short term exposures to PM<sub>2.5</sub>, in an urban area were associated with increased risk of out-of-hospital cardiac arrest (OHCA).

**Methods:** The organization providing Emergency Medical Services to the city of Indianapolis provided data on OHCA during the period of July, 2002 through June, 2006. Confirmed cardiac arrests were recorded in a standardized format (the Utstein system), specifying whether or not they were dead-on-arrival (DOA, gross signs of death such as rigor mortis), whether they were witnessed by bystanders, the age, sex and race of the subject, and the presenting heart rhythm. Average daily PM<sub>2.5</sub> values were obtained from filter samples collected by the City of Indianapolis at two centrally located sites. Hourly PM<sub>2.5</sub> values were obtained from a Tapered Element Oscillating Microbalance (TEOM) at one of the sites. Data were analyzed with a case-crossover design using conditional logistic regression, with the PM<sub>2.5</sub> at the time of the OHCA, or a specified time lag before it, being the exposure of the "case". Referent exposures were taken as the exposures on all days falling within the same month and on the same day of the week as the case. The hazard ratio (HR) was calculated as the increased risk corresponding to a 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure.

**Results:** For all non-DOA OHCA (N = 1374), average PM<sub>2.5</sub> exposures on the day of the arrest, or 1–3 days before it, did not significantly affect OHCA incidence. For cardiac arrests witnessed by bystanders (N = 511), OHCA risk significantly increased with PM<sub>2.5</sub> exposure during the hour of the arrest (HR for a 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure = 1.12, 95% confidence interval(CI): 1.01, 1.25). For the subsets of subjects who were white, 60–75 years of age, or presented with asystole, OHCA risk significantly increased with PM<sub>2.5</sub> during the hour of the arrest (HRs for a 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> = 1.18, 95%CI: 1.03, 1.35; 1.25, 95%CI: 1.05, 1.49 and 1.22, 95%CI: 1.01, 1.59 respectively). HRs and their statistical significance generally decreased as the time lag between PM<sub>2.5</sub> exposure and OHCA increased.

**Conclusion:** The results suggest an acute effect of short-term PM<sub>2.5</sub> exposure in precipitating OHCA, and a need to investigate further the role of subject factors in the effect of PM<sub>2.5</sub> exposure on the risk of OHCA.

**Objective:** We developed a sensitive and selective method for measuring glyphosate (Gly) and its main degradate/metabolite aminomethylphosphonic acid (AMPA) in human urine using isotope dilution high-performance liquid chromatography-negative ion electrospray ionization-mass spectrometry (HPLC/ESI-MS/MS).

**Methods:** Gly and AMPA were derivatized with 9-fluorenylmethyl-chloroformate (FMOC) followed by solid phase extraction using AccuBond II ENV PS DVB cartridges. The analytical separation was performed by HPLC and detection by a triple quadrupole mass spectrometer, the TSQ Quantum Ultra, with an ESI source and a heated-ESI probe in negative ion mode using multiple reaction monitoring.

**Results:** Average extraction efficiencies of the SPE cartridges were 79% for Gly and 92% for AMPA. Repeated analyses of urine samples spiked with high, medium and low concentrations of the analytes gave relative standard deviations ≤ 10%. The limits of detection (LOD) were 0.5 ng/ml for Gly and 1.7 ng/ml for AMPA. The calibration range was linear ( $R^2 > 0.993$  and error of slope < 3%).

**ISEE-587****NO<sub>x</sub> Concentrations in Gothenburg, Sweden: Present Levels and Changes Over Time Due to Traffic Planning**

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**Background:** Traffic is one of the major sources of air pollution in many cities in Europe. Over the years the traffic volume has increased, but on the other hand catalytic converters and other new techniques have reduced the emissions per vehicle and kilometre. In Gothenburg, the traffic office has records on the traffic volume for most streets since 1975. The net traffic increase between 1975 and 2004 was 20%, but not evenly distributed. The traffic planning in Gothenburg is aimed towards reducing traffic in the city centre and in housing areas, and to promote public transports. Traffic is directed to some major traffic routes through and around the city. The result is a 20% reduction in the city centre between the years 1975 and 2004 while there has been a 140% increase of vehicles passing the city limit during the same period.

**Objective:** The aim was to investigate changes in outdoor NO<sub>x</sub> levels for subjects living in Gothenburg, Sweden.

**Methods:** The environmental office in Gothenburg has modelled the NO<sub>x</sub> levels for the years 1975 and 2004 using the emission inventory database and traffic records using the Enviman AQPlanner (OPSIS Sweden). Enviman consists of two types of models, a street canyon model, OSPM (DMU, Denmark) and a Gaussian model, AERMOD (US EPA). Yearly mean levels are available in 50 × 50 m grid cells. The levels of NO<sub>x</sub> at the home addresses for 72 randomly selected men born around 1920 (the Primary Prevention Study cohort, PPS) have been calculated for the years 1975 and 2004.

**Results:** The mean levels of NO<sub>x</sub> at the home addresses 1975 was 32.6 µgm<sup>-3</sup> compared to 19.8 µgm<sup>-3</sup> for 2004 (see table). The average decrease in the exposure to NO<sub>x</sub> was 12.8 µgm<sup>-3</sup> between the years 1975 and 2004. There has been a clear reduction of NO<sub>x</sub> levels in most of the city apart from a few areas around some of the major roads.

**Conclusions:** The homes in the lower quartile (LQ) are considered low exposure homes, while the homes in the upper quartile (UQ) are considered high exposure homes. The contrast between high and low exposure homes (UQ/LQ) for NO<sub>x</sub> is clear (2.8 and 2.6 for the years 1975 and 2004 respectively). This contrast will be used in epidemiological studies in the whole PPS cohort. The reduction in levels of NO<sub>x</sub> is highest among the high exposure homes. This demonstrates the beneficial result of focused traffic planning to reduce the exposure at homes.

**ISEE-584****Quantification of Glyphosate and Aminomethylphosphonic Acid in Human Urine Using High-Performance Liquid Chromatography-Tandem Mass Spectrometry**

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**ISEE-588****Maternal Passive Smoking Exposure and Offspring Birthweight: A Gene-Environment Study**

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**Background:** The effect of environmental factors on birth weight may be modified by polymorphisms of genes coding for xenobiotic-metabolizing enzymes. Our aim was to identify genetic polymorphisms modifying the effect measure of atmospheric pollution exposure on the birth weight of the offspring.

**Methods:** Within the German LISA birth cohort of non-twin births born after 37 gestational weeks with a birth weight above 2500 g, DNA was extracted from a whole blood sample collected from the newborn and 4 polymorphisms of genes implied in the metabolism of xenobiotics (GSTT1, GSTP1, GSTM1, and CYP2D6) were assessed. To limit the chances of random findings, we successively tested if there were polymorphism-specific differences in the association between maternal passive smoking exposure (binary variable) and birth weight, and in the association between exposure to fine particulate matter ( $PM_{2.5}$ ) during pregnancy and birth weight.  $PM_{2.5}$  exposure was estimated from a land-use regression model previously defined in the Munich metropolitan area. Birth weight was analyzed by linear regression and the regression parameters (beta) were adjusted for maternal height, pre-pregnancy weight, parity, educational level, gestational duration and sex of the newborn.

**Results:** Among the 802 non-smoking women, the apparent effect of passive smoking tended to be stronger for newborns carrying the \*1B/\*1B polymorphism of GSTP1 (beta = -190 g,  $P = 0.09$ ) compared to the wild type (wt) (beta = 2 g,  $P = 0.97$ ; interaction test,  $P = 0.19$ ) as well as for newborns carrying the \*4/\*4 polymorphism of CYP2D6 (beta = -170 g,  $P = 0.22$ ), compared to the wild type (beta = 1 g,  $P = 0.98$ ; interaction test,  $P = 0.19$ ). Among the 357 women with an estimated  $PM_{2.5}$  exposure, there was no deleterious effect of  $PM_{2.5}$  pregnancy exposure on birth weight in the GSTP1 wild type group (beta = 80 g for women above the  $PM_{2.5}$  median level, compared to women below the median), but a trend towards a deleterious effect of  $PM_{2.5}$  in the wt/\*1B (beta = -97,  $P = 0.09$ ) as well as in the \*1B/\*1B polymorphisms (beta = -173,  $P = 0.13$ , overall interaction test,  $P = 0.03$ ). For CYP2D6, the deleterious effect of  $PM_{2.5}$  also tended to be stronger for the \*4/\*4 polymorphism compared to the wild type (interaction test,  $P = 0.12$ ).

**Conclusion:** Our study suggests a stronger effect measure of maternal passive smoking on birth weight for newborns with the \*1B/\*1B polymorphism for GSTP1 and the \*4/\*4 polymorphism for CYP2D6, compared to newborns with the corresponding wild type polymorphisms. Similar effect measure modifications with these polymorphisms were observed when the environmental factor was maternal exposure to  $PM_{2.5}$ . This coherence of the interaction pattern (in the sense of a departure from an additive effect of genetic and environmental factors on birth weight) with polymorphisms in the xenobiotics-metabolizing genes GSTP1 and CYP2D6 between maternal passive smoking and  $PM_{2.5}$  exposure gives some plausibility to the apparent effect of maternal  $PM_{2.5}$  exposure on birth weight reported in previous studies without genetic information.

**ISEE-591****Season, Gender, Age, and Education as Modifiers of the Effects of Outdoor Air Pollution on Daily Mortality in Shanghai, China: The Public Health and Air Pollution in Asia (PAPA) Study**

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**Objectives:** Various factors may modify the health effect of outdoor air pollution. Prior findings about modifiers are inconsistent, and most of these studies were conducted in developed countries. We conducted a time-series analysis to examine the modifying effect of season, gender, age and education on the association between outdoor air pollutants ( $PM_{10}$ ,  $SO_2$ ,  $NO_2$  and  $O_3$ ) and daily mortality in Shanghai, China, using four years of daily data (2001–2004).

**Materials and Methods:** Natural spline model was used to analyze the data. We examined effects of air pollution for the warm season (from April to September) and cool season (from October to March) separately. For total mortality, we examined the association stratified by gender and age. Stratified analysis by educational attainment was conducted for total, cardiovascular and respiratory mortality.

**Results:** Outdoor air pollution was associated with mortality from all causes and from cardiopulmonary diseases in Shanghai. An increase of  $10\mu g/m^3$  of 2-day average concentrations of  $PM_{10}$ ,  $SO_2$ ,  $NO_2$  and  $O_3$  corresponds to 0.25% (95%CI 0.14%–0.37%), 0.95% (95%CI 0.62%–1.28%), 0.97% (95%CI 0.66%–1.27%), and 0.31% (95%CI 0.04%–0.58%) increase of all-cause mortality. The effects of air pollutants were more evident in the cool season than in the warm season. Females and the elderly were more vulnerable to outdoor air pollution. Effects of air pollution were generally greater in residents with low educational attainment (illiterate or primary school) compared with those with high educational attainment (middle school or above).

**Conclusions:** Season, gender, age and education may modify the health effects of outdoor air pollution in Shanghai. These findings provide new information about the effects of modifiers on the relationship between daily mortality and air pollution in developing countries and may have implications for local environmental and social policies.

**ISEE-594****Mobile Outdoor Particulate Matter Monitoring with Real Time Portable Analyzers Onboard a Moving Car: A Comparison with a Reference Fixed Station**

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**Background:** Particulate matter (PM) pollution is a concern for its health consequences. Fixed monitoring stations based on gravimetric method offer standard reference data, but the equipment costs and their maintenance are expensive, so that they are available only in a limited number for a given geographic area, and their data are useful for modelling pollution over wide extensions. Real time portable instrument based on optical particle counter (OPC) technology are user-friendly and cheap, and allow also quick assessment because of sampling time as low as 2 minutes. In addition, they enable mobile recordings that can be useful to study PM exposure along highways or beltways.

**Objective:** To evaluate the reliability of OPC real time PM recordings obtained by equipment located on board a moving car, sampling outdoor air from an external inlet.

**Methods:** Two 5 channels ( $PM_1$ ,  $PM_{2.5}$ ,  $PM_7$ ,  $PM_{10}$  and TSP) laser-operated portable OPC with temperature/relative humidity sensor (Aerocet 531, MetOne, USA) and a sampling time of 2 minutes, was placed inside a car and connected with outdoor air through a heated pipe to eliminate relative humidity interference and a special sample inlet designed to reduce air velocity interference. The car was equipped with a GPS tracking system synchronized with the OPC to precisely correlate PM

concentrations with geographical position. Mobile PM measures were collected along an orbital itinerary around the city, while the fixed instrument was placed in a residential area of the orbital. Both instruments had been previously calibrated for comparison with a gravimetric reference instrument (FRM).

**Results:** On board mobile and fixed station mean (SD)  $PM_{10}$  was 68.7 (7.3) and 69.6 (5.7)  $\mu\text{g}/\text{m}^3$  respectively (n.s), while mean (SD)  $PM_{2.5}$  was 18.0 (1.5) and 18.8 (1.3)  $\mu\text{g}/\text{m}^3$  respectively (n.s).

**Conclusions:** Mobile real time portable OPC's with a modified sampling inlet and GPS tracking allow reliable outdoor PM measurements and detailed mapping of PM spatial and temporal distribution.

#### ISEE-595

#### Feasibility of a Detailed Mapping of Urban Particulate Matter Pollution with Real Time Portable Analyzers: Detecting Exposure "Hotspots" in the City of Milan

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**Background:** Particulate matter (PM) pollution is a concern for its health consequences. Fixed monitoring stations based on gravimetric method offer standard reference data, but the equipment costs and their maintenance are very expensive, so that they are available only in a limited number for a given geographic area, and their data are useful for modelling pollution over wide extensions. Real time portable instrument based on optical particle counter (OPC) technology are user-friendly and cheap, and allow also quick assessment because of sampling time as low as 2 minutes. In addition, they enable to study different locations in the same day to have a first appraisal of possible high polluted "hotspots" at limited cost.

**Objective:** To evaluate the presence of "hotspots" in crowded sites in the town of Milan and outskirts.

**Methods:** Two 5 channels ( $PM_1$ ,  $PM_{2.5}$ ,  $PM_7$ ,  $PM_{10}$  and TSP) laser-operated portable OPCs with temperature/relative humidity sensor (Aeroctet 531, MetOne, USA) were used. One placed in the town of Bareggio, a residential area in the suburb of Milan, Italy, as a fixed station 2 m high for continuous recording with a sampling time of 2 minutes. This instrument will be called "master" because it was previously calibrated with comparison close to a gravimetric fixed station of the ARPA (the regional Agency for environmental protection). The other instrument, calibrated with the "master", was used to carry out spot measurements (30 minutes each) of PM levels in different locations in the town in the same day. PM levels were studied in the subway platforms and inside the carriages, in railway stations and in the carriages of a commuter line, and in three city parks. The results were correlated the fixed "master" instrument and with the data from the closest official fixed gravimetric stations. Statistical analysis was done with the Student t-test.

**Results:** Railway station hall, subway ticket floor and train platforms were found highly polluted, with a mean (SD)  $PM_{2.5}$  of 53.3(6.4), 57.4(6.7), and 69.2(13.1)  $\mu\text{g}/\text{m}^3$  respectively, as compared to concurrent outdoor  $PM_{2.5}$  levels of 45.0(2.7)  $\mu\text{g}/\text{m}^3$  ( $P < 0.001$ ). The pollution inside carriages of old commuter trains was higher than outdoors', with a mean (SD)  $PM_{2.5}$  of 23.9(10.8) vs 3.4(2.7) ( $P < 0.01$ ). No significant difference was found between the air quality inside carriages of new trains and outdoors'. Only in one of the 3 city parks studied  $PM_{2.5}$  levels were significantly lower than in busy streets of the town or the beltway.

**Conclusions:** Real time PM measurement with calibrated portable OPCs represent a reliable and affordable method to evaluate pollution "hotspots" in polluted cities.

#### ISEE-600

#### Climate Variability and Ross River Virus Infections in the Riverland, South Australia, 1992–2004

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**Background:** Ross River virus (RRV) infection is the most common notifiable vector-borne disease in Australia, with around 6000 cases per annum.

**Objectives:** To examine the relationship between climate variability and notified RRV infections in the Riverland region of South Australia and to set up an early warning system for the disease in temperate climate region.

**Methods:** Notified data of RRV infections were collected by the South Australian Department of Health. Climatic variables and monthly River flow were provided by the Australian Bureau of Meteorology and South Australian Department of Water, Land and Biodiversity Conservation over the period 1992–2004. Spearman correlation and time-series adjusted Poisson regression analysis were performed.

**Results:** The results indicate that monthly mean minimum and maximum temperatures, monthly total rainfall, monthly mean Southern Oscillation Index and monthly flow in the Murray River increase the likelihood but monthly mean relative humidity decreases the likelihood of disease transmission in the region, with different time-lag effects.

**Conclusion:** This study demonstrates that a useful early warning system can be developed for local regions based on the statistical analysis of readily available climate data. These early warning systems can be utilised by local public health authorities to develop disease prevention and control activities.

#### ISEE-603

#### Exposure to Violence—Mental Health Impact on Men and Women

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**Background:** The number of people living as refugees because of war in their home countries has grown over the past several decades. Prevalence rates of mental illness (e.g. depression, anxiety, posttraumatic stress disorder) among refugees vary between 2% and 80%, and there is little data on differences on subgroups like men and women. We aimed to investigate the prevalence of mental ill-health among refugees and to analyse differences in quantity and quality of symptoms of mental ill-health.

**Methods:** Cross-sectional cluster sample survey was conducted among refugees living in Germany ( $n = 170$ ). Main biographical data (age, sex, professional background in home country) and data on exposure to traumatic events were collected (e.g. death of a relative, forced expulsion, lack of food or water, lack of shelter). Main outcome measures were depression, anxiety and posttraumatic stress disorder (PTSD). Outcome was assessed with the Harvard-Trauma-Questionnaire (HTQ) and the "Hopkins-Symptom-Checklist 25" (HSCL-25).

**Results:** The refugees were exposed to high levels of traumatic events, most commonly reported events were forced expulsion (98%) and lack of water or food (80%) and lack of shelter (78%). Prevalence rate of depression was 78%, of anxiety 76% and of PTSD, 42%. Exposure to violence was higher among men than among women. Symptoms of mental ill-health among men and women differed; prevalence rates of mental ill-health did not differ.

**Conclusion:** High levels of mental ill-health are likely to occur in populations affected by war. Further research is needed to acquire specific knowledge on mental ill-health among subgroups of populations affected by war.

**ISEE-608****Seasonal Patterns of Mortality and Temperature-Mortality Relationship in Summer, Rome, 1987–2005**

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**Background:** Several studies have described seasonal patterns of mortality, with higher levels in winter and smaller in summer. To our knowledge, however, no investigation has dealt with the interrelationships between winter and summer mortality rates and how winter mortality levels may influence the impact of high temperatures and heat waves on mortality during summer. We hypothesized a mechanism of seasonal fluctuations of susceptible population as underlying the mortality patterns, and tested the role of summer temperature on these dynamics.

**Methods:** All natural deaths ( $n = 314,496$ ) occurring in Rome between 1987 and 2005 among subjects aged 65+ years old were selected. Daily mean temperature and humidity were collected. Patterns of seasonality in mortality were investigated via Fourier decomposition and autocorrelation and regression analyses on winter/summer average daily deaths. The effect of summer apparent temperature on mortality was estimated using the case-crossover approach, and the effect modification by mortality level during preceding winter was tested.

**Results:** Strong negative autocorrelation between average mortality in the winter/summer seasons was identified ( $r = -0.80$ ), once the long-term trend component was removed. However, the regression coefficient of summer against winter mortality was negligible. The effect of summer apparent temperature on natural mortality was much stronger in years characterized by low winter mortality (RR at 30°C versus 20°C = 1.63, 95%CI = 1.45; 1.83), as opposed to years with medium (RR = 1.39, 95%CI = 1.33; 1.45) or high winter mortality (RR = 1.35, 95%CI = 1.24; 1.47). Mean annual deaths attributable to high summer temperatures were 842, 552 and 552 for the three previous-winter-mortality strata, respectively.

**Conclusions:** A strong seasonal pattern of mortality was confirmed in Rome, though evidences on a direct relationship between winter and summer daily deaths were weak. Summer temperature exerts a stronger impact on mortality during years with lower winter mortality. Low-mortality winters inflate susceptible population at risk of dying by high temperature in the following summer. However, the size of such subpopulation is too small to be detectable in the summer-to-winter regression analysis. Our results provide further evidence to support public health programs focused on small susceptible populations to prevent the health effects of heat waves.

**ISEE-611****Traffic-Related Air Pollution and Socioeconomic Status: A Spatial Environmental Equity Study on a Small-Area Scale**

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**Background:** Although most ecological studies of environmental equity show that groups with lower socioeconomic status (SES) are more likely to be exposed to higher air pollution levels than groups of higher SES, they rarely consider the data's spatial autocorrelation.

**Objectives:** After investigating the associations between traffic-related air pollution and SES on a small-area scale (census block) in the Strasbourg metropolitan area (northeastern France), we assessed the impact that spatial autocorrelation may on the results, from an epidemiological perspective.

**Methods:** We used a deprivation index, constructed from census data, to estimate SES at the block-level. Average ambient nitrogen dioxide ( $\text{NO}_2$ )

levels during 2000, modeled at the block-level by the ADMS Urban air dispersion model, served as a marker of exposure to traffic exhaust. We tested the association between exposure estimates and the deprivation index using an ordinary least squares model (OLS) and a simultaneous autoregressive model (SAR), the latter taking spatial autocorrelation into account, while the former does not. The spatial autocorrelation in data was estimated using Moran's index (I).

**Results:** A high positive spatial autocorrelation was detected in both deprivation index ( $I = 0.54$ ;  $P$ -value < 0.01) and  $\text{NO}_2$  levels distributions ( $I = 0.79$ ;  $P$ -value < 0.01). The spatial distribution of the deprivation index shows a socioeconomic gradient from the most deprived blocks in the urban center and inner suburbs to the least deprived blocks in the outskirts. The spatial distribution of  $\text{NO}_2$  levels shows a pollution gradient from the most polluted blocks in the urban center and its proximate suburbs, to the least polluted blocks in the outskirts. Regardless of the regression model used, the association between the deprivation index and  $\text{NO}_2$  levels was positive and nonlinear, and the middle classes were most exposed; they dwell in the Strasbourg urban center surrounded by heavy traffic arteries. Control of spatial autocorrelation in the SAR model strongly reduced the strength of the association between traffic-related air pollution and the deprivation index, the most pronounced reduction being observed for the middle classes (regression coefficients decreased by 67%). The model's goodness of fit was, however, clearly improved (Akaike's criterion reduced from -360.80 (OLS) to -513.80 (SAR)).

**Conclusions:** A nonlinear association exists between traffic-related air pollution and socioeconomic status at the census block level in the Strasbourg metropolitan area, when spatial autocorrelation is taken into account. These disparities of air pollution exposures are in part explained by the socioeconomic and demographic organization of the neighborhoods within the study area and are thus specific to our local setting. This study confirms the need to take spatial autocorrelation into account in ecological studies and demonstrates to epidemiologists studying the role of air pollution on social inequalities in health that failure to do so may lead to biased and unreliable estimates and thus to erroneous conclusions.

**ISEE-612****Prenatal and Postnatal Exposure to Cell Phone Use and Behavioral Problems in Children**

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**Background:** Exposure to radiofrequency fields is increasingly common, but the potential influence on health has not been thoroughly investigated, especially in children. Between 2003 and 2008, there were more than 900 million new cell phone subscribers worldwide, with a total of more than two billion subscribers. The World Health Organization has emphasized the need for research into the possible effects of radiofrequency fields in children. We examined the association between prenatal and postnatal exposure to cell phones and behavioral problems in young children.

**Methods:** This study was based on the Danish National Birth Cohort, which recruited women during pregnancy from March 1996 through November 2002. A total of 101,032 pregnancies were enrolled in the cohort. Mothers and live-born children constitute two fixed cohorts that are to be followed for decades in a life-course perspective. Detailed information on life-style factors, dietary habits and environmental exposures were collected in a series of four telephone interviews from pregnancy to when the newborn reached 18 months. In 2005 and 2006, when the children of those pregnancies had reached 7 years of age, mothers were asked to complete a new questionnaire regarding the current health and behavioral status of children, as well as their cell phone during pregnancy and child's current cell phone use. Mothers evaluated the child's behavior problems using the Strength and Difficulties Questionnaire, which consisted of 25 questions with scaled responses

regarding their child's behavior. Based on the specific numerical score, children were classified as abnormal, borderline, or normal for overall behavioral problems as well as for the specific outcomes such as emotional, conduct, hyperactivity, or peer problems.

In the analysis, comparisons were made between baseline characteristics and prenatal and postnatal cell phone exposure. An ordinal logistic regression model was used to estimate the odds of the outcomes of behavioral problems in children according to combined prenatal and postnatal exposure to cell phones, prenatal exposure only, and postnatal exposure only. To evaluate possible dose-response patterns, proxies of prenatal exposure intensity were considered.

**Results:** Mothers of 13,159 children completed the follow-up questionnaire. Thirty percent of children were using a cell phone at 7 years of age, and about 11 percent of children were exposed to cell phones both prenatally and postnatally. Greater odds ratios for behavioral problems were observed for children who had possible prenatal or postnatal exposure to cell phone use. After adjustment for potential confounders, the odds ratio for a higher overall behavioral problems score was 1.80 (95% confidence intervals = 1.45–2.23) in children with both prenatal and postnatal exposure to cell phones.

**Conclusions:** Exposure to cell phones prenatally—and, to a lesser degree, postnatally—was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school entry. These associations may be noncausal and may be due to unmeasured confounding. If real, they would be of public health concern given the widespread use of this technology.

#### ISEE-614

##### Associations of Air Pollution on Small Airway Function, Inflammation and Oxidative Stress in Asthmatic Children

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**Objective:** We investigated whether an acute exposure to ambient air pollutants contributed to reduced pulmonary function and increased oxidative stress and inflammation in the airways of asthmatic children, using non-invasive methods.

**Methods:** We recruited 182 asthmatic children, age 9–14 years, from Windsor, Ontario, Canada. Once a week, we measured children's pulmonary function and fractional exhaled nitric oxide (FeNO), and collected their exhaled breath condensate (EBC) to determine concentrations of thiobarbituric acid reactive substances (TBARS), 8-isoprostanate and interleukin –6. Daily concentrations of sulphur dioxide ( $\text{SO}_2$ ), nitrogen dioxide ( $\text{NO}_2$ ), ozone ( $\text{O}_3$ ) and particulate matter with an aerodynamic diameter  $\leq 2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ) in ambient air were collected from 2 monitoring stations. Associations were tested using mixed-effects regression models, adjusting for temperature, relative humidity, asthma medication use, gender and co-pollutants.

**Results:** Forced expiratory flow between 25% and 75% of the forced vital capacity ( $\text{FEF}_{25-75\%}$ ), a small airway function marker, was significantly negatively associated with  $\text{SO}_2$ ,  $\text{NO}_2$  and  $\text{PM}_{2.5}$  ( $P < 0.05$ ). Forced expiratory volume in one-second ( $\text{FEV}_1$ ) and FeNO were not significantly associated with air pollutants. TBARS and 8-isoprostanate in EBC were significantly positively associated with  $\text{SO}_2$  ( $P < 0.05$ ), and TBARS was also significantly positively associated with  $\text{NO}_2$  and  $\text{PM}_{2.5}$  ( $P < 0.05$ ). The significant risk estimates for  $\text{FEF}_{25-75\%}$  and TBARS lasted for at least 3 days post elevation of air pollutants. The associations between oxidative stress markers and air pollutants appear to be stronger in children who did not take inhaled corticosteroids than in children who did. Interleukin-6 level was undetectable in many EBC samples, which warrants further study to develop more sensitive methods for inflammation.

**Conclusion:** Elevated  $\text{SO}_2$ ,  $\text{NO}_2$  and  $\text{PM}_{2.5}$  in ambient air may contribute to decreased small airway function and increased oxidative stress in

asthmatic children. TBARS in EBC can be used as sensitive non-invasive marker of oxidative stress for investigating adverse health effects of air pollution among children.

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#### ISEE-615

##### Integrating Biomonitoring and Biological Plausibility into a Prostate Cancer Case-Control Study: Evaluation of Pesticide Exposure Metrics

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**Background:** Epidemiologic studies exploring possible links between pesticide exposure and diseases with long latency are inconsistent. Sources of these discrepancies may include 1) failure to consider the toxicological relevancy of chemicals when classifying exposures; and 2) inaccurate categorization of individuals based on the magnitude of the dose during exposure events. The importance of these factors was evaluated within the Minnesota and Wisconsin Prostate Cancer Study, a population-based study of prostate adenocarcinoma.

**Methods:** We created a hierarchy of four pesticide exposure metrics ranging from simple (exposed yes/no) to refined (exposure scores accounting for duration, frequency, and intensity of use together with biological mechanisms) and compared resulting exposure rankings and effect estimates within a defined population. Odds ratios with 95% confidence intervals derived from logistic regression estimated associations between lifetime occupational and residential pesticide exposure and prostate cancer for each metric.

**Results:** Pesticide exposure metrics accounting for intensity and commonality of biological activity, compared to simpler metrics, influenced the classification of study subjects. Residential odds ratios generally increased as the definition of exposure was refined while changes in occupational risks were unsystematic.

**Conclusions:** Metrics of intensity and pathogenesis can change individual pesticide exposure categorization and therefore affect risk interpretation. Although the results do not represent a conclusive evaluation of the causal association between pesticides and prostate cancer, associations between home use and prostate cancer suggest that researchers should not disregard residential exposures as irrelevant.

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#### ISEE-619

##### Smoke Free Law should be Comprehensive to be Effective

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**Background:** Smoke-free laws have been implemented in many communities of Kentucky to protect the public from the harmful effects of secondhand smoke exposure.

**Objectives:** Impact of different types of smoke-free laws on indoor air quality was assessed.

**Methods:** This study assessed indoor air quality of hospitality venues in five communities before and after comprehensive smoke free laws, in one community before and after partial smoke free laws and in two communities after partial smoke-free laws were implemented. One community was measured three times, before smoke-free law, after the initial partial law and after the law was strengthened to cover all workplaces and public places with few exemptions. Real-time measurements of particulate matter with  $2.5 \mu\text{m}$  aerodynamic diameter or smaller ( $\text{PM}_{2.5}$ ) were made.

**Results:** When comprehensive smoke free laws were implemented, indoor  $\text{PM}_{2.5}$  concentrations decreased significantly from  $169 \mu\text{g}/\text{m}^3$  to  $20 \mu\text{g}/\text{m}^3$ . When partial smoke-free laws were implemented, indoor  $\text{PM}_{2.5}$  concentration was  $249 \mu\text{g}/\text{m}^3$ , over 7 times higher than the US National

Ambient Air Quality Standard (NAAQS) for 24 hours ( $35 \mu\text{g}/\text{m}^3$ ). In one community that implemented a comprehensive smoke free law after initially passing a partial law, indoor fine particle concentrations were  $304 \mu\text{g}/\text{m}^3$  before the law,  $338 \mu\text{g}/\text{m}^3$  after the partial law, and  $9 \mu\text{g}/\text{m}^3$  after the comprehensive law. A significant linear trend indicated that PM<sub>2.5</sub> levels in the establishments decreased with fewer numbers of burned cigarettes. One cigarette smoked was sufficient to increase indoor concentrations that exceeded the NAAQS.

**Conclusions:** The study clearly demonstrated that partial smoke-free laws do not improve indoor air quality. Several communities and countries have implemented and aim to pass smoke-free laws even if the law is not comprehensive. This study concluded that only comprehensive smoke-free laws are effective means of reducing indoor air pollution.

#### ISEE-620

#### Bullying in the Workplace and Musculoskeletal Disorders of the Upper Limb Among Seafarers

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**Objectives:** Seafaring is a specific occupation due to long-term isolation from the society and the family, thus it is likely that workplace bullying would be prevalent among seafarers. Recent investigations have indicated that workplace bullying is associated with stress and adverse psychosomatic outcomes. Chronic neck and upper limb pain often occurs in the absence of obvious tissue pathology. The investigations in the recent years have shown that the epidemics of non-specific occupational arm pain have arisen in various countries without any abrupt corresponding changes in occupational physical workload. It has been suggested that psychosocial factors matter more for chronic upper limb pain than physical exposures and activities. We investigated the prevalence of bullying among seafarers in Lithuania and the associations between workplace bullying and musculoskeletal disorders of the upper limb.

**Methods:** We conducted a study among seafarers attending the mandatory health examination in the Maritime Medical Centre in Klaipeda. We investigated workplace bullying, using the Negative Acts Questionnaire (S.Einarsen & H.Hoel). We measured the overall feeling of victimization and its associations with diagnosed by the medical doctor musculoskeletal disorders of the upper limb over the last six months in the random sample of seafarers. Totally 370 seafarers answered the questionnaire (response rate 53%). We used the statistical software SPSS 13.0 for Windows and performed the logistic regression analysis for the calculations of the associations between workplace bullying and upper musculoskeletal disorders, controlling for age, physical workload, occupational status, exposure duration.

**Results:** Our results indicated that prevalence of occasional bullying in the workplace among seafarers was 10.1%, severe bullying 3.8%. The prevalence of musculoskeletal disorders of the upper limb was 5.2%. The prevalence of musculoskeletal disorders of the upper limb among the regularly bullied seafarers was 21.4%, among non-bullied—4.1% ( $P = 0.012$ ). Regular bullying was associated with musculoskeletal disorders of the upper limb ( $OR = 6.36$ ; 95%CI 1.58–25.57). After adjustment for age, physical workload, occupational status, exposure duration, OR increased to  $OR = 10.54$ ; 95%CI 2.17–51.25. Spearman correlation between bullying and perceived stress was  $0.176$  ( $P < 0.01$ ), between workplace bullying and post-traumatic stress disorder— $0.336$  ( $P < 0.01$ ), between stress and post-traumatic stress disorder— $0.520$  ( $P < 0.01$ ).

**Conclusions:** Workplace bullying among seafarers was not more prevalent than among other occupations. We found consistent associations between workplace bullying and musculoskeletal disorders of the upper limb among seafarers. The preventive measures should be directed

towards the improvement of the psychosocial work environment in the workplace among seafarers.

#### ISEE-621

#### Association Between Myocardial Infarction Risk and Indicator of Traffic-Related Air Pollution

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**Objectives:** The relation between long-term urban traffic air pollution and myocardial infarction incidence is under investigation in recent studies. The aim of our study was to investigate the effect of long-term ambient nitrogen dioxide (NO<sub>2</sub>) exposure as indicator of traffic-related air pollution on the first myocardial infarction risk among women.

**Methods:** We conducted the population-based case-control study among 35–64 year old women in Kaunas city, Lithuania. First non-fatal myocardial infarction cases ( $N = 368$ ) were identified from the hospital register and 848 population controls were selected in 1997–2004. We used the measurements of ambient NO<sub>2</sub> exposure, collected at 12 monitoring posts to assess the residential exposure levels, classified into three pollution tertiles. Multivariate logistic regression was used to estimate the effect of NO<sub>2</sub> on first myocardial infarction, controlling for potential confounders, such as age, smoking, blood pressure, body mass index and psychological stress.

**Results:** Myocardial infarction risk had a tendency to be increased for women, living in the second tertile area as compared to the first tertile ( $OR = 1.08$ ; 95%CI 0.78–1.50). Women in the third tertile area had a higher risk ( $OR = 1.60$ ; 95%CI 0.85–1.67). Traffic-related air pollution by NO<sub>2</sub> had a higher risk for the development of myocardial infarction among the 55–64 year old women.

**Conclusion:** Exposure to traffic-related air pollution in the living area had a tendency to increase the risk of the first myocardial infarction among middle-aged women.

#### ISEE-623

#### Sales of Short-Acting Beta Agonist for Asthma, Air Pollution and Socioeconomic Deprivation: A Small-Area Case Crossover Study in Children and Adolescents

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**Background:** The effects of air pollution on the triggering of asthma attacks are well established. Besides, the possible modulation of these effects by socioeconomic deprivation remains unclear. Investigation of such potential interactions requires sufficient statistical power, which can be obtained either by numerous observations or by the use of very sensitive asthma attacks indicators.

**Objectives:** To investigate, through a small-area case crossover approach, i) short-term relations between ambient air pollution and sales of short-acting beta agonist (SABA) drugs -a frequent event specific of asthma attacks treatment in children and adolescents ii) the influence of socioeconomic deprivation on these relations.

**Methods:** The study setting was Strasbourg (France), year 2004. Four health insurance systems, covering more than 90% of the local population, provided data on 7,774 SABA sales to people aged 0–19. These sales were geocoded by neighborhoods of residence (French census blocks,

2000 inhabitants on average). Deprivation was estimated by block, using an index constructed by principal component analysis from census data. Hourly particulate matter < 10  $\mu\text{m}$  ( $\text{PM}_{10}$ ), nitrogen dioxide ( $\text{NO}_2$ ) and ozone ( $\text{O}_3$ ) concentrations were modeled by block with the ADMS-Urban model, then averaged by day (24-hour averages for  $\text{PM}_{10}$  and  $\text{NO}_2$ , maximum 8-hour moving average for  $\text{O}_3$ ). Case-crossover analyses adjusting for pollen counts, influenza, meteorology and holidays were conducted using a monthly time-stratified design. Lags from 0 to 10 days were investigated. Optimal lag times (a combination of consecutive lags for which significant or marginally significant positive associations were observed) were then retained to test interactions by deprivation. For that purpose, odds ratios were estimated separately for five deprivation strata, defined according to quintiles of the block-level deprivation index.

**Results:** Positive and significant ( $P < 0.05$ ) or marginally significant associations were observed for lags from 4 to 7 days for  $\text{PM}_{10}$ , from 4 to 10 days for  $\text{NO}_2$  and for a 5 days lag only for  $\text{O}_3$ . Odds ratios of SABA sales for a 10  $\mu\text{g.m}^{-3}$  increase in pollutant concentrations were 1.110 (95%CI: 1.062, 1.160) for  $\text{PM}_{10}$  (lag 4–7), 1.166 (95%CI: 1.082, 1.256) for  $\text{NO}_2$  (lag 4–10) and 1.019 (95%CI: 1.002, 1.036) for  $\text{O}_3$  (lag 5). The values of the odds ratios showed no trends according to deprivation level.

**Discussion:** This first ecological study of the relations between air pollution and SABA sales reported statistically significant associations. These are consistent with associations reported by panel studies focusing on SABA use, although here they appear for longer lags. These increased delays likely result of the addition of physio-pathological latency and of private drug stock exhaustion times. These associations are stronger than those reported in the same study setting for another indicator of asthma attacks (emergency phone calls to physician networks). This suggests the higher sensitivity of SABA sales as an indicator for asthma attacks. Despite satisfying statistical power, we did not observe any interaction by neighborhood deprivation. This is consistent with previous results reported in the same study setting for emergency calls, but still needs to be confirmed in other settings.

#### ISEE-624

#### Impact of the Milan Traffic Charging Scheme on Particulate Matter Pollution

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**Background:** In January 2008 the Municipality of the city of Milan enacted an ordinance to restrict vehicular traffic in the city center, introducing a ticket to enter the inner boundary for polluting cars, on the basis of “principle of polluter-payer”, according to the Directive 2004/35/CE on Environmental Liability. One of the targets of the intervention was the reduction of particulate matter (PM) pollution. Although similar strategies in a big European city like London did not set pollutant reduction as one of the target, and the restriction ticket was called “Congestion charge”, the program in Milan put the accent on the possibility of a substantial improvement in air quality index. Accordingly, the taxation regimen was called “Ecopass”.

**Objective:** To assess the impact of the traffic restriction charging scheme comparing PM levels before and after the “Ecopass” implementation inside and outside the boundary.

**Methods:** Three kinds of measurement were carried out: 1) the “walking itinerary”, by collecting data from a real-time portable particle analyzer (Aerocon 531, MetOne Instruments, USA) in a walking trip with a GPS tracking system; 2) the “ring itinerary”, by collecting data with the same instrument on a car travelling along the inner, intermediate and outer ring of the city; 3) by using official data from two ARPA (the official Environmental Protection Agency of Lombardy) fixed monitoring

gravimetric stations. Paired, two-tail Student’s t-test was used for statistical analysis.

**Results:** The “walking itinerary” PM concentrations were recorded on February 02, 2008. The mean (SD)  $\text{PM}_{1,2.5}$  and  $\text{PM}_{10}$  were 58 (3), 197 (13) and 247 (24)  $\mu\text{g/m}^3$  in the outer zone, respectively, while in the Ecopass zone 56 (2), 183 (14) and 245 (28)  $\mu\text{g/m}^3$ , respectively. No significant difference was found between the two areas of the city. The “ring itinerary” PM measurements were recorded on February 22, 2008. Mean (SD)  $\text{PM}_{1,2.5}$  and  $\text{PM}_{10}$  were 39 (4), 102 (15), 127 (24)  $\mu\text{g/m}^3$  in the outer ring, 42 (3), 116 (14), and 152 (28)  $\mu\text{g/m}^3$  in the intermediate ring, and 41 (2), 110 (9), and 148 (16)  $\mu\text{g/m}^3$  in the Ecopass zone. Again, no significant difference was found between the three areas of the city. The sets of data retrieved from ARPA official website for the two months prior to the ordinance implementation (November and December, 2007), showed a mean  $\text{PM}_{10}$  concentrations in the Ecopass zone and in the closest outer zone (Città Studi) of 74.8 vs 71.2  $\mu\text{g/m}^3$  (n.s.), and after the implementation (January and February, 2008) of 70.9 vs 67.3  $\mu\text{g/m}^3$  (n.s.).

**Conclusions:** The “Ecopass” charging scheme does not appear to improve PM pollution in the area subject to vehicular restriction in the city of Milan.

#### ISEE-627

#### Air Pollution—Occupational and Environmental Exposures to VOCs and other Pollutants in Prague and Biomarkers of Oxidative Stress

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**Background:** Adverse effects of different pollutants on human health have been well documented in many parts of the world. These include many diseases and an estimated reduction in life expectancy of a year or more for people living in European cities. The capital of the Czech Republic Prague appears today to be one of the most polluted residential areas in Europe. Particulate matter  $\leq 2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ), carcinogenic polycyclic aromatic hydrocarbons (c-PAHs) and volatile organic compounds (VOCs) are ones of the main important pollutants. VOCs represent high volatility in ambient environment. Benzene is a recognized human carcinogen and some of the other VOCs are highly toxic, especially to the central nervous system in humans.

**Methods:** This traffic related exposure study was conducted in Prague during the years 2005–2007 in conjunction with Prague bus drivers ( $N = 50$ ), policemen ( $N = 120$ ) and office workers ( $N = 50$ ). Traffic-related VOCs (benzene, toluene, ethylbenzene, m/p xylen and o-xylene) were collected on adsorbent tubes Radiello Diffusive Samplers and analyzed by thermal desorption and gas chromatography/flame ionization detector technique. We analyzed the variability of 8-oxodeoxyguanosine (8-oxodG), a marker of oxidative damage to DNA in urine of bus drivers and controls to investigate the oxidative stress caused by air pollution. For the analysis of 8-oxodG levels ELISA technique was used. In order to identify factors that influence 8-oxodG levels we pooled data of exposure to c-PAHs, benzo[a]pyrene and VOCs obtained from personal and stationary monitors, information on plasma triglycerides, LDL and HDL cholesterol, vitamins and cotinine levels and age and analyzed their association using bivariate linear regression, logistic regression and multivariate regression analysis.

**Results:** We found out the significant seasonal differences. The personal median benzene/toluene/ethylbenzene/mp-xylene/o-xylene values (B/T/E/X) were (6.3/23.5/3.9/11.5/3.4  $\mu\text{g/m}^3$ ) in winter 2006 and (5/8.8/2.2/7.5/2.7  $\mu\text{g/m}^3$ ) in winter 2007 versus lower values in summer 2006 (5.1/18.5/2.9/8.5/2.7  $\mu\text{g/m}^3$ ) and (3.35/7.65/2.6/5.5/2.25  $\mu\text{g/m}^3$ ) in summer 2007. No differences in the exposure to B/T/E/X between bus drivers and controls were observed. According to our study B/T/E/X values in Prague corresponded to VOCs concentrations in other European cities (as e.g. Amsterdam, Copenhagen, Birmingham). In comparison to stationary

monitoring the personal VOC values were 3–5x higher. The median levels (min, max) of 8-oxodG in bus drivers vs. controls were as follows: winter 2005: 7.79 (2.64–12.34) vs. 6.12 (0.70–11.38) nmol/mmol creatinine ( $P = 0.01$ ); summer 2006: 6.91 (1.30–10.68) vs. 5.11 (2.34–12.32) ( $P < 0.01$ ); winter 2006: 5.73 (1.54–11.89) vs. 3.94 (0.45–7.65) nmol/mmol creatinine ( $P < 0.001$ ). The differences between seasons were also statistically significant. Multivariate logistic regression analysis identified PM<sub>2.5</sub> and PM<sub>10</sub> levels measured by stationary monitors during a three-day period before urine collection as the only factors significantly affecting 8-oxodG levels while the levels of c-PAHs had no significant influence.

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**ISEE-628**
**The Critical Time Windows for the Effect of Black Smoke on Birth Weight**

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**Objective:** Many studies have now implicated air pollution to have an adverse effect on birth weight. However, to our knowledge, only one study so far has investigated the critical time window of exposure using monthly exposures. The aim of this study was to investigate the critical time window using weekly exposures of black smoke air pollution during pregnancy.

**Materials and Methods:** These analyses were part of the historical cohort UK PAMPER (Particulate Matter and Perinatal Events Research) study investigating the association between maternal exposure to black smoke and adverse perinatal outcomes in singleton births (N = 109,086) in Newcastle upon Tyne from 1961 to 1992. The PAMPER birth record database contained information on birth weight, gestational age, infant gender, maternal age, parity and neighbourhood socio-economic status. Weekly black smoke exposure estimates for each individual pregnancy were derived from a two-stage modelling process incorporating monitored black smoke data with temperature and pollution source information. Linear regression was used to model the effect of black smoke exposure on birth weight and fractional polynomials were used to model non-linear relationships. The critical windows were examined separately for males and females.

**Results:** Male infants were found to be vulnerable from week five to week 37 of gestation. The association was highest and the relationship was non-linear from the fifth to the 12<sup>th</sup> week. From week 13 to 37 the relationship was linear and the associations were relatively smaller. The association was highest in the fifth week, when with an increase in exposure from the 1<sup>st</sup> (6 µg/m<sup>3</sup>) to the 25<sup>th</sup> (16 µg/m<sup>3</sup>) percentile birth weight reduced from 3638g (95% CI: 3623, 3654) to 3632g (95% CI: 3617, 3646). When exposure increased from the 1<sup>st</sup> to the 75<sup>th</sup> (92 µg/m<sup>3</sup>) percentile during the same week, birth weight reduced to 3527g (95% CI: 3511, 3544). From week 13 onwards birth weight reduced by about 10 g for every 100 µg/m<sup>3</sup> increase in exposure. In female infants the critical window of exposure was narrower than in males from week nine to week 33. Between week nine and 12 the estimated reduction was <10 g for every 100 µg/m<sup>3</sup> increase in exposure, after which it slightly increased. On week 23 the birth weight reduction was highest about 15.8g (95% CI: 9.2, 22.4) for every 100 µg/m<sup>3</sup> increase in exposure. Unlike in males, there was no significant association after week 33.

**Conclusions:** This is the first study that used weekly exposures to black smoke to investigate the critical time window of exposure during pregnancy. Using detailed individual exposure estimates we did not confirm earlier reports of the effect of black smoke on birth weight to be limited to a particular month or trimester. The analyses showed a continuous association with reduction in birth weight between the fifth and the 37<sup>th</sup> week of gestation. Furthermore, the vulnerable period for male infants was longer than for females.

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**ISEE-629**
**Deaths from Heat in Persons in Residential Care in England**

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**Background:** In Europe and North America, the elderly population is known to be at high risk from temperature extremes. Physiological studies have indicated that the presence of co-morbidities is more important for impaired thermoregulation than the normal patterns of ageing. Social vulnerability is also a major determinant of heat vulnerability and related to the care given to frail individuals. Heat wave events in Europe have shown that people in residential home are particularly vulnerable to heat-related mortality, as such buildings did not typically have space cooling before 2003 event. We have analysed the sensitivity to mortality in this vulnerable population to heat using routine mortality data for England and Wales.

**Methods:** Individual mortality records (1993–2003) were linked by postcode to a database of care and nursing homes to determine whether or not individuals were residents of care homes at the time of death. Poisson regression adapted for time series data was used to quantify the effect of daily temperatures on mortality risk for persons in different types of homes, after adjusting for the effect of season, air pollution, holidays and day of week. The heat relationship was modelled using temperature averaged across values on the same day and the day before the day of death (lags 0–1). For quantification of temperatures effects, simple linear threshold models were assumed—i.e. models that assume a log-linear increase in risk above the heat threshold (95th centile of the daily mean temperature). Sensitivity analyses were undertaken to assess the effect of seasonal control and region, together with further validation of the classification of deaths by residence type.

**Results:** We estimated the relative risks of mortality per 1 degree increase in temperature for two age groups: non-elderly (0 to 75 years) and elderly (75 years and above). For the elderly, relative risks were: living at home 1.05 (95% CI 0.99, 1.12), nursing home 1.10 (1.01, 1.20), care home 1.01 (0.92, 1.09), home for persons with physical disability 1.34 (1.10, 1.64), home for persons with mental disability 0.99 (0.79, 1.25). The non-elderly population relative risks were: living at home 0.99 (95% CI 0.92, 1.08), nursing home 1.15 (0.87, 1.52), care home 1.16 (0.84, 1.61), physical disability 1.03 (0.69, 1.53), mental disability 0.96 (0.53, 1.73).

**Conclusions:** Our findings are consistent with previous studies indicating that elderly persons in nursing homes have a much higher risk of heat-related mortality than the general population and those in care homes. Elderly residents in homes for physical disabilities appear particularly at risk of heat-related mortality. Although such populations have a higher absolute mortality risk, reflecting their greater physical and social frailty, there should no additional effect of heat due to appropriate care and cooled environments.

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**ISEE-630**
**Is Exposure to Particulate Air Pollution During Pregnancy Associated with Risk of Stillbirth? The UK PAMPER Study, 1961–92**

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**Objective:** A growing body of evidence exists to suggest that exposure to ambient air pollutants can adversely affect the growth and development of the fetus and infant survival. Much less is known regarding the potential for an association between black smoke air pollution and stillbirth risk. This potential association was examined using data from the historical cohort UK Particulate Matter and Perinatal Events Research (PAMPER) study.

**Materials and Methods:** Using data from paper-based neonatal records from the two major maternity hospitals in Newcastle, we constructed a

birth record database of all singletons born during 1961–1992 to mothers resident in the city. Weekly black smoke levels were obtained from routine data recorded at 20 air pollution monitoring stations over the study period. A two-stage statistical modelling strategy was used, incorporating temporally and spatially varying covariates to estimate black smoke exposure during each trimester and for the whole pregnancy period for each individual pregnancy.

**Results:** The PAMPER database consists of 90,537 births with complete gestational age and residential address information, of which 812 were stillborn. Using a linear term for black smoke exposure, an odds ratio of 1.04 per each  $10 \mu\text{g}/\text{m}^3$  (95% CI 1.035–1.051) was seen for weekly black smoke exposure averaged across the whole pregnancy period. However, this association was shown to be significantly non-linear. Using fractional polynomials and adjusting for year of birth, parity, sex and Townsend material deprivation score, the increased risk with increasing black smoke exposure during pregnancy remained.

**Conclusions:** This large study over a 30 year period has shown an association between black smoke exposure during pregnancy and risk of stillbirth. If causal, this would be of particular relevance to parts of the world now experiencing the levels of black smoke seen in Newcastle early in the study period. However, as this is the first study to demonstrate such an association, further research is required to confirm or refute our findings and if confirmed to identify the biological mechanisms involved.

#### ISEE-631

##### Traffic Exposure Model Estimates of Residential NO<sub>2</sub> Levels

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**Background:** Exposure to vehicle traffic is associated with impaired respiratory health. Exhaust from vehicles is an important source of nitrogen dioxide (NO<sub>2</sub>) and particulates such as carbon which may exacerbate respiratory symptoms. Several studies have used distance from residence to roadway to model traffic exposure, but this metric does not capture traffic density or complicated roadway patterns. Using traffic volume, distance from roadway, length of road segments, and wind direction in a generalized linear model, we estimated a dispersion function for NO<sub>2</sub> level at a residence.

**Methods:** NO<sub>2</sub> values were obtained from a study of 138 families residing in Connecticut, in which outdoor NO<sub>2</sub> was measured over a 10 to 14 day period using Palms tubes. Average daily traffic volume on state highway segments were obtained from Connecticut State Department of Transportation and converted into Geographic Information Systems (GIS) data. Traffic density could then be calculated for a 2000 m area surrounding each residence. Exposure to traffic from a line source (roadway) was expressed as a line integral of a function proportional to average daily traffic and a nonparametric dispersion function which takes the form of a step, polynomial or spline model. Modifiers of pollutant dispersion, such as wind direction, and landscape features may also be included in the model. Using our model, we estimated NO<sub>2</sub> levels for the entire state.

**Results:** The step function dispersion model (with steps at 400, 800, 1200, and 1600 m) showed the highest level (least dispersion) in the first 400 m ( $R^2 = 0.510$ ). This result indicates that the effect of traffic on NO<sub>2</sub> level varied by distance to highway. A step function model incorporating wind direction showed the largest effect on NO<sub>2</sub> level in first 400 m downwind (southwest). The polynomial of one to three showed the evidence of improvement over the constant model, though none of them did not appear to capture well the shape of the dispersion function implied by step function. The linear spline dispersion model showed a peak around 400 m ( $R^2 = 0.505$ ). When NO<sub>2</sub> levels mapped for the entire state, estimated NO<sub>2</sub> levels were highest in Hartford and New Haven where major interstate highways intersect.

**Conclusions:** Our approach is similar to the use of a distance weight that allows for dispersion, but does not require that dispersion rates be known. Our traffic exposure model explains about 50% of the variation in measured levels of NO<sub>2</sub> and suggests that levels are affected by the distance to roadway as well as by wind direction.

#### ISEE-634

##### Mortality from Liver and Hemo-lymphopoietic Cancers Among Workers Exposed to Vinyl Chloride Monomer in Taiwan: An Updated Study

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**Background:** The relationship between vinyl chloride monomer (VCM) exposure and angiosarcoma of liver has been established. However, it is not clear about the effects of VCM on other cancers. In our previous study, we found an increased standardized mortality ratio (SMR) for liver cancer in polyvinyl chloride (PVC) workers who were employed at least one year after 1950.

**Methods:** To further investigate the types of cancers caused by VCM and their trends with time, we extended the follow-up period from 1997 to 2005. A total of 3313 male PVC workers were included in the analysis and further linked with National Mortality Registry. SMR was calculated as compared to Taiwanese general population. Subsequently, six-year moving averages of the SMRs were calculated to examine the trend of cancer mortality.

**Results:** The results showed that the mortality caused by liver cancer increased around 1989–1994 (SMR 1.93, CIs 1.03–3.31), reached a peak around 1991–1996 (SMR 2.35, CIs 1.42–3.68), then became insignificant in 1994–1999 (SMR 1.45, CIs 0.81–2.39). Angiosarcoma of liver was not identified and most liver cancers were found to be hepatocellular cancers. The mortality of hemo-lymphopoietic cancer became significant in 1985–1990 (SMR 3.97, CIs 1.07–10.17), reached a peak in 1986–1991 (SMR 4.81, CIs 1.55–11.21), then became nonsignificant in 1991–1996 (SMR 2.22, CIs 0.45–6.50).

**Conclusions:** Our results demonstrate that VCM may increase the risk of liver and hemo-lymphopoietic cancers. With the control of VCM exposure at worksites, the mortality of these cancers has returned to the background levels of general population.

#### ISEE-637

##### Modelling Intra-Urban Concentrations of Traffic-Related Air Pollution in New York City for the U.S. Multi-Ethnic Study of Atherosclerosis

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**Background:** Accurate assessment of intra-urban variability in air pollution concentrations is essential to linking exposures and health effects in air pollution epidemiological studies. Predicting these concentrations in urban areas dominated by street canyons poses additional complexity.

**Methods:** We validated the Danish AirGIS air quality model system on air quality measurement data in New York City from three US Environmental Protection Agency (EPA) monitor stations and data from a comprehensive measurement campaign that is part of the Multi-Ethnic Study of Atherosclerosis Air Pollution Study (MESA Air) (<http://depts.washington.edu/mesaair/>). MESA Air is designed to examine the relationship between air pollution exposures and the

progression of cardiovascular disease over time. The study includes study areas in six states in USA—one being New York City (NYC). The Danish model system has specifically been developed to describe conditions in street canyons that are predominant in the study area that includes in the boroughs of Manhattan, The Bronx, Queens, and Brooklyn. In street canyons with buildings along the sides the dispersion is restricted and re-circulation of air in the street under cross-wind conditions leads to elevated concentration levels. AirGIS is a deterministic location-based exposure model system based on the Danish dispersion models Operational Street Pollution Model (OSPM) and the Urban Background Model (UBM) (<http://airgis.dmu.dk>). The system encompasses digital maps of roads with traffic data, building footprints with building height, and receptor locations together with a Geographic Information Systems (GIS). The model system estimates air pollution levels at high temporal (hourly) and spatial resolutions (street level). It provides for efficient and operational prediction at a large number of locations. Traffic data on individual road links are based on the Best Practice Model (BPM), a travel demand model for New York Metropolitan Area. EPA MOBILE6.2 vehicle emission factors were implemented in the model system together with a description of the diurnal and weekly variation in traffic. The contribution from other sources than vehicles is also taking into account. A dataset with building footprints and building height on individual buildings was also established. The regional background concentrations to the model domain area were based on representative EPA air quality monitor stations. Meteorological surface data are from the Laguardia Airport in New York and upper air data for mixing height estimation are from Upton located on Long Island, the nearest upper air station to New York City. The validation study included about 150 different locations in NYC and about 650 samples of 1–2 week measurements of NO<sub>x</sub>, NO<sub>2</sub> and PM<sub>2.5</sub>. The Urban Background Model generally reproduced the annual levels, seasonal variation and diurnal variation at three urban background EPA monitor stations.

**Results:** The full model with OSPM and UBM reproduced the MESA Air measurements with a correlation coefficient of  $r^2 = 0.51$  for NO<sub>x</sub>,  $r^2 = 0.21$  for NO<sub>2</sub> and  $r^2 = 0.73$  for PM<sub>2.5</sub>. The model was used to predict outdoor exposure levels for NO<sub>x</sub>, NO<sub>2</sub> and PM<sub>2.5</sub> for all locations of the about 1,000 participants in MESA Air study in NYC.

#### ISEE-638

#### Exposure Considerations for Chemical Prioritization and Toxicity Testing

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**Background:** Globally there is a need to characterize potential risk to human health and the environment that arises from the manufacture and use of tens of thousands of chemicals. Currently, a significant research effort is underway to apply new technologies to screen and prioritize chemicals for toxicity testing as well as to improve understanding of toxicity pathways. The 2007 National Research Council report, *Toxicity Testing in the 21st Century: A Vision and a Strategy*, calls for a collaborative effort across the toxicology community to rely less on animal studies and more on *in vitro* tests using human cells and cellular components to identify chemicals with toxic effects. A framework for implementing this long-range vision is provided by the recently formalized collaboration between two NIH institutes and the EPA to use high-speed, automated screening methods to efficiently test compounds for potential toxicity (Science Feb 15, 2008). More immediately, the US EPA is completing the Phase I pilot for a chemical prioritization research program, called ToxCast™. Here EPA is developing methods for using computational chemistry, high-throughput screening, and toxicogenomic technologies to predict potential toxicity and prioritize limited testing

resources. These high visibility efforts in computational toxicology raise important research questions for exposure scientists. As the NAS points out, population-based data and human exposure information are required at each step of their vision for toxicity testing. In addition, the ToxCast™ program has identified the need to include exposure considerations for chemical prioritization.

**Discussion:** Two major areas of exposure research are required to meet immediate needs for chemical screening, prioritizing and toxicity testing. First, it is imperative that exposure data be accessible and linked to the rapidly growing base of toxicity data. Development of consolidated data and knowledge bases for exposure is a high priority. Second, novel computational approaches are required to ensure that information on biological effects is developed at environmentally relevant exposures. Computational tools and approaches for characterizing and prioritizing exposure are required: to provide input for selection of chemicals; to select doses for toxicity tests; and to interpret and extrapolate results of *in vitro* tests. Examples of tools available for further development and application to address this need can be found by considering state-of-the-art research in modeling exposure of phthalates and other semi-volatile organic compounds (SVOCs) from emitting source to metabolic sink or dose. Data analysis and modeling to understand behavior of phthalates provides insight on determinants of exposure that can be applied to a broad range of compounds. In this presentation, the need for exposure science to address chemical screening, prioritizing, and toxicity testing in the 21<sup>st</sup> century is identified; examples of relevant computational research activities are highlighted; and an approach forward for exposure scientists is proposed.

*This work has been reviewed and approved by the US EPA for publication but does not necessarily reflect Agency policies.*

#### ISEE-640

#### Association Between Black Smoke and Birth Weight: Variation Across Three Decades

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**Objective:** A number of studies have investigated the association between ambient air pollution and birth weight. To date none have explored this relationship in a long term study spanning more than three decades. We investigated whether the effect of black smoke on birth weight varied across the three decades between 1961 and 1992.

**Materials and Methods:** These analyses were part of the historical cohort UK PAMPER (Particulate Matter and Perinatal Events Research) study investigating the association between maternal exposure to black smoke and adverse perinatal outcomes in singleton births (N = 109,086) in Newcastle upon Tyne from 1961 to 1992. The PAMPER birth record database contained information on birth weight, gestational age, infant gender, maternal age, parity and neighbourhood socio-economic status. Weekly black smoke exposure estimates for each individual pregnancy were derived from a two-stage modelling process incorporating monitored black smoke data with temperature and pollution source information. Linear regression was used to model the effect of black smoke exposure on birth weight and logistic regression for low birth weight. Fractional polynomials were used to model non-linear relationships.

**Results:** Interaction between black smoke and decade of birth (first: 1961–1970, second: 1971–1980, third: 1981–1992) in their effect on birth weight was significant for the whole pregnancy and for the three trimester exposures, and the best fitting models were linear. The estimated reduction in birth weight for each 10 µg/m<sup>3</sup> increase in black smoke exposure during the whole pregnancy was 3.00 g (95% CI: 1.82, 4.17) for the first decade, 5.53 g (95% CI: 2.96, 8.11) for the second and 10.57 g (95% CI: -1.34, 22.48) for the third decade. The point estimates were consistently higher for all three trimesters during the third decade

compared to the first and second but some were not statistically significant. Interaction between black smoke and decade of birth was also significant for low birth weight. The odds ratio (OR) for low birth weight for a 10  $\mu\text{g}/\text{m}^3$  increase in exposure during the whole pregnancy was 1.01 (95% CI: 0.99, 1.02) for the first decade, 1.03 (95% CI: 1.01, 1.06) for the second decade and 1.11 (95% CI: 0.97, 1.28) for the third decade. For all three trimesters, the ORs for the third decade were relatively higher than for the first and the second.

**Conclusions:** This is one of the first studies reporting changes in the effect of particulate matter on perinatal outcomes over an extended period in a single location. The association between black smoke and birth weight was found to be relatively stronger in the third decade than in the previous two, whilst median exposures were lowest in the third decade. We suggest that changes in the composition of black smoke due to changes in domestic fuel consumption, traffic and industrial emission may be responsible.

#### ISEE-641

#### The Association Between Acanthamoeba Keratitis and the Presence of Acanthamoeba in Water Supplies Sampled from the Home

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**Background:** Acanthamoeba keratitis (AK) is a serious eye infection that can lead to visual loss and ocular morbidity. Acanthamoeba is a ubiquitous, free-living, waterborne amoeba consisting of an active trophozoite and highly resistant cyst form, and believed to infect the cornea through contaminated water exposure potentiated by contact lens use. The U.S. annualized incidence rate is conservatively estimated at 1.7 to 2.0 cases per million contact lens wearers, although we demonstrated a statistically significant, six-fold increase in AK cases in the Chicago area beginning in June 2003; the Chicago outbreak preceded a national increase that began in 2004. The purpose of this analysis is to determine whether Acanthamoeba presence in the domestic water supply is a risk factor for AK.

**Methods:** A retrospective, case-control study investigating AK risk factors that involved individual surveys and water sampling of homes with laboratory and molecular analysis of identified corneal and environmental Acanthamoeba isolates was conducted. Cases were diagnosed at the University of Illinois at Chicago (UIC) Cornea Service and controls were clinic-matched on age and date-of-service ( $\pm 5$  years;  $\pm 1$  month). Logistic regression was used to estimate the unadjusted association between positive Acanthamoeba microbial water sample analysis and AK disease; analysis was restricted to soft lens users.

**Results:** Forty-nine AK cases diagnosed between June 30, 2003 and November 30, 2007 participated in this study. Among soft contact lens users, a marginal association is observed between Acanthamoeba-positive water sample results and AK disease. Fourteen of 49 (28.6%) AK cases had Acanthamoeba present in the water, as compared to 10 of 71 (14.1%) controls (OR: 2.4, 95% CI: 0.98–6.07).

**Conclusions:** AK is marginally associated with the presence of positive Acanthamoeba microbial results sampled from the home water supply. Two recent AK case-control studies, our Chicago area study and a CDC multi-state outbreak investigation, recently identified use of a specific contact lens solution use as strongly associated with AK, leading to a worldwide product recall in May, 2007. However, despite the strong specific solution association, nearly 40% of cases did not use the recalled solution. Environmental Protection Agency (EPA) regulations decreasing allowable disinfection byproducts in the domestic water supply became effective nationally between 2002 and 2004, which is similar to the beginning of the Chicago and multi-state AK outbreak. Our results demonstrate over a two-fold elevated relative risk which is borderline statistically significant between AK and Acanthamoeba presence within

the domestic water supply, suggesting it is possible that a subsequent microbial shift of the water supply following changing disinfectant practices may be contributory to the AK outbreak.

#### ISEE-642

#### Air, Water, House Dust, Blood and Hair Manganese of Children Living in the Vicinity of a Ferro-Manganese Alloy Plant

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**Background:** For over thirty years, a ferro-manganese alloy plant has been polluting the Cotelipe village in the metropolitan area of Salvador, Brazil. A recent report showed that air manganese (Mn) concentration in  $\text{PM}_{10}$  (inhalable fraction) was 0.55  $\mu\text{g}/\text{m}^3$ .

**Objective:** Our objective was to evaluate the overall environmental exposure of children to manganese (Mn) originating from the industrial emissions.

**Methods:** The present study examined Mn exposure in children ( $n = 109$ ), in the age range of 1 to 10 years, living in the vicinity of the plant (0.5 to 2 Km radius). Measurements were made of: airborne Mn concentration, measured in the respirable fraction ( $\text{PM}_{2.5}$ ) during seven 24 h sampling periods; potable water (MnW), sampled from pre and post-treatment locations; settled house dust (MnD), collected by aspiration onto cellulose ester filters; blood (MnB) and hair (MnH), analyzed by graphite atomic absorption spectrometry with Zeeman background correction. Other possible confounders like hematological and parasitological parameters were also assessed.

**Results:** Manganese mean concentration in  $\text{PM}_{2.5}$  was 0.15  $\mu\text{g}/\text{m}^3$  and ranged 0.01–0.44  $\mu\text{g}/\text{m}^3$ . MnW level in the pre-treatment point was 80.1  $\mu\text{g}/\text{L}$  and ranged from 5.7 to 57.8 in samples collected from drinking water. A gradient of exposure with respect to proximity to the emission source and the downwind location was observed. In the high risk area MnD means were 20,727 ( $\pm 11,294$ ) mg/Kg; 4,127 ( $\pm 590$ ) mg/Kg in the moderate risk area and 2,607 ( $\pm 731$ ) mg/Kg in the area considered low risk. MnH means in the high, moderate and low risk areas were 34.11 ( $\pm 6.97$ )  $\mu\text{g}/\text{g}$ , 11.64 ( $\pm 1.14$ )  $\mu\text{g}/\text{g}$  and 7.95 ( $\pm 1.40$ )  $\mu\text{g}/\text{g}$ , respectively. MnB means showed the same trend with means of 15.2 ( $\pm 1.06$ )  $\mu\text{g}/\text{L}$ , 12.3 ( $\pm 0.38$ )  $\mu\text{g}/\text{L}$  and 11.7 ( $\pm 0.78$ )  $\mu\text{g}/\text{L}$ , respectively. Significant differences in mean MnH were observed ( $P = 0.035$ ) between boys 11.01 ( $\pm 1.83$ )  $\mu\text{g}/\text{g}$  and girls 19.16 ( $\pm 2.43$ )  $\mu\text{g}/\text{g}$ .

**Conclusions:** The data suggest that the major source of Mn body burden in these children is from airborne particles; settled house dust may represent a source of recontamination. Dietary contribution is being evaluated, assessing the major crops grown locally. More than ninety percent of the children have hair levels that surpass those that have been associated with hyperactivity. A study of neurobehavioral effects of Mn exposure in these children is currently underway.

#### ISEE-649

#### Residential Proximity to Heavy-Duty Diesel Traffic and Subclinical Atherosclerosis

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**Objective:** Epidemiologic studies have linked residential proximity to major roads with markers of subclinical atherosclerosis. Experimental evidence suggests that the smallest particles, which mainly result from Diesel traffic, may have the largest adverse potential. We investigate the association between exposure to high general and high Diesel traffic with

subclinical atherosclerosis, hypothesizing that living close to high Diesel traffic is more closely associated with subclinical atherosclerosis than proximity to high general traffic.

**Material and Methods:** We used baseline data from the Heinz Nixdorf Recall Study, an ongoing population-based study of 4814 subjects aged 45–75, living in the highly industrialized Ruhr Area in Germany. Actual traffic volumes for all major inner city roads, specified by vehicle type, were provided by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV NRW) for the year 2000. Residential exposure to high general (passenger cars, vans, motorbikes) and heavy-duty Diesel traffic (trucks, busses) was assessed separately by proximity to highly trafficked roads defined by vehicle type-specific traffic volumes in the upper quintile. We also calculated vehicles per day (vpd) by vehicle type within a 100m buffer zone around the participants' home address and dichotomized the maximum vpd according to the 90<sup>th</sup> percentile to identify subjects with a relevant exposure. We analyzed the association between traffic exposure and coronary artery calcification with multiple regression, controlling for background fine particulate matter exposure and individual level risk factors for atherosclerosis.

**Results:** Of the 4229 participants with complete information on exposure variables and covariates, 496 (11.7%) and 438 (10.4%) lived within 200 m of high general traffic and high heavy-duty Diesel traffic, respectively. The majority (398) was exposed to both (Spearman correlation coefficient for distance to high general and high Diesel traffic 0.83). In the crude model, a 50% reduction of the distance to a road with high general traffic was associated with a 13.2% [95% confidence interval 2.5–25.0%] higher coronary artery calcification, while the same reduction in distance to high heavy-duty Diesel traffic led to a 19.2% [7.0–32.7%] increase. Adjustment for risk factors (age, sex, education, smoking, passive smoking, diabetes, obesity, physical inactivity) attenuated the estimates (8.5% [0–17.9%] for general traffic and 12.2% [2.5–22.7%] for Diesel traffic). Additional adjustment for hypertension and cholesterol, which both might lie on the mechanistic pathway, further attenuated the estimates (7.4% [−0.8–16.3%] for general and 10.1% [0.9–20.1%] for Diesel traffic). In the crude model for traffic density in the 100m buffer zone, high general and high heavy-duty Diesel traffic were associated with a 1.63 [1.13–2.35] and 1.75 [1.20–2.54] fold higher coronary calcification, respectively. Corresponding fully adjusted estimates were 1.45 [1.08–1.95] and 1.40 [1.03–1.88].

**Conclusions:** Living close to high heavy-duty Diesel traffic might be more closely associated with atherosclerosis than general traffic. Possible explanations include specific characteristics of Diesel particles, confounding by noise, and an accumulation of cardiovascular risk factors close to high heavy-duty Diesel traffic.

#### ISEE-652

#### Use of GIS and Time-Activity Matrix for Assessment of Personal NO<sub>2</sub> Exposure in Pregnant Women from INMA-Valencia, Spain

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**Background:** The INMA—INFancia y Medio Ambiente (Environment and Childhood) project is a multi-center prospective Spanish cohort which aims to study the role of the most prevalent environmental pollutants and diet on fetal and child growth and development. The aim here is to present the methodology for assigning levels of exposure to outdoor nitrogen dioxide (NO<sub>2</sub>) for every pregnant women included in the cohort INMA-Valencia, Spain, with Geographic Information System (GIS) and time-activity matrix.

**Methods:** A total of 855 pregnant women were recruited between 2003 and 2005 in Valencia. Outdoor concentrations of NO<sub>2</sub> were monitored in 93 sites of the study area, in 4 campaigns (once per trimester), with

adequate node distance in each type of zone (urban, metropolitan, semiurban and rural). Land use regression (LUR) was used for assessment of NO<sub>2</sub> levels in the study area. The Universal kriging was used to predict NO<sub>2</sub> levels in not monitored sites. The precision of the method was scored by means cross validation. The kriging prediction was used as first information layer, by adding GIS variables to improve it. Traffic information (distance and intensity), land use (use percentage within buffers of 150, 300 and 500 m) and geographic elevation were obtained. The Moran's test was used to analyze the spatial autocorrelation. Seasonality was assigned for the pregnancy period of each woman by means of continuous monitored from surveillance net. In order to assess individual outdoor NO<sub>2</sub> exposure, indexes that combined the time-activity pattern, obtained through 32 week of pregnancy questionnaire (n = 787), with estimated concentrations by mean of models of the 4 campaigns at home and job were built. Different models were proposed: 1. home exposure, 2. home and job exposure.

**Results:** The mean regression model that better predicted the NO<sub>2</sub> levels included the mean kriging prediction, percentage of continuous urban land use within buffer 500m and the logarithm of minimum distance to a road with more than 10000 vehicles/day ( $R^2 = 0.81$ ). The coordinates of 785 homes and 466 jobs were obtained from public GIS. The 82.5% of women had worked during pregnancy. Women who did not work spent 82% of their time at home, women who worked spent 57% at home and 29% in job. NO<sub>2</sub> medians were: 35.8(P10–90:21.2–50.9)  $\mu\text{g}/\text{m}^3$  for model 1 and 36.6(21.4–49.3) for model 2. A relative difference between models 1 and 2 of 3.0% (P10–90: 0.4–11.9)  $\mu\text{g}/\text{m}^3$  was found.

**Conclusions:** The results show the large possibilities offered by GIS for spatial pattern identification of outdoor NO<sub>2</sub> levels in our study area. Models that did not considerate the kriging predictions were fine, although the spatial autocorrelation was not eliminated. Important differences were not found between the models 1and 2. They will allow the analysis of the possible effect between NO<sub>2</sub> levels foetal development and early childhood health.

#### ISEE-655

#### Urban/Rural Differences in Occurrence of Neural Tube Defects in Texas

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**Background:** Neural tube birth defects (NTDs), which include anencephaly, spina bifida, and encephalocele, affect more than 4,000 pregnancies in the U.S. annually. The etiology of NTDs is believed to be multifactorial, but much remains unknown.

**Methods:** We examined the pattern and magnitude of urban-rural variation in anencephaly, spina bifida without anencephaly, and encephalocele in Texas using four different indicators of urban-rural status for the period 1999 to 2003. Case data came from the Texas Birth Defects Registry, maintained by the Texas Department of State Health Services (TDSHS). The numerator study population included live births, fetal deaths and elective terminations, yielding 514 cases of anencephaly, 643 cases of spina bifida without anencephaly, and 168 cases of encephalocele. Denominator data for the prevalence rates came from TDSHS vital records, yielding a total of 1,827,317 live births delivered in 1999–2003 by women residing in all Texas counties. Fetal deaths and elective terminations were not included in the denominator study population. However, sensitivity analyses suggest that case ascertainment from live births, fetal deaths and induced terminations is similar across urban-rural status and that live births are a reasonable proxy for all pregnancies at risk for NTDs. Data on residential, medical, reproductive and sociodemographic factors were abstracted from both vital records and birth defects registry files. Residence was defined as mother's residence at

time of delivery. Urban-rural variation was measured using four different classification schemes: Rural Urban Continuum Codes (RUCCs), Urban Influence Codes (UICs), percent of county in cropland, and Rural Urban Commuting Areas (RUCAs). We calculated prevalence rate-ratios for the three diagnostic categories of NTDs using Poisson regression.

**Results:** There was no evidence that urban-rural status was associated with changes in the rate of anencephaly or spina bifida without anencephaly in unadjusted analyses, or after adjustment for maternal age, maternal race/ethnicity, gestational age, maternal education and parity. In contrast, rates of encephalocele were statistically significantly higher in areas classified as suburban or more rural compared with urban areas under all four of the urban-rural status indicators. For instance, residence in counties with more than 36% croplands had an increased rate ratio of 1.55 (1.03–2.29) compared to residence in counties with less than 12% cropland. Most striking was the adjusted rate ratio for RUCAs of 2.26 (1.27–3.75) comparing small town area/rural areas with urban core areas. Results for RUCAs were robust in models using either three or four levels of urbanization with the p for trend <0.05 in both cases. Restricting the analyses to include only live born infants with encephalocele did not change the findings appreciably. In summary, we found no evidence that urban/rural residence was associated with anencephaly or spina bifida without anencephaly.

**Conclusions:** Our results suggest a relationship between more rural residence and an increased risk of encephalocele, but we encourage future work in the area to attempt to confirm the association given the relatively small number of encephalocele cases in our study.

*The views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.*

#### ISEE-656

##### Association of Obesity and Asthma in Inner City Minority Children

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**Background:** Asthma and obesity are more common in low-income minority communities such as East Harlem in New York City (NYC). Evidence for an association between increased body fat and asthma exists, and postulated mechanisms include inflammatory mediators, hormones, mechanics and genetics. Studies to date have only used body mass index (BMI) as a measure of obesity. BMI may not be ideal since actual body fat level varies by age, sex, maturity level, and ethnicity. Superior obesity measures include: (1) percent body fat and (2) waist circumference and waist-to-height ratio (indicators of fat distribution). In addition, few studies have looked at physical activity's association with asthma or its effect on the adiposity-asthma relationship.

**Objective:** To study the association between asthma diagnosis and (1) BMI percentile, (2) percent body fat, (3) fat distribution and (4) physical activity.

**Methods:** Cross-sectional data from Growing Up Healthy, a community based study of 6–8 year old NYC children, were used. Body measurements were performed using a standardized protocol. Asthma was defined as parental report of physician-diagnosed asthma. Adiposity-asthma associations were estimated by multivariate poisson regression. Questionnaire-based physical activity information and pedometer measurements among asthmatics and non-asthmatics were compared using T-tests.

**Results:** At baseline 39% of girls (155/398) and 53% of boys (56/105) had a BMI greater than the 85<sup>th</sup> percentile based on CDC normative values. Twenty-six percent of children had physician-diagnosed asthma. In multivariate adjusted models, there were strong associations between each body fat measure and asthma diagnosis. The prevalence ratios (95% CI) for asthma for the highest quintile of adiposity measure compared to the combined first and second quintiles were 1.68 (1.15–2.46) for BMI

percentile, 1.43(0.97–2.10) for percent body fat, 1.74(1.16–2.61) for waist circumference and 1.46(0.98–2.19) for waist-to-height ratio. Asthmatic children also had statistically significantly more sedentary activity and fewer metabolic hours per week from recreational activity.

**Conclusions:** We found similar associations for four adiposity measures with doctor-diagnosed asthma. Prospective observations will allow investigation of asthma severity in relation to body fat measures and activity levels. Enhanced understanding could improve outcomes for both health conditions.

#### ISEE-657

##### The Impact of Human and Environmental Factors on Personal PM<sub>2.5</sub> Exposures

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**Background:** The US EPA's Research Triangle Park Particulate Matter Panel Study involved extensive collections of personal, residential indoor, residential outdoor and community-based particulate matter (PM) mass concentration data during the 2002–2001 time period.

**Methods:** The study involved over 700 twenty-four hour (daily) monitoring sessions from a total of 38 participants using a variety of both integrated and continuous measurement approaches. Surveys were employed that focused upon human activity and environmental exposure factors. These were either daily or single use questionnaires. Examples of the type of information collected included: 15-minute segmented time activity patterns (location and activity), use of home heating and air conditioning systems, duration of household activities that might generate PM (such as cooking events), volume of the home, and the impact of air exchange. In total, 54 specific parameters were available to be incorporated into the analyses examining the impact of these factors upon personal exposures. This data set has also provided the means to understand the impact of various personal activity factors such as cooking, cleaning, and grooming episodes upon total PM<sub>2.5</sub> personal exposures as compared to that of ambient origin.

**Results:** As expected, ambient PM<sub>2.5</sub> mass concentrations had a significant impact upon personal exposures. As indicated by examining the personal/ambient PM<sub>2.5</sub> sulfur ratios for the 38 study participants, ambient contributions typically represented 54% ( $\pm 40$ ) of their total PM<sub>2.5</sub> personal exposures. However, this value fell to 49% ( $\pm 12$ ) when actual time activity patterns were incorporated. Home indoor and other non-home indoor sources (e.g., doing laundry, restaurant dining) were responsible for an addition of 6.6 and 5.9  $\mu\text{g}/\text{m}^3$ , on average, respectively to the total personal exposure. Certain daily personal activities were observed to be highly significant. Particular cooking activities such as meat frying, often resulted in increases above the personal background of 50  $\mu\text{g}/\text{m}^3$ . Cleaning and grooming episodes were on average responsible for an average increase of 38 and 20  $\mu\text{g}/\text{m}^3$ , respectively, to the individual's total PM<sub>2.5</sub> daily exposure.

**Conclusions:** This work shows the importance of understanding the impact of non-ambient sources relative to total personal exposures with respect to epidemiological considerations.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-658

##### The Impact of Human and Environmental Factors on Personal Exposures to Ozone, Nitrogen Dioxide and Sulfur Dioxide

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**Methods:** The US EPA's Detroit Exposure and Aerosol Research Study (DEARS) involved the collection of over 5500 total ozone, nitrogen dioxide and sulfur dioxide daily (24-hr) measures. A mixture of residential indoor, residential outdoor, community and personal exposure monitoring was conducted in support of this effort and involved a volunteer cohort consisting of a total of 142 enrollees. Participants were given no restrictions on their activities and asked to continue their daily lives and operate their homes in a normal fashion. All participants and their households were asked to be non-smoking during their monitoring periods. The monitoring was performed during summers and winters over a three-year period (2004–2007). In addition to the collection of environmental measures for the criteria gas pollutants described above, a series of four surveys were used to assess factors that might have influenced the participant's daily exposures. These surveys included a daily (15-minute interval) time activity diary, a participant background questionnaire, a residential survey, and a daily follow-up questionnaire. All of the DEARS surveys are fully described on the study's website ([www.epa.gov/DEARS](http://www.epa.gov/DEARS)) and are available for downloading. Survey and questionnaire data were used to examine 47 environmental and human exposure factors that might influence personal exposures. Examples of factors include the use of gas appliances in the home, burning of candles, environmental tobacco smoke (ETS) exposure, use of air conditioning, and various residential exhaust systems. Mixed models analyses with backward elimination were then used to discern which specific factors were influencing personal exposures to each pollutant by season.

**Results:** Summertime mean personal exposures to ozone, nitrogen dioxide, and sulfur dioxide were observed to be  $2.7 \pm 3.9$ ,  $25.3 \pm 23.4$  and  $0.5 \pm 2.3$  ppb, respectively. Personal exposures during the winter seasons resulted in mean exposures of  $1.2 \pm 2.6$ ,  $35.2 \pm 53.7$  and  $0.3 \pm 1.2$  ppb as ordered above. Analyses revealed that seasonality was a major influence on exposure. This was especially true with respect to ETS influence. Although the participant population was required to be non-smoking, passive and potentially even active ETS exposures during the winter seasons were observed to influence personal exposures to nitrogen dioxide and ozone ( $P < 0.05$ ). This factor had no impact upon personal exposures for any gas pollutant during the summertime. ETS exposures were determined to have no observable influence upon sulfur dioxide exposures ( $P > 0.3$ ) in any season. The seasonal differences are believed to be influenced by residential indoor air exchange rates which varied from  $1.0 \pm 0.7$  (winter) to  $1.9 \pm 2.1$  (summer) exchange/hr.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

contributor to SENS (i.e., more immunologically sensitive organ than the lung).

**Discussion:** Development of SENS is known to require exposure factors and involve immunologic and genetic factors; however, the mechanisms by which these factors interact to cause SENS remains poorly understood. In our model, exposure factors include contaminant distributions (mass, chemistry, and particle size, number, and surface area) and the rates at which materials are deposited, cleared, and made bioavailable in the skin. Immunologic factors include the rates at which bioavailable material is processed to form antigen; antigen is presented by Langerhans cells and recognized by beryllium-naïve T-lymphocyte cells (a genetic factor); and activated T-lymphocyte cells proliferate and differentiate into beryllium-specific memory CD4+ T-cells (i.e., development of SENS). We hypothesize that the rate-limiting exposure factor in the SENS process is the rate at which beryllium becomes bioavailable in the skin. As such, biologically relevant exposure metrics for SENS include beryllium dissolution rate characterized by chemistry, particle size and surface area and the exposure pattern (duration, amount, etc.). In summary, this model is potentially useful for selecting biologically relevant metrics of exposure for use in the development of job-exposure matrices for epidemiology studies of systemic sensitizers.

## ISEE-662

### Urinary Phthalate Metabolite Concentrations Among Workers in Selected Industries

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**Background:** Phthalates are used as plasticizers and solvents in industrial, medical, and consumer products; however, occupational exposure information is limited.

**Objectives:** We sought to obtain preliminary information on occupational exposures to diethyl phthalate (DEP), di-n-butyl phthalate (DBP), and di(2-ethylhexyl) phthalate (DEHP) in a cross-section of industries.

**Methods:** We recruited 156 workers in 2003–2005 from eight industry sectors. Mid- and end-shift urine samples were analyzed for phthalate metabolites. We assessed occupational contribution by comparing creatinine-adjusted end-shift concentrations to mid-shift and U.S. general population concentrations.

**Results:** Evidence of occupational exposure to DEHP was strongest in *polyvinyl chloride (PVC) film manufacturing* and *PVC compounding*, to DBP in *phthalate manufacturing* and *rubber gasket manufacturing*, and to DEP in *phthalate manufacturing*. Each of these sectors used or produced the indicated phthalate. Geometric mean end-shift ( $GM_{end}$ ) concentrations of the DEHP metabolites, mono(2-ethyl-5-hydroxyhexyl) phthalate and mono(2-ethyl-5-oxohexyl) phthalate, were highest in *PVC film* (151 and 84.6  $\mu\text{g/g}$ , respectively), and *PVC compounding* (102 and 60.8  $\mu\text{g/g}$ , respectively). DEHP monoester was highest in *nail-only salons* ( $GM_{end} = 19 \mu\text{g/g}$ ). DBP monoester was 12-fold higher in *rubber gasket* ( $GM_{end} = 418 \mu\text{g/g}$ ) than in *nail-only salons* ( $GM_{end} = 34.2 \mu\text{g/g}$ ). DEP monoester decreased within-shift in all sectors, except in *phthalate manufacturing* which produced DEP ( $GM_{end} = 716 \mu\text{g/g}$ ).  $GM_{end}$  phthalate metabolite concentrations frequently exceeded U.S. general population concentrations even when no workplace use was reported.

**Conclusions:** Using phthalate urinary metabolites, we successfully identified workplaces with occupational phthalate exposure. Additional work is needed to distinguish occupational from non-occupational sources in low-exposure workplaces.

## ISEE-660

### A Simple Biologically-Based Dynamic Model for Beryllium Sensitization

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**Background:** People exposed to beryllium compounds are at risk of developing immunologic sensitization to beryllium (SENS). Using inhalation exposure estimates derived from airborne sampling data, epidemiology studies have been unable to demonstrate a clear and consistent exposure-response relationship for SENS.

**Objectives:** The purpose of this work is to present a novel, biologically based dynamic model that emphasizes the contribution of skin exposure in development of SENS and focuses on a few key steps in the progression from skin exposure to SENS. This model is part of a larger overall conceptual model that accounts for inhalation exposure. For at least a subset of the beryllium exposed population, skin exposure is the primary

**ISEE-663****Development of Historical Exposure Estimates for an Epidemiologic Study of Beryllium Sensitization and Chronic Beryllium Disease at a Beryllium Production Facility**

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**Background:** A number of epidemiologic studies have reported elevated prevalence of beryllium sensitization and chronic beryllium disease among employees in specific work processes. However, exposure-response relationships have been inconsistent, perhaps due to exposure misclassification from a lack of accurate, precise and/or biologically relevant estimates of historical exposures. In 1999, an epidemiologic study surveyed 264 workers hired after 1/1/1994 at a beryllium production facility.

**Methods:** Personal (full-shift) beryllium exposure data from a 1999 exposure survey ( $n = 3,906$ ) were used to obtain mean baseline exposure estimates (BEE) for 272 jobs in a job-exposure matrix (JEM). We used historical general-area air samples ( $n = 77,183$ ) collected between 1994 and 1999 to estimate the fractional annual change in exposure for 29 different work-process areas. The data were modeled using tobit regression to account for the left censoring of the air samples (17%–98% < detection limit). Historical job-level exposure estimates were calculated by applying the fractional annual change to the BEEs of jobs in the respective work-process areas. Workers were assigned exposure estimates based on their reported work for a given year and the locations of their jobs.

**Results:** The mean beryllium time weighted average BEEs for all jobs ranged from  $0.01 \mu\text{g}/\text{m}^3$  for Administration to  $28.01 \mu\text{g}/\text{m}^3$  for Atomizer Operator. Changes in exposure over time between 1999 and 1994 were observed in many of the work-process areas; some of these changes were non-linear and differed among work-areas. The overall median cumulative and average beryllium exposures were  $1.49 \mu\text{g}/\text{m}^3\text{-years}$  and  $0.62 \mu\text{g}/\text{m}^3$  respectively for participants over their work histories. The historical exposure estimates will be validated using limited personal exposure data collected between 1994 and 1998.

**Conclusions:** Using our JEM, exposure-response analyses can be explored over a range of exposure metrics, including summary measures such as cumulative, annual, or peak exposures, with the ultimate objective of elucidating an exposure-response relationship.

**ISEE-668****House Refurnishing Related Indoor Environmental Hazards and the Risk of Childhood Leukemia**

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**Background:** With living conditions improving in China, the purchase of new homes and furniture as well as interior decorating has become increasingly popular. Currently, as a new source of indoor pollution, the impact of environmental hazards from home decoration and furnishing materials on the health of children, especially on childhood leukemia, has been a great concern in China.

**Methods:** In order to evaluate the potential effects of interior decorating-related indoor environmental hazards on childhood leukemia, an exploratory case-control study was conducted in Shanghai, China, between November 2005 and August 2007. A total of 218 children aged less than

15 years with newly diagnosed acute leukemia (including 158 acute lymphoid leukemia (ALL) and 60 acute myeloid leukemia (AML) and 218 controls matched on gender, age, and hospital were included in this study. The data were obtained from face to face interviews of the mothers with detailed questions on home construction and furnishing materials related exposure and other potential indoor risk factors. Conditional logistic regression was used to estimate odds ratios and 95% confidence intervals (CI).

**Results:** There was a statistically significant association between childhood acute leukemia and the usage of furnitures with synthetic materials in the child's bedroom ( $OR = 1.43$ , 95% CI: 1.00–2.03), having television in the child's bedroom ( $OR = 1.49$ , CI: 1.03–2.16), and never using a kitchen ventilator ( $OR = 1.52$ , 95% CI: 1.09–2.12). Risk for leukemia was significantly elevated for closing the window and/or door while sleeping in winter, with the highest for both window and door closed ( $OR = 2.72$ , 95% CI: 1.53–4.81), and a moderately increase for either closing the window or door while sleeping in winter ( $OR = 2.12$ , 95% CI: 1.05–4.28). We also observed a significant association between childhood acute leukemia and other indoor hazards such as home insecticide use ( $OR = 1.68$ , CI = 1.22–2.32), and residing near a chemical factory ( $OR = 1.58$ , CI = 1.08–2.30) or a transformer of high voltage ( $OR = 1.58$ , CI = 1.08–2.30).

**Conclusions:** The results of this study support the hypothesis that house refurnishing related indoor environmental pollution is a risk factor for childhood leukemia.

**ISEE-670****The Effect of Heatwaves on Hospital Admissions for Renal Disease in Adelaide, South Australia**

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**Background:** Increases in morbidity associated with heatwaves have been well documented. During periods of extreme heat, the body's thermoregulatory adjustments can place stress on the kidneys and compromise the function of the renal system. However renal dysfunction as a consequence of heat-exposure is rarely investigated despite the fact that progression to acute renal failure (ARF) may have serious and life-threatening consequences. Those most at risk are the elderly and those with chronic medical conditions including diabetes.

**Objective:** This study aimed to determine if, in a temperate Australian climate where summer heatwaves are common, a relationship exists between exposure to extreme heat and hospital admissions for renal disease.

**Methods:** Data relating to hospital admissions in Adelaide, South Australia were collected for the period 1 January 1995 to 31 December 2006. Daily counts of admissions with principal discharge diagnoses of renal disease (ICD-10-AM N00-N39), ARF (ICD-10-AM N17) and renal dialysis not otherwise specified (ICD-10-AM Z49.1) were accessed. Diabetes (E10-E14) as a contributing diagnosis was also investigated as were other comorbidities including 'exposure to excessive natural heat' (ICD-10-AM X30) and 'effects of heat and light' (ICD-10-AM T67) collectively termed 'effects of heat'. Meteorological data were sourced from the Australian Bureau of Meteorology. Heatwaves were defined as being three or more consecutive days when daily maximum temperatures reached or exceeded  $35^\circ\text{C}$ . Using data from the warm season, conditional fixed effects Poisson regression models were used to quantify the association between admission counts and heatwaves, with the referent period being non-heatwave days. A goodness of fit test was applied to each model and if significant overdispersion was detected, a negative binomial regression model was fitted. Within years analyses accounted for long term trend.

**Results:** A total of 31 heatwaves were recorded over the study period including a four day period with temperatures exceeding  $40^\circ\text{C}$ . Our results

showed that admissions for renal disease were significantly increased during heatwaves compared to non-heatwave periods (IRR 1.10, 95% CI 1.00–1.21) with very elderly females (85+ years) having the highest estimate of effect (IRR 1.22, 95% CI 1.02–1.45). Significant increases were also observed for ARF admissions (IRR 1.26, 95% CI 1.04–1.52) with males aged 15–64 being most at risk (IRR 1.79, 95% CI 1.17–2.73). Hospitalizations for dialysis were not increased during heatwaves and having diabetes did not increase the risk of renal admission. Comorbid ‘effects of heat’ was however a significant risk factor.

**Conclusions:** Our results suggest that hospitalizations for renal disease and ARF are significantly increased during heatwaves. With heatwaves predicted to occur more frequently as a consequence of global warming and treatment options for renal diseases often being costly and resource intense, these findings could have notable implications for the public health sector. Health authorities may need to consider strategies for the mitigation of heat-related renal disease including health promotion programs to encourage adequate hydration during periods of extreme heat. Ongoing monitoring of renal morbidity is recommended to detect possible trends associated with climate change.

#### ISEE-671

##### Prenatal and Postnatal Exposure to Phthalates in Central Taiwan

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**Background:** Exposure to phthalates may bring adverse health effects, including reproductive and developmental abnormalities, among others.

**Methods:** We studied phthalate ester metabolites in pregnant women and their newborns in a perspective cohort from the general population. Eleven phthalate metabolites (MEHP, 5OH-MEHP, 2cx-MEHP, 5cx-MEPP, 5oxo-MEHP, MiBP, MnBP, MBzP, OH-MiNP, cx-MiNP and oxo-MiNP) representing the exposure to five commonly used phthalates (DEHP, DiBP, DnBP, BP, DiNP) were measured by fully automated LC-LC/MS-MS-system in urine, cord serum, and human milk in 100 pregnant women and their children aged 2–3 years and 5–6 years from Central Taiwan during 2001–2006. Metabolic rates of each metabolite from toxicokinetic studies were taken into account to estimate the original levels of parent compounds. Correlations among metabolites of the same parent compound were tested. Prenatal and postnatal exposures to phthalates in the young children were assessed.

**Results:** Urinary total phthalate metabolite concentration was found to be higher in 2-year-old children (geometric mean = 398.6 µg/L, 95% C.I.: 282.6–562.3) and 5-year-old children (333.7, 251.8–442.2) than the pregnant women (205.2, 172.7–243.8). The concentration of urinary phthalate metabolite was higher for DEHP metabolites (2yr old children: 200.3; 5yr old children: 152.3; pregnant women: 102.2), followed by MnBP (2yr: 100.4; 5yr: 75.1; p.w.: 72.3), MiBP (2yr: 17.2; 5yr: 25.2; p.w.: 12.5), and MBzP (2yr: 3.40; 5yr: 3.61; p.w.: 0.96). The proportion of DiNP (a phthalate widely used in toys and now used to replace DEHP) metabolites was higher in children urine samples than in adult samples (2y: 17.5; 5y: 27.7; p.w.: 1.71). Our urinary DEHP metabolite percentages were similar to the profiles reported in literature, except for a slightly lower 5OH-MEHP proportion. DiNP metabolite percentages varied among the three groups, and differed from those reported in literature. DBzP-derived metabolites are MBzP and MnBP. We observed no correlation between the concentrations of these two metabolites. We suspect that DnBP is probably contributing to the formation of MnBP. The concentrations of phthalate metabolites are much lower in cord blood samples (GM = 37.5, 95% C.I.: 33.8–41.5) and milk (14.9, 11.0–20.2)

compared to urinary samples. The compositions of the phthalate metabolites found in these matrices are also very different. DEHP metabolite levels in pregnant women urine samples and their corresponding cord blood samples are significantly correlated (Pearson correlations coefficients for 5cx-MEPP: 0.53,  $P < 0.01$ ; 2cx-MEHP: 0.44,  $P < 0.05$ ; 5OH-MEHP: 0.39,  $P < 0.05$ ; sum of DEHP-derived metabolites: 0.39,  $P < 0.05$ ).

**Conclusions:** Children presented higher metabolite levels than adults. Metabolites in urine are mainly from DEHP, followed by DEHP, DnBP/BBP, and then DiNP. The levels of DiNP metabolites found in children were much higher than in pregnant women. Although phthalate metabolite levels in milk and cord blood are low, cord blood metabolite levels are well correlated with maternal urinary metabolite level. DEHP metabolites may cross the placental barrier. Maternal urinary metabolite levels during pregnancy may be useful for prenatal exposure measurement to the offspring.

#### ISEE-673

##### Impact of Continuous Terrorism Missle Attacks on the Emotional and Physical Strength of the Local Population in Sderot, Israel

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**Background:** Sderot is a 24,000 population city located 1 km from the Israeli and Gaza strip border. Since 2001, the city and surroundings are subjected to continuous “Kassam” missiles (average of 3 missiles a day during 2006) leading to various reactions and property damages. Responses to traumatic events may involve intense fear, helplessness, horror, grief and anxiety along with physical and behavioral responses. When problems become worse or last longer, a person may be suffering from post-traumatic stress disorder, depression or anxiety disorders.

**Objective:** The aim of this study was to asses the changes of health services utilization along with diagnoses rates of anxiety depression and treatment use for these diagnoses, by the “Sderot’s” population treated by “Maccabi healthcare services” HMO, compared to matched “Offakim” population which is out of missile range.

**Materials and Methods:** Retrospective cohort study compared two populations exposed and unexposed to stress of missile attacks, based on analysis of computerized database of Maccabi HMO after approval of the Helsinki committee. Data collected from 2000 (year 2000 as baseline) to 2006 of all active Maccabi members Sderot and Offakim (5323 and 9518 respectively). Collected data included: demographic data, primary physician visits, PTSD, anxiety and depression diagnoses and anxiolytic antidepressant medication consumption (according to pharmacy sales). Data was analyzed by SPSS14. We used chi square and T-test analysis to compare proportions and means.

**Results:** Surprisingly, mild elevation of Primary physician visits was observed in Sderot between 2000 and 2006 (5.3 and 7.69 visits per year) compared to Offakim (4.52 and 9.04). Significance was reached during 2004–2006. Depression diagnoses rose between 2001–2006 from 0.8 to 6.2 in Sderot and 0.6 to 4.9 in Offakim reaching significance between city populations’ averages since 2003 ( $P = 0.001–0.0013$ ). Baseline and post exposure rates of anxiety diagnoses were significantly higher in Sderot compared to control, these rates increased from 3.4% and 2.1% in Sderot and Offakim respectively in 2000 to 16% and 9.4% during 2006. Rate of antidepressant use by adults: 1.6% and 2.1% of the population in Sderot and Offakim bought antidepressant drugs before the missile attacks during 2000 (NS). Antidepressant drug consumption rose to 5.5% and 2.8% favoring Sderot by 2006. ( $P = 0.001$  2005–6). Benzodiazepine anxiolytic drug prescription was assessed as multipliers of daily drug dose

DDD bought. The multiplier of DDD rose by 2.3 vs. 0.8 between 2000 and 2006. Inter city difference was significant in 2005–6 ( $P = 0.007$ ).

**Conclusions:** Severe chronic traumatic situation in Sderot was not associated with elevation of primary physician visits in the exposed population checked. Depression diagnosis and depression drug therapy became significantly higher among Sderot residents after 3–5 years of exposure. In the year of 2003 significant increase of in total “Kassam” missile attacks was observed. Anxiety disorders rates were higher pre and post exposure in the exposed group. Basic missed differences and bias between populations or therapists, concrete fear to leave home to visit the infirmary and ongoing projects favouring recognition and awareness of anxiety and depressive disorders are possible explanations for these results.

#### ISEE-675

#### Acute Exposure to Disinfection By-Products in Swimming Pools and Short-Term Changes in Respiratory Biomarkers

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**Background:** Exposure to disinfection by-products in swimming pools has been associated with respiratory symptoms suggestive of asthma and/or with altered levels of lung proteins in workers, professional swimmers and children. Evidence is inconclusive and effect mechanisms are not well understood.

**Objectives:** We conducted a study to measure respiratory biomarkers of inflammation (exhaled nitric oxide - $\text{FE}_{\text{NO}}$ ), oxidative stress (8-isoprostane), lung permeability and immunological response (surfactant protein -SP-D) and lung damage (Clara cell protein -CC16-) in healthy volunteers before and after swimming in a chlorinated pool.

**Methods:** We enrolled 48 non-smoking non-asthmatics adults (63% women) aged 18 to 50 years (mean 30) who acceded to swim in a chlorinated pool during 40 minutes, after one week without attending a pool. We collected blood and exhaled breath condensate (EBC), measured lung function and  $\text{FE}_{\text{NO}}$  using NIOX MINO before and after the exposure event. We measured CC16 and SP-D in serum and 8-isoprostane in EBC through ELISA (Enzyme-Linked Immuno Sorbent Assay). Lifestyle data, chronic respiratory symptoms, usual swimming habits and water use were collected through questionnaires. A food frequency questionnaire was collected to calculate antioxidant intake. We took daily pool water and air samples to measure trihalomethanes (THM), chloramines (water) and trichloramine (air). THM in exhaled air was measured in all the subjects before and immediately after the exposure.

**Results:** Preliminary results show that study subjects were exposed, with an average increase of THM in exhaled air of 800%. Median CC16 levels before and after swimming in a chlorinated pool were respectively 6.01 ( $\pm 0.39$ ) and 6.21 ( $\pm 0.44$ )  $\mu\text{g/l}$ , average increase 8%,  $N = 48$ , paired Wilcoxon test  $P$ -value = 0.03. This increase was more pronounced in individuals who had swum 900 meters or more (11% increase,  $P$ -value 0.02,  $N = 27$ ). The relative increase in CC16 level was correlated with distance swum (Spearman's  $r = 0.35$ ,  $P$ -value = 0.02). SP-D levels did not change after swimming (median levels before and after exposure were  $54.4 \pm 5.6$  and  $55.1 \pm 5.5 \mu\text{g/l}$ , respectively; average increase 4%,  $P$ -value difference 0.44,  $N = 48$ ). Median 8-isoprostane levels before and after exposure were similar ( $1.57 \pm 0.23$  and  $1.34 \pm 0.33 \text{ pg/ml}$ , respectively). Median  $\text{FE}_{\text{NO}}$  levels before and after swimming were respectively  $11 \pm 1.3$  and  $12 \pm 1.3 \text{ ppb}$  (average increase 1%,  $P$ -value difference 0.81,  $N = 47$ ). SP-D, 8-isoprostane and  $\text{FE}_{\text{NO}}$  levels were unaffected by distance swum. Baseline levels of the different biomarkers were not

correlated (Spearman's  $r \leq 0.1$ ). Trichloramine measurements, lung function analysis and antioxidant calculations are in progress.

**Discussion:** We showed a rapid increase in serum CC16 levels after 40 minutes of regular swimming in a chlorinated pool. This effect appeared to be stronger when the level of exercise was higher. This may point towards an acute respiratory epithelial injury. We could not demonstrate concurrent effects on biomarkers of airway inflammation, oxidative stress or immunological responses. Sample size and exposure level could be small to detect slight changes in other biomarkers. However, the experiment reflect a real exposure situation.

**Conclusion:** The mechanism of lung damage after exposure to a swimming pool seemed to be unspecific through CC16 and didn't involve  $\text{FE}_{\text{NO}}$ , 8-isoprostane and SP-D changes.

#### ISEE-676

#### Risk Factors for Respiratory Disease in Puerto Rican Adults

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**Background:** The population of Puerto Rican ancestry in the mainland United States has grown steadily over the last two decades. This group has the highest prevalence of asthma of any Latino national subgroup.

**Objective:** In this study, we examine variables associated with respiratory disease (RD) in a representative sample of Puerto Rican adults, aged 45–75 y, living in the Boston, MA metropolitan area.

**Methods:** Eligible participants were interviewed in the home by bilingual interviewers, in their language of choice. Participants were asked if they had been told by a physician that they had chronic RD. Depressive symptomatology was measured with the Center for Epidemiologic Depression Scale (CES-D), acculturation with the Psychological Acculturation Scale (PAS), and stressful events with the Perceived Stress Scale (PSS). Demographic data and health behaviors were captured by questionnaire.

**Results:** A total of 1168 (77.6% of eligible subjects) participants completed baseline interviews, and 899 participants with complete data are included in this analysis. 37% reported a diagnosis of RD. RD (y/n) was regressed onto a series of variables in logistic regression models. In a full model, with all variables adjusted for each other, RD with significantly positively associated with female sex (OR = 1.96; 95%CI = 1.38–2.77), depressive symptomatology (CES-D > 16, OR = 1.87; 1.38–2.54), and current (vs. never) smoking (OR = 1.59; 1.09–2.30). RD was negatively associated with light (OR = .69; 0.51–0.93) or moderate/heavy (OR = 0.39; 0.17–0.88) (vs. sedentary) physical activity, and > (vs. ≤) 8<sup>th</sup> grade education (OR = 0.73; 0.54–0.98). When CES-D, which was highly correlated with the PSS ( $r = 0.70$ ), was replaced in this model with the PSS, the latter was also significant ( $\geq$  median, 24, vs. lower, OR = 1.43; 1.07–1.90). Acculturation level, age, poverty status and past smoking were included, but were not significant. However, PAS  $\geq$  (vs. <) 20 approached significance ( $P = 0.06$ , OR = 1.35 (0.98–1.85), as did poverty status ( $P = 0.06$ , OR = 1.33; 1.0–1.80).

**Conclusions:** Together, these results suggest that respiratory disease is most prevalent in Puerto Rican women, smokers, those with lower education, and those who have lived in the US mainland for a longer time. Because this analysis is cross-sectional, the direction of causality between RD and perceived stress, depressive symptomatology, and sedentary lifestyle cannot be determined. Longitudinal studies are needed to both better understand the etiology and consequences of the high prevalence of RD in this population.

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ISEE-677**Air Pollution Effects on Birth Weight in Connecticut and Massachusetts**

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**Background:** Low birth weight is an important predictor of infant's health. Several studies found associations between mother's exposure to air pollution and increased risk of low birth weight or other pregnancy outcomes such as preterm delivery, while other studies did not. This inconsistent result might be attributed to inadequate control for confounders, insufficient sample size, differences in populations or study design, or other factors. Furthermore, many of these epidemiological studies were conducted in Southern California or outside of the U.S., with fewer studies conducted in the Eastern U.S. We investigated the association between air pollution and birth weight in Connecticut and Massachusetts over a four year period for  $\text{SO}_2$ ,  $\text{NO}_2$ , CO,  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  using identified risk factors as confounders. Earlier work found lower birth weight to be associated with mother's exposure to air pollutants. This study performs sensitivity analysis to further investigate the robustness of our results.

**Methods:** All registered births in Connecticut and Massachusetts from 1 January 1999 to 31 December 2002 were obtained ( $n = 495,260$ ). Air pollution exposure was assigned as the average county-level concentration over gestation and each trimester based on mother's residence. After combining these data sets and excluding births that did not satisfy our study criteria, such as gestational length <32 weeks or >44 weeks, the study included 358,504 births. Analysis included linear models with birth weight as a continuous variable for gestational and each trimester exposure, and logistic models for low birth weight (<2500 gm) for gestational exposure. We adjusted for gestational length, prenatal care, type of delivery, child's sex, birth order, weather, year, and mother's race, education, marital status, age, and tobacco use. We conducted analyses for two-pollutant models for all pairs of pollutants that did not co-vary, and for analysis of a dataset including only first births. As a sensitivity analysis on our earlier work, we restricted observations with 37 to 44 gestational weeks to avoid inclusion of preterm births. Previously, we examined two-pollutant models, however not all observations have data for all pollutants. In this study, we investigated two-pollutant models by estimating effects with and without co-pollutant adjustment based on a dataset with data available on the two pollutants of interest.

**Results:** Results indicate that the original findings were robust to the sensitivity analyses. Gestational exposure to  $\text{NO}_2$ , CO,  $\text{PM}_{10}$ , and  $\text{PM}_{2.5}$  were linked to lower birth weight and results were statistically significant. An interquartile increase in gestational exposure to  $\text{NO}_2$ , CO,  $\text{PM}_{10}$ , and  $\text{PM}_{2.5}$  lowered birth weight by 8.9 gm (95% confidence interval 7.0, 10.8), 16.2 gm (12.6, 19.7), 8.2 gm (5.3, 11.1), and 14.7 gm (12.3, 17.1), respectively. Results by trimester were also similar to those of the original analysis. In logistic regression, an interquartile increase in gestational exposure to  $\text{NO}_2$  and  $\text{PM}_{2.5}$  increase the odds ratio of being low birth weight by 2.7% (0.2, 5.1) and 5.4% (2.2, 8.7), respectively.

**Conclusions:** Results indicate that exposure to air pollution, even at low levels, may increase risk of low birth weight. Average concentrations for all pollutants in our study were below the EPA standards.

positive tests were classified as acute (<16 days), recent (<200 days), and non-recent (>200 days).

**Methods:** Our research investigated three methods for creating maps to show HIV incidence rates. An incident case was defined as an acute or recent positive HIV test within a 3-month period. The results from this research help to evaluate which methods should be used in real-time HIV mapping. The first method for creating incidence maps treated the test results as hard data. In each zip code, the sum of incident cases was divided by the number of tests and assigned to that zip code's centroid. The second method treated observed rates as soft data, or an interval of possible values, where the interval size depended on the number of tests. This method gives more weight to zip codes with a large number of tests. The third method used a Bayesian approach that treated each zip code's HIV prevalence as a prior distribution for the incidence rate, creating soft data with a smaller variance. In all three methods the rate was mapped using the Bayesian Maximum Entropy method of non-linear spatiotemporal geostatistics.

**Discussion:** Using hard data is not very effective for creating a map of HIV incidence. The low number of tests by zip code often leads to unstable estimates of the true rate. By using an interval of possible rates, one can obtain a much smoother map of HIV incidence and if the historic rate of positive cases is used as additional information one obtains what is probably the most realistic depiction of the disease. Due to the low prevalence of HIV, many of the zip codes included very few tests and their results do not represent the true incidence rate. Therefore, interval soft data should be used in lieu of raw rates. One should be aware that the term incidence is being used roughly. In this context, a new case is defined as a positive test within a 3-month period where the actual date when a case contracted the disease cannot be known. Even with these limitations, using soft data for HIV provides a smoother map which can be used by the state to identify areas of concern as well as show how HIV rates are changing over time.

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ISEE-685**Chronic Exposure to Benzene in Indoor Air**

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**Background:** Indoor residential air in Alaska has been shown to have higher concentrations of benzene than what is found in other states. This is associated with the high benzene content of gasoline (3.5–5%) in Alaska and the presence of attached garages.

**Methods:** Using the property tax database that identified homes with attached garages, 2000 homes were randomly chosen to participate in a survey of health conditions of residents and a measurement of indoor benzene in the home. Of particular interest were diagnoses of asthma or allergy and the association of these conditions with chronic exposure to benzene at concentrations exceeding the ATSDR maximum for chronic exposure (3ppb).

**Results:** The response rate for the random recruitment was greater than 30%. Respondents were asked to display a passive vapor monitoring badge in their home for one week noting the day and time of opening and closing the badge. More than one third of the homes measured had benzene levels higher than 3ppb average. Duplicate samples and field blanks insured the quality of the data. The results will be presented.

**Conclusion:** This study demonstrates an inexpensive way to do large scale monitoring for volatile organic compounds in indoor air.

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ISEE-679**Methods for Space/Time Mapping of HIV Incidence Rates in North Carolina**

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**Background:** The state of North Carolina maintains a database of results from HIV tests that include date and zip code of test. Starting in 2003,

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ISEE-688**Prevalence and Psychiatric Co-Morbidity of Self-Reported Electromagnetic Field Sensitivity in Taiwan: A Population-Based Study**

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**Background:** Environmental illness has been demonstrated to be crosslinked with psychiatric disorders. No published population-based studies have investigated the relationship between electromagnetic hypersensitivity and psychiatric morbidity.

**Objective:** In this study, we aimed to investigate the prevalence and characteristics of people with self-reported electromagnetic field sensitivity (SREMFS), especially the psychiatric co-morbidity, in adult population of Taiwan.

**Methods:** Questions regarding hypersensitivity to EMF were included in a telephone survey of environmental health risk perception. Participants were adults selected from nation-wide households registered in the database of the computer-assisted telephone interviewing (CATI) system via two-stage geographically stratified systematic sampling. A total of 1251 persons successfully completed telephone interviews administered by trained interviewers (response rate = 17.76% and cooperation rate = 32.5%). Data analyses were conducted among subjects with complete information ( $n = 1197$ ). SREMFS was defined as self-referred to be "Allergic or very sensitive to getting near any electromagnetic field". SREMFS questions included presence of electromagnetic hypersensitivity, their most sensitive EMF sources, and severity of hypersensitivity (with a four-point Likert scale). People with psychiatric morbidity were identified by a screening questionnaire, the Brief Symptom Rating Scale-5 (BSRS-5), with a cutoff score at 6. Sample weight was adjusted according to age, gender and geographical distribution of nation-wide population. Statistical analyses were performed using STATA 8.0 (StataCorp, 2003).

**Results:** The prevalence of SREMFS in Taiwan (13.4%, 95% C.I. = 11.4–15.3) was higher than that of Western countries. The psychiatric co-morbidity rate among people with SREMFS was 28.8% (95% C.I. = 21.6–36.0). Dose-response relationship existed between percentage of psychiatric morbidity and severity of SREMFS. No statistical significance in gender, geographical area, education, and marital status between individuals with SREMFS and those without SREMFS. Associated risk factors for SREMFS included age above 65 (OR = 0.20, 95% C.I. = 0.08–0.56), poor self-reported health condition (OR = 6.03, 95% C.I. = 1.99–18.22), unable to work (OR = 2.09, 95% C.I. = 1.21–3.60), as well as psychiatric morbidity (OR = 2.18, 95% C.I. = 1.43–3.33) after controlling for all other factors using multiple logistic regression. We further restricted the analyses on people with SREMFS in the severe end. Age and unable to work became borderline significant, while psychiatric morbidity (OR = 4.68, 95% C.I. = 2.50–8.78) remained statistically significant in their relationship with SREMFS.

**Discussion and Conclusion:** This study demonstrated that people with psychiatric morbidity were more likely to report hypersensitivity to EMF after controlling for the risk factors including age and working status. The effect of psychiatric morbidity on SREMFS needs to be studied further.

#### ISEE-692

#### Assessment of Self-Pollution of School Buses with Various Retrofit Technologies

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**Background:** In the United States, millions of children commuting by school buses are likely exposed to exhaust from the buses and other on-road vehicles. Studies have shown that the time spent on or near these diesel-powered buses lead to high exposures of vehicle-related pollutants. Our previous studies of bus's self-pollution demonstrated elevated concentrations of PM<sub>1</sub>, ultrafine particle counts, elemental and organic carbon on the bus than those in the roadway. We further identified crankcase emissions as the predominant source of bus's self-pollution.

**Methods:** In summer 2006, we conducted a comprehensive monitoring campaign in Seattle, WA, to further examine levels of self-pollution and efficiencies of various engine retrofit configurations in 6 school buses (9 different configurations), with and without crankcase ventilation (CCV) and/or diesel oxidation catalysts (DOC). Each bus drove along a residential route simulating stops, 4 runs with windows closed or and another 4 runs with windows open. PM<sub>2.5</sub> and its constituents were monitored in the bus and on a LV. In addition, we collected concurrent source samples from the tailpipe exhaust and crankcase vent using two on-board dilution tunnels while buses were on the road. We used source sampling to characterize chemical profile and the lead vehicle (LV) and the dual tracers methods to estimate self-pollution attributable to diesel exhaust from the tailpipe, PM from crankcase emissions, and exhaust from other on-road sources.

**Results:** Our results show higher in-bus PM<sub>2.5</sub> concentrations when windows were closed ( $31.3 \pm 16.2 \mu\text{g}/\text{m}^3$ ; windows open =  $26.3 \pm 8.1 \mu\text{g}/\text{m}^3$ ). Higher PM<sub>2.5</sub> levels were observed in older buses ( $32.2 \pm 15.1 \mu\text{g}/\text{m}^3$ ) than newer ones ( $24.6 \pm 7.7 \mu\text{g}/\text{m}^3$ ). In newer buses, CCV retrofit alone resulted in as much reduction (~48–63%) in the on-bus PM<sub>2.5</sub> levels as the combination of CCV and DOC (~40–71%). For older buses, DOC alone achieved most of the reduction in PM<sub>2.5</sub> on the bus, with marginal reduction in PM<sub>2.5</sub> with the addition of CCV. These findings are validated and self pollution levels are estimated using the LV method. Source contributions and chemical profiles are examined using the dual tracer method and source samples.

#### ISEE-693

#### Modeling Personal Exposures to Various Components of Fine Particulate Matter from Different Sources in Southern California

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**Background:** Recent studies have shown associations between adverse respiratory and cardiovascular health effects and measured or modeled estimates of air pollutant concentrations of traffic origin. However, little is known about the validity of these outdoor concentrations as an estimate for personal exposure to traffic. Moreover, most studies do not take into account activity patterns and exposure in different locations.

**Methods:** Personal exposures of 63 children with asthma ages 9–18 yrs were assessed for 10 days in 2003/2004 in two different areas of Southern California. Each child carried an active personal DataRAM in a backpack to measure continuous PM<sub>2.5</sub> (particulate matter <2.5  $\mu\text{m}$ ) and 24-hr PM<sub>2.5</sub>, EC (elemental carbon), OC (organic carbon) and NO<sub>2</sub> (nitrogen dioxide). Each child completed an electronic time-place-activity diary every two waking hours. One of the 4 children's homes was also monitored for 24-hr PM<sub>2.5</sub>, EC and OC using Harvard Impactors (HI). Identical measurements were also taken daily at the respective central sites. We developed multilinear regression models to predict outdoor exposures to PM<sub>2.5</sub>, EC and OC and compared them with the personal measurements.

**Results:** The model fit ( $R^2$ ) for home outdoor estimates was 0.94, 0.74 and 0.80 for PM<sub>2.5</sub>, EC and OC, respectively. These outdoor estimates showed good agreement with the personal measurements for PM<sub>2.5</sub> ( $R^2 = 0.68$ ). However, outdoor estimates for EC and OC were not related or were poorly related to personal measurements ( $R^2 = 0.22$  and

0.08, respectively). Home outdoor estimates, therefore, are not appropriate for estimating personal daily exposure to traffic-related air pollutants such as EC and OC and hence personal activities and other microenvironments also need to be considered. On a daily basis, the subjects spend most of the time indoors (87%, combined home and school) compared to 5% in traffic/transit. Primary indoor sources of PM<sub>2.5</sub> were identified as cooking, use of stove/grill, cleaning and pets. Opening of windows, age of homes, and AC use also affected the personal and indoor concentration of the measured pollutants. We then developed multilinear regression models to predict personal exposures to traffic-related pollutants based on their concentrations and time spent in various microenvironments. Geographic and meteorological parameters are incorporated in the models and results are adjusted for autocorrelation between repeated measurements.

#### ISEE-695

#### Exposure to Ultrafine Particles and Noise During Cycling and Driving in 11 Dutch Cities

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**Background:** Recent studies have suggested that exposures during traffic participation may be associated with adverse health effects. Traffic participation involves relatively short but high exposures. Potentially relevant exposures include ultrafine particles (UFP) and noise. The main source of UFP is motorized traffic.

**Methods:** Simultaneously, detailed real time exposure of UFP and noise has been measured while driving and cycling 12 predefined routes of approximately 15 minutes duration. These measurements were performed in 11 medium sized Dutch cities between August 31st and October 9th 2006. Potential predictor variables that have been collected include meteorological data, exact time, GPS coordinates, type of road, traffic intensity, passing cars and mopeds while cycling.

**Results:** Concentrations of UFP varied substantially between routes and within routes. UFP concentration patterns were characterized by short-term (typically less than 10 seconds) sharp increases in concentrations. Mean UFP concentrations per sampling day varied from 15,150 particles/cm<sup>3</sup> to 35,206 particles/cm<sup>3</sup>. The 98 percentile varied between 50,548 and 126,548 particles/cm<sup>3</sup>. On average median UFP were 11% higher while driving in a car compared to cycling. However, higher short-term peaks of UFP have been measured during cycling. High UFP concentrations occurred, especially in the following situations: passing mopeds (increase of 91% (95% CI: 69–117) and passing cars (+24% (95% CI: 21–27), waiting for a traffic light (+27% (95% CI: 24–30) and a railway crossing (+45% (95% CI: 28–65). The number of observations was small for passing mopeds (90 sec) and railway crossings (79 sec). Correlations between UFP and noise were low (0.10–0.30) for 1-second averaging time and moderate (0.20–0.50) when 1-minute averages were compared.

**Conclusion:** Higher median UFP concentrations were measured in a car compared to cycling the same route. Higher short-term peaks of UFP have been measured when cycling. The health effects of these short-term peaks of UFP concentrations have not been studied sufficiently. Different factors were associated with high UFP and high noise exposures.

#### ISEE-696

#### Spatial Implications of Covariate Adjustment on Patterns of Risk: Respiratory Hospital Admissions in Christchurch, New Zealand

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Christchurch, New Zealand; and §University of Otago, Christchurch, New Zealand.

**Background:** Epidemiological studies that examine the relationship between environmental exposures and health often address other determinants of health that may influence the relationship being studied by adjusting for these factors as covariates. While disease surveillance methods routinely control for covariates such as deprivation, there has been limited investigative work on the spatial movement of risk at the intraurban scale due to the adjustment. It is important that the nature of any spatial relocation be well understood as a relocation to areas of increased risk may also introduce additional localised factors that influence the exposure-response relationship. This paper examines the spatial patterns of relative risk and clusters of hospitalisations based on an illustrative small-area example from Christchurch, New Zealand.

**Methods:** A four-stage test of the spatial relocation effects of covariate adjustment was performed. First, relative risks for respiratory hospitalisations from 1999 to 2004 at the census area unit level were adjusted for age and sex. In three subsequent tests, admissions were adjusted for annual exposure to particulate matter less than 10 mm in diameter (PM<sub>10</sub>), then for a deprivation index, and finally for both PM<sub>10</sub> and deprivation. Spatial patterns of risk, disease clusters and cold and hot spots were generated using a spatial scan statistic and a Getis-Ord Gi statistic.

**Results:** In all disease groups tested (except the control disease), adjustment for chronic PM<sub>10</sub> exposure and deprivation modified the position of clusters substantially, as well as notably shifting patterns and hot/cold spots of relative risk. Adjusting for PM<sub>10</sub> and/or for deprivation shifted clusters in a similar spatial fashion. In Christchurch, the resulting shift relocated the cluster from a purely residential area to a mixed residential/industrial area, possibly introducing new environmental exposures.

**Conclusion:** Researchers should be aware of the potential spatial effects inherent in adjusting for covariates when considering study design and interpreting results.

#### ISEE-698

#### Cadmium and Breast Cancer Risk

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**Background:** Cadmium is a known human carcinogen based on findings of lung cancer in exposed populations. A more controversial target site for cadmium is the human mammary gland, for which some studies indicate a link between cadmium exposure and cancer. Some authors suggest that cadmium is a new environmental estrogen that mimics the effects of estradiol in estrogen-responsive breast cancer cell lines.

**Objective:** The objective of the study was to examine cadmium concentration in breast tissue of patients with breast cancer and non-malignant breast tumor.

**Materials and Methods:** Cadmium was analyzed in breast tissue of 21 breast cancer patients and 19 benign tumor patients. Two samples of breast tissue from each patient, i.e. tumor and some healthy tissue close to tumor were taken for the analysis. Cadmium was determined by atomic absorption spectrometry (Perkin-Elmer, Zeeman 3030). Information on smoking habits, number of pregnancies and children, use of hormones was obtained by questionnaire.

**Results:** In breast cancer patients mean cadmium concentration was 33.1 ng/g (95% CI = 21.9–44.4) for tumor sample and 10.4 ng/g (95% CI = 5.6–15.2) for healthy breast tissue sample ( $P = 0.002$ ). In benign tumor patients the figures were following: 17.5 ng/g (95%

CI = 8.4–26.5) and 11.8 ng/g (95% CI = 5.1–18.5) ( $P = 0.3144$ ). Cadmium concentration found in the sample of malignant tumor differed significantly from that in the sample of benign tumor ( $P = 0.009$ ). Almost two times higher concentration of cadmium found in breast cancer patients with estrogen positive receptors, but the difference was not statistically significant (43.1 ng/g, 95% CI = 24.3–61.8, vs. 29.3 ng/g, 95% CI = 9.4–49.2,  $P = 0.098$ ). Content of cadmium in cancer patients was not related to smoking.

**Conclusions:** The data obtained show higher content of cadmium in tumor sample of breast cancer patients than that in healthy tissue sample. The metal concentration in malignant tumor is significantly higher than that in benign tumor. More data on the subject are necessary to determine difference in cadmium concentration according to estrogens receptor level or smoking.

#### ISEE-699

##### **GerES IV: Contact Allergies in Children - More Prevalent than Previously Thought**

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**Background:** Contact allergens are substances often found in the private domain and hence also in the environment of children. It has long been assumed that contact allergies are extremely rare in children. Recent studies have shown, however, that type-IV sensitizations and manifest contact allergies occur relatively often in childhood. Available estimates of the prevalence need to be improved. Children may be exposed to contact allergens as a result of personal behaviour, for example in the case of body piercings or when using fragrance-containing body care products and detergents, or perfume. They may also come into contact with type-IV allergens at home or at school. Examples of this include the use of disinfectants, aromatic candles, perfume oil, do-it-yourself products such as multiple-component glues and the like. Due to its high health-relevance, the issue of contact allergies and possible causative factors in children's environment was included in the German Environmental Survey for Children (GerES IV), which was carried out jointly with the German Health Interview and Examination Survey for Children and Adolescents (German acronym: KiGGS) conducted by the Robert Koch Institute.

**Methods:** GerES IV used a randomly selected sub-sample of the KiGGS study, which was carried out from 2003 to 2006. The sub-sample consisted of a total of 1790 children (907 girls and 883 boys) 3 to 14 years of age from 150 locations. Data on the prevalence of allergic contact eczemas was collected by a questionnaire addressed to the children's parents as part of the KiGGS study. Information on possible exposure sources, such as the use of household chemicals for example, was generated by an "environmental questionnaire" as part of GerES IV.

**Results:** The lifetime prevalence of allergic contact eczemas among the children, based on information provided by their parents, was 9.4% of all participants. The evaluation showed that personal influencing factors such as the use of certain products at home (e.g. disinfectants) or certain modes of behaviour (e.g. body piercings) have a clear influence on the prevalence of contact allergies among children. For some influencing factors, an association with the occurrence of contact allergies was found only for certain age groups or a certain gender.

**Discussion:** Like type-I allergies, contact allergies are more prevalent in children from western than from eastern Germany. The use of disinfectants in the children's homes showed a significant correlation for all age groups and both genders. The exposure to tobacco smoke seems to have a significant influence on contact allergies, albeit in an unexpected way: exposure to environmental tobacco smoke and prevalence of contact allergies are significantly negatively correlated. This gives rise to the question whether exposure to environmental tobacco smoke might have an immunosuppressive effect or whether parents of children that have a

contact eczema are less apt to smoke (possibly for the sake of their children).

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#### ISEE-700

##### **Hazard Identification of Environmental Pollutants by Combining Results of Ecological and Biomarker Studies: An Example**

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**Objective:** Linking exposures from environmental pollutants with adverse health effects is difficult because these exposures are usually low-dose and ill-defined. According to several investigators, a series of multidisciplinary, multilevel studies is needed to address this problem. Ecological studies are a first step in the identification of a public health problem associated with a suspected environmental exposure. Based on their results hypotheses for more targeted studies are created in order to confirm the association.

**Materials and Methods:** Publicly available, national databases were used for the ecological and targeted studies in this example. Spring wheat, grown in Minnesota, Montana, North Dakota, and South Dakota, is treated for at least 85% of its acreage with chlorophenoxy herbicides. Ecological studies investigated rates of birth malformations and mortality from cancer, ischemic heart disease, and diabetes during the 1980's and 1990's in rural, agricultural counties of these four states. Wheat acreage per county was used as a surrogate for exposure to chlorophenoxy herbicides. In a subsequent more targeted study based on NHANES III data, recent exposure to the chlorophenoxy herbicide 2,4-D, as indicated by presence in the urine, was investigated in association with changes in lipid profile and glucose metabolism.

**Results:** Results from the ecological studies showed that in counties with a high level of wheat agriculture, levels of adverse effects were increased in comparison to low-wheat counties. Examples of statistically significant increases for cancer mortality among men, age 65 and over, were: pancreas 33%, prostate 23%, larynx 58%. Increased birth malformations for combined boys and girls were observed for circulatory/respiratory (65%) and musculoskeletal/integumental (50%) malformations. Infant death from congenital malformations among boys in high wheat counties was more than double the rate in low-wheat counties. Significantly increased mortality from acute myocardial infarction was observed for ages 25–85+ among men (30%) and women (25%), and from type 2 diabetes for ages 45–85+ among men (24%) and women (17%). Analyses of NHANES III data are ongoing. The results are expected to increase our understanding of the causal path between environmental exposures to chlorophenoxy herbicides and disease.

**Conclusions:** The low resource-intensive methods developed in these studies can be used to link observed increases of many diseases with environmental pollutants.

**Disclaimer:** This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

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#### ISEE-701

##### **Indoor Air Pollution and Cognitive Functioning in Children Effect Modifier of GSTP1 Gene**

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**Objective:** Indices of a neurological effect of air pollution have recently been published. Chronic exposure to low levels of indoor air pollution continues to be a public health concern. We aim to examine the association between early-life exposure to gas appliances and indoor

nitrogen dioxide ( $\text{NO}_2$ ) exposure and cognitive outcomes in preschoolers, and to assess the influence of GSTP1 polymorphisms.

**Methods:** Children (n = 418) from a prospective population-based birth cohort in Menorca (Spain) were assessed at the age 4 years. The McCarthy Scales of Children's Abilities (MCSA) was administrated.  $\text{NO}_2$  was measured with passive diffusion tubes placed in the living room for 2 weeks when infants were 3 months old. Information about gas appliances systems was obtained by questionnaire. Genotyping was conducted for the coding variant Ile105Val from GSTP1. Multivariable linear regression models were used to measure the association between indoor pollution and cognitive outcomes.

**Results:** Exposure to gas appliances was inversely associated with global cognitive ( $\beta = -5.11$ , 95% CI  $-9.34$ ,  $-0.89$ ), verbal ( $\beta = -6.27$ , 95% CI  $-10.68$ ,  $-1.86$ ), and executive function scores ( $\beta = -5.56$ , 95% CI  $-9.90$ ,  $-1.22$ ) with a dose-response relationship between the number of gas appliances and cognitive scores. Adjustment by parental social class or education did not confound these associations. A non-statistically significant negative association between  $\text{NO}_2$  as continuous variable (log transformed) and cognitive outcomes was found (general cognitive:  $\beta = -0.57$ , 95% CI  $-1.99$ ,  $0.86$ ; verbal:  $\beta = -0.73$ , 95% CI  $-2.20$ ,  $0.75$ ; executive function:  $\beta = -1.19$ , 95% CI  $-2.65$ ,  $0.27$ ). Children with GSTP1 Val-105 allele were at higher risk of  $\text{NO}_2$  effects (general cognitive:  $\beta = -2.73$ , 95% CI  $-4.79$ ,  $-0.67$ , P for interact. 0.010; verbal:  $\beta = -2.84$ , 95% CI  $-4.94$ ,  $-0.73$ , P for interact. 0.009; executive function:  $\beta = -3.38$ , 95% CI  $-5.43$ ,  $-1.32$ , P for interact. 0.001).

**Conclusion:** Early life exposure to indoor air pollution from gas appliances reduced cognitive functioning among preschoolers. Children with GSTP1 Val-105 allele were at higher risk of the neurocognitive effects of  $\text{NO}_2$  exposure.

#### ISEE-702

#### Cancer Incidence and Mortality Among Workers Exposed to Benzidine and 3,3-Dichlorobenzidine

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**Background:** Benzidine is classified as a human carcinogen by the US Environmental Protection Agency (EPA), National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC) and production has been banned in the United States since 1973. Although 3,3-dichlorobenzidine (DCB) has been shown to increase cancer risk in animals, occupational cohorts exposed to DCB but not benzidine are rare, making it difficult to determine human carcinogenicity. DCB, currently categorized as a probable human carcinogen, is still produced in China, India, Japan, South Korea and Germany and used widely around the world for manufacturing dyes.

**Objectives:** To assess cancer risk among former workers in a chemical production facility in Connecticut employed from 1945–1993. A total of 1,678 workers were ever employed at the facility—970 were employed between 1945 and 1965 when both benzidine and DCB were produced. The facility voluntarily ceased production of benzidine in 1965 after several cases of bladder cancer were identified among workers. Workers (n = 708) employed at the facility between 1966 and 1993 and were exposed to DCB but not benzidine.

**Methods:** Exposures were estimated using job exposure matrices and urinary monitoring data. Cancer incidence and mortality were determined using the National Death Index, the Connecticut Tumor Registry, the Social Security Administration and data collected by the Johns Hopkins Bladder Cancer Monitoring Program. Standardized incidence ratios (SIRs) were calculated using incidence rates from the State of Connecticut for comparison. Workers were categorized into exposure groups (high, medium, low, none) for the analyses. Survival Analyses were performed

using the SAS Cox proportional hazard regression model taking into consideration potential confounders such as age at hire, and year of hire.

**Results:** Previous studies reported a total of 68 cancers in this cohort, 15 of which were bladder cancer. Additional follow-up of 29 and 17 years, for the 2 exposure groups respectively, identified a total of 349 cancers including 36 cases of bladder cancer. Among workers exposed to both benzidine and DCB, SIRs for all cancers as well as cancer of the bladder and heart were significantly elevated and risk increased with increasing exposures. SIRs for cancer of the brain, breast, esophagus, liver, tongue, leukemia and non-Hodgkins lymphoma were also elevated but not significantly. Among workers exposed to DCB but not benzidine, SIRs for cancer of the bladder, brain and central nervous system, and tongue were all significantly elevated. The risk for cancers of the bladder and brain increased with increasing exposures. SIRs for cancers of the heart, testis, pancreas, prostate and non-Hodgkins lymphoma were also elevated in these workers, but not significantly.

**Conclusion:** Results from this study support previous findings of a significantly increased risk of bladder cancer among workers exposed to benzidine and DCB, and DCB without benzidine. These results also indicate that exposure to benzidine and DCB are associated with increased risks for cancers other than cancer of the bladder.

#### ISEE-703

#### Exposure to Perfluorooctanoate (PFOA)-Contaminated Drinking Water Resulted in Increased PFOA Plasma Concentrations—a Biomonitoring Study from Arnsberg, Germany

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**Objective:** In Arnsberg, Germany, Perfluorooctanoate (PFOA)-contaminated drinking water had been supplied to 40,000 residents. A human biomonitoring study was performed to assess internal exposure of Arnsberg's residents to 6 perfluorinated compounds (PFC) in comparison to reference areas.

**Study design:** 170 children (5–6 years old), 317 mothers (12–49 years) and 204 men (18–69 years) took part in the cross-sectional study.

**Methods:** Lifestyle factors and drinking water consumption habits were assessed by questionnaire and interview. PFOA, perfluorooctanesulfonate (PFOS), perfluorohexanoate (PFHxA), perfluorohexanesulfonate (PFHxS), perfluoropentanoate (PFPA) and perfluorobutanesulfonate (PFBS) in blood plasma and PFOA/PFOS in drinking water samples were measured by solid phase extraction, HPLC and MS/MS detection.

**Results:** PFOA-concentrations in drinking water ranged between 0.5 and 0.64  $\mu\text{g/L}$ . PFOA-levels in blood plasma of residents living in Arnsberg were 4.4–8.3 times higher compared to the reference populations (ratios based on geometric means: children 22.1/4.8  $\mu\text{g/L}$ , mothers 23.4/2.8  $\mu\text{g/L}$ , men 25.3/5.8  $\mu\text{g/L}$ ). Consumption of tap water at home was a significant predictor of internal exposure to PFOA in Arnsberg. PFHxS-concentrations were significantly increased in Arnsberg compared to the respective reference areas ( $P < 0.05$ ). PFBS was detected in 33% (4%, 13%) of the children (women, men) in Arnsberg compared to 5% (0.7%, 3%) in the reference areas ( $P < 0.05$ ). Associations of internal exposure to PFC with age and other regressors are reported.

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**ISEE-705****Environmental Health Indicators for the Metropolitan Area of Guadalajara, Mexico**

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**Objective:** To identify a system of indicators used to determine Environmental Health in Guadalajara's Metropolitan Area such as City Sprawl in order to identify priority action measures to be taken.

**Materials and Methods:** The methodology we used was based on the model proposed by Corvalán (2000) for establishing Environmental Health indicators which include driving forces, and pressure, state, exposure and effect indicators for each of the action measure indicators. Whereas Guadalajara is behaving as a city with accelerated growth and expansion (urban sprawl), Driven Force indicators were developed considering the three components identified by Ehrlich (1971) which are associated to the manner in which the population grows, its consumption patterns and the technology it uses; these in turn generate diverse pressure factors that impact the deterioration of air, water and food quality as well as the organization of life in the city, resulting in health and organizational risks whose consequences are increased morbidity and mortality rates.

**Results:** The main guideline followed for establishing indicators was the driving force of technology, with transportation technology, both private and public, as one of its main components, and whose pressure is greater in diesel-consuming vehicles for public transportation. In the case of private vehicles, their age is one of the driving force as 40% of the approximately one million vehicles circulating daily in Guadalajara use highly-polluting technology. The environmental state indicators which were established evidenced that in more than half of the urban area, air pollution by particulates is a significant problem as the yearly average is above the established limits. Exposure indicators are related to the city's inhabitants and the consequences considered for this study are those pertaining to morbidity and mortality related to respiratory and cardiovascular diseases and automobile accidents, which have doubled in the past 10 years.

**Conclusions:** Due to the patterns of growth in Guadalajara's metropolitan area, pressure factors and negative consequences on health, as well as a marked deterioration in quality of life have shown a marked increase. It is acknowledged that due to its rapid urbanization rate and population concentration, dangerous patterns in growth, production and land use are emerging, giving rise to pollution problems as well as irreversible losses of the area's natural heritage and of the population's quality of life and health.

**ISEE-707****Model Estimates of Arsenic Exposure and Dose and Evaluation with 2003 NHANES Data**

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**Background:** Many studies have revealed that chronic arsenic (As) exposure may be linked to various cancers, cardiovascular disease, diabetes, peripheral artery diseases, and other diseases. Modeling human exposure from dietary and drinking water ingestion of As and evaluating model predictions using real-world urine biomarker data is important for conducting source-to-effects analyses.

**Methods:** We applied EPA/ORD's Stochastic Human Exposure and Dose Simulation (SHEDS) dietary module to estimate As exposure from dietary and drinking water using the following data: (a) direct and indirect drinking water (16,934 person-days) and 30 day fish consumption recall data (2106 person) from the 2003 NHANES, (b) As food residue data from FDA, and (c) As concentrations in drinking water of 25 states

reported from the Natural Resources Defense Council (Feb. 2000). The exposure distributions were then used as inputs for the calculation of target tissue doses employing the Physiologically Based Pharmacokinetic (PBPK) module of MENTOR (Modeling Environment for Total Risk studies). This offers the advantage of allowing estimation of biologically relevant doses as well as model evaluation against biomarker measurements (i.e., urinary total and speciated As concentrations from 2003 NHANES).

**Results:** Analyses show: 1) the average, 95<sup>th</sup> and 99<sup>th</sup> percentiles of exposure are 0.37, 1.39 and 4.63 µg/kg/day respectively, which are very comparable with As intakes from the NHEXAS duplicate food study (0.185, 0.612 µg/kg/day for mean and 95<sup>th</sup>); 2) the main contribution to the exposures are fish, shellfish, rice, and beer; and 3) shellfish and seafood consumptions are statistically correlated with urine biomarker, arsenobetaine data from 2003 NHANES and rice with total As, Dimethylarsinic (DMA) and Monomethylarsonic (MMA).

**Conclusions:** Results show that on a population basis, the linked SHEDS — MENTOR PBPK model overpredicted DMA and MMA, but predicted the total Arsenic in urine very well (slope = 1.4 and R<sup>2</sup> = 0.91 with logarithmic transformation for R<sup>2</sup>).

**Disclaimer:** Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-709****Polybrominated Diphenyl Ethers in Maternal Blood from Mexico, Canada and the USA**

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**Background:** In 1994, the three North American countries entered into two continental agreements critical to furthering the scope of trade and environment among Canada, Mexico and the USA. In parallel with the North American Free Trade Agreement, a North American Agreement on Environmental Cooperation was finalized. This resulted in the establishment of the North American Commission for Environmental Cooperation (CEC), and its Sound Management of Chemicals (SMOC) program. The SMOC program has been tasked with implementing trinational efforts to reduce the risks of exposure to toxic substances related to human health and the environment in the three countries.

**Objective:** This project was established to enhance the capacity of Mexico to monitor Stockholm Convention Persistent Organic Pollutants (POPs) and selected toxic metals and to enable Mexico to meet its international monitoring requirements under international treaties such as the Stockholm convention on POPs. This project has also allowed the development of compatible human biomonitoring data for the three North American countries. Previously data on conventional POPs and metals in maternal blood have been presented. This is the first assessment of the polybrominated diphenyl ether (PBDE) data in this project.

**Methodology:** This project utilizes a sampling protocol that results in a simple convenience sample. Each country used slightly different methods for population selection although samples are comparable since the same inclusion criteria were used. Study subjects were recruited from five Canadian cities between December 2005 and August 2007; ten Mexican cities (November 2005 and February 2006) and from NHANES (2003–2004) in the USA. Inclusion criteria for the mothers were ages between 15 and 40 years, first pregnancy, and resident in the country for more than ten years. Mothers who develop pre-eclampsia, eclampsia, gestational diabetes, placental abruption, placenta previa or any other disease during pregnancy that significantly affects maternal or child health were excluded from sampling. Samples of maternal blood were collected toward the end of the third trimester. They were collected according to the

agreed sampling protocols and analyzed at two laboratories which participate in inter-laboratory round robins for various POPs including PBDEs.

**Results:** At the present time only data for Canada and Mexico are available. Four PBDE congeners (#47, 99, 100, 153) were measured in the maternal samples. In the Mexican maternal samples less than 33% had measurable levels of any these PBDEs while PBDEs 47 and 153 were detectable in 82 and 86% of the Canadian maternal samples. PBDE 47 was the congener found at the highest concentrations which ranged from 9.9 in Canadian mothers to 3.2 µg/kg lipid in the Mexican mothers. The second most prominent congener was PBDE 153 and this congener was also found at the highest concentration in the Canadian mothers (3.7 vs 1.0 µg/kg lipid).

**Conclusion:** The prevalence of PBDE congeners and their respective concentrations is higher in Canadian than Mexican mothers. This data will be compared to levels in the national United States NHANESurvey and levels elsewhere in the world.

#### ISEE-712

#### Traffic-Related Air Pollution, Climate, and Prevalence of Eczema in Taiwanese Schoolchildren

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**Background:** The prevalence of childhood eczema, a common skin disorder, is increasing in many countries. Epidemiological studies, however, say little of its association to outdoor air pollution and climate factors.

**Materials and Methods:** We conducted a nationwide survey of middle-school students in Taiwan from 1995 to 1996. The 12-month prevalence of eczema was compared with air monitoring station data of temperature, relative humidity, sulfur dioxide, nitrogen oxides ( $\text{NO}_x$ ), ozone, carbon monoxide (CO), and particulate matter with an aerodynamic diameter of less than 10 micrometers.

**Results:** A total of 317,926 children attended schools located within two kilometers of 55 stations. Prevalence rates of recurrent eczema were 2.4% and 2.3% in boys and girls, respectively, with prevalence rates of flexural eczema 1.7% in both sexes. After adjustment for possible confounders, flexural eczema was found to be associated with traffic-related air pollutants (RR 1.09, 95% CI 1.00–1.19 in boys; RR 1.12, 95% CI 1.04–1.22 in girls), including  $\text{NO}_x$  and CO. Recurrent eczema was associated with traffic-related air pollution only in girls. There were no associations for the highest monthly means of temperature, while the annual means and the lowest monthly means of temperature were negatively related to flexural eczema, but only in girls. The lowest monthly mean relative humidity was positively related to eczema. Compared with recurrent eczema, we also found that the effects of outdoor factors were larger on flexural eczema in both sexes.

**Conclusion:** The results suggest that air pollution and climatic factors, which showed stronger associations in girls than boys, may affect the prevalence of childhood eczema.

#### ISEE-717

#### Phthalate Metabolites and Asthma in Urban Minority Girls

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**Background:** Asthma is a chronic respiratory condition that affects more than six-million U.S. children, making it one of the most common diseases of childhood. Epidemiological data show that the prevalence of asthma has increased markedly since the 1980s and while its etiology is not completely understood, environmental factors such as second hand smoke, dust mites, and chemical toxins have been associated with the frequency and severity of symptoms. Phthalates, which are respiratory toxins, are present in many consumer products as well as many common household materials such as plastics and fragrances. Given the rising rates of asthma and the universality of human exposure to phthalates, we are investigating the relationship between phthalate exposure and asthma among young girls.

**Methods:** Growing Up Healthy (GUH) is a prospective cohort study of Hispanic and Black, New York City girls between 6 and 8 years old. GUH is part of a NIEHS/NCI funded consortium (Breast Cancer and the Environment Research Centers) of three centers across the U.S. At baseline, parents/guardians were interviewed in-person, in either English or Spanish, about the girls' environmental exposures, physical activity, medical history, and demographics. Doctor diagnosed asthma and asthma-related symptoms were ascertained. Anthropometric measurements, using a standardized protocol, were made by trained interviewers. Casual urine samples provided by each girl were analyzed by the Centers for Disease Control and Prevention for a panel of environmental exposure biomarkers, including 9 phthalate metabolites. The molar sums of low and high molecular weight phthalate metabolites, (LoMWP:mEP, mBP, miBP and HiMWP:mBzP, mCPP, mEHP, mEHHP, mEOHP, mECPP, respectively) were calculated. Cross-sectional analysis using baseline data was conducted for this report. Age/race-ethnicity/BMI adjusted geometric means for each phthalate metabolite as well as LoMWP and HiMWP were compared between girls with and without reported asthma or asthma-related symptoms using generalized linear models. Adjusted geometric means (nmoles/ml) and 95%CI are presented.

**Results:** Data from 398 girls were available for analysis from 412 girls enrolled at baseline. Adjusted geometric means for HiMWP were significantly different for doctor diagnosed asthma [Yes: 1.058 (0.821–1.362 vs. No: 0.801 (0.686–0.935));  $P = 0.05$ ], cough at night not associated with a cold [Yes: 1.031 (0.824–1.290) vs. No: 0.784 (0.667–0.923);  $P = 0.04$ ], and at least one of four reported asthma-related symptoms [Yes: 0.976 (0.811–1.174) vs. No: 0.757 (0.630–0.908);  $P = 0.04$ ]. There were no LoMWP geometric mean differences for any of the asthma-related symptoms or doctor diagnosed asthma.

**Discussion:** Our results are supported by a reported relationship between DEHP in household dust and asthma or other respiratory problems as well as a suggested a link between phthalate containing PVC flooring/plastic wall material and respiratory problems, both among children. Public concern about phthalate exposure and child health has been growing mainly due to detrimental reproductive effects observed in animals. These results highlight another possible health effect that has not yet been well studied.

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**ISEE-718****Acute Cardio-Respiratory Effects of SO<sub>2</sub> and NO<sub>2</sub> Exposure in Southern Israel—a Case-Control Design for Data Collection and Analysis**

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**Background:** The impact of SO<sub>2</sub> and NO<sub>2</sub> on population health is growing, due to increasing industrialization.

**Objective:** To measure the effects of ambient SO<sub>2</sub> and NO<sub>2</sub> on cardiac and respiratory emergency department (ED) patient load.

**Methods:** Half-hourly values for NO<sub>2</sub> and SO<sub>2</sub> concentration, temperature, precipitation, and wind direction from 18 regional monitoring stations between January 2000 and December 2006, were pooled by consecutive 12-hour periods. Outcome data, based on ICD-9 codes, included acute cardiac and respiratory admissions to a regional ED. Cases and controls were periods with the highest and lowest ED patient volumes, respectively. For each 12-hour period, pollutant concentrations were introduced as independent exposure variables. Measurements during case and control periods were compared using logistic modeling to estimate the effects of pollutants on the risk of high-volume ED periods, adjusting for additional air quality parameters. Poisson regression addressed the number of daily admissions, enabling evaluation of the risks associated with single-unit increases in pollutant concentration.

**Results:** Logistic regression analysis of the 2000–2004 data subset demonstrated that NO<sub>2</sub> and SO<sub>2</sub> concentrations were higher during case periods than during control periods: OR = 1.45 (95%CI 1.09–1.93) for SO<sub>2</sub> and OR = 2.34 (95%CI 1.69–3.23) for NO<sub>2</sub>. The strongest specific association was found between NO<sub>2</sub> exposure and acute respiratory ED outcomes (OR = 1.82, 95%CI 1.28–2.58). Poisson regression demonstrated similar associations, expressed as relative risks: RR = 1.002 (95%CI 1.001–1.003) for NO<sub>2</sub> and RR = 1.0065 (95%CI 1.0028–1.0102) for SO<sub>2</sub>.

**Conclusion:** Increased cardio-respiratory patient load associated with SO<sub>2</sub> and NO<sub>2</sub> concentrations is a marker of these pollutants' impact on population health.

pollution episodes and the potential for cost savings through a strategy of pollution abatement.

**Results:** Substantial regional variation was observed for all pollutants. A decreasing trend in SO<sub>2</sub> concentrations, with a marked drop in 2004, coincides with the conversion of a regional power plant from crude oil to natural gas. NO<sub>2</sub> concentrations were substantially lower on weekends than on weekdays. NO<sub>2</sub> and SO<sub>2</sub> concentrations were lower in the summer months than during other seasons. The logistic model utilized in the exploratory case-control investigation yielded an association between NO<sub>2</sub> values and emergency department patient volume for acute cardiovascular complaints (OR 1.065, 95%CI 1.009–1.124). The model also demonstrated that overall cardio-respiratory Emergency Department (ED) visits were associated with NO<sub>2</sub> and SO<sub>2</sub> concentrations: OR = 1.45 (95%CI 1.09–1.93) for SO<sub>2</sub> and OR = 2.34 (95%CI 1.69–3.23) for NO<sub>2</sub>. The strongest specific association was found between NO<sub>2</sub> exposure and acute respiratory ED outcomes (OR = 1.82, 95%CI 1.28–2.58). No effect was observed for PM<sub>2.5</sub>.

**Conclusion:** In this study area, which is characterized by low levels of air pollution, the increased cardio-respiratory patient load associated with SO<sub>2</sub> and NO<sub>2</sub> concentrations is a marker of these pollutants' impact on population health. These methods and initial results will provide the basis for further analyses of pollution-related health effects. The development of advanced analytical capabilities is crucial for future assessment of extensive health-related databases.

**ISEE-721****Overview of Participatory Method to Change Hygiene and Sanitation Behavior in the African Region**

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**Background:** The participatory hygiene and sanitation transformation (PHAST) methodology was introduced as a pilot project in seven African countries (Botswana, Ethiopia, Kenya, Mozambique, Tanzania, Uganda, Zimbabwe) in 1993 as a joint effort of WHO, UNICEF, UNDP and the World Bank. The objective was to boost health benefits attributed to community water supply and sanitation and ensure the sustainability of water supply and sanitation facilities. Since then several countries have adopted PHAST as a tool for hygiene behavioral changes and community management of water supply and sanitation projects.

**Methods:** A step-by-step guide with defined activities was developed for community health workers to introduce the PHAST methodology. The guide demonstrated the relationship between sanitation and health status, improved hygiene behaviors and community management of water and sanitation facilities. Different kinds of drawings, charts and visual materials were used to facilitate discussion with the community group. Participatory tool kits that reflected the actual cultural, social and physical characteristics of the communities were produced on-site with the help of local artists. A small learning group of less than 40 persons was selected among the communities and trained in participatory methods to initiate community action. Group members mobilized the community by creating awareness to improve behaviors of hygiene and sanitation and to own and manage their water and sanitation facilities.

**Results:** The participatory approach made people to feel more confident about themselves and their ability to make health and environmental improvement in their communities by organizing themselves. There was increased understanding and good communication with the extension health workers during group training which boosted the image of the trainers. At community and household level frequent hand-washing and improved water transportation and storage was practiced. Communities took full responsibility for their water supply and sanitation facilities and contributed for the construction, operation and maintenance of their water points including monitoring and evaluating their own progress. This resulted in the reduction of the outbreak of waterborne diseases particularly cholera in communities hard hit by epidemics in the past.

**ISEE-719****Designing a Methodology to Measure the Health Effects of Air Pollution in Southern Israel: Estimation of Attributable Morbidity, Mortality and Healthcare Consumption**

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**Background:** In Israel, research of the health effects of air pollution, while still limited, is rapidly developing.

**Objectives:** Quantification of air pollution exposure through geo-mapping, correlation with hospital and community-based health outcomes, and cost-benefit evaluation of treatment versus pollution abatement.

**Methods:** Air quality data collected from 18 regional monitoring stations from January 2000 through December 2006 are being used to construct interpolation maps of SO<sub>2</sub>, NO<sub>2</sub>, and PM<sub>2.5</sub> concentrations. Health outcomes are being evaluated using a historical-prospective study design to describe the association between pollution episodes and diagnosis-specific emergency department admissions, community clinic visits and selected pharmacy purchases. A cost-benefit analysis will explore the cost of treating the short-term health effects of

**Discussion:** In a social environment where people have different beliefs and cultural taboos on health and sanitation issues the PHAST method proved to be effective in raising the profile of sanitation and hygiene resulting in improvement of the health status in the communities. Most of the countries that are applying the method did not carry out baseline surveys at the beginning of the process which made it difficult to provide quantitative epidemiological evidence on health impact. There is a need for systematic monitoring and documentation of the changes that are taking place by the community itself. The PHAST method also requires considerable financial, material and financial resources for training of facilitators and production of tool kits including visual aid materials. This demands supportive government policy, adequate budgetary allocation, institutional commitment and the collaborative efforts of NGOs, external support agencies and sector related organizations.

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**ISEE-723****Estimating Daily PM<sub>2.5</sub> Exposure in Massachusetts with Satellite Aerosol Remote Sensing Data, Meteorological, and Land Use Information**

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**Discussion:** In this analysis, we present a flexible two-level GAM model to predict daily PM<sub>2.5</sub> concentration in a domain centered at Massachusetts with GOES AOD data and various meteorological and land use parameters. The two levels in the GAM model are designed to capture the temporal and spatial variabilities in PM<sub>2.5</sub> concentrations, respectively. The predicted PM<sub>2.5</sub> concentrations have a correlation coefficient of 0.89 with EPA observations, and the overall model relative error is 30%. The cross-validation R<sup>2</sup> (0.50–0.91, average 0.79) is very close to the model R<sup>2</sup>(0.79), indicating that the model has a stable structure without significant overfitting. The estimated spatial distribution of annual PM<sub>2.5</sub> concentrations in the modeling domain shows elevated pollution levels at densely populated urban areas and also along major inter-state highways. The estimated seasonal average PM<sub>2.5</sub> concentrations are in general highest in the summer with an overall gradient from south to north, which reflects the influence of long-range transport of the precursor gases. Although the overall PM<sub>2.5</sub> level is the lowest in winter, model predicts the greatest spatial heterogeneity and several hot spots with the highest seasonal mean PM<sub>2.5</sub> concentrations. This model can be used to expand ground monitoring network, therefore improve the capabilities of epidemiological study to capture particle health effects. It can be combined with other spatial modeling techniques such as GIS-based spatial models in order to capture the sub-pixel spatial variability of PM<sub>2.5</sub>. Other parameters such as large point sources and more refined traffic information are also likely to further improve model performance. These possibilities will be explored in future research.

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**ISEE-724****The Effects of Fine Particulate Matter on Daily Mortality in Japan: Comparison of Case-Crossover Analysis and Time-Series Analysis Using Generalized Additive Model**

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**Background:** While there are consistent evidence indicating the short-term effects of particulate matter on daily mortality in North America and Europe, the heterogeneity in its health effects by region has been observed. In Japan, suspended particulate matter (SPM), particles less than 10 µm in aerodynamic diameter with a 100% cut-off level, which is assumed to consist mainly of PM<sub>2.5</sub>(50% cut-off), was regularly monitored

and the association between SPM and daily mortality was observed. Recently, the working group set up by the Japanese Ministry of the Environment released a report examining the effects on health outcomes for PM<sub>2.5</sub>. We evaluated the short-term effects of both SPM and PM<sub>2.5</sub> on daily mortality in 20 cities in Japan from 2002 to 2004. In this study, we compared the results obtained by case-crossover analyses (CC) to those obtained by generalized additive model (GAM).

**Methods:** We used daily mortality data obtained from the Ministry of Health, Labour, and Welfare of Japan. Air pollution and meteorologic data in 20 cities in Japan were obtained from the National Institute for Environmental Studies and Japan Meteorological Agency, respectively. We analyzed the data using time-stratified CC and GAM to evaluate the association between daily mean concentration of PM<sub>2.5</sub> and the daily mortality. Estimated relative risks were adjusted for ambient temperature, relative humidity, NO<sub>2</sub>, and photochemical oxidant routinely measured in the monitoring system in Japan. Then, we combined the area-specific results using meta-analysis with random-effect model.

**Results:** The daily mortality for the elderly aged 65 and over varied from 1 to 127 by city. The mean daily concentration of PM<sub>2.5</sub> and SPM in each city ranged from 11.8 to 22.8 µg/m<sup>3</sup> and from 13.7 to 39.4 µg/m<sup>3</sup>, respectively. In the city-specific analyses, the point estimates were similar, but the variances of the estimates obtained by CC were larger than those obtained by GAM. When we compared the combined values, CC showed higher point estimates and larger variances than GAM. At lag3 and lag4, we observed significant negative associations between PM<sub>2.5</sub> and mortality in GAM while not in CC.

**Conclusions:** These findings add evidence about the short-term effects of air pollutants on daily mortality in Japan. The effects of fine particulate matter on all-cause mortality were subtle in Japan. We need to take into account of the differences in estimates by statistical models when we interpret the effects which are expected to be small.

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**ISEE-725****An Approach to Lowering Children's Susceptibility to the Combined Lead and Cadmium Nephrotoxicity Associated with Environmental Exposure to These Metals**

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**Objectives:** To find out whether renal damage in children associated with combined toxicity of cadmium and lead can be attenuated with a complex of bioprotectors.

**Material and Methods:** In 2004 and 2005 we examined 3 to 7 year old preschool children from four towns in the Middle Urals (Russia), three towns being polluted by the copper industry. Only those children were included into the studied groups who had no known renal disease. Urinary concentrations of Cd and Pb, and of beta-2-microglobulin (B2u) were measured in 89 children in the 2004 cohort, and 184 in the 2005 cohort. A case control study design was used to evaluate the association between B2u levels and body burdens of Pb and Cd as measured by their urinary levels. "Cases" were defined as those with B2u levels above the median and "controls" as those at or below the median. In 2006 we examined 38 children aged 3–7 (without exclusion those with any renal symptoms) in the fifth town polluted with emissions from a big copper smelter. Beside the abovementioned exposure and renal effect indices, we performed liquid crystallography of urine. All the tests were performed just before and immediately after the 5 weeks period during which the children were being given the bio-protective complex comprising pectin, glutamate, a multivitamin-multimineral medicine, and a calcium supplement, which

complex had been earlier shown to protect laboratory rats against Cd-Pb nephrotoxicity.

**Results:** Both 2005 and 2006 cohorts demonstrated a statistically significant association between Cd and Pb levels and the probability of having a B2u level above the median. The adjusted odds ratios (ORs) per  $\mu\text{g/L}$  were 1.89 (1.13–3.16,  $P < 0.02$ ) for Cd and 1.19 (95% CI 1.07–1.31,  $P < 0.001$ ) for Pb in the 2004 cohort. The ORs were 1.13 (95% CI 1.04–1.22,  $P < 0.03$ ) for Cd and 1.03 (95% CI 1.02–1.05, p300  $\mu\text{g/L}$ ) but many children were found to have micro-urolithiasis seen with the polarization microscopy (in 86.8% of children) which revealed also the formation of birefringent lipoprotein crystals characteristic of renal membranolysis of different extent (in 100%) and the presence of an albuminous ring around the microscopy preparation (in 65.7%). One third of the group had abnormally high urine specific gravity ( $>1025$ ). After the bio-protective intervention the prevalence of all these indices has statistically significantly ( $P < 0.05$ ) diminished.

**Conclusions:** (a) Our study suggests that urinary cadmium and lead concentrations characteristic of children living in polluted areas may be associated with incipient (mostly sub-clinical) renal damage in some of them. (b) A clear beneficial renal effect produced by a combination of bio-protective agents previously proven in an animal experiment to be inhibitors of cadmium/lead nephrotoxicity may be considered as additional circumstantial evidence of this association.

#### ISEE-727

##### Air Pollution and the Risk of Oral Clefts

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**Background:** To assess the relations between exposure to ambient air pollution and the risk of cleft lip with or without cleft palate (CL/P), we conducted a population-based case-control study in Taiwan.

**Methods:** All 653 cases of CL/P from 721,289 newborns in 2001–2003 in Taiwan and a random sample of 6530 control subjects from the source population were selected. We used routine air-pollution monitoring data for sulfur dioxide ( $\text{SO}_2$ ), nitrogen oxides ( $\text{NO}_x$ ), ozone ( $\text{O}_3$ ), carbon monoxide (CO), and particles with an aerodynamic diameter of 10  $\mu\text{m}$  or less ( $\text{PM}_{10}$ ). The exposure parameters were calculated, using geographic information system, from the mean monthly averages during the first three months pregnancy. The effect estimates were presented as odds ratios (ORs) per 10 ppb changes for  $\text{SO}_2$ ,  $\text{NO}_x$ , and  $\text{O}_3$ , 10 pphm changes for CO, and 10  $\mu\text{g/m}^3$  changes for  $\text{PM}_{10}$ .

**Results:** The risk of CL/P was increased in relation to the first (adjusted odds ratio (OR) = 1.20, 95% confidence interval (CI): 1.02, 1.39), and second gestational month  $\text{O}_3$  levels (adjusted OR = 1.25, 95% CI: 1.03, 1.52) in the range from 14.4 ppb to 50.3 ppb.

**Conclusion:** The risk of CL/P was not related to CO,  $\text{NO}_x$ ,  $\text{SO}_2$  and  $\text{PM}_{10}$ .

#### ISEE-728

##### GerES IV: The Quality of Drinking Water from German Homes with Children

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**Background:** The German Environmental Survey (GerES) is a large scale population study which has been carried out repeatedly since the mid-1980s. Main objectives are to generate, update and evaluate representative data. The GerES IV is the first survey focussing solely on children. It was performed in conjunction with the German Health Interview and

Examination Survey for Children and Adolescents (KiGGS) by the Robert Koch Institute (RKI), Berlin.

**Methods:** In GerES IV 1,790 children aged 3- to 14-years were selected randomly to represent a subsample of the cross-sectional sample ( $N = 17,641$ ) of KiGGS. The participants of GerES IV lived in 150 sampling locations all over Germany. Field work was carried out from May 2003 to May 2006. Among other investigations, samples of drinking water were taken in the children's homes and were analysed for elements which may enter drinking water via the domestic water distribution system (cadmium, lead, copper, nickel) as well as for uranium. Water samples were taken from the taps from which the survey participants or their parents usually draw water for cooking and drinking purposes. In the interests of standardisation, water was sampled without forerun (first draw samples), after a stagnation period in the water pipe for at least four hours during the night (0.5 l sample volume). In addition, random samples (1 l) were taken from the same tap in accordance with the German recommendation on the "Evaluation of drinking water quality with respect to the parameters lead, copper and nickel".

**Results:** Average concentrations (geometric means) in the first draw and random samples were 1.47  $\mu\text{g/l}$  and 0.61  $\mu\text{g/l}$  for lead, 0.055  $\mu\text{g/l}$  and 0.021  $\mu\text{g/l}$  for cadmium, 161  $\mu\text{g/l}$  and 69.9  $\mu\text{g/l}$  for copper, 4.48  $\mu\text{g/l}$  and 2.48  $\mu\text{g/l}$  for nickel, and 0.155  $\mu\text{g/l}$  and 0.169  $\mu\text{g/l}$  for uranium. These average concentrations were low compared to the limit values of the German Drinking Water Ordinance. However, 0.9% of the first draw samples and 0.4% of the random samples contained lead concentrations higher than 25  $\mu\text{g/l}$ . For copper, concentrations above 2000  $\mu\text{g/l}$  were determined in 3% of the first draw samples and in 1% of the random samples. Nickel concentrations higher than 20  $\mu\text{g/l}$  were measured in 9.4% of the first draw samples and in 1.8% of the random samples. Nevertheless, no significant correlations could be observed between lead, cadmium and nickel in the tap water and in blood or urine samples, which were additionally taken from the children. However, the situation is different for uranium. There is a comparatively low but significant correlation ( $r = 0.32$ ) between the concentrations of uranium in urine and in drinking water.

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#### ISEE-729

##### Prenatal Exposure to Organochlorine Compounds and Thyroid Hormone Levels in a Prospective Mother-Infant Cohort Study in Valencia, Spain

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**Background:** Certain organochlorine compounds (OC), including some polychlorobiphenyls (PCBs) and pesticides, can alter thyroid function during critical periods of thyroid hormone-dependent brain development. The aim of the present study was to investigate the association of maternal serum concentrations of p,p'-DDE, hexachlorobenzene (HCB), and the sum of 7 PCB congeners (PCB 28, 52, 101, 118, 138, 153, 180) with thyroid hormone status.

**Material and Methods:** A total of 855 mother-infant pairs were recruited between 2003 and 2005 in Valencia, Spain, as a part of the Spanish Environment and Child's Health (INMA) Project. Thyroid stimulating hormone (TSH), total

triiodothyronine ( $TT_3$ ), and free thyroxine ( $FT_4$ ) were measured as biomarkers of thyroid function in 158 maternal serum samples at 12 weeks of pregnancy. OC compound concentrations were measured by gas chromatography coupled to electron capture detection in the same samples. Mothers with hormone disease were excluded from this study. Values of thyroid hormones (THs) and OC concentrations were transformed by natural logarithm to obtain normally distributed variables. THs were treated as continuous variables and TSH as dichotomous variable, with a cutoff point for the first trimester of pregnancy of  $2.5 \mu\text{U}/\text{mL}$ . OC levels were treated as continuous variables and also as categorical variables (categorized into quartiles and  $<50$ ,  $50-90$ ,  $>90$  percentiles). Linear regression analysis was used to evaluate the association between maternal serum concentrations of contaminants and TH levels, and logistic regression analysis to evaluate the relationship between these compounds and TSH. Models were adjusted for variables associated with TH levels in bivariate analyses at a significance level of  $\leq 0.20$ , i.e., maternal age, race, country of birth, marital status, education, pre-pregnancy body mass index, gestational age at time of sample collection, parity, smoking habit, and alcohol and caffeine consumption at 12 weeks.

**Results:** Serum  $TT_3$ ,  $FT_4$ , and TSH concentrations ranged from 1.20 to  $4.30 \text{ nmol/L}$ , 8.30 to  $17.30 \text{ pmol/L}$ , and 0.04 to  $8.61 \mu\text{U}/\text{mL}$ , respectively. Geometric mean serum OC values ( $\pm$ standard deviation) were  $1.28 (\pm 2.30) \text{ ng/mL}$  for p,p'-DDE,  $0.92 (\pm 2.15) \text{ ng/mL}$  for sum of PCBs, and  $0.26 (\pm 3.25) \text{ ng/mL}$  for HCB. A significant negative association was found between serum p,p'-DDE categories and  $\ln FT_4$  levels [ $P_{50-90}$ :  $\beta = -0.05$ , 95% CI =  $-0.09$  to  $-0.01$ ,  $P = 0.024$ ;  $P_{>90}$ :  $\beta = -0.07$ ; 95% CI =  $-0.14$  to  $-0.01$ ;  $P = 0.026$ . Mothers with TSH levels  $>2.5 \mu\text{U}/\text{mL}$  had higher p,p'-DDE levels ( $P_{50-90}$ : OR =  $0.52$ , 95% CI =  $0.50$  to  $5.60$ ,  $P = 0.403$ ;  $P_{>90}$ : OR =  $1.83$ ; 95% CI =  $1.43$  to  $27.03$ ;  $P = 0.015$ ) after adjustment for confounders. No association was found between sum of PCB congeners or HCB and THs.

**Conclusions:** The results show that serum concentrations of p,p'-DDE have no effect on  $TT_3$  levels but are associated with a decrease in  $FT_4$  levels and an increase in TSH levels. These findings suggest that some environmental chemicals may interfere with the thyroid system of pregnant women with possible detrimental effects on the neurologic development of their newborns, given the importance of thyroid hormones in brain development.

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#### ISEE-735

##### High Urine Specific Gravity among Clean Room Workers

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**Background:** In low humidity environments, workers may have excessive body water loss through epidermal evaporation, which can lead to dehydration. Before the development of clinical symptoms and signs, concentrated urine may be applied as an indicator of dehydrated status. We used urine specific gravity (USG) as a biomarker to evaluate the hydration status of workers working in such a controlled environment.

**Material and Methods:** We collected the urine samples from workers of a TFT-LCD plant during their annual health examination. The relative humidity was  $55 \pm 5\%$  in clean rooms in the plant and  $85 \pm 5\%$  in regular offices and outdoors was. We recruited workers in those clean room as the exposure group ( $N = 2957$ ), and defined the remaining workers, including administration office workers, as the comparison group ( $N = 1232$ ). The prevalence of abnormally concentrated urine (defined as USG  $> 1.030$ ) and related factors were compared between these two groups.

**Results:** While the exposure group were younger and had shorter employment durations compared to the comparison group ( $P < 0.05$ ), they had a higher prevalence of abnormally concentrated urine ( $P < 0.01$ ). After adjusting for age, gender, employment duration, and body surface area, we found that working in the clean room with a low humidity environment was associated with an odds ratio (OR) of  $2.69$  (95% confidence interval [CI]: 1.55 to 4.67) of having abnormal concentrated urine. Drinking water more than  $2000\text{cc}$  per shift was found to be a protective factor for concentrated urine. (OR =  $0.43$ ; 95%CI =  $0.20-0.93$ ).

**Conclusion:** USG is a good biomarker for evaluating the hydration status of workers working in relatively low humidity environments, who need proper protection and adequate fluid supply to prevent excess water loss and its adverse health effects.

#### ISEE-741

##### Development of an Asthma Education Program for Chinese Immigrant Children

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**Abstract:** A series of research projects in Boston Chinatown led to an understanding of the prevalence of childhood asthma and the relative lack of knowledge about the disease in the community. These studies showed that asthma prevalence was much lower among children born in China than it was among children born in the US and that there were problematic issues with the translation of some key concepts, such as the word wheeze, into Cantonese. Pilot data also suggest that exposure to major highways adjacent to Boston Chinatown might be contributing to asthma prevalence. The findings led to a collaboration between Tufts Medical Center and the Josiah Quincy Elementary School, which has developed and implemented an asthma education program, including curriculum and materials that are culturally and linguistically appropriate to the Chinese population focusing on the recognition, longitudinal management and treatment of asthma. The curriculum and materials (children's book, DVD) were specifically tailored to the Chinese community both in their content and written/spoken language. The program is designed to promote self-management skills in children with asthma through a series of educational sessions and to evaluate the impact of the program by following pre- and post-education school absence data for asthmatic students over a three-year period and administration of a satisfaction survey to determine efficacy.

#### ISEE-742

##### The Use of Exposure-Response-Functions within Integrated Assessments for Policy Decision Support—A European Perspective

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**Background:** All recently adopted environmental directives of the European Union dealing with pollution and climate control have been justified with a cost benefit analysis, that shows that the costs of implementing the directive is lower than the monetized benefits, especially the avoided health impacts. Furthermore, when deciding about energy and transport policies, their appraisal uses monetized estimations of the environmental and health impacts of the consequences of these decisions. The methodology used to provide these estimations is the ExternE or impact pathway approach (IPA). Starting with the definition of a policy scenario, emissions of pollutants to air, water and soil are quantified, then available exposure-response-relationships are used to quantify health impacts. Chronic mortality occurring after long term exposure or with latency is expressed in reduced life expectancy or life years lost rather

than number of cases. Results are time and space dependent, i.e. depend on where and when the release of harmful substances occurs. To be able to add or compare health risks with each other and with other damage categories, e.g. biodiversity loss, the different health endpoints are converted in a common monetary unit, basically by using contingent valuation, i.e. by asking people about their willingness to pay to avoid a specific risk. Averaged and aggregated results for the EU27 in Euro per ton emission are 9500€/t for NH<sub>3</sub>, 5600€/t for NO<sub>x</sub>, 6100€/t for SO<sub>2</sub> and 24,400€/t for PPM<sub>2.5</sub>.

**Discussion:** In the paper this methodology is described, especially the use of concentration-response-relationships and exposure-response-relationships. The features that this relationships should have to be useful for integrated assessments are described. One major contributor to impacts is PM, however uncertainties and knowledge gaps about which fraction of PM is how harmful exist. Furthermore, the role of NO<sub>2</sub> is unclear and co-factors and conglomerations are under investigation. Thus sensitivity analyses with different assumptions have to be made. This is shown for two policy relevant analyses: (1) future electricity generation: to identify the most promising technologies for electricity generation, the total (internal plus external) costs including monetized health impacts of emissions of pollutants from the whole life cycle are estimated. In this case, the variation of the ERF does not provoke major changes in the ranking of the technologies. (2) Efficient PM<sub>10</sub> control strategies: results depend extremely on assumptions about the toxicity of different substances. If, according to the WHO recommendation, all anthropogenic primary and secondary PM is treated equally, then measuring like reducing ammonia emissions from manure and fertilizer use become efficient. On the other hand, the use of particulate filters in Diesel automobiles is only efficient, if soot is more toxic than other PM species. The latter example shows, that epidemiological studies should be designed in such a way, that statements about the impact of different PM mixtures become possible, eventually this could be supported by carrying out toxicological studies with varying mixtures instead of single species.

#### ISEE-743

#### Proximity to Transmission Lines and Potential Exposure to Electromagnetic Fields

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**Background:** The raising concern about electromagnetic pollution generated by power lines and use of electricity has mobilized various sectors of society in the search for answers about the relationship of exposure to electromagnetic fields and public health. Therefore, this work aims to quantify the percentage of people residing in areas potentially exposed to electromagnetic fields generated by power lines in the city of São Paulo, Brazil.

**Methods:** Information about transmission lines were provided by the utilities and geocoded using a Geographic Information System (GIS). We adopt buffers of 50 meters width were created around each power line. Demographic and socioeconomic data were obtained from the 2000 Census and included in the GIS as a different layer. Through this survey, it was possible to estimate the percentage of population potentially exposed to electromagnetic fields generated by transmission lines that cross the city of São Paulo and its characteristics according to age, income and education.

**Results:** The 50 meters corridors of each side of power lines totaled 3,518,532.4 m<sup>2</sup> and included approximately 2.33% of households, and 2.41% of the population, which is potentially subject to the electromagnetic fields generated by such lines.

**Conclusion:** This study also suggests that the groups of suppliers of households whose characteristics suggest more vulnerability, such as low levels of income and education, were those who had higher prevalence to

reside in these areas. Electromagnetic fields from power lines are more a harmful burden delegated to these populations.

#### ISEE-745

#### A Case-Crossover Study of Air Pollution and Preterm Birth in Taiyuan, Shanxi, China

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**Background:** Several studies have examined whether air pollution affects preterm birth; however, results vary and most studies were conducted outside of China, one of most environmentally challenged countries in the world.

**Objectives:** We investigated maternal exposure to particulate matter with aerodynamic diameter <10, sulfur dioxide, and nitrogen dioxide, and preterm births in Taiyuan, Shanxi, China from Nov. 2005 to Jan. 2007, where PM<sub>10</sub>, SO<sub>2</sub> and NO<sub>2</sub> averaged 142.13 µg/m<sup>3</sup> (range: 37.57–508.43 µg/m<sup>3</sup>), 86.66 µg/m<sup>3</sup> (range: 14.71–317.43 µg/m<sup>3</sup>), and 24.88 µg/m<sup>3</sup> (range: 7.14–52.71 µg/m<sup>3</sup>) during study period.

**Methods:** Case-crossover design for 716 preterm birth cases was used to examine the association of air pollution with preterm birth. The case period was assigned according to their birthday. we investigated single and cumulative lagged exposure periods ranging from 0 days to 7 days. Analyses were performed for both single-pollutant models to full models adjusting for temperature and humidity.

**Results:** Controlling for weather, the authors detected a significant increase in risk for 50µg/m<sup>3</sup> increase in PM<sub>10</sub> at a 5-day lag (odds ratio = 1.169, 95% confidence interval: 1.058, 1.292) and at a 6-day lag (odds ratio = 1.235, 95% confidence interval: 1.115, 1.367). For SO<sub>2</sub>, it was found at a 7-day lag (odds ratio = 1.346, 95% confidence interval: 1.122, 1.616) and during 8-days cumulation (odds ratio = 2.203, 95% confidence interval: 1.517, 3.201) Sensitivity analysis showed that the lagged effects of PM<sub>10</sub> and the cumulative effects of SO<sub>2</sub> were robust.

**Conclusions:** Results indicate that in a high level of particle and SO<sub>2</sub> air polluted setting, PM<sub>10</sub> and SO<sub>2</sub> may have acute effect on preterm birth.

#### ISEE-747

#### Assessing Inter-Generational Transfer of Brominated Flame Retardants

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**Background:** Both human and animal studies have indicated that lipophilic toxicants, such as brominated flame retardants (BFRs), preferentially partition into breast milk. Studies have shown that the high fat content of breast milk leads to over a 100 fold higher concentration than in maternal serum for a particular BFR, polybrominated biphenyl (PBB). PBB production was ceased in the United States in the mid-1970s. However, PBBs are persistent organic pollutants with a very long half-life. We examined whether concentrations of PBB in mother's serum were related to PBB in their child's serum and whether this association was modified by breastfeeding.

**Methods:** The mothers and children are participants of the Michigan PBB registry which originated in 1976 after Michigan farm products were inadvertently contaminated with PBB (mainly 2,2',4,4',5,5'-hexabromobiphenyl BB-153) during 1973–1974. The mothers were exposed to PBB through diet, but the children were born after the contamination episode began and were exposed to PBB mainly *in utero* and for some, through breastfeeding. We included 145 mother-child pairs

who both had a serum sample analyzed for PBB during 1976–1993. With 70% of the children having an undetectable PBB concentration in their serum (limit of detection (LOD) = 1.0 part per billion (ppb)), we dichotomized our outcome variable into child's PBB < LOD and child's PBB ≥ LOD. We performed all analyses using generalized estimating equations adjusting for siblings. Several confounding variables were considered in our models (maternal variables for: age, smoking history, body mass index, parity, and prior breastfeeding history).

**Results:** The mother's serum PBB concentration ranged from < LOD to 933 ppb (median > LOD = 4 ppb, 37% ≤ LOD). The child's serum PBB concentration ranged from < LOD to 482 ppb. The following variables were associated with the child having a detectable serum PBB concentration: mother's serum PBB concentration ≥ 4 ppb, breastfeeding ≥ the median duration of 5.5 months, and mother's age at child's birth ≥ 28 years. Mothers who had a detectable serum PBB concentration and who breastfed for ≥ 5.5 months were 6 times more likely to have a child with a detectable serum PBB concentration when compared to a child who was not breastfed. Mothers who had a serum PBB concentration ≥ 8 ppb and who breastfed for ≥ 5.5 months were 11 times more likely to have a child with a detectable serum PBB concentration (OR = 11.14, CI: 3.7–33.6). A small subset of children born during the PBB exposure period potentially had access to PBB through dietary means other than breast milk. For these children (n = 20), the association between maternal and child serum PBB concentrations were stronger.

**Conclusions:** The results of this study confirm that the lactational transfer of PBB is a significant contribution to the overall serum PBB concentration of children born during and after the exposure period and this effect was highly dependent upon breastfeeding duration.

#### ISEE-749

#### Increased Risk of Parkinson Disease Associated with Dopamine Transporter Variability and Pesticide Exposure

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**Objective:** To examine main effects of 5' and 3' region variability in the coding region of the dopamine transporter gene (DAT) and interactions with occupational and residential pesticide exposure in Parkinson's disease (PD).

**Background:** DAT has been implicated in the selective degeneration of DA neurons found in PD possibly through the uptake of DAT-dependent neurotoxins.

**Methods:** We compared 328 incident idiopathic PD cases to 334 population controls that were recruited in a case control study in rural California. We genotyped rs2652510 and rs2550956 in the 5' region to determine clades (A or B), and the 3' VNTR polymorphism of DAT. A GIS-based model linking agricultural pesticide usage reports to subjects' historical addresses was used to determine residential exposure to maneb and paraquat. Occupational pesticide exposure was determined from a job exposure matrix based on job title and tasks. We calculated odds ratios for clade diplotypes, VNTR genotype, and number of risk alleles (A clade and 9-repeat alleles), adjusting for age, sex, smoking, education, and race. We stratified by pesticide exposures and sex, and repeated analyses restricting to Caucasians.

**Results:** Our data suggest an increased PD risk for Caucasian 3'VNTR 9/9 carriers (OR=1.81; 0.92, 3.57). We also observed a strong association and dose response relation between the A clade diplotype and PD (AA vs. BB: OR = 1.80; 1.11, 2.91; BA vs. BB OR = 1.57; 1.07, 2.31). Carrying 3+ risk alleles was even more strongly associated with PD risk (3+ vs. 0: OR = 2.50; 1.33, 4.71). PD risk was also particularly high for carriers of 2+ risk alleles when exposed to either high levels of paraquat (OR = 3.21; 1.36, 7.63), or of maneb (OR = 9.74; 1.22, 77.54). General occupational pesticide exposure in men with 2+ risk alleles also resulted

in an increased risk (OR = 2.65; 0.81, 8.64). Results were similar for all races combined.

**Conclusions:** Our results suggest that DAT genetic variability and pesticide exposure interact to increase PD risk. Dopamine imbalances conferred by DAT function may increase vulnerability of the neurons to damage caused by these chemicals.

#### ISEE-752

#### Concentrations of Toxic Chemicals in PVC Shower Curtains

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**Methods:** Concentrations of diester phthalates and organotins were determined in five shower curtains which are made of polyvinyl chloride (PVC) and widely used in USA. The tested curtains and retailer where purchased were: Premium Weight Vinyl Shower Curtain Liner, Bed Bath and Beyond (BB&B); Martha Stewart Everyday Vinyl Shower Curtain, Bath Bliss, K Mart; Whole Home Deluxe Vinyl Stall Liner, Sears; Contemporary Home Shower Curtain, Metro Blocks, Target; HomeTrends Kids Vinyl Shower Curtain, Under the Sea, Wal-Mart. After purchase, representative portions of each shower curtain were cut into small pieces, and combined as 1 g aliquots for analysis. Chlorine concentrations determined in bomb combustates by ion chromatography ranged from 30% to 35% by weight, demonstrating that each curtain was made from PVC. Diester phthalates were extracted by soaking and sonication with hexane and determined by GC/MS. Organotins were extracted by sonication in acidified hexane, cleaned with Florisil/silica gel, derivatized with n-pentylmagnesium bromide, and determined by GC/MS selected ion monitoring.

**Results:** Di(2-ethylhexyl) phthalate (DEHP) comprised 16% to 25% by weight of three of the shower curtains, while diisononyl phthalate (DINP) comprised 38–39% of the other curtains. All five curtains contained both DEHP and DINP: Wal-Mart (25% DEHP, 0.10% DINP), BB&B (24%, 1.3%), Target (16%, 0.11%), Sears (4.8%, 39%), K Mart (0.14%, 39%). Dibutyl tin (0.8–3.5 ppm) and monobutyl tin (0.1–0.4 ppm) were found in three of the curtains. Only the curtain from Wal-Mart was tested for volatile organic compounds (VOCs) by leaching into heated water, purge and trap, and GC/MS analysis; it contained much toluene (> 2.5 ppm), 2-butanone (~ 5 ppm), and 4-methyl-2-butanone (MIBK) (~ 2 ppm).

**Conclusion:** It is anticipated that these phthalates, organotins, and VOCs are constantly emitted into the air surrounding the shower curtain, since they are not chemically bound to the PVC. Emissions from a PVC shower curtain will be evaluated in a subsequent dynamic chamber study.

#### ISEE-753

#### A Functional Assay for Measuring Loss of Genomic Imprinting with High Accuracy

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**Background:** Loss of imprinting (LOI) is the gain of expression from the silent or imprinted allele normally expressed from only one parental copy. LOI has been associated with the development of placentation disorders, adult behavioral diseases of fetal origin, and cancer. This study has resulted in (i) the development of a highly sensitive functional assay for measuring LOI as a tool in epidemiology and (ii) the application of the assay to LOI in human placental samples. The mechanisms of imprinting are varied, with DNA methylation representing only one.

**Methods:** Because our functional assay measures LOI at the RNA level, it is not limited to a single mechanism of imprinting. The assay employs quantitative allele-specific PCR (qASPCR) analysis of RT-PCR products

containing common readout polymorphisms. The qASPCR LOI assay is highly sensitive since mRNA LOI can be detected as a small deviation from 0% in the silenced allele. With this assay, we are able to measure LOI down to 1% with high accuracy. Although the application reported here used human placenta as the RNA source, the assay could easily be adapted to other tissue types. The assay has been applied to measurement of LOI in human placentas. Placenta may be an ideal tissue for analyzing LOI as a critical step in the pathogenesis of adverse pregnancy outcomes such as pre-eclampsia as well as diseases in the offspring that are initiated *in utero*. Placentas are easy to collect and provide a large amount of tissue to be analyzed. We found that RNA was stable in placentas stored up to 6 hours at 4°C following delivery. We analyzed a test panel of 26 genes known to be imprinted in humans.

**Results:** We found that 18 genes were expressed in placenta. Twelve of the 18 expressed genes contained common readout polymorphisms in the transcripts with a minor allele frequency >20%. We found that 3 of the 12 were not imprinted in placenta. Using the remaining 9 genes, we examined the 93 heterozygosities in 27 samples. Among the 93 heterozygosities, we found 23 examples of LOI >3% and an additional 8 examples of LOI between 1 and 3%. These LOI measurements were unchanged when using a DNA polymerase with enhanced allele-specificity.

**Conclusion:** These results indicate that LOI in imprinted genes is common in placenta and demonstrate the utility of the assay in quantifying low levels of LOI.

#### ISEE-754

#### Air Pollution and Cardiovascular Disease in the California Teachers Study Cohort

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**Background:** Few studies have examined associations between long-term exposure to air pollution and mortality. Fewer still have examined such exposure in relation to cardiovascular disease incidence. We examined associations between long-term exposure to several air pollutants and total mortality, cardiopulmonary mortality, and incidence of both fatal and non-fatal myocardial infarction and stroke among over 100,000 female participants in the California Teachers Study (CTS). The CTS is a prospective cohort of active and retired female public school teachers and administrators initiated in 1995. At enrollment, participants completed a baseline questionnaire, including several questions on medical history, specifically prior myocardial infarction and stroke. Therefore, incidence analysis was limited to these two conditions. As many first occurrences of acute myocardial infarction and stroke prove fatal, we combined both hospitalization and mortality data for each of these events in the incidence analyses. Outcomes were assessed through linkage with government-maintained files on mortality and hospitalizations. We developed estimates of long-term air pollution exposure using geographic information systems to link geocoded residential addresses with inverse distance-weighted monthly pollutant surfaces for several ambient pollutants, including PM<sub>2.5</sub> and PM<sub>10</sub> (particulate matter less than 2.5 and 10 microns in diameter, respectively), ozone, nitrogen dioxide, carbon monoxide and sulfur dioxide.

**Methods:** The analysis used Cox proportional hazard regression models from cohort inception through 2002, except for PM<sub>2.5</sub>, for which monitoring data only became widely available in 1999. Models were adjusted for smoking status, total pack-years (for current and former smokers), body mass index, marital status, alcohol consumption, second-hand smoke exposure at home, dietary fat, fiber and calories, physical activity, menopausal status, hormone therapy use, family history of

myocardial infarction and stroke, use of aspirin and blood pressure medication, and several Census-derived contextual (neighborhood) variables, including income, income inequality, education, population size, racial composition, and unemployment.

**Results:** We found strong and consistent associations between PM<sub>2.5</sub> and total and cardiopulmonary mortality, as well as with the incidence of myocardial infarction and stroke. Based on an interquartile range of long-term average exposure to PM<sub>2.5</sub> (9.1 µg/m<sup>3</sup>), the hazard ratios for all outcomes were significantly elevated: all-cause mortality (1.17, 95% CI, 1.10–1.24), cardiopulmonary mortality (1.25, 95% CI, 1.15–1.35), myocardial infarction incidence (1.24, 95% CI, 1.14–1.35), and stroke incidence (1.29, 95% CI, 1.16–1.42). We also identified somewhat less consistent relationships with the other pollutants.

**Conclusions:** This study provides evidence that long-term exposure to PM<sub>2.5</sub>, in particular, is associated with the incidence of myocardial infarction and stroke, and provides additional evidence that long-term exposure to particulate air pollution is associated with mortality.

#### ISEE-755

#### Maternal Exposure to Carbon Monoxide and Risk of Term Low Birth Weight Among Singleton Births, Between 1997 and 2005 in Denver, Colorado

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**Objectives:** Over the past decades, numerous studies have investigated the association between ambient air pollution and adverse birth outcomes. In this study conducted in Denver, Colorado, between 1997 and 2005, we explored associations between a pregnant woman's exposure to carbon monoxide (CO) during each trimesters of pregnancy and the risk of giving birth to a low weight infant.

**Methods:** Birth certificates from the birth registry and information about the location of air monitoring stations and air monitoring data were obtained from the Colorado Department of Public Health and Environment. Employing a geographic information system, we determined the concentrations of CO at each maternal residential address during each trimester of pregnancy based on inverse distance weighted (IDW) interpolation methods. Logistic regression analyses were used to estimate the relative risk of low birth weight associated with maternal exposure to carbon monoxide levels in the ambient air after controlling for gestational week, marital status, maternal age, maternal race, maternal education, cigarette smoking during pregnancy, parity, and year of birth.

**Results:** In this study, we found that the odds of low birth weight consistently increased with increasing carbon monoxide exposures in the third trimester of pregnancy, regardless of controlling other pollutants (i.e. nitrogen dioxide, sulfur dioxide, ozone, and particle diameter less than 10 µm). Both crude and adjusted ORs for term LBW increased with third trimester CO concentrations above the 25th percentile (11, 25 and 39%; Ptrend = 0.07). We also found a 33.8 g (95% CI: -70.3 g to 2.6 g) reduction in birth weight when mothers were exposed to CO air pollution in the third trimester.

**Conclusions:** Our results suggest an adverse effect of CO exposure on birth weight in the third trimesters of pregnancy. Compared with a historical study in Denver by Alderman et al. (1987) that suggested an association between ambient CO exposure above 3 ppm in the third trimester of pregnancy and the risk of LBW, our study examined the associations of much lower levels of ambient CO on birth weight but confirmed Alderman et al.'s suggestion. This finding may be especially important for Denver due to its high altitude and high incidence of LBW.

**ISEE-757****Effects of Environmental Noise Exposure on Ambulatory Blood Pressure in Healthy Adults**

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**Background:** Epidemiological studies have demonstrated that environmental noise exposure is associated with hypertension in the middle-age population, but such effect in the young subpopulation is unclear.

**Objective:** This panel study aimed to investigate effects of environmental noise exposure on 24-hour ambulatory blood pressure in healthy adults.

**Methods:** We recruited 48 volunteers (28 male and 20 female) from a university in Taiwan. We simultaneously measured individual noise exposure and personal ambulatory blood pressure during the 24-hour period. Linear mixed-effects regression models were used to estimate effects of noise exposure on ambulatory systolic blood pressure (SBP) and diastolic blood pressure (DBP) during different periods by adjusting some confounders collected from self-administrated questionnaires.

**Results:** The total subjects ( $56.69 \pm 16.59$  dBA; mean  $\pm$  standard deviation) had significantly higher mean values of SBP, DBP and noise exposure during work and off-duty periods than those measured during the sleep period. The male group ( $56.54 \pm 16.30$  dBA) had significant increases in work-time SBP ( $12.57 \pm 1.78$  mmHg), off-duty-time SBP ( $11.32 \pm 2.45$  mmHg), and in sleep-time SBP ( $12.22 \pm 3.00$  mmHg) than the female group ( $56.88 \pm 16.96$  dBA). There were no significant gender-specific differences in the mean values of DBP and noise exposure during different periods. For 24-hour environmental noise, a 10-dBA increase in exposure was significantly associated with an elevation of  $1.73 \pm 0.32$  mmHg in SBP and  $1.13 \pm 0.28$  mmHg in DBP among total subjects, as well as  $2.69 \pm 0.46$  mmHg in SBP and  $1.81 \pm 0.40$  mmHg in DBP among females, and  $0.97 \pm 0.43$  mmHg in SBP among males over a 24-hour period.

**Conclusions:** Our findings suggest that environmental noise exposure may have elevated effects on young adults' ambulatory blood pressure. In addition, females are more susceptible to noise exposure than males; therefore, the gender-specific effect should be considered for future noise exposure and hypertension studies.

**ISEE-758****The Study of Hearing Loss Among MP3 Player Users**

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**Background:** As personal music players have become popular, mainstream media has vocalized hearing concerns due to MP3 listening, although no scientific evidence has been reported yet. We sought to find out the relationship between usage of MP3 player under general condition and hearing loss.

**Methods:** 113 university students who used MP3 player frequently and 132 non-users were recruited. Permanent threshold shifts (PTS) were evaluated by pure tone hearing examination in the morning before they attended any classes. MP3 player users all participated in a further experiment regarding temporary threshold shifts (TTS), during which they listened to MP3's in their ordinary ways (such as using their own players and listening in accustomed sound levels) and completed repeated hearing examinations. To obtain the general usage condition and other information, a questionnaire containing weekly usage hours, locations of usage, headphone types, demographic data and lifestyles was administered.

**Results:** There were 82.1% MP3 player users who reported less than 12 hours usage in a week. They mainly listened at noisy locations such as public transportation (93.8%). Ear bud was the most used headphone type (98.2%). There was no significant different PTS between MP3 player

users and non-users. Multifactor analyses revealed that using ear bud was associated with TTS, among which right ear 250 (OR = 5.3, 95% CI = 1.4–20.0), 3000 (OR = 6.1, 95% CI = 1.6–23.1) and 6000 (OR = 5.6, 95% CI = 1.5–20.8) Hz and left ear 250 (OR = 13.4, 95% CI = 3.5–51.6), 500 (OR = 6.2, 95% CI = 1.6–23.7), 1000 (OR = 6.2, 95% CI = 1.5–24.7) and 3000 (OR = 4.0, 95% CI = 1.0–15.1) Hz thresholds were affected, although no consistent relationship between usage time, location and TTS in various frequencies was found.

No permanent hearing loss due to MP3 player usage was observed.

**Conclusions:** The majority choice of headphone type may worsen temporary hearing loss. MP3 listening may not be as significant a concern as has been reported, but the ways of listening MP3 could be modified for enhanced hearing protection.

**ISEE-759*****Tradescantia Pallida* Biomonitoring: Identifying the Air Pollution Sources in an Industrial Brazilian City**

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**Introduction:** Vitória is a seaboard Brazilian industrial city, which has faced an increase in the automotive fleet in the last decade, and, consequently, air pollution levels. *Tradescantia Pallida* biomonitoring was applied in order to identify their predominant air pollution sources, collecting local information about environment exposition.

**Methods:** Vases were placed in 4 areas inside the city with different air pollution sources, and a sample in a rural blank. The leaves exposed to the environmental air pollution were collected from these vases. Elementary analysis by energy-dispersive x-ray fluorescence analysis (EDXRF) were done, evaluating quantity and quality elementary particles deposited on that. Factor analysis, using the varimax rotation technique, was used to identify the main factors from the several tracer elements in each area.

**Results:** The predominance of Cl and Si in the seaboard area (resuspension source), Fe, K and Ni in an industrial area, and V and Pb (automotive trace) near the automotive emissions area were found. No significant difference were found among the areas to automotive sources, in opposition of industrial sources, which has twice Fe, K and Ni (when compared with each area).

**Conclusion:** Despite the increase of automotive contribution to the pool of air pollutants in the city of Vitória, industrial emissions still prevail in part of city nearest of industrial plants and its air pollution emissions. The *Tradescantia Pallida* biomonitoring may be a good strategy to identify the sources of air pollution with low cost, contributing to the environmental control policies.

**ISEE-760****Effect of Prenatal Exposure to Dioxins on Size for Gestational Age**

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**Background:** Background-level exposure to environmental chemicals, such as polychlorinated biphenyls (PCBs) and methyl mercury, negatively influences birth outcomes in several human studies. Previous studies have examined the effects of organochlorine pesticides and PCBs on size for gestational age. It was reported that the levels of organochlorine pesticides in the maternal blood, cord blood and placenta are significantly associated with intrauterine growth retardation. However, this relationship was not shown in a recent study, which reported no significant association between maternal PCB levels and size for gestational age. Results for the effect of organochlorine pesticides and PCBs on birth sizes have been inconsistent.

Furthermore, the effects of background-level exposure to polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and dioxin-like PCBs on birth outcomes have not been clarified in human study. This article presents the effects of prenatal exposure to dioxins (29 congeners) on size for gestational age.

**Methods:** A prospective cohort study was established by the Hokkaido University Graduate School of Medicine in 2002, entitled the "Hokkaido Study on Environment and Children's Health", to investigate the possible adverse effects of PCDDs/PCDFs, dioxin-like PCBs and methyl mercury, on fetal growth and neurodevelopment. We recruited a total of 514 pregnant women between July 2002 and October 2005 in Sapporo, Japan. The concentrations of dioxins in the maternal blood were measured using a high-resolution gas chromatography/high-resolution mass spectrometer (HRGC/HRMS) equipped with a solvent-cut large-volume injection system. Maternal hair samples were also analyzed by an oxygen combustion-gold amalgamation method using an atomic absorption detector in order to detect total mercury levels. A self-administered questionnaire survey provided us with potential confounding variables in relation to past medical histories of both the mothers and their partners. Prenatal medical information of the mothers and their children were collected from their medical records at the hospital.

**Results:** We examined the risk of being small-for-gestational age (SGA) in relation to dioxin levels and hair mercury by using logistic regression analysis. We found a significantly increased risk for being SGA for total PCDDs levels (OR; 1.51), total PCDFs levels (OR; 1.36), and total PCDDs/PCDFs levels (OR; 1.52). However, we found no significant effects on the ORs for being SGA with total non-*ortho* PCBs and total mono-*ortho* PCBs. Furthermore, the maternal hair mercury level significantly decreased the risk of being SGA (OR; 0.60). We also examined the association between the levels of each congener of PCDDs/PCDFs, which were found to have a significantly negative correlation to being SGA. The ORs of being SGA were significant increased for the levels of OCDD (OR; 1.51) and the levels of 1,2,3,6,7,8-HxCDF (OR; 1.53).

**Conclusions:** We found that prenatal exposure to dioxins negatively influences size for gestational age, although the exposure levels were low background levels. Our findings suggest that prenatal exposure to dioxins, especially PCDDs/PCDFs, has effects on fetal growth. The harmful influences on the fetus should be avoided by reducing maternal exposure to dioxins.

#### ISEE-761

#### Spatial Analysis of Human Time Location Data: Development of Exposure Weighted Standard Deviational Ellipsis (EW-SDE)

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**Background:** Human space-time behavior in the form of either daily mobility or migration is an important determinant of health because of the possibility of exposure to different microenvironments and hazards. Lack of detailed individual mobility data and appropriate methods to obtain such data make it difficult to examine the interrelationship between human mobility and exposure. Because complex process of human mobility may have a significant effect on exposure patterns, we explored the potentials of global positioning system (GPS) data in environmental health studies. It becomes increasingly possible to examine this relationship due to the increased use of Geographic Information Systems (GIS) and related geospatial technology, including GPS.

**Methods:** In this study, we conducted a pilot study to develop an exposure weighted spatial distribution for subject mobility that includes time and weights for indoor and outdoor exposures. We collected week-

long GPS data from 32 participants in California, as a part of the study of personal exposure related behavior (SUPERB). Standard Deviational Ellipses (SDEs) of five subjects were generated to represent generalized patterns of activity space, and descriptive statistics, including mean center, standard deviations, and area, were calculated and compared. A GPS device cannot receive a signal indoors, thus GPS data do not include indoor time. Because personal exposure is also affected by time spent indoors, we developed Exposure Weighted SDEs (EW-SDEs) that include different exposure during indoor and outdoor times; SDEs were constructed to assess the effects of indoor time, and of differential in- and outdoor weights on exposure space.

**Results and Discussion:** Overall, EW-SDEs had smaller size and slightly different orientation than the SDEs without indoor time and weights. The EW-SDEs that include time and exposure weights may more realistically represent human exposure spaces. This study indicates that GPS collected data may be of use in further exposure assessment and modeling of human space-time behavior. While there are opportunities and challenges using GPS data, we illustrated the expanded use of GPS data in environmental health studies; the EW-SDEs developed here can be further used to investigate what and how people are exposed to. Incorporating spatial-temporal patterns of human mobility may be of significance in understanding human exposure behavior in space-time and its complex relationship with the environment.

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#### ISEE-762

#### Horse Allergen at School—a Dark Horse?

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**Background:** Today, there are about 280 000 horses in Sweden, which is much more than there were fifty years ago. However, horses today are used more for leisure and racing and only a third are at agricultural holdings. As a consequence, about 2/3 of horses are now found close to cities and integrated with built-up areas. Thus, the spread of horse allergen into nearby homes and public premises may be of concern for people who are allergic to furry animals.

**Objectives:** We have studied the presence of horse allergen in schools, the prevalence of horse allergy among school children, and the relationships between indirect horse contact and respiratory symptoms in school children.

#### Study 1: Measurement of horse allergen

**Methods:** In total, 35 primary and secondary schools in the county of Uppsala were randomly selected. Samples of settled dust were collected once in 118 classrooms using a vacuum cleaner with a special sampling filter (ALK Abello). For each sample, half the classroom was vacuumed during 4 minutes, equally divided between floors and furniture. Horse allergen (Ecu cx) levels were determined by ELISA. Data on horse contact was collected by a postal questionnaire. Correlations between allergen levels in settled dust and percentage of riders in each class were analysed by Spearman's rank correlation. A two-tailed significance level of 5% was used.

**Results:** The GM level of horse allergen in settled dust was 1 340 U/g, with a range of 34–121 056 U/g. The GM percentage of pupils in classes with horse contact was 8% (0–44%). There was a moderate, 0.436, but highly significant ( $P < 0.000$ ) correlation between allergen level and percentage of pupils with horse contact.

#### Study 2: Health effects

**Methods:** The pupils in the 7<sup>th</sup> form of the secondary schools (approximately 13 years of age) were given a postal questionnaire with questions about asthma, respiratory symptoms, and allergies. Relationships between horse exposure and health symptoms were analysed by logistic regression, controlling for gender and age.

**Results:** In total, 679 pupils (70%) answered the questionnaire. Of these, 40% reported a history of an allergy, 4.1% reported horse allergy and 12% asthma. Horseback riding was performed regularly by 14% of the pupils. If attending a class with a higher proportion of riders, pupils with any allergy, or horse allergy, more often reported having an asthma diagnosis (OR = 1.3 and OR = 3.4, respectively, per 10% increase of riders) and pupils with horse allergy also more often reported recent asthma attacks (OR = 3.6 per 10% increase of riders). However, we found no significant relationship between health effects and allergen levels measured on one occasion.

**Conclusions:** A substantial proportion of children and adolescents have regular contact with horses despite living in a highly urbanised and modern society. This results in a general spread of horse allergen into public environments where it may constitute a health risk for those with allergy and who are unaware of the problem.

#### ISEE-764

##### Phthalate Concentrations Among Pregnant Women in Jerusalem, Israel: Results of a Pilot Study

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**Background:** Phthalates can disrupt endocrine function and induce reproductive and developmental toxicity in laboratory animals. Few studies have evaluated exposure to phthalates in pregnant women, despite the potential sensitivity of the developing fetus to adverse effects of phthalates.

**Methods:** We measured urinary concentrations of 11 phthalate metabolites in 19 pregnant women in Jerusalem, Israel and collected questionnaire data on demographic factors and consumer habits from these women.

**Results:** Nine metabolites were detected in at least 95% of the samples: mono-2-ethyl-5-carboxypentyl phthalate, mono-2-ethyl-5-hydroxyhexyl phthalate, mono-2-ethyl-5-oxohexyl phthalate, mono-3-carboxypropyl phthalate, mono-n-butyl phthalate, monobenzyl phthalate (MBzP), monoethyl phthalate (MEP), mono-2-ethylhexyl phthalate and mono-isobutyl phthalate. Phthalate metabolite concentrations were remarkably similar to those in the general United States female population. MBzP concentrations were higher in pregnant women living in buildings existing 40 years or more. Women who reported smoking prior to pregnancy had higher concentrations of MEP, as did women who worked with smokers. In women who used five or more personal care products (perfume, deodorant, lipstick, nail polish, or hand/face cream) in the 48 hours prior to providing the urine sample, MEP concentrations were almost 6 times higher than concentrations in women using only two of the aforementioned products.

**Conclusions:** Pregnant women in Jerusalem are exposed to a wide range of phthalates. Building materials used in old constructions may be a source of exposure to benzylbutyl phthalate, the parent compound of MBzP. Passive tobacco smoke and personal care products may be sources of exposure to diethyl phthalate, the parent compound of MEP.

#### ISEE-765

##### GSTM1 Genotypes Modify the DEP Enhancement of Nasal Responses after Cat-Allergen Challenge

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**Background and Objective:** The prevalence of upper airway allergic disease increased from 5% to 20% over the last several decades. Although changes in a number of exposures have occurred, a growing body of evidence indicated that diesel exhaust particles (DEPs) may contribute to this increase by enhancing IgE, histamine and cytokine production and exacerbating allergic inflammation in the respiratory track. We reported the role of enzymatic antioxidants such as the glutathione S-transferase M1 (GSTM1) genotypes (null/present) in modulating ragweed allergic responses following DEP exposure in 19 individuals. The present study was to examine a broader number of allergic endpoints to evaluate the effects of GSTM1 genotypes on DEP enhancement of nasal responses after cat-allergen challenge with a much larger sample.

**Methods:** Sixty-five cat allergic individuals completed all 4 challenges over the course of the study: nasal challenge with 1) saline only (-), 2) allergen only (Ag), 3) DEP only (DEP), and 4) allergen + DEP (DEP+Ag). Nasal allergen-specific IgE, IgG4, IL4, IL5, histamine, and interferon- $\gamma$  (IFNr) were collected by nasal lavage. Genotypes were determined using DNA from buccal cell specimens.

**Results:** Thirty-one individuals (48%) carried the GSTM1 null genotype. DEP markedly enhanced IL4 and IL5 levels following allergen challenge, especially among the GSTM1 null individuals (significant interaction between GSTM1 genotype and DEP on IL4 and IL5 ( $P < 0.0001$  for both)). Among GSTM1 present individuals, the mean IL4 level was 0.26 (SD = 0.13) and 3.78 (SD = 2.75) pg/mL for nasal challenge with "Ag" and "DEP+Ag", respectively; while, among individuals with a null GSTM1 genotype, IL4 level was 0.25 (SD = 0.16) and 7.74 (SD = 3.35) pg/mL for nasal challenge with "Ag" and "DEP+Ag", respectively. Moreover, three-way interactions among GSTM1 genotypes, DEP, and Ag were observed for IFNr ( $P = 0.0153$ ), IgE ( $P = 0.0001$ ), IgG4 ( $P < 0.0001$ ), and histamine ( $P < 0.0001$ ) levels. After the challenge with "DEP+Ag", IgG4, IgE, and histamine dramatically increased compared to the other challenge conditions, and the increases were twice or greater among the GSTM1 null individuals than among GSTM1 present individuals. In individuals carrying a present GSTM1 genotype, the mean IgE level was 0.64, 8.64, 0.61, and 70.29 U/mL for "-", "Ag", "DEP", and "DEP+Ag", respectively. In individuals with a null GSTM1 genotype, the mean IgE level was 0.55, 8.19, 0.62, and 162.35 U/mL for "-", "Ag", "DEP", and "DEP+Ag", respectively. The pattern for IgG4 and histamine levels was similar to the IgE response. The change of IFNr was in the opposite direction, but it also showed that the adverse effect of DEP exposure after cat-allergen challenge was much stronger in people with the null GSTM1 genotype.

**Conclusions:** GSTM1 genotypes modify the DEP enhancement of allergic inflammation of the upper respiratory track following cat allergen exposure and may indicate a large susceptible population for the adverse effects of DEP exposure.

#### ISEE-766

##### The Occurrence of Heavy Metals in House Dust from Selected Urban Residential Homes

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**Objectives:** Heavy metals are well-known for their ability to interfere with human health and potentially cause a number of chronic toxicity even at relatively minor levels. This result of their tendency to accumulate in selected tissues of human body, more particular infants and young adults. In South Africa, not much work has been done with respect to the occurrence of heavy metals in indoor environment; more precisely, in the settled dust. The objectives of this study were to investigate the occurrence of heavy metals (arsenic, lead, and mercury) and associated levels with locations.

**Material and Methods:** One hundred and five residential homes ( $n = 105$ ) were selected from the following communities namely: -

Lamontville, KwaMashu, Merebank, Bluff, Newlands East, Newlands West and Wentworth. In each home, a sample of settled dust was collected using standardized protocols, sieved and individually packed into polystyrene bags and sent to Umgeni Water Board, Pietermaritzburg for heavy metal (arsenic, lead, and mercury) analysis.

**Results and Discussion:** Heavy metals were detected in the dust in the following order: - As ranged from 1.3 µg/g–18.4 µg/g (mean, 4.26 µg/g), Pb ranged from 28.0–872 µg/g (mean 171.66 µg/g), and Hg ranged from 0.6–19.0 µg/g (mean, 2.22 µg/g), respectively. The mean concentration of Pb in the dust was within the range of Canadian National Classification guidelines on residential contamination (500 µg/g). There is however, concern that there were numerous samples that exceeded this guideline. The mean concentration of As was within OSHA guidelines (<10 µg/m<sup>3</sup>), apart from only 2 locations that were marginally high Bluff (10.0 µg/g) and Merebank (18.4 µg/g). Mercury was within limits when compared with the Global Mercury Project guidelines of soil/residential (6.6 µg/g Hg), though some of the samples were notably above this mean.

**Conclusion:** Some of the heavy metals that have been reported in this study were higher or marginally higher than international norms and guidelines. This study contributes towards the development of South Africa's guidelines.

#### ISEE-767

#### The Effects of Fine Particulate Matter on Daily Mortality for Specific Heart Diseases in Japan

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**Background:** It is considered that biological responses to particulate matter modify the progress of various heart diseases and that the time course and magnitude of its effects differ by disease. So far, the effects of particulate matter on specific heart diseases remain unclear although many reports have shown that particulate matter has adverse effects on overall heart disease mortality and morbidity. We examined the short-term effects of PM<sub>2.5</sub> on mortality for specific heart diseases in 9 Japanese cities during 2002 and 2004.

**Methods:** We used daily mortality data obtained from the Ministry of Health, Labour, and Welfare of Japan. Air pollution and meteorologic data were obtained from the National Institute for Environmental Studies and Japan Meteorologic Agency, respectively. We carried out the time-stratified case-crossover analyses to evaluate the association between daily mean concentration of PM<sub>2.5</sub> and the daily mortality. We bidirectionally selected control periods matched on month and day of week for each case. We adjusted estimated relative risks for ambient temperature, relative humidity, NO<sub>2</sub>, and photochemical oxidant, using conditional logistic regression. Then, we combined the area-specific results using meta-analysis with random-effect model.

**Results:** From 2002 to 2004, 59,972 deaths for heart disease aged over 65 years due to heart disease were observed. Ischemic heart disease, cardiac arrhythmia and conduction disorders, and heart failure accounted for 49.5%, 9.9%, and 26.5% of all heart disease mortality, respectively. The association between PM<sub>2.5</sub> and overall heart disease mortality were positive but insignificant from lag0 to lag4. In the cause-specific analyses, we observed a difference. A 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> was associated with a 2.5% (−0.2, 5.2) at lag2 and a 2.7% (0.0, 5.5) at lag3 increases in mortality due to ischemic heart disease. On the other hand, the associations were not clear in mortality due to heart failure, and cardiac arrhythmia and conduction disorders.

**Conclusions:** We observed positive associations between PM<sub>2.5</sub> and heart disease mortality in Japan. The results suggest that the lag pattern and magnitude of PM<sub>2.5</sub> effect may vary depending on disease.

#### ISEE-768

#### Protective Effect Of N-acetyl-cysteine Against Noise-Induced Temporary Threshold Shift Among Workers with Different Glutathione S-Transferase M1, T1, P1 Polymorphisms

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**Background:** Both genetic and environmental factors contribute to noise-induced hearing loss (NIHL). The cellular antioxidant system appears to protect cochlear hair cells from oxidative stress due to noise. Previous animal studies showed protective effects of anti-oxidant medicines against NIHL.

**Objective:** The objective of this study is to test the hypothesis that pretreatment of an antioxidant affects noise-induced temporary hearing threshold shift.

**Methods:** The noise-exposed male workers from one steel industry in Taiwan were recruited. Those workers with middle ear disease or permanent threshold of greater than 50 dBA in high tone areas were excluded. These subjects were divided into 2 groups, one for treatment of N-Acetylcysteine (NAC) (Acetine, 1200 mg/day) and the other for that of placebo. After 2 weeks of treatment and 2 weeks of washout, the regimens were crossed-over for another 2 weeks. At the beginning of the study, questionnaire interview about noise exposure, smoking, alcohol drinking, drug history and Body Mass Index (BMI) were done. After otoscopic examination, these subjects received pure-tone audiometry (PTA) before and after their work shift. Noise exposure was calculated by personal dosimeters for 8 hours. Deletion polymorphisms in the GSTT1 and GSTM1 genes, and single nucleotide polymorphism (Ile-105 Val) in GSTRP1 were determined by polymerase chain reaction-based methods. Statistical analysis was performed to evaluate the relation between anti-oxidant medicine and noise-induced temporal threshold shift (TTS).

**Results:** A total of 52 male subjects satisfactorily completed the study. The mean age was 40.6 years (95% C.I.: 37.6–43.4). The pre-shift hearing impairment at high frequency (HF, average of 3, 4 and 6 kHz) was 17.1dB HL (95% C.I.: 16.1–18.0). The daily (8 hours) amount of noise exposure was 88.7 dBA (95% C.I.: 88.2 ~ 89.2). The threshold shift at HF across working day was 5.0 dBA after placebo-treated period, and was 3.2 dBA after NAC-treated period ( $P < 0.05$ ). Such protective effect was found more prominent among workers with GSTT1-null or GSTM1-null genotypes ( $P < 0.05$ ).

**Conclusion:** Our results suggested that under similar daily noise exposure, workers with lower antioxidation capability had higher TTS at HF, which might be protected after preventive treatment of NAC.

#### ISEE-769

#### The Impact of Active and Passive Smoking on Fetal Growth Assessed by Ultrasounds During Pregnancy

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**Background:** While there are sufficient data regarding the adverse effect of exposure to tobacco smoke on neonatal size it still unclear whether this effect may originate in early pregnancy on fetal biometry. Furthermore, neonatal size measures could be inappropriate for assessing effects on

fetal growth as the same size may represent both normal and abnormal development in different subjects.

**Objective:** To examine the association of self-reported active and passive smoking on fetal growth characteristics in different periods of pregnancy among pregnant women participating in a prospective birth cohort within the Spanish Environment and Child (INMA) project.

**Methods:** This study includes 787 mothers living in Valencia (Spain). They were recruited in the same hospital at early pregnancy between November 2003 and June 2005. Fetal ultrasound examinations were carried out around 12, 20 and 32 weeks of pregnancy for all women. Fetal characteristics measured were biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL). Gestational age was established by ultrasonography (Crown-rump length). Longitudinal growth curves adjusted for maternal height, weight, age, parity, ethnic group, gestational age and gender, were fitted by means of mixed models. Unconditional and conditional standard deviation scores were constructed. Unconditional z-scores at 12, 20 and 32 weeks of gestation were used as size indicators at early, mid and late pregnancy. Conditional z-scores for week 20 given the value of the same parameter at week 12, and for week 32 given the value at week 20 were used as growth indicators for 12–20 and 20–32 gestational age intervals. Maternal smoking status (AS) and environmental tobacco smoke (ETS) were assessed by questionnaire administered in late pregnancy (week 32). Mothers were classified as “smokers” or “non-smokers” at three different periods: at enrollment, during the first trimester, and up to week 32. We defined ETS exposure (yes/no) at several environments: home, work, and meals and leisure activities. Associations between maternal smoking and fetal growth were analyzed using one-way analysis of variance.

**Results:** Only 38.1% of our women never smoked, 41% smoked at recruitment and 23% still smoking at week 32 of pregnancy. Only 186 women (22.7%) declared themselves as nowhere exposed to ETS. All AS variables were associated with fetal growth between weeks 20 and 32; particularly, still smoking at week 32 reduced the FL z-score in 0.39 points ( $P = 0.000$ ), 0.24 in AC ( $P = 0.000$ ) and 0.22 in BPD ( $P = 0.005$ ). All AS variables were associated with reduced fetal size at week 32, but “smoke at enrollment” in BPD. FL was the more affected characteristic in growth as in size. ETS at home had negative effects on fetal growth in late pregnancy in AC ( $P = 0.069$ ) and BPD ( $P = 0.049$ ).

**Conclusions:** Results from this study support the conclusion that maternal smoking is associated with reduced growth in fetal characteristics. Adverse effects have been observed since week 32 of pregnancy.

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#### ISEE-771

#### Relations Between Environmental Factors and Bronchial Obstructive Phenotypes Identified Among Infants of the Paris Birth Cohort Study

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**Objective:** The Paris prospective birth cohort study was implemented to assess the role of behavioural/environmental factors on respiratory/allergic manifestations in Paris children up to the age of 6. We tried to identify bronchial obstructive phenotypes among one-year old infants and their associated risk factors.

**Material and Methods:** Data were collected by five regular short-interval self-administered standardised questionnaires, when the child was 1, 3, 6, 9 and 12-month old. Partitioning around medoids was used to classify

infants in three groups (G0, G1, G2) according to their bronchial obstructive symptoms (wheeze, nocturnal dry cough, shortness of breath, dyspnoea). A polytomous logistic regression was performed to assess the associations with various risk factors, using the G0 infants as the reference group: results were expressed as adjusted OR with their 95% confidence interval (OR<sub>a</sub> [95%CI]).

**Results:** Results are given for 2,632 infants. Apart from a set (G0 group) of 1786 infants (67.8% of total infants) mostly asymptomatic, two distinct bronchial obstructive phenotypes were identified, with specific risk factors. The G2 phenotype affected 23.5% of total infants. It was defined by dyspnoea associated with ≥ one other obstructive symptom in half of cases: it was strongly related to lower and upper respiratory infections (OR<sub>a</sub> [95%CI] for one unit increment of bronchitis and/or bronchiolitis number: 1.36 [1.26–1.48] and for ≥1 cold (vs 0): 2.55 [1.51–4.30] as compared to G0 infants). More frequent early day care attendance (yes vs no) and postnatal exposure to environmental tobacco smoke (yes vs no) increased the risk of belonging to G2 whereas pet ownership (yes vs no) was negatively linked to G2 (OR<sub>a</sub> [95%CI]: 1.39 [1.06–0.83]; 1.43 [1.13–1.83]; 0.68 [0.50–0.92] respectively as compared to G0 infants). All G1 infants (8.7% of total infants) suffered from nocturnal dry cough that was not related with any other bronchial obstructive symptom in two thirds of cases. Parental asthma (OR<sub>a</sub> [95%CI] (vs no parental asthma) for one asthmatic parent: 1.07 [0.73–1.56] and both asthmatic parents: 2.59 [0.90–7.50],  $P = 0.07$  as compared to G0 infants), symptoms indicative of rhino-conjunctivitis (yes vs no) and a birth in spring months (vs in fall months) (respective OR<sub>a</sub> [95%CI]: 4.87 [3.12–7.60]; 1.71 [1.10–2.68] as compared to G0 infants) were positively related to G1. The G1 infants could be more prone to develop allergy, as suggested by other risk factors we identified: high frequency of dwelling cleaning habits (OR<sub>a</sub> [95%CI] for vacuum cleaner use once a day at least vs less often: 0.56 [0.38–0.84] and for Swiffer® use once a week at least vs less often: 0.65 [0.44–0.95] as compared to G0 infants) reduced the risk of belonging to G1 while parental separation in the first year of their infant (yes vs no) was positively linked to this phenotype (OR<sub>a</sub> [95%CI]: 2.72 [1.31–5.64] as compared to G0 infants).

**Conclusions:** Further follow-up of our birth cohort will determine the future clinical of these two bronchial obstructive phenotypes we identified as early as in the first year of life.

#### ISEE-772

#### Impact in the Levels of Secondhand Smoke Exposure Two Years after the Implementation of the Non-Smoking Law in Spain

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**Objectives:** A non-smoking law was implemented in Spain in January 2006. The law bans smoking in all indoor workplaces except in hospitality venues, where restrictions have been established depending on the size of the venue. The objective of this study is to assess the impact of the Spanish smoking law on exposure to secondhand smoke (SHS) in indoor offices and hospitality venues two years after the implementation of the law.

**Methods:** This is a before and after study with repeated measures. Vapour-phase nicotine was measured as an airborne SHS marker. The settings studied were offices from the public and private sector, university premises, and hospitality venues from eight different regions of Spain.

The nicotine measurements were taken three months before the law, and repeated 6 months, one year and two years after the law. All the samples were analyzed with gas chromatography/mass spectrometry (GC/MS).

**Results:** 266 paired samples taken before and two years after the law have been included in this study. The preliminary results show that the median nicotine concentration in offices from Public Administration decreased by 85.7% (from 0.21 to 0.03  $\mu\text{g}/\text{m}^3$ ,  $P < 0.05$ ). In universities, there was a decrease of 82.7% (from 0.29 to 0.05  $\mu\text{g}/\text{m}^3$ ,  $P < 0.05$ ), and in private sector there was a decrease of 91.2% (from 0.57 to 0.05  $\mu\text{g}/\text{m}^3$ ,  $P < 0.05$ ). Regarding the hospitality sector, in restaurants declared smoke-free the levels of exposure decreased by 97.2% (from 2.15 to 0.06  $\mu\text{g}/\text{m}^3$ ,  $P < 0.05$ ). However, in those restaurants where smoking is still allowed, as well as in discos and pubs, no significant differences in the levels of SHS have been found. Furthermore, the median nicotine concentrations found in discos and pubs two years after the law is still extremely high (39.81  $\mu\text{g}/\text{m}^3$ ).

**Conclusions:** Overall, this study shows the long term positive impact of the law in reducing SHS in indoor workplaces, where SHS exposure has been nearly eliminated two years after the law. However, in hospitality sector SHS was substantially reduced only in bars and restaurants that became smoke-free. Two years after the law, most hospitality workers continue to be exposed to very high levels of SHS. Therefore, a total ban including all hospitality venues is required in Spain.

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#### ISEE-774

#### The Effect of Ignoring Interpolation Error on the Inferred Relationship Between Ambient Particulate Matter Exposure and Median RR Interval in Post-Menopausal Women

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**Background:** There are numerous sources of uncertainty when estimating individual air pollution exposures based on data from a dispersed network of monitors. Among these, the uncertainty due to spatial misalignment is both important and straightforward to model statistically given an interpolation method such as kriging or regression splines. The effect of Gaussian interpolation error on exposure-response associations has been previously addressed in the linear model setting, but less is known about the effect of log-normally distributed error, and less still about such errors in the hierarchical model setting. We address these deficits in the context of a Women's Health Initiative ancillary study, the Environmental Epidemiology of Arrhythmogenesis in WHI (EEAWHI). We are specifically interested in whether EEAWH findings are robust to ignoring log-normal spatial interpolation error from kriging.

**Methods:** We use a multivariable adjusted, Bayesian hierarchical model in which the response is the logarithm of the median RR interval (ms) from 53,494 clinical trial participants' first-recorded, resting, resting standard twelve-lead electrocardiograms (ECGs) between 1999 and 2004. The exposures are daily mean concentrations ( $\mu\text{g}/\text{m}^3$ ) of ambient particulate matter  $<2.5$  and 10  $\mu\text{g}$  in diameter ( $\text{PM}_{2.5}$ ;  $\text{PM}_{10}$ ) spatially interpolated at their geocoded addresses and averaged over the day of and before the ECGs (lag0–1). We perform within-site regressions involving only those women examined at each of 57 exam sites in the contiguous U.S.; however, the site-specific exposure-response effects are drawn from a distribution centered on a national effect that is our main epidemiologic focus. Inference about

this national effect is confounded by interpolation uncertainty, the magnitude of which is estimated by kriging. Because kriging was performed on the log-PM scale in EEAWH, uncertainty in the interpolated PM concentrations is log-normally distributed.

**Results:** We find that when this uncertainty is modeled explicitly by placing a log-normal prior on the exposures, the posterior distribution of the national effect is closer to zero and narrower than when it is ignored. The shift toward the null would be expected in a simple Gaussian error linear model, but the distribution would be expected to broaden, not narrow. In the present case, the combined effect of the shift and the narrowing leaves the posterior probability of the inverse PM-RR association observed among non-smokers without chronic lung disease almost unchanged. Simulations are presented to demonstrate that this is not a spurious result, but rather the natural outcome whenever predictor error is log-normally distributed.

**Conclusion:** We therefore conclude that the significance of the observed association is robust against ignoring kriging uncertainty, though the magnitude of the association is not.

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#### ISEE-777

#### Smokeless Tobacco and School Children

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**Background:** Smokeless tobacco or spit tobacco has gone from a product used primarily by older men to one used predominantly by young men and boys. Smokeless tobacco products have been marketed to children through a number of channels, including sales in the school premises. Studies have found that 60–78% of spit tobacco users have oral lesions.

**Methods:** This study was conducted in the northern part of Kerala among school children to determine the pattern of tobacco use by them. Children studying in high schools were given a pretested questionnaire, and anonymity was maintained by asking them not to reveal their names. A total of 1200 children participated in the study.

**Results:** The data showed that 16% of children admitted that they are using tobacco products. Among these, 12.8% were using only spit tobacco, while the rest were using both forms of tobacco, i.e., smokeless and tobacco smoke. The majority had started to smoke when they were 12 years old. Not only that, most of them purchased tobacco products from the shops around their school premises. Most of them are using because of the novelty and the misconception that they are a safe form of tobacco use and because they can be consumed much less conspicuously than either cigarettes or bidi products at home, in school and other locations.

**Conclusion:** The results of the study suggest that Students Advising and Guiding Units should be started in schools to offer consulting services to needy children and those who are addicted to this habit.

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#### ISEE-778

#### Will Smoking Rate Increase with Work Stress Among Female Shift Workers in High-Tech Industry in Southern Taiwan

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**Objective:** The overall prevalence of smoking is decreasing in Taiwan but is increasing in women. In industrialized countries, shift work is common but may affect psycho-physical conditions and life style. We conduct a study to evaluate whether shift work may increase the smoking rate among female workers in the high-tech industry.

**Materials and Methods:** We recruited female workers working in an industrial park in southern Taiwan during their routine annual health examination between July 1 and August 31, 2007. Information on

demographic characteristics was collected through a self-administrated questionnaire. Participants also reported smoking habit, completed a job content questionnaire, and received anthropometric measurements.

**Results:** There were 2,408 female workers participated in this study, and the overall smoking rate was 5.1%. The smoking rate was higher than the national average (4.1%) reported by the Bureau of Health Promotion of Taiwan and even higher among shift workers (6.7%). We observed positive associations between smoking and marriage, education, work class, and shift work (all with  $P < 0.01$ ). Through further analyses using logistic regressions, we found marriage, education, and shift work were predictors of smoking. After adjusting for other factors, we found divorced (adjusted odds ratio [AOR] = 2.99, 95% confidence interval [CI]: 1.29–6.89), shift work (AOR = 4.88, 95% CI: 1.22–19.62), job control (AOR = 1.54, 95% CI: 1.02–2.34), and physical demand (AOR = 1.55, 95% CI: 1.02–2.33) were independent risk factors of smoking rate, while married (AOR = 0.47, 95% CI: 0.28–0.80) and higher education (colleague, AOR = 0.6, 95% CI: 0.37–0.96; university, AOR = 0.44, 95% CI: 0.22–0.89) were protective factors.

**Conclusion:** In female workers in high-tech industry, smoking rate is associated with shift work, marital status, education level, job control, and physical demand. Therefore, female shift workers should be targeted for intervention for smoking.

#### ISEE-779

#### The Role of Exposure to Phthalates from Polyvinyl Chloride Products in the Development of Asthma and Allergies: A Systematic Review and Meta-Analysis

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**Background:** There are suggestions that phthalates from polyvinylchloride (PVC) plastics have adverse effects on airways and immunological systems, but the evidence has not been reviewed systematically.

**Objective:** To review the evidence for the role of exposure to phthalates from PVC products in the development of asthma and allergies.

**Methods:** We conducted a Medline database search (1950-May 2007) for relevant studies on the respiratory and allergic effects of exposure to phthalates from PVC products.

**Results:** The review was based on 27 human and 14 laboratory toxicology studies. Two mouse inhalation experiments indicated that MEHP has the ability to modulate the immune response to exposure to a co-allergen. A NOEL ( $30 \mu\text{g MEHP}/\text{m}^3$ ) was suggested and calculated to be below the estimated level of human exposure in common environments. Case reports and series ( $n = 9$ ) identified and verified cases of asthma which were with high probability caused by fumes emitted from PVC film. Epidemiologic studies in adults ( $n = 10$ ), most small studies in occupational settings, showed associations between heated PVC fumes and asthma and respiratory symptoms, and in children ( $n = 5$ ) an association between PVC surface materials in the home and the risk of asthma (fixed-effects model: summary OR 1.55, 95%CI 1.18–2.05, 4 studies) and allergies (1.32, 95%CI 1.09–1.60, 3 studies).

**Conclusions:** High levels of phthalates from PVC products can modulate the murine immune response to a co-allergen. Heated PVC fumes possibly contribute to development of asthma in adults. Epidemiologic studies in children show associations between indicators of phthalate exposure in the home and risk of asthma and allergies.

#### ISEE-782

#### Prenatal Exposure to PCBs is Related to Asthma in Female Adult Offspring

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**Objectives:** In 2001, we reported that asthma in schoolchildren was associated with their serum concentration of dichlorodiphenyl ethylene (DDE). These findings were corroborated by Spanish studies and motivated us to test whether prenatal exposure to organochlorines such as DDE and polychlorinated biphenyls (PCB) are also associated with asthma in adults.

**Methods and Procedures:** We have established a two-generation cohort of female fish-eaters in Michigan including the mother and at least one daughter. The mothers participated between 1973 and 1991 in a minimum one of three consecutive surveys with serum measurements of DDE and total sum of PCBs. Based on linear regression, DDE and PCB levels were extrapolated to the time of the pregnancy of the respective offspring. Health information on their daughters was collected through telephone interviews in 2001/02 and repeated in 2006/07. Using repeated measurement analyses nested for mothers, we analyzed the association between prenatal DDE and PCBs and asthma in offspring (odds ratios). Statistically, we controlled for age, maternal history of asthma/wheezing (collected in 1989/91), and breastfeeding (gathered from the mother and the offspring). Prenatal DDE and PCB levels were grouped into quartiles.

**Results:** Of mothers with organochlorines levels, 151 female offspring participated in 2001/02 and 129 in 2006/07; 104 participated in both investigations. The offspring were between 18 and 58 years old. Doctor's diagnosed asthma was reported by 17.2% in 2001/02 and 10.1% in 2006/07. There was moderate agreement between asthma reported in 2001/02 and 2006/07 ( $\kappa = 0.59$ ). Compared to the lowest quartile, prenatal PCB levels  $>5 \text{ mg/L}$  (highest quartile) were related to a 10.4-fold increased odds of adult offspring asthma ( $P = 0.001$ ). Prenatal DDE did not show any association with asthma. Since prenatal DDE and PCB levels were correlated, we ran the analyses again, excluding DDE. In this case, the highest PCB quartile showed a 5.58 fold increased odds for asthma in adult offspring.

**Conclusion:** Our results provide further evidence that prenatal exposure to endocrine disrupting chemicals may be associated with an increased risk of asthma. Since our results are based on the total sum of PCBs, further investigations are needed to determine which PCB congener may be associated with asthma.

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#### ISEE-783

#### Oral Cleft Defects and Maternal Exposure to Ambient Air Pollutants in New Jersey

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**Background:** Accumulating epidemiological evidence links exposure to ambient air pollution during pregnancy, particularly gaseous pollutants and particulate matter, to an increased risk of adverse reproductive outcomes, including intrauterine growth retardation, preterm birth, and perinatal mortality. These results have led to hypotheses that increased levels of air pollutants could be risk factors for particular birth defects.

**Methods:** We used a case-control design to compare estimated exposure to ambient air pollutants during early pregnancy among mothers of birth defect cases to that among mothers of births without birth defects (controls) adjusting for risk factors available on the birth certificate. We obtained the air pollutant data from ambient air monitoring sites in New Jersey for carbon monoxide (CO), nitrogen dioxide ( $\text{NO}_2$ ), ozone ( $\text{O}_3$ ), sulfur dioxide ( $\text{SO}_2$ ), particulate matter less than  $10 \mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{10}$ ) and particulate matter less than  $2.5 \mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{2.5}$ ). The average daily concentration of these pollutants during early pregnancy, obtained from the nearest monitor (within 40 km of the geocoded residence at birth), defined exposure for each case and control maternal residence. We conducted logistic and linear regression

analyses for each contaminant and all contaminants together, for both cleft lip with or without cleft palate (CLP) and cleft palate only (CPO).

**Results:** There was no consistent pattern of increasing risk of oral clefts with increasing exposure. Only one model showed a statistically significant association with the overall indicator for quartile concentration in the logistic regression model: quartile of CO concentration showed a consistent protective association with CPO ( $P < .01$ ). Confidence intervals for some odds ratios excluded one, but only for a few quartiles. CLP showed some evidence of an association with increasing SO<sub>2</sub> exposure while CPO showed weak associations with increasing O<sub>3</sub> exposure. When evaluated using only monitors within 10km of residence at birth, only the association between O<sub>3</sub> and CPO showed generally increased odds ratios in comparison to those measured using monitors within 40km, which might be expected with increasing accuracy of exposure measurement. Multi-pollutant models showed results similar to the individual pollutants. Overall, the results show weak associations only, consistent with previous birth defect studies, although results for individual pollutant-defect pairs varied.

**Conclusions:** Because of limitations of the exposure assessment process and classification of birth defects, we cannot rule out an increased risk associated with particular pollutants or disease subgroups. These results differ from those resulting from evaluation of adverse reproductive outcomes other than birth defects.

#### ISEE-784

##### Gene Environment Interactions and Postural Blood Pressure in Community Exposed Elderly Men: The VA Normative Aging Study

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**Background:** Evidence has shown a positive association between environmental air pollution and blood pressure (BP) change, a marker of autonomic function and a predictor of cardiovascular outcomes. We investigated the associations between postural changes in systolic and diastolic BP and fine particulate matter (PM<sub>2.5</sub>), single nucleotide polymorphisms (SNPs), and SNP-by-PM<sub>2.5</sub> interactions.

**Methods:** Systolic and diastolic BP measurements were obtained from men in the Normative Aging Study who lived in the Boston area and visited the study center every 3–5 years. Postural BP change was defined as the difference between standing and supine measurements for systolic and diastolic BP. PM<sub>2.5</sub> was measured continuously with exposures averaged over 48 hours prior to study visit for analyses. Blood samples were analyzed for 975 SNPs in 62 candidate genes and included haplotype tag SNPs and known or suspected functional SNPs. Data were stratified into a screening cohort and testing cohort. In the screening cohort, the relationship between postural change in BP and SNP, PM<sub>2.5</sub>, and SNP-by-PM<sub>2.5</sub> interactions was analyzed using linear mixed effect models with random intercepts for each subject to account for repeated BP measurements within the study period. Models were adjusted for age and body mass index (BMI). A positive outcome in the screening cohort was defined as a  $P$ -value  $< 0.1$  for the interaction term. SNPs meeting these criteria were subsequently analyzed in the testing cohort. SNPs were confirmed as significant predictors if they also met criteria of  $P < 0.05$  in the testing cohort with an association in the same direction as in the screening cohort. All confirmed associations were analyzed within the full cohort data in models adjusted for age, BMI, smoking status and use of hypertension medications.

**Results:** 930 participants with a mean ( $\pm$ SD) age of 72 ( $\pm 7$ ) provided information on exposure, outcomes and covariates of interest. Average systolic BP was 132.97 ( $\pm 17.9$ ) mmHg with a postural change in pressure of 2.4 ( $\pm 12.7$ ) mmHg. Average diastolic BP was 78.11 ( $\pm 10.4$ ) mmHg

with  $-0.5$  ( $\pm 6.5$ ) mmHg change. SNP-by-PM<sub>2.5</sub> interactions in *ITPR2* and *MMP1* decreased the magnitude of change in systolic BP and a polymorphism in the *PHF11* gene suppressed postural change in diastolic pressure. For example, the main effect of the minor allele of rs9568232 in *PHF11* was associated with greater postural change in diastolic BP ( $\beta = 2.5$ ,  $P = .001$ ) and the interaction was associated with a suppression in diastolic BP change ( $\beta = -2.4$ ,  $P = .001$ ) for an increase of 10  $\mu\text{g}/\text{m}^3$  PM<sub>2.5</sub>. The effect of PM<sub>2.5</sub> in subjects with the major variant was non-significant ( $\beta = 0.3$ ,  $P = .23$ ).

**Conclusions:** We observed SNPs associated with decreases in magnitude of postural change in BP and found different candidate genes to be associated with differences in postural change in diastolic and systolic blood pressure. Our findings also suggest that considering gene main effects alone may overlook relationships modified by environmental exposures such as PM<sub>2.5</sub>.

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#### ISEE-785

##### The Effect of Prenatal Tobacco Smoke Exposure on Intellectual Disabilities Among 8-Year Old Children in Arkansas, Georgia, and North Carolina

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**Background:** Prenatal tobacco smoke exposure has been implicated as a risk factor for cognitive deficits in children. Small shifts in the IQ distribution among children exposed to tobacco smoke may increase the proportion of children with intellectual disabilities (ID).

**Objective:** The purpose of this study is to examine the association between prenatal tobacco smoke exposure and ID diagnosis at 8 years of age among children living in Arkansas, Georgia, and North Carolina.

**Methods:** In 2002 and 2004, 1,261 ID case children were identified through a surveillance network and compared to the population of children born in the surveillance region during the same period ( $n = 94,830$ ). Smoking status was determined from birth certificates. We estimated the effect of prenatal tobacco smoke exposure (none,  $< 10$ , 10–19, and  $\geq 20$  cigarettes per day) on ID using logistic regression models adjusting for maternal age, maternal education, race, child sex, study site, and year of birth.

**Results:** Compared to children whose mothers did not smoke during pregnancy, children exposed to  $\geq 20$  cigarettes per day had a 1.22-fold [95% (confidence interval) CI: 0.95, 1.56] increased odds of ID after adjustment for maternal education, race, child sex, maternal age, marital status, birth year, and study site. The effect of exposure to  $\geq 20$  cigarettes per day significantly differed for males (OR 1.5, CI: 1.1, 2.0) compared to females (OR 0.8, CI: 0.5, 1.3).

**Conclusion:** These results suggest that sex may modify the effect of prenatal tobacco smoke exposure on cognitive deficits in children.

#### ISEE-786

##### Ultrafine Particle Exposures in Homes, Automobiles, and Restaurants

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**Background:** Ultrafine particles (UFP) are increasingly linked to human morbidity and perhaps mortality. A major outdoor source is motor vehicle exhaust. A major indoor source is cooking.

**Methods:** Personal exposures to UFP from these two sources have been measured over the past year using a portable particle counter (Model 3007, TSI Inc., Shoreview MN) sensitive to particles from 10 nm to 1  $\mu\text{m}$ . Two investigators located in San Jose, CA and Reston, VA used two

Model 3007 monitors for all measurements. Personal exposures were measured in automobiles while driving in varied situations from local roads to interstate expressways. Multiple restaurants were also investigated. Exposures in homes and in a test house were measured while cooking with gas stoves, electric stoves, and electric toaster ovens. Several other UFP sources in homes were also investigated.

**Results:** The mean particle count for all driving situations was similar for both investigators about 30,000 particles per cubic centimeter ( $\text{cm}^{-3}$ ) compared to background concentrations of about 5000  $\text{cm}^{-3}$ . Concentrations in restaurants averaged about 80,000  $\text{cm}^{-3}$ . Concentrations in the home and test house varied with the type and duration of cooking, but exceeded 100,000  $\text{cm}^{-3}$  multiple times. UFP emission rates from the cooking sources were calculated. Both gas and electric sources emitted UFP in copious quantities ranging from  $10^{11}$ – $10^{12}$  particles per minute.

**Implications:** A 4-minute period boiling water is sufficient to elevate UFP levels throughout a house by an order of magnitude, and elevated concentrations continue for several hours in houses with typical air exchange rates. Because of their increased Brownian motion, UFP have lower penetration coefficients and higher deposition rates than larger fine particles. This means less exposure to UFP of ambient origin, and therefore a greater relative importance of indoor sources in homes and other indoor locations with UFP sources such as restaurants. Concentrations and emission rates developed in studies such as this will allow more accurate models of personal exposure to UFP and the influence of ambient vs. indoor sources.

#### ISEE-787

#### Air Pollution and the Related Asthma-Burden for Children in Two Impacted Communities of Southern California

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#### Introduction

**Background:** Air pollution risk assessment is a useful tool to prioritize state and national regulation and policy development. However, only rarely has this methodology been applied to smaller geographical scales and has taken into account local air pollution conditions and sources, although local analysis is highly relevant for policy making. We quantify the burden on health of air pollution for children living in two highly polluted communities in Southern California and affected by primary and secondary pollutants. Air pollution in these communities results in part from activities related to the ever expanding ports of Long Beach and Los Angeles. The study focuses on asthma-related morbidity on children, because emerging research indicates that previous analyses underestimated the effects of air pollution in these sensitive populations.

**Methods:** Standard methodologies were used to derive attributable fractions and to quantify the number of asthma related morbidity that are expected to be prevented in children if air quality was improved both in a community located adjacent to the Long Beach port complex (Long Beach community) and in a community located downwind of this port (Riverside). We chose  $\text{NO}_2$  as a marker of goods movement related air pollution. For Riverside, we also used  $\text{O}_3$  reflecting the impact of secondary oxidant pollutants. Community population exposure was represented by a 4-year mean concentration obtained from fixed site monitors. Benefits were estimated by choosing a reference point corresponding to levels observed in the cleanest Southern Californian communities. Several recent studies have found evidence for suggesting a causal role of traffic related pollutants not only in the exacerbation of asthma symptoms but also in the development of this chronic disease. These new findings have a substantial impact on the approach taken to quantify the asthma related burden due to air pollution (Künzli et al, Epidemiology March 2008).

**Results:** Compliance with a  $\text{NO}_2$  reference point of 5 ppb annual mean would result in substantial reductions in the number of bronchitis episodes (66% reduction in Long Beach; 59% in Riverside), health care facility visits (4.6%; 4.1%), and in the number of children with low lung function capacity (85%; 68%) defined as <80% predicted. In Riverside, compliance with an  $\text{O}_3$  reference point of 28.5 ppb annual mean would result in reductions in the number of bronchitis episodes by 72%, health care facility visits by 3.8%, and respiratory illnesses among asthmatics by 56%. If we take into account the contribution of traffic pollution to the onset of asthma in children, 9% of asthma cases in Long Beach and 6% in Riverside would be attributed to air pollution. Thus, the above estimates further increase, ranging from an additional burden of 1.7% for the number of bronchitis episodes to 9.1% for emergency room visits. Uncertainties in these estimates are provided based on Monte Carlo simulations.

**Conclusions:** Although the contribution to local air quality of port expansions in these communities remains unclear, this assessment clearly indicates the need for integrating children's health and local source impact in air quality risk assessment.

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#### ISEE-788

#### Pilot Study of Barcelona Commuters' Exposure to Particulate Matter

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**Background:** Exposure during outdoor activities in urban areas is possibly the least well understood exposure period in a day but is potentially highly relevant. Although commutes may represent a relatively short time, they can account for substantial amounts of total exposures because of elevated pollutant concentrations in roadway environments. Barcelona commuters may particularly be at risk of elevated exposures: the city is amongst the most polluted in Europe, and traffic is shown to dominate emission sources. Within commute patterns however, there may be important exposure concentrations variations. Results from the little research that compares exposures in different travel modes are inconsistent. Further, during active commutes such as walking or biking, inhalation rates and exposure duration could be greater than for other modes. Actual concentrations in Barcelona transportation microenvironments have not been measured other than at the handful of traffic monitoring stations in the city. Estimates of inhalation associated with commute patterns using simultaneous measures of personal exposures and energy expenditure have seldom been made in an urban environment. Understanding pollutant inhalation variability across travel modes, space and time is crucial to reduce exposure assessment errors in epidemiologic studies.

**Methods:** A MonteCarlo simulation of exposures and inhalations on three commute routes and 5 travel modes (walk, bike, car, bus, metro) in Barcelona was performed in Matlab and ArcGIS NetworkAnalyst. The model uses an existing simple dispersion model of annual mean  $\text{PM}_{10}$  (500 meter resolution), and uncertainty distributions of factors found in the scant literature for energy expenditure and microenvironmental penetrations of  $\text{PM}_{10}$  in different transportation modes.

**Results:** Results indicate that across the routes modeled, exposure concentrations are on average 30% higher for the bike and pedestrian modes and five times higher for transit compared to inside a car. The amount of pollutant inhaled, however, is on average and compared to drivers' inhalation dose: 5 times higher for cyclists, 20% lower for pedestrians, and twice as high for transit-users. Greatest variabilities are found for transit users, then cyclists.

**Discussion:** Inputs of the simulation model, particularly penetration factors, may not be valid for Barcelona. Further, results could be quite different for other pollutants for which no data was available. Because of the dearth of knowledge in this field, and consequentially the low confidence in these

results, actual measurements are necessary to develop better representations of the variability in exposures and inhalations. This has led to the design of a pilot study to measure in Barcelona across different individuals and commute patterns: continuous ultrafine particulates (TSI p-track); 30-minute average PM<sub>2.5</sub> (personal sampling equipment developed by Adams et al. (2001)); energy expenditure (Bodymedia Sensewear accelerometer); location of commuter (GPS data-logger system); and, to calibrate pollution inhalation functions, breathing rates under rest and exercising conditions (EasyOne spirometry equipment). Individual sampling is useful to assess variability in exposures as a function of lifestyle choices, estimate measurement errors when using least costly methods, and simulate exposures in a population, so as to improve estimations of dose-response relationships in air pollution epidemiology.

#### ISEE-791

#### Short-Term Effects of Air Pollution and Temperature on Daily Morbidity in Chiang Mai, Thailand

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**Background:** Chiang Mai, the second biggest province of Thailand, has confronted air pollution problems due to its rapid economic growth, development and urbanization to serve an increasing population and an influx of tourists from all over the world. Although a large body of epidemiological evidence has suggested that air pollution exposure and temperature changes have been associated with an increase in morbidity and mortality in many cities worldwide, apart from the Public Health and Air Pollution in Asia (PAPA) research projects, few investigations have been made in tropical climates and less developed regions.

**Objectives:** To investigate the effects of air pollution and temperature on the health of people in Chiang Mai, Thailand, and to identify people who are more susceptible to air pollution and temperature exposure. Methods: A regression analysis of retrospective time series data to assess the effects of air pollution and temperature on daily out-patient visits among people in Chiang Mai from October 2002 to September 2006. Health records of daily out-patient visits obtained from the Chiang Mai Provincial Health office were stratified by age, sex, and occupation and were divided into five disease groups in accordance with International Classification of Diseases, 10th revision(ICD-10), including all-cause, respiratory(J00-J99), circulatory(I00-I99), diabetic(E10-E14), and intestinal infectious(A00-A09) visits. Daily levels of NO<sub>2</sub>, SO<sub>2</sub>, CO, O<sub>3</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> and weather data, including temperature, relative humidity, and rain, were obtained from the two air monitoring stations located in Chiang Mai, provided by the Air Pollution Control Department. Generalized linear models were fitted using negative binomial regression with cubic splines and controlling for seasonal patterns, long time trend, day of week, and holidays. The lag effects of air pollution up to 4 days and of temperature up to 13 days were examined.

**Findings:** There were the notable effects of SO<sub>2</sub> and O<sub>3</sub> (lag 0-4 days) for most disease groups. The air pollution effects on respiratory visits were predominantly found in the elderly ( $\geq 65$  years), but not statistically significant. The effects of a 10-unit increase of SO<sub>2</sub> were found in male for circulatory visits (RR = 1.26, 95% CI = 1.00–1.59, P-value = 0.053), and diabetic visits (RR = 1.46, 95% CI = 1.00–2.14, P-value = 0.051). There was a significant effect of SO<sub>2</sub> on all-cause visits in manual workers (RR = 1.25, 95%CI = 1.00–1.55, P-value = 0.047). For temperature, the risk estimates of circulatory visits was found about 1.12 (95% CI = 1.03–1.21, P-value = 0.008) per 1 degree increase in temperature above 29°C. There was no significant difference in temperature effects in different groups of people.

**Conclusions:** There was evidence of air pollution effects on daily out-patient visits in Chiang Mai for all disease groups. More attention should be paid on the more vulnerable groups of people such as the elderly ( $\geq 65$  years) and manual workers. Since there was strong evidence of

temperature effects at above 29°C on circulatory visits, public health responses targeting on people who are more susceptible to temperature changes are also needed.

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#### ISEE-793

#### Comparison of Land Use Regression Models for NO<sub>2</sub> and VOC Exposure Studies in Three Cities

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**Introduction:** Recent spatial analysis efforts in EPA/ORD have included application of land-use regression (LUR) models in support of respiratory health and urban air quality studies. Gaseous air pollutants, nitrogen dioxide (NO<sub>2</sub>) and volatile organic compounds (VOC) have been collected at urban air monitoring networks in El Paso, Detroit, and Dallas to assess spatial variability and source influences. Comparisons on the development and predictive capabilities of these LUR models will be presented to address uniform application of such models across study areas.

**Methods:** Monitoring efforts were conducted at local elementary schools or fire stations to be representative of neighborhood ambient exposures. A statistically-based approach (for example, employing correlation and cluster analyses) was used to select variables and sites. The land-use variables and (for Detroit and Dallas) monitoring locations were selected to span the mathematical space considered within the urban study areas, thus assuring that the LUR models developed were reliable. Passive exposure monitoring methods for NO<sub>2</sub> and selected VOCs were used for week-long intervals to mimic chronic exposures. For these three cities, similar predictive variable types were considered in the LUR models: traffic intensity within set distances, distance to nearest road of selected traffic volumes, housing unit density within set distances, population density within set distances, and distance to nearest major point sources. For El Paso and Detroit, distance to nearest border crossing was used, and in El Paso, elevation above sea level was also considered as an explanatory variable. Based on graphical inspection of the values of the predictor variables relative to the ambient data, generalized additive models were applied in El Paso, while Detroit and Dallas used weighted multiple linear regression.

**Results and Discussion:** The explanatory capability of the LUR models was high for both pollutants in El Paso (NO<sub>2</sub>: R<sup>2</sup> = 97%; benzene: R<sup>2</sup> = 93%) and high for one pollutant in Detroit (NO<sub>2</sub>: R<sup>2</sup> = 82%; benzene: R<sup>2</sup> = 43%) and Dallas (NO<sub>2</sub>: R<sup>2</sup> = 34%; benzene: R<sup>2</sup> = 72%). LUR predictions revealed spatial gradients in the BTEX species and NO<sub>2</sub> for the three cities, even though pollutant levels were generally medium to low during the monitoring periods. The results from these three cities indicate that from city-to-city there appear to be common types of predictor variables (such as traffic influences and population density), but that city-specific influences (such as elevation and proximity to a border crossing) must also be considered.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

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#### ISEE-794

#### The Use of Zip Code Level Mortality Data in Community, Time-Series Epidemiology Yields Higher and More Significant Associations of Daily Deaths with Daily PM<sub>2.5</sub> and Demonstrates Effect Modifications from Income Level, Proximity to Roads, and Distance from the Monitor

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**Abstract:** The availability of mortality data at the Zip Code level in Phoenix (2/95–6/98) allows us to investigate in the time-series framework the associations between mortality and air pollution as a function of income and proximity to traffic, as done previously in long-term cohort studies. We also investigate how the % excess risk per  $10 \mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{2.5}$  (%ER) and lag day patterns change with the distance of the test population from the monitoring site. The results below give the Zip Code area, the number (#) of cardiovascular deaths, the t-statistic and the %ER for the unconstrained distributed lag (UDL) for lag days 0 through 6 (0–6), and t and %ER for the individual lag day with the maximum %ER (MaxInd). The presentation includes figures showing incremental UDL from 0–1 to 0–14 and individual lag days, each run separately, for lag days 0 to 14. “Small” represents a group of Zip Code areas within 25 km of the monitor. “Middle” represents a ring of Zip Code areas around the “Small” area. “Outer” represents the remaining Zip Codes in Maricopa county. The %ER of 15.1 over 6 lag days for “Small” Phoenix is the highest ever reported for a community, time-series study of mortality and air pollutants and is in the range reported for long-term cohort studies. Areas 1, 2, & 3 show how the %ER and significance fall for Zip Code areas farther from the monitoring site. Area 4 shows the effect of more deaths using all Zip Code areas, “Small” still has the highest significance and %ER. Areas 5 & 6 and 7 & 8 show major differences between Zip Code areas that differ in income level or in the presence or absence of a transecting or bordering highway. Except for Highways, the data show that the significant associations tend to occur at longer lags as the distance from the monitoring site or income increases. The results suggest that use of county-wide mortality data, especially when limited to short lags, can lead to inappropriately low %ERs. The differences in the magnitude and significance of the %ER and in the lag structure may be influenced by exposure error (due to distance from the monitor), by income, or by proximity to highways. These differences need to be considered in interpreting epidemiologic results and the importance of air pollution to public health.

1. Small; # = 4,847; UDL0–6, t = 3.43, %ER = 15.1%; MaxInd, lag = 1, t = 2.58, %ER = 6.8%.
2. Middle; # = 4,986; UDL0–6, t = 1.23, %ER = 5.1%; MaxInd, lag = 2, t = 2.24, %ER = 5.6%.
3. Outer; # = 5,059; UDL0–6, t = 0.09, %ER = 0.4%; MaxInd, lag = 11, t = 2.58, %ER = 6.0%.
4. All; # = 14,892; UDL0–6, t = 2.60, %ER = 6.6%; MaxInd, lag = 8, t = 2.65, %ER = 3.9%.
5. Highways; # = 5,931; UDL0–6, t = 3.14, %ER = 11.6%; MaxInd, lag = 3, t = 2.13, %ER = 4.7%.
6. No Highways; # = 6,660; UDL0–6, t = 1.76, %ER = 6.5%; MaxInd, lag = 1, t = 2.23, %ER = 5.0%.
7. Low Income; # = 4,342; UDL0–6, t = 2.81, %ER = 12.2%; MaxInd, lag = 4, t = 2.18, %ER = 5.8%.
8. High Income; # = 5,954; UDL0–6, t = 1.65, %ER = 6.4%; MaxInd, lag = 1, t = 2.17, %ER = 5.2%.

#### ISEE-797

#### Changes in Respiratory Symptoms and Health Conditions Among Children During Wood Stove Changeout Program

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**Background:** Several mountain valley communities suffer from sustained elevations in seasonal PM due to domestic wood burning during periods of cold temperature inversions. One such community initiated a community-wide wood stove changeout program in response to historical

annual exceedances of the Environmental Protection Agency’s (EPA) National Ambient Air Quality Standard for  $\text{PM}_{2.5}$ .

**Objective:** The purpose of this study is to assess changes in reporting of children’s winter period respiratory symptoms and infections during the changeout program and corresponding changes in ambient PM.

**Methods:** Symptom surveys are distributed to parents of school children (grades 1 through 8) in March/April of each year. Symptom questions were based on the International Study of Asthma and Allergies in Childhood (ISAAC) core questionnaire on asthma, rhinitis and eczema. Parents were asked to report on their child’s symptoms and health conditions during the preceding two months. Differences (and 95% CI) in the frequency of reporting between the two years are presented here. Data on ambient  $\text{PM}_{2.5}$  were collected from the county’s compliance monitoring site. Additional quartz filter samples were collected for monitoring of chemical wood smoke markers.

**Results:** Between two recent winter periods ambient  $\text{PM}_{2.5}$  fell by 14% with an average reduction (95% CI) of  $3.6 \mu\text{g}/\text{m}^3$  ( $-0.6$  to  $7.9$ ). Ambient levoglucosan concentrations fell by 21% with an average reduction (95% CI) of  $393 \text{ ng}/\text{m}^3$  ( $34$  to  $753$ ). In 2006 381 surveys were returned (45% response), and in 2007 386 surveys were returned (47% response). Approximately 36% of children were reported to have had at least one asthma-related symptom in the 2006 survey compared to 33% in the 2007 survey. In unadjusted analyses there was a 4.3% ( $-0.2$  to  $8.8$ ) reduction in reported wheezing between the two years. Other symptoms not specific to asthma such as water/itchy eyes, headache, sore throat, fever, runny nose, coughing and sneezing were reported less frequently in 2007 compared to 2006. No reductions were observed in reporting of nausea, vomiting, diarrhea, or stomach pain. Among the specific health conditions reported to have been diagnosed by a physician, reductions were observed for flu (4.9% ( $-0.1$  to  $9.9$ )), cold (5.7% ( $0.5$  to  $10.9$ )), and bronchitis (4.0% ( $1.2$  to  $7.0$ )) but not for throat or middle-ear infections.

**Conclusions:** These interim data suggest reductions in the frequency of reported respiratory symptoms and health conditions concurrent with modest reductions in ambient levels of wood smoke-derived PM. Future evaluations will include an additional year of winter observation and analyses that will account for temporal effects and repeated measures.

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#### ISEE-798

#### Sources of Uncertainty in Pesticide Postapplication Exposure Estimates

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**Abstract:** Re-entry into areas previously treated with pesticides leads to inadvertent chemical exposures for agricultural workers and the general public. In order to assess the risks from these exposures, data must be available concerning contaminant levels and vectors leading to human exposures. Although exposure estimates are as important as toxicological data in the pesticide risk assessment process, there are no FIFRA-mandated exposure studies or even standardized exposure studies that might be comparable to FIFRA guideline toxicity studies. Environmental monitoring and passive dosimetry data are used to estimate dermal, oral and inhalation exposures to pesticides due to re-entry into treated areas. When chemical- and activity-specific exposure data are unavailable, regulatory agencies tend to rely on algorithms, “Standard Operating Procedures” (SOPs), surrogate data, and generic databases of pooled data. Exposure studies tend to vary in their designs and methodologies, particularly with regard to determining levels of “biologically available” pesticide residues. The operational definitions of “transferable residue” and “pesticide exposure” require consideration of both the uncertainties their assumptions entail and their inconsistency across exposure studies and algorithms. In the context of risk assessment, it is important to

understand such sources of uncertainty and their associated magnitudes involved in generating exposure estimates. Many of the uncertainties associated with using SOPs have been examined here, specifically the quantitative impact of using default values for absorption and retention, assumptions of spatial and temporal patterns governing the environmental fate of residues, and conjectured human activity patterns. Application of default values tends to compound uncertainties in many input parameters for exposure and can overestimate exposure by several orders of magnitude. While the use of screening tools in Tier 1 risk assessment may be a necessary first step, the high degree of uncertainty and inaccuracies of resulting point estimates of exposure from SOPs undermine their utility for pesticide risk management. Generic exposure databases and surrogate exposure studies can be employed to reduce some of the uncertainties in an exposure assessment while providing for an adequate level of health-protectiveness.

#### ISEE-801

#### Intervention Study to Reduce Tannery Worker Exposures in Ulaanbaatar, Mongolia

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**Background:** Ulaanbaatar has 34 tanneries all using chromium-based technology. In 2007, we tested an intervention to increase the use of personal protective equipment (PPE) among tannery workers. The study was approved by the Ethical Committee of Health Professionals of the Mongolian Health Ministry.

**Methods:** We recruited a convenience sample of 16 small/medium-sized tanneries (<50 workers), assigned 8 each to the intervention and control groups, and randomly selected 2–12 workers per tannery from personnel rosters. Tanneries were not blinded as to their intervention/control status. A recruitment target of 45 workers in each group was set based on 2006 pilot observational data. Both groups were given basic training for workers/managers/owners on tannery workplace health and safety (one hour/month for 6 months). The intervention group received intensive follow-up assistance on PPE procurement for three months after basic training. Baseline and follow-up data were collected during the first month and one month post-intervention, respectively. Observational data on the minutes each worker wore task-appropriate PPE during his/her shift were collected in 15-minute intervals by trained researchers using standardized forms. Task-appropriate PPE was determined by compliance with Mongolian regulations by PPE type (dust mask, water-resistant boots, apron, rubber gloves). Our primary outcome was the change in task-appropriate PPE wearing minutes per worker from baseline to follow-up. A secondary outcome was the change in total chromium concentration in urine samples. Workers collected their own spot urines; these are being analyzed at the Korean Occupational Safety and Health Agency Laboratory (Incheon, Republic of Korea). Response rates, descriptive statistics, and hypothesis tests were conducted on the observational data using SAS 9.1 (SAS Institute, Cary, NC). Data were tested for normality and two-sample t-tests with unequal variances used to test whether the mean change in task appropriate PPE minutes differed significantly between intervention and control workers. We also calculated the median change in PPE minutes by tannery and conducted a t-test of the difference between intervention and control tannery medians.

**Results and Discussion:** Forty-one intervention and 36 control workers participated. Two control tanneries dropped out before follow-up. Thirty-two workers provided both baseline and follow-up data, while 45 mostly seasonal workers provided either baseline or follow-up data. The mean change in mask wearing minutes was  $202 \pm 161.1$  for intervention and  $118 \pm 116.6$  for control workers. For boots, the means were  $137 \pm 190.8$

(intervention) and  $28 \pm 93.0$  min (control); for aprons,  $161 \pm 210.9$  (intervention) and  $-27 \pm 201.6$  min (control); and for gloves,  $171 \pm 175.5$  (intervention) and  $-23 \pm 124.6$  min (control). Intervention and control workers differed significantly with respect to the change in PPE minutes for boots (*t*-test  $P = 0.04$ ), aprons ( $P = 0.01$ ), and gloves ( $P = 0.001$ ), but not masks ( $P = 0.09$ ). On the tannery scale, intervention and control tanneries differed significantly by the median change in mask wearing minutes (*t*-test  $P = 0.02$ ), but not boots ( $P = 0.09$ ), gloves ( $P = 0.08$ ), or aprons ( $P = 0.06$ ). Thus, at the worker level, the intervention successfully increased the time workers wore boots, aprons, and gloves, while results are less clear at the tannery level. Excluding seasonal workers from this study would have eliminated the need for tannery-level analysis yet ignored an important fraction of the tannery workforce.

#### ISEE-805

#### Genetic Polymorphisms, Proximity to Traffic, and Left Ventricular Mass: The Multi-Ethnic Study of Atherosclerosis and Air Pollution

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**Context:** Understanding genetic factors that influence susceptibility to air pollution's effects may provide insight into potential mechanisms. Although a relationship between close (<50 meters) residential proximity to major roadways and increasing left ventricular mass (LVM) has previously been described, the pathways responsible for this relationship are uncertain. Changes in vascular and autonomic function, blood pressure, inflammation, and oxidative stress have all been implicated in air pollution's associations with cardiovascular disease (CVD).

**Objective:** To determine whether genetic polymorphisms in genes affecting vascular and autonomic function, blood pressure, inflammation, or oxidative stress influence the previously observed relationship between close residential traffic proximity and LVM.

**Design, Setting, and Participants:** This is a cross-sectional study of 1,939 genotyped participants in the Multi-Ethnic Study of Atherosclerosis, with cardiac MRI exams performed between 2000 and 2002. The impact of common-variant single-nucleotide polymorphisms (SNPs) and inferred haplotypes in angiotensin converting enzyme (ACE), beta-2 adrenergic receptor (ADRB2), angiotensinogen (AGT), type-1 angiotensin II receptor (AGTR1), arachidonate 15-lipoxygenase (ALOX15), endothelin 1 (EDN1), g protein-coupled receptor kinase 4 (GRK4), prostaglandin-endoperoxide synthase 1 and 2 (PTGS1 and PTGS2), vascular endothelial growth factor A and B (VEGFA and VEGFB)—105 tagSNPs and 76 inferred haplotypes—on the relationship between residential proximity to major roadways and LVM was analyzed using multiple linear regression, adjusting for city, race/ethnicity, a city by race/ethnicity interaction, anthropometric factors, age, gender, education, income, cigarette smoke exposure, cholesterol levels, diabetes, physical activity, alcohol use, and medication use (ACE inhibitors, ARBs, beta blockers, NSAIDS, COX-2 inhibitors, statins, and aspirin). SNPs and haplotypes were modeled as linear terms. To account for multiple testing, a false discovery rate of 0.2 was set.

**Results:** After accounting for multiple testing and comparing homozygotes, SNPs in AGTR1 (rs3772616, rs4488792, rs389566, rs6801836), ALOX15 (rs2664593, rs7220870), PTGS1 (rs3842787), and VEGFA (rs3025035) were significantly ( $q \leq 0.2$ ) associated with a 6–13% difference in the effect of residential proximity to major roadways on LVM. Inferred haplotypes did not reach criteria for statistical significance, although AGTR1 haplotype findings supported the 4

significant SNP findings within that gene. These effects remained after additional adjustment for blood pressure.

**Conclusions:** SNPs in genes responsible for vascular function (AGTR1, VEGFA), inflammation and oxidative stress (PTGS1, ALOX15) appear to modify associations between proximity to major roadways and LVM. Further understanding of how genes modify effects of air pollution on CVD may help guide research efforts into specific mechanistic pathways.

#### ISEE-806

#### Interaction of Stress and Lead Burden on Cognition in Older Men: The VA Normative Aging Study

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**Background:** Low-level environmental lead exposure is related to cognitive decline among older adults. Likewise chronic stress may influence cognitive function. However, the modifying effect of stress on lead's neurotoxicity has not been examined in elderly populations.

**Methods:** We used an on-going cohort study of aging to examine the interaction between two self-reported measures of stress appraisal (self-reported stress related to their most severe problem and the perceived stress scale score (PSS)), and biomarkers of lead exposure on Mini-Mental State Examination (MMSE) scores. We used both blood lead and bone (tibia and patella) lead with K-shell x-ray fluorescence as indices of lead exposure, with blood representing acute exposure and bone lead cumulative exposure. We cross-sectionally evaluated the interactive effect of median-dichotomized stress groups and continuous lead measures in 783 participants in the Normative Aging Study, a cohort of community-dwelling older U.S. men.

**Results:** Those with high stress had lower MMSE scores ( $\beta = -0.97$ ; 95% CI:  $-1.56, -0.37$  for self-reported stress;  $\beta = -0.22$ ; 95% CI:  $-0.44, 0.01$  for PSS), after adjusting for age, education, computer experience, English as a first language, smoking and alcohol intake. In multivariable-adjusted tests for interactions, each standard deviation increase in log patella lead was associated with a 1.01 point reduction on the MMSE comparing those with high self-reported stress to those with low self-reported stress ( $P = 0.01$ ); those with high PSS had a 0.29 reduction on the MMSE compared to those with low PSS ( $P = 0.07$ ). High PSS was also associated with a 0.30 reduction on the MMSE for each standard deviation increase in blood lead relative to low PSS ( $P = 0.02$ ).

**Conclusion:** These results suggest that psychological stress has both an independent inverse association and a modifying effect on the relation of lead exposure to cognitive performance among older men.

#### ISEE-807

#### A Hybrid Mechanistic-Empirical Model for the Accumulation of Lead in Household Dust

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**Abstract:** The risk assessment performed for the recent review of the EPA's National Ambient Air Quality Standard (NAAQS) for lead involved characterizing risk to children resulting from lead contained in ambient (outdoor) air. In addition to direct inhalation, lead in ambient air can impact children through a number of deposition-related pathways including the loading of outdoor soil/surface dust and penetration of lead into residential dwellings with subsequent loading of indoor dust. Of

particular interest in relation to the risk assessment performed for EPA's review of the lead NAAQS was the potential impact of changes in ambient air lead levels on indoor dust lead levels (children may obtain a significant fraction of their residential exposure to lead through incidental ingestion of indoor dust). However, relating changes in outdoor ambient air lead with changes in indoor dust lead levels is a technically challenging task. As part of the risk assessment performed for the lead NAAQS review, EPA sponsored development of a hybrid mechanistic-empirical model relating changes in ambient air lead to changes in indoor dust lead levels. This presentation provides an overview of that hybrid indoor dust lead model. Many factors affect the level of indoor dust lead contamination including air penetration rates, settling rates, indoor paint lead concentrations, paint flaking rates, resuspension rates, yard soil lead concentrations, tracking patterns of outdoor soil into the home, and household cleaning practices. We have constructed a mechanistic model which assumes mass balance and captures the most important processes affecting indoor dust lead levels. Based on literature reviews and first principal considerations, we have derived reasonable parameter values for the penetration rate of air to the indoor environment, the deposition rate of particles onto the floor, and the size and configurations of typical homes. Because paint flaking rates and soil tracking rates are highly variable and not abundantly available in the literature, these two processes cannot be reliably modeled. Therefore, we combined a steady-state mechanistic model for the penetration, settling, and cleaning of dust (i.e., the contribution of outdoor ambient air lead) with empirical data to capture the remaining sources of lead in dust (e.g., flaking indoor paint and tracking in outdoor soil). We assumed typical values of cleaning frequencies and efficiencies (based on household cleaning studies) and derived indoor dust loadings to represent average exposure conditions. We then compared the model predictions to existing data. Finally, we tested the sensitivity of the model to changes in some important parameters and found that cleaning frequency and efficiency contributed a large proportion of the total variability in the model predictions.

#### ISEE-809

#### Relationships Between Environmental Concentrations and Measured Urinary Biomarker Levels

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**Background:** Observational exposure measurement studies may collect a plethora of information, including environmental (indoor and outdoor air, transferable residues, dust, soil), biological (urine, saliva), and personal (cotton garments, duplicate diet) samples, as well as activity patterns and questionnaire information.

**Methods:** Data from selected studies were analyzed individually and then combined and analyzed collectively to evaluate the relationships between various environmental, personal, and biological concentrations for selected pesticides and their corresponding urinary metabolites. In this presentation, observations will be made on the relationships between the environmental concentrations and the measured urinary metabolite concentrations for the individual and combined analyses. Individual and combined data were evaluated using regression models.

**Results:** Preliminary data analyses indicated associations between analyte concentrations on socks data and measured urinary 3-phenoxybenzoic acid (3-PBA) concentrations ( $r^2 = 0.95$ ) and the indoor air data and measured urinary 3-PBA concentrations ( $r^2 = 0.35$ ) for a subset of the individually analyzed data ( $n = 9$ ).

**Discussion:** Included in this presentation will be a discussion of the challenges often encountered when interpreting environmental and biological data, including variations in sample collection strategies, parent

pesticide half-life, and presence of pesticide metabolites in environmental media. We conclude by comparing our observations to the NHANES and GerES population studies.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-811

##### Dioxins and Cardiovascular Mortality: A Review

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**Background and Significance:** We present here the results of the first systematic review, to our knowledge, of the association of cardiovascular disease (CVD) mortality with exposure to dioxins. Dioxins are a group of pollutants resulting from the production and combustion of chlorinated compounds. This review complements both the large body of dioxin epidemiology research that until now has focused primarily on carcinogenicity, and also the substantial evidence for dioxin cardiotoxicity in animal experiments.

**Search Strategy and Selection Criteria:** Articles were found by searching PubMed in December 2007 using the keyword 'mortality' in combination with each of the following: dioxin, TCDD, PCDD, PCDF, phenoxy, chlorophenoxy, chlorophenol, and trichlorophenol. From this initial list, we selected articles reporting original data, in English, on human mortality from either all cardiovascular diseases (all CVD), or ischemic heart disease (IHD), from dioxin-exposed cohorts. To focus on dioxins, we excluded cohorts that were either primarily exposed to PCBs, or from the leather and perfume industries, which involve other cardiotoxic co-exposures. The reference lists of included articles were searched using the same criteria.

**Results:** Results from twelve cohorts were included in the review. Most cohorts were occupationally exposed. Analyses were divided according to two well-recognized criteria of epidemiologic study design quality: the accuracy of the exposure assessment, and whether the exposed population is compared to an internal or an external (e.g. general population) reference group. Analyses using internal comparisons with accurate exposure assessments are the highest-quality, since they minimize both exposure misclassification, and confounding due to workers being healthier than the general population ("healthy worker effect bias"). The studies in the highest-quality group found consistent and significant dose-related increases in IHD mortality, and more modest associations with all CVD mortality. Their primary limitation was a lack of adjustment for potential confounding by the major risk factors for CVD.

**Conclusions:** The results of this systematic review suggest that dioxin exposure is associated with mortality from both ischemic heart disease and all cardiovascular diseases, although more strongly with the former. However, it is not possible to determine the potential bias, if any, from confounding by other risk factors for cardiovascular disease.

#### ISEE-812

##### Well Water Consumption and Parkinson's Disease in Rural California

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**Background:** Consumption of well water has been hypothesized to play a role in Parkinson's disease (PD) as a potential vehicle of exposure to pesticides, metals and other toxins, and some previous mostly ecological epidemiologic studies have provided support for this hypothesis.

**Methods:** We are currently investigating whether well water consumption is associated with an increased risk of PD among 370 incident PD cases and 341 population controls residing in three largely rural California

counties and enrolled in the Parkinson's Environment and Genes (PEG) study. Patients who were diagnosed between January 1998 and December 2006, and confirmed as having either probable or possible idiopathic PD by PEG movement disorder specialists are included in the analyses. We collected data on self-reported consumption of types of drinking water (unfiltered tap, filtered tap, bottled and well water) and frequency of consumption during four age periods [young adult (<25 years), adult (25–44 years), middle-aged (45–64 years) and senior (>65 years)].

**Results:** In our study population, 31.5% of subjects reported ever having consumed well water in their lifetime; 22.9% reported consumption during young adult years. In logistic regression models adjusted for age (continuous), gender, education (<12 years, 12 years, >12 years), race/ethnicity (white, non-white) and smoking (never, former, current) ever/never consumption of well water during three or four of the age periods investigated was only weakly if at all associated with PD risk (OR = 1.36, 95%CI = 0.73, 2.53). Consumption during young adult or adult years was mostly responsible for this association (OR = 1.33, 95%CI = 0.94, 1.88).

**Conclusions:** While our findings do not support any strong association between well water consumption and PD, we have started modeling the influence of pesticide use in proximity to homes and wells as reported in the California Pesticide Use Reporting system, based on historical land use maps and subjects' report of residential addresses. We will present results based on this modeling approach and expect this to help us refine our well water exposure measures and identify possible pesticide-contaminated wells.

#### ISEE-813

##### Evaluation of Factors Associated with Occurrence of Congenital Malformations in an Area Close to a Large Municipal Dump Site in Cali, Colombia

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**Objective:** A hospital based surveillance system was established since 2004 in Cali, Colombia, and geographical analysis of cases distribution showed malformations are clustered in poorer areas which are close to the main river of the city. This river is polluted by contaminants from the municipal waste disposal site and agricultural pesticides. A study is developed to evaluate environmental factors potentially associated to occurrence of clusters of congenital malformations in this area.

**Materials and Methods:** We have collected information to describe routes and pathways of exposure to contaminants. Specifically, water, soil and air samples were analyzed. In addition, to understand population believes and practices which may facilitate intake of pollutants, we developed a survey among 380 women.

**Results:** Neural tube defects and vascular disruption defects are among the most frequent malformations in the area (5 to 10 times higher occurrence as compared with similar surveillance systems in other cities of the world). Ground water and soil samples demonstrated presence of metals, particularly cadmium, lead and mercury. These contaminants and other pollutants, including pesticides, can reach pregnant women by several routes and pathways, including fish and crops in diet (oral) and also indoor exposure to batteries of vehicles and other chemical products (inhalation and dermal contact).

**Conclusions:** Multiple routes and pathways allow exposure of women to pollutants and explain clustering of congenital malformations in this area. Indoor exposures and behavioral factors, as fish consumption during pregnancy, need to be considered to understand causes of congenital malformations.

**ISEE-814**

**Enhancing Surveillance of Reasons for Tardiness and Leaving Early at Primary Schools to Inform Planning of Interventions to Improve Student Health and Productivity: A Pilot Study in DeKalb County, Georgia, USA**  
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**Background:** Student health, well-being and productivity are determined in part by attending school daily. Increased annual average daily attendance (ADA) increases public funding for school district-based enrichment programs. For example, asthma is the #1 cause of American school absenteeism due to chronic illness. However, there are only limited, estimated national data on the true magnitude of the problem, and accurate, precise ways to assess potential disparities based on gender, race-ethnicity and/or age do not yet exist. Nevertheless, we can control asthma through proper clinical, behavioral and environmental management and education services at schools, day care, homes, and local clinics if key people are informed. Environmental and epidemiologic issues regarding asthma, and other chronic diseases of emerging importance (e.g., diabetes, obesity), are complex and may include identifying and reducing levels of, or preventing exposure to, triggers. In addition, exposure to some triggers may also lead to other acute and chronic adverse health outcomes of present concern.

**Discussion:** We present a summary of the community-based participatory research planning process, and the content of and outcomes from (final results) a set of matching field and computer-based spreadsheet (table) tools tested throughout DeKalb County, Georgia during the fall semester of 2007 (August–December). These data comprised half of the overall project. For attendance, we tracked with staff involvement (six schools paper version, one school computer version) over 900 children from seven randomly selected, consenting participating schools, overall and then stratified (per 4<sup>th</sup>–5<sup>th</sup> grade classroom, 2–4 classrooms per school) by asthma diagnosis, gender and race-ethnicity. For these children, and in four schools also the K-3<sup>rd</sup> graders (few thousand children in total), we tracked—based on parent, caregiver and guardian responses—the numbers and reasons for tardiness and leaving early with our community-based surveillance tool and researcher constructed database. The list of 15 coded reasons used in the pilot study included multiple chronic diseases known to be caused by, or with symptoms exacerbated by, exposure to environmental agents both indoors and outdoors. The tool was customized to each school, based on the number of grades participating and other information the principal and school nurse wanted recorded. This was because most schools had limited formal truancy recordkeeping systems prior to participation in this project. This pilot study can inform future interdisciplinary research combining indoor air and environmental quality measures, with concurrent outdoor measures as appropriate, and health and academic productivity outcomes.

main contributor to becoming overweight. However, genetics and environmental factors may also play a role. Phthalates, chemicals found in many consumer products, flexible plastics and fragrances, have the potential to disturb endogenous hormonal levels and may influence the development of obesity by affecting insulin sensitivity. A recent report using the NHANES 2001–2002 cross-sectional data in men supports this hypothesis. Given the increasing rates of overweight and the ubiquitous exposure to phthalates, we are investigating the relationship between phthalate exposure and body size characteristics among young girls.

**Methods:** Growing Up Healthy (GUH) is a prospective cohort study of Hispanic and Black, New York City girls between 6 and 8 years old. GUH is part of a NIEHS/NCI funded consortium (Breast Cancer and the Environment Research Centers) of three centers across the U.S. At baseline, parents/guardians were interviewed in-person, in either English or Spanish, about the girls' environmental exposures, physical activity, medical history, and demographics. Anthropometric measurements (weight, height, waist (WC) and hip circumference (HC)), using a standardized protocol, were made by trained interviewers. Body mass index (BMI: weight/height<sup>2</sup>) and BMI percentile (CDC age and gender specific) were calculated. Casual urine samples provided by each girl were analyzed by the Centers for Disease Control and Prevention for a panel of environmental exposure biomarkers, including 9 phthalate metabolites. The molar sums of low and high molecular weight phthalate metabolites, (LoMWP:mEP, mBP, mIBP and HiMWP:mBzP, mCPP, mEHP, mEHHP, mEOHP, mECPP, respectively) were calculated. Cross-sectional analysis using baseline data was conducted for this report. Age and race-ethnicity adjusted geometric means for each phthalate metabolite as well as LoMWP and HiMWP were compared between girls in the upper quartile of each body size characteristic (BSC) and those in the combined lower 3 quartiles using generalized linear models. Adjusted geometric means (ng/ml or nmoles/ml) and 95%CI are presented.

**Results:** Data from 398 girls were available for analysis from 412 girls enrolled at baseline. Adjusted mEP geometric means (BSC Q4 vs. BSC Q1–3) were significantly higher for BMI [271.2(176.2–417.5) vs. 155.7 (127.2–190.7);  $P = 0.05$ ], HC [275.6(186.4–407.6) vs. 154.3(127.0–187.5);  $P = 0.02$ ] and WC [291.5(196.8–431.8) vs. 151.9(125.3–184.3);  $P = 0.01$ ]. Similar differences were observed for the LoMWP, primarily due to mEP's contribution to this sum. Adjusted HiMWP geometric means were elevated for girls in the upper quartile of HC and WC [1.198 (0.833–1.723) vs. 0.764 (0.638–0.916)  $P = 0.05$ ; 1.342 (0.932–1.932) vs. 0.737 (0.616–0.882)  $P = 0.01$ , respectively].

**Discussion:** These findings suggest that phthalate exposure may contribute to increased overweight in children. However given the cross-sectional design of this analysis, we expect that our longitudinal data, when it becomes available, will help to clarify this association.

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**ISEE-815**

**Phthalate Metabolites and Body Size Characteristics in Urban Minority Girls**

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**Background:** According to the CDC, the prevalence of overweight among U.S. children aged 6–11 years has risen from 6.5% in 1976–1980 to 18.8% in 2003–2004. Overweight children are at increased risk of becoming overweight adults which in turn puts them at increased risk for many chronic diseases including diabetes, heart disease and cancer. Energy imbalance (more calories consumed than used) is considered the

**ISEE-816**

**Dampness, Mould, and Health—a Review of Epidemiologic Evidence for the Upcoming WHO Guidelines for Indoor Air Quality**

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**Background:** Increasing epidemiologic evidence links dampness-related factors in buildings (including visible dampness/water damage/mold, mold odor, and measured microbial agents) to adverse health effects. The Institute of Medicine (IOM) has reviewed this epidemiologic literature to mid-2003.<sup>1</sup> The World Health Organization requested an updated review on this topic to support guidelines for indoor air quality related to dampness and mold in buildings.

**Methods:** We included peer-reviewed publications on respiratory health and risk factors of dampness, fungi, or microbiologic components/products (excluding dust-mites), available in mid 2007 but not included in the IOM review, and meeting specific selection criteria. We abstracted reported findings by the specific risk factor/health effect pairings assessed (e.g., visible mold and wheeze), although ultimately combined all dampness-related factors into a single category. We abstracted all findings or where necessary extracted a representative subset of findings. For each health effect, we summarized the numbers of reported assessments that were statistically significantly positive, statistically significantly negative, and neither. We then combined the current assessment of recent published studies with the prior conclusions of the IOM review into an overall synthesis of relationships between dampness-related factors and specific health outcomes. We also performed a more detailed review on asthma development.

**Results:** There were no health outcomes with sufficient epidemiological evidence of causal relationships with indoor dampness-related factors, with the possible exception of asthma exacerbations in asthmatic children. For the category of sufficient evidence of an association with dampness-related factors, recent evidence was consistent with health effects listed here in the IOM review (upper respiratory tract symptoms, wheeze, cough, and asthma exacerbations), and also supported inclusion of asthma development and respiratory infections in infants and children, bronchitis in children, and current asthma in adults. For the category of limited or suggestive evidence of an association with dampness-related factors, recent evidence was consistent with health effects listed here in the IOM review (lower respiratory illness, dyspnea, and asthma development), and also supported inclusion of allergic rhinitis and current asthma in infants and children, and allergy/atopy in adults. For other health effects assessed, there was inadequate or insufficient evidence to determine whether an association existed with dampness-related factors. From the more detailed review of asthma development, associations with qualitative factors of dampness/mold were more frequently positive for infants or children (73% with ORs >1.0, with 60% statistically significant) than for adults (50% and 25%, respectively). Unweighted mean ORs for these associations were, for infants or children, 1.82; children, 1.52; and adults, 1.26.

**Discussion:** The evidence still does not identify specific agents as the causes underlying dampness-related health effects. Endotoxin and some fungi were associated with both increased and decreased health risks. Dampness-related chemical emissions from building materials or surfaces may play a role. Currently, remediation of dampness and mold in existing buildings, and prevention of such conditions in new buildings, are clearly warranted. Improved exposure assessment methods are also necessary to identify causal exposures and improve prevention strategies.

<sup>1</sup>IOM, *Damp Indoor Spaces and Health*. 2004, Washington, D.C.: National Academies Press.

#### ISEE-817

#### Chromosomal Aberrations and Aneuploidies in the Sperm of Chinese Men Occupationally Exposed to Benzene

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**Background:** Benzene is a product of combustion and a common industrial chemical found in crude oil, gasoline, and some solvents, paints and adhesives. In China, benzene-containing adhesives and solvents are regularly used in their important shoemaking industry. Because benzene is a known leukemogen, it is highly regulated in many countries including the US and

China where the 8-hour Permissible Exposure Limits are 1 ppm and 6 mg/m<sup>3</sup> (1.9 ppm), respectively. However, actual exposure is frequently higher than this in China because of the challenges of enforcement. In addition, these limits may not be adequate because benzene has been found to reduce blood cell counts (hematotoxicity) below these limits. Benzene and its toxic metabolites are known to induce DNA strand breaks, mitotic recombination, chromosome translocations and aneuploidy in lymphocytes, but little is known of its effects on germ cells.

**Methods and Results:** We investigated the effects of benzene exposure on chromosomal aberrations and aneuploidy in the sperm of a group of 33 men who were occupationally-exposed to benzene-containing solvents and a reference group of 33 men who worked in factories with no benzene use (meat packing and ice cream manufacturing plants). Work place exposure was assessed at two time points a month apart prior to semen analyses using: 1) urinary muconic acid levels, 2) urinary benzene levels, and 3) personal air monitoring of ambient levels. Ambient air levels in the exposed group ranged from below detectable to 24 ppm with a median level of approximately 3 ppm. Urinary benzene and air monitoring data confirmed that the unexposed group had approximately 40-fold lower exposures, and all three exposure measures were well-correlated. Given its reliability as a biomarker of benzene exposure, muconic acid levels were used to dichotomize the exposed at the median. The low-exposed and high-exposed had median muconic acid levels of 1.9 and 14.4 mg/L, respectively. We applied a sperm-FISH assay with probes for chromosomes X, Y and 21 to determine whether benzene exposure increased the frequencies of sperm with abnormal numbers of these chromosomes. A second sperm-FISH assay (ACM) was used to measure the frequencies of sperm with structural and numerical abnormalities in chromosome 1. We found dose-dependent increases in hyperhaploidy of the two sex chromosomes, after controlling for confounding and matching variables ( $P < 0.001$ ). We also detected benzene dose-dependent increases in structural aberrations of chromosome 1 ( $p_{trend} < 0.001$ ), including breaks, segmental duplications and deletions. The frequency of sperm with diploidy measured by the X-Y-21 assay was positively associated with diploidy/disomy of chromosome 1 ( $r = 0.33$ ,  $P = 0.04$ ). The aggregate frequencies of sperm with hyperhaploidy of X, Y, or 21 were positively correlated with the frequencies of sperm with structural aberrations of chromosome 1 ( $r = 0.39$ ,  $P = 0.01$ ).

**Conclusion:** Our findings suggest that benzene exposure induces numerical and structural abnormalities in human sperm that may yield poor reproductive outcomes including spontaneous abortions and increased frequencies of aneuploid pregnancies and live births.

#### ISEE-821

#### Relationships of Ambient Nitric Oxide and Exhaled Nitric Oxide (by Either Real-Time On-Line or Delayed Off-Line Measurement) in an Epidemiologic Survey of Schoolchildren

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**Background:** Field measurement of exhaled nitric oxide (eNO) may be useful in epidemiologic assessment of respiratory health, and also facilitates short-term air pollution exposure assessment, in that ambient nitric oxide (aNO) can be measured concurrently on-site with the same apparatus. “On-line” eNO measurement, with real-time direct sampling of exhaled breath, maximizes precision and quality control. “Off-line” measurement, with breath collection in Mylar bags for delayed analysis, is sometimes more practical. Cross-comparisons of these methods are needed to maximize data value. We obtained concurrent on-line and off-line measurements of eNO and aNO in 386 schoolchildren at 15 schools in 8 Southern California communities—a subsample from the longitudinal Asthma Incidence Risk Study (AIRS), in which both methods have been applied at different times in a larger population.

**Methods:** Following common practice, off-line breath samples were collected at 100 ml/sec expiratory flow with dead-space discard, while on-line eNO measurements were made at 50 ml/sec expiratory flow. Scrubbing of NO from inhaled air was nearly 100% effective with the on-line apparatus, but less effective with the off-line apparatus. Off-line samples were stored on "blue ice" and analyzed 2–36 hr later at a central laboratory.

**Results:** Off-line and on-line eNO showed a highly but not completely linear relationship ( $r^2 = 0.91$ ); their means (ranges) were 10 (3–104) and 16 (3–181) ppb respectively. The aNO concentration mean (range) was 31 (0–212) ppb. Off-line eNO showed a significant ( $P < .001$ ) positive relationship to aNO; while the corresponding relationship for real-time on-line measurements was less significant, with a smaller effect size. This suggests that off-line eNO might have been influenced by artifacts related to incomplete removal of inhaled NO. Separate studies using the same off-line bag-collection technique documented artifacts related to lag time between collection and analysis (positive at low and negative at high initial NO concentrations, likely attributable to a combination of gas-phase reactions and bag surface phenomena), and to bag aging (a positive effect of the number of prior uses). Even with adjustment for artifacts and for host factors known to influence eNO, off-line eNO differed significantly ( $P < .001$ ) between schools, while on-line eNO did not. This suggests that off-line measurements were influenced by differences in storage and transport conditions between schools. Variance introduced by artifacts was small in comparison with between-subject variance of eNO.

**Conclusions:** Both on-line and off-line NO measurements in the field can be useful for health and exposure assessment. It is important to be aware of and account for possible artifacts in off-line measurement.

#### ISEE-823

#### Transfer of Contaminant Particles from Skin or Clothing to Common Household Surfaces and Implications to Subsequent Exposure

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**Background:** Direct dermal contact is a primary exposure route and significant contributor to a person's overall dose of a contaminant. Such exposure to environmental contaminants has been a priority research focus for pesticides, toxic metals, and biocontaminants. Most of this research has focused on transfer of these particles and residues from common surfaces to a person's skin or clothing. This research investigated transfer in the opposite direction. Our goal was to determine the transfer rate of contaminant particles from a person's skin or clothing to common indoor surfaces. Once deposited on the new surface, subsequent dermal contact by another person will contribute to that individual's total exposure. This mechanism of contaminant transport may be a significant contributor to the exposure of additional people who may not normally come into direct contact with the contaminant. The findings of this research may have implications for children's and adult's health as well as homeland security.

**Methods:** A volunteer wearing normal clothing was uniformly exposed to a high concentration of a fluorescent aerosol inside a wind tunnel. After exposure, the volunteer immediately entered an exposure chamber where a series of scripted activities were performed. The activities were designed to insure equal contact with a variety of rigid and upholstered furniture surfaces. Fluorometric analysis of skin, clothing, and surface samples collected before and after the volunteer conducted the activities quantified the particle mass transferred to a unit area of the surface ( $\text{ng}/\text{cm}^2$ ). The mass transferred was normalized by the aerosol concentration ( $\text{ng}/\text{cm}^3$ ) and exposure time (min) inside the wind tunnel during the experiment to yield a transfer velocity ( $\text{cm}/\text{min}$ ). Independent variables included in the linear multivariate analysis of the transfer velocities included volunteer identification, surface type contacted, clothing type, and the corresponding second and third level interactions.

**Results:** The linear multivariate regression model was statistically significant ( $P$ -value  $< 0.0001$ ) with a correlation coefficient of 0.84. The median transfer velocity was 0.047 cm/min with quartiles of 0.008 and 0.209 cm/min. The largest fraction of particles was transferred from clothing to upholstered surfaces. Direct contact of skin to a hard surface transferred one fifth fewer particles. Clothing contact with a hard surface transferred the lowest percentage of particles.

**Discussion:** The experimental findings highlight the importance of particle transfer from a person to other surfaces on subsequent exposures and contaminant transport routes. Upholstered surfaces may receive the most particles during contact but the three dimensional nature of the surface may not easily release the particles for transfer to another person. Transfer of particles from a person to a hard surface is substantially lower; indicating secondary exposure of an unexposed person may not contribute significantly to their overall dose. However, a child or adult unknowingly exposed to a contaminant may inadvertently transport the contaminant to a previously clean room within a building or to a completely different microenvironment. This accidental transport and transfer to surfaces may subsequently increase the exposure risk of additional children and adults who are unaware of the contamination threat.

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#### ISEE-824

#### The SUPERB Study: An Overview

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**Objective:** The goal of the SUPERB Study (Study of Use of Products and Exposure-Related Behaviors) is to determine optimal data collection methods for environmental exposures in longitudinal epidemiologic studies, taking into account acceptability and feasibility, as measured by retention, compliance, reliability, and error rates.

**Methods:** Three data collection modalities address exposure-related behaviors: annual computer assisted telephone interviews (Tier I); a series of eighteen monthly web-based surveys (Tier II); passive data collection involving home visits (Tier III). Domains of interest include food, household products and time-activity information, with a special focus on pesticides, metals, phthalates, acrylamide, PAHs, and benzene. The passive measures of exposure in Tier III involve weighing and scanning barcodes of food items, pesticides, and cleaning, other household and personal care products twice per season, separated by 1 week. During this week of monitoring, a video camera in the kitchen records food preparation methods, and subjects are asked to wear a GPS and activity monitor, as well as to collect food receipts. Participants are California residents and include young children and their parents, and older adults. When the study is concluded, de-identified data will be provided to the EPA to augment the Consolidated Human Activity Database (CHAD).

**Results:** A total of 680 households have participated in Tier I; 1/3 are enrolled in at least one other tier. Lengthy interviews were sometimes difficult to complete, particularly in families with small children, and required numerous call-backs. Despite extensive efforts taken to facilitate the web-based survey and to make it user-friendly, retention in this Tier has been low, with well over 50% of participants not completing three consecutive months. In contrast, compliance and retention in the passive monitoring (Tier III) has been very high, with fewer than 10% of participants dropping out of this protocol (for most participants, this meant four seasons, each with two home visits). With regard to the quality of data obtained: 37% of consumer products found in at least one home contained a barcode that provided ample information from publicly available databases to identify the product. Forty five percent of the products had an uninformative barcode; these typically were store brand products and were identified by field staff and then added to our database

such that these products became identifiable at other homes and on subsequent visits. Nine percent of the products had no barcode. At the end of the week, field staff were able to find and reweigh 91% of cleaning and 87% of personal care products. Passive measures to record food consumption and activity were also collected. On average, the first house visit took 2 hours, with the participant being involved for approximately 35 minutes, and the participant's time was reduced to 13 minutes on subsequent visits.

**Conclusion:** Our results suggest that longitudinal epidemiologic studies may benefit from the use of passive monitoring methodology without sacrificing data quality. The database of barcodes that the SUPERB study is assembling will be a valuable resource for other researchers.

#### ISEE-828

##### Traffic-Related Air Pollution, Acculturative Stress, and Childhood Respiratory Health in Urban New Zealand: The Pacific Islands Families Study

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**Background:** Prior epidemiologic evidence suggests elevated susceptibilities to traffic-related air pollution among children exposed to social stressors. To further explore this hypothesis, we are creating residence-based pollution exposure estimates for a prospective birth cohort of 1,398 Pacific Islander children in urban Auckland, New Zealand.

**Methods:** Questionnaire data was collected longitudinally since birth provided self-reported asthma and wheeze, as well as measures of family stressors including financial problems, intimate partner violence (IPV), and acculturation stress at multiple time points. Current residence was geocoded for 1,258 children, using roadway networks data obtained from Manukau and Auckland City Councils. A range of GIS-based traffic indicators were derived, and sampling homes were selected to represent the observed range of traffic densities, smoking behaviors, occupant densities, building types, neighborhoods, and proximities to industry and airport. NO<sub>2</sub> was measured indoors and outdoors using Yanagisawa passive filters for one week, summer and winter. The AirQuality OptimaTM collected 24-hour indoor and outdoor continuous measures of fine particles (PM<sub>2.5</sub>), large particles (PM<sub>10</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), ozone, total volatile organic compounds (TVOC), radon, temperature, relative humidity (RH), and spattered molds.

**Results:** Summertime outdoor NO<sub>2</sub> was correlated with 100 m roadway density (Spearman  $\rho = 0.49$  ( $P = 0.02$ )). Summer PM<sub>2.5</sub> was higher indoors than out, peaking during morning hours. PM<sub>10</sub> was generally higher indoors and during daytime. Indoors and out, PM<sub>2.5</sub> was positively correlated with CO, CO<sub>2</sub>, PM<sub>10</sub>, and TVOC, negatively with temperature. Indoors and out, PM<sub>10</sub> was positively correlated with PM<sub>2.5</sub> and CO; negatively with CO<sub>2</sub> and RH. Mold analyses indicated high levels of Cladosporium. Preliminary multivariate logistic regression analyses of GIS-based exposure metrics and family stressors on asthma diagnosis at six years indicate a significant effect of distance from major roadway. Some modest increase in the effect of GIS-based distance-to-roadway measures by maternal acculturation at four years and intimate partner violence (IPV) at six years is observed.

**Discussion:** Results indicate that chronic family stressors may influence children's susceptibility to local traffic-related air pollution in the onset of asthma.

#### ISEE-829

##### Estimation of Daily Inhalation Rate of Preschool Children by Using Tri-Axial Accelerometer

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**Background:** Inhalation rate is an important factor for assessing dose resulting from exposure to airborne gases and particle in the environment. The potentially greater dose to environmental pollutants per unit body in young children have become important issues in setting standards related to hazardous environmental pollutants. However, few data regarding the daily inhalation rate of young children are available. This study aimed to estimate daily inhalation rate in preschool children by using accelerometer.

**Methods:** Continuous monitoring of 3 days (2 weekdays and 1 weekend) physical activity intensity of 70 Japanese preschool children (44 boys and 26 girls, mean age,  $6.2 \pm 0.3$  yr.) recruited from 3 kindergartens and a day-care center in Kanto area was conducted in free living conditions from January 2007 through January 2008. Physical activity was monitored at 1 minute interval by using tri-axial accelerometer Activtracer (GMS Co., Japan) which detects motion in 3 dimensions, giving output measurements in the form of activity counts in anteroposterior (x), mediolateral (y), vertical (z) direction, and a synthesis of these directions (xyz). Discontinuation of monitoring was permitted during sleeping, dressing, bathing, and swimming. Parents of subjects were asked to record the time-activity diary for 3 days. The case with total time for removing the accelerometer more than 1 hour per 3 days except for those permitted periods was regarded as poor compliance. Using equations on activity counts–ventilation rate relationships, obtained from 29 Japanese preschool children 5- to 6-yr old, physical activity ratio (PAR: energy expenditure divided by basal metabolic rate) and daily inhalation rate of the subjects was estimated. The equations were developed based on the data obtained by the measurement of minute respiratory ventilation rate and activity counts during 9 different physical activities.

**Results:** 40 of 70 subjects completed 3 days activity monitoring with total monitoring period 31.2 to 42.6 hours, while the remaining 30 discontinued monitoring due to the poor compliance (13 cases), unexpected shutting down of accelerometer (12 cases), and our incorrect setting of devices (3 cases). Activity counts during waking up periods ranged from 0 to 1826 mG. On weekdays, average time for sleeping was 10.2 hrs/day, light level of physical activity (PAR < 3) was estimated to be 12.3 hrs/day, moderate level (3 = < PAR < 6) 1.3 hrs/day, and vigorous level (PAR > = 6) 0.20 hrs/day. On weekend, average time for sleeping was 10.8 hrs/day, light level 12.0 hrs/day, moderate level 1.1 hrs/day, and vigorous level 0.07 hrs/day. Average daily inhalation rate was estimated to be 8.2 m<sup>3</sup>/day (range, 6.7–10.9 m<sup>3</sup>/day) for weekday, 7.7 m<sup>3</sup>/day (range, 5.8–9.2 m<sup>3</sup>/day) for weekend, and overall average daily inhalation rate was 8.0 m<sup>3</sup>/day (range, 6.5–9.7 m<sup>3</sup>/day). There was no statistically significant gender difference in the estimated daily inhalation rate. Comparing with our estimates, the daily inhalation rate for 3- to 5-yr old based on oxygen uptake associated with energy expenditure and a ventilatory equivalent (Adams 1993) was 8.3 m<sup>3</sup>/day.

#### ISEE-831

##### A Comparison of Zero-Inflated Poisson and Classification and Regression Trees for Predicting the Incidence of Cryptosporidiosis

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**Background:** It remains largely unknown how we can best use weather data to predict the transmission of infectious disease. This paper examined the impact of weekly weather variability on the transmission of cryptosporidiosis and explored the possibility of developing a disease early warning system using weather data.

**Methods:** Data on weather variables, notified cryptosporidiosis cases and population size in Brisbane were supplied by the Australian Bureau of Meteorology, Queensland Department of Health, and Australian Bureau of Statistics, respectively. Time series zero-inflated Poisson (ZIP) and classification and regression trees (CART) models were performed to examine the association between weekly weather variability and the transmission of cryptosporidiosis.

**Results:** The results of the ZIP model show that weekly maximum temperature at a moving average of 0–8 weeks (relative risk (RR): 1.25, 95% confidence interval (CI): 1.15–1.35), relative humidity at a moving average of 0–1 week (RR: 1.03; 95%CI: 1.01–1.05), and wind speed at a lag of 4 weeks (RR: 1.02; 95%CI: 1.01–1.03) were positively but rainfall at a moving average of 0–1 week (RR: 0.95; 95%CI: 0.92–0.98) was inversely associated with the cryptosporidiosis disease. Time series CART model indicates that, when maximum temperature exceeded 31°C and relative humidity was under 63%, the RR of cryptosporidiosis rose by 13.64.

**Conclusion:** The results of this study suggest that probability of cryptosporidiosis incidences was best described by an interaction between maximum temperature and relative humidity.

#### ISEE-833

#### Omega-3 Fatty Acid and Methylmercury Effects on Intelligence Quotient (IQ) in Children Due to Prenatal Fish Exposure

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**Background:** Fish has been recognized as a food item with various beneficial qualities but hazardous as well. Finns, among others, have been concerned about the seafood safety. The coast of Finland, the Baltic Sea, is highly polluted by organic pollutants. Methylmercury (MeHg) is also a concern when dealing with the food safety of fish. There are number of studies showing an adverse effect of MeHg on the brains and intelligence quotient (IQ). However, the beneficial effects of omega-3 fatty acids on IQ are also recognized. This makes the question of the total IQ effects due to fish consumption interesting. An important aspect is the fact that these two effects share a common metric and no conversion between different metrics is needed. Fortunately, the general population usually does not face a significant health risk from MeHg exposure. However, prenatal life is much more sensitive to the toxic effects of MeHg than adult life. Docosahexaenoic acids (DHA), a subgroup of omega-3 fatty acids, affect the brains as well by promoting brain development, particularly in children. IQ is a composite index that averages a child's performance across many functional domains, providing an overall picture of cognitive health. Child's IQ also predicts future outcomes in life such as occupational and academic success. We conducted a quantitative benefit-risk assessment of DHA and MeHg on the total IQ effects of prenatal fish consumption to children using Monte-Carlo simulation.

**Methods:** We constructed different fish consumption scenarios for pregnant women and studied their effect on child's IQ. The data for the fish consumption scenarios were attained from the National Public Health Institute and the National Game and Fishery Research Institute, and concentrations of DHA in fish by using the nutritional database Fineli. To estimate the effects of MeHg, we used single-compartment model suggested by the World Health Organisation. Exposure-response function for MeHg effect based on studies conducted by Cohen et al (2005), and Axelrad et al (2007). Exposure-response function for DHA used values suggested by Cohen et al (2005).

**Results and Discussion:** The small health benefits of DHA appeared to neutralize the small health risk of MeHg. The total result was very slightly on the beneficial side, depending on consumption scenarios. However, the differences between the consumption scenarios were small, and the net results were very close to zero in each scenario. We must also bear in mind that the results are not universally applicable to all parts of

the World. Great geographical variation in concentrations of fish and fish intake exist. However, this study found that low level exposure to mercury in fish with the Finnish (North European) fish consumption pattern at least does not pose a large risk to the child. Conversely, the balance might be slightly on a beneficial side.

#### ISEE-834

#### Spatio-Temporal Modelling of Long-Term Exposure to Outdoor Black Smoke

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**Objective:** To predict point exposure to ambient black smoke (BS) through time and across region.

**Methods:** We developed a regional model for predicting long-term BS levels using data obtained from 56 monitors across NE England (2055 km<sup>2</sup>) for the period 1985–1996. The model separates the temporal trend in BS for the region as a whole (Stage 1) from clustered within-region spatial variation (Stage 2) for groups of monitors with similar patterns of deviations from region-wide temporal trend. The final stage (3) is a linear model which predicts BS at all locations in the region using cluster membership and spatially referenced data on pollutant sources (or their surrogates) at individual monitors as predictors and predicted regional temporal trend as an offset.

**Results:** Stage 1: Region-wide weekly average of Log transformed BS levels ( $\mu_t$  say) for each week of study were calculated. We then fit the following dynamic regression model

$$\mu_t = \alpha + \beta t + \gamma m_t + \delta w_t + B_t \cos(\lambda t) + C_t \sin(\lambda t) + R_t \quad (1)$$

where  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  are static parameters,  $m_t$  and  $w_t$  are respectively region-wide weekly average of minimum temperature and maximum wind speed for the week  $t$ ,  $\lambda$  is corresponding to annual cycle and defined as  $2\pi/52.14$ ,  $B_t$  and  $C_t$  are dynamic parameters, and  $R_t$  was the residual term for the week  $t$ . Fitting this model, we could explain about 98% of variation in  $\mu_t$  ( $R^2 = 0.978$ ) with no obvious temporal autocorrelation in residuals.

Stage 2: Individual monitor were classified according to their deviations from the fitted model of the region wide temporal trends derived in [1] using K means clustering in the *R statistical package*. The best partition identified 5 clusters.

Stage 3: To address different sources of BS, 11 predictors were determined as surrogates of BS. Sources included were traffic, industries, and population density. Using a manual step-forward policy, we then fitted the following linear regression model

$$Y_t(x_i) = \hat{\mu}_t + \boldsymbol{\beta}X + Z_t(x_i) \quad (2)$$

where  $Y_t(x_i)$  is the observed log-BS by monitor  $x_i$  for the week  $t$ ,  $\hat{\mu}_t$  is the predicted region wide weekly average of log-BS in [1],  $\boldsymbol{\beta}$  and  $X$  are matrices of regression coefficients and predictors (respectively) and  $Z_t(x_i)$  is the residual term for monitor  $x_i$  for the week  $t$ . The assigned cluster number was used as a categorical variable. The covariates which remained in the final model were distance to motorway, Length of local roads/streets in buffers of 250 m, and distance to A/B type roads.  $R^2$  for the final model was 0.713. There was no significant evidence of spatial autocorrelation in residuals.

**Model validation:** To validate the final model, we used BS data available for four monitors which were located within 5 km distance from boundaries of the study region and were active during the study period.  $R^2$  fits of observed versus predicted for these monitors were 82.6%, 72.3%, 63.8% and 63.2%.

**Conclusions:** The three stage approach appears to provide a robust way of estimating BS point-exposure across this region at weekly intervals over 12 years.

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#### ISEE-835

#### Lifetime Swimming Pool Attendance, Asthma, Eczema and Respiratory Symptoms in School-Age Children

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**Background:** Indoor swimming pools may have high levels of trichloramine, a strong irritant in air. The prevalence of swimming pool attendance among children is high. An increased risk of chronic respiratory effects such as asthma has been associated with pool attendance in children, but the evidence is inconclusive. This observed association may be affected by selection bias in either direction since both recommendations to practice swimming for asthmatic children and selective avoidance may play a role.

**Objective:** To estimate the risk of respiratory and allergic symptoms associated with pool attendance in school-age children.

**Methods:** In June 2006 we conducted a cross-sectional population-based study of 3,324 children 9 to 12 years old (response rate 58%) in 53 primary schools in the municipality of Sabadell (Spain; 200,900 inhabitants in 2006). After providing informed consent, the parents completed a questionnaire on frequency of indoor and outdoor pool attendance during lifetime, respiratory and allergic symptoms in the last 12 months (questions on wheezing, asthma medication and allergic rhinitis based on the ISAAC questionnaire), ever had asthma or eczema, age, BMI, physical activity and parental educational level. Cumulative pool attendance was defined as the number of months lifetime attending outdoor or indoor pools at least once a month. Air samples were collected to measure trichloramine, in all indoor ( $N = 9$ ) and in two outdoor swimming pools in Sabadell.

**Results:** Current pool attendance ( $\geq$  once per month in the last year) was: 65% for outdoor pools only in summer, 20% for outdoor and indoor pools and 15% never attended. Outdoor and indoor pool attendance were correlated (Spearman's  $r = 0.58$ ;  $P$ -value  $< 0.001$ ). 7.1% of children reported to have had ever asthma, 35% ever eczema and 9.6% wheezing in the last year. Children attending pools more than once per month during some period in their life had an increased risk for ever having had eczema (Odds Ratio (OR) = 1.5; 95% Confidence Interval (CI) = 1.3–1.8). This association was not apparent for ever having had asthma (OR = 0.9; CI = 0.7–1.3). No association was found between cumulative pool attendance and current respiratory symptoms in non-asthmatics. Among asthmatics ever attending swimming pools, the OR of current rhinitis symptoms of those attending  $>50$  months vs.  $<50$  months was 2.32 (CI = 1.1–4.7). Children who did not swim in the last year used more asthma medication in the last 12 months compared to children who attended only outdoor pools in summer (OR = 1.4; CI = 1.1–2.2), especially among asthmatics (OR = 2.9; CI = 1.1–7.7) or children having had eczema (OR = 2.9; CI = 1.7–5.0), what may indicate reverse causation. Trichloramine analyses are in progress.

**Discussion:** Potential recall bias and self-reported symptoms may have introduced exposure and outcome misclassification. The major strengths of this study include: large and population-based study sample and that there are different swimming pool habits from previous studies.

**Conclusions:** Pool attendance was higher in summer and in outdoor swimming pools. Cumulative pool attendance was associated with ever had eczema but not with ever had asthma and with current respiratory symptoms in asthmatic children. The data suggest the presence of reverse causation and longitudinal studies are required to rule out these sources of bias.

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#### ISEE-836

#### Personal Exposure to BTEX in Children of a Spanish Area with High Industrial Activity

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**Objectives:** To estimate personal exposure to BTEX in child population of the Campo de Gibraltar exposed to emissions from the petrochemical industry, and compare these levels with an area not exposed to industrial activity.

**Methods:** Cross-sectional study in children 8–12 years living in two neighbourhoods of Campo de Gibraltar (Puente Mayorga and Guadacorte) and the town of Tarifa (control zone). In a sample of children from each area were measured levels of BTEX (benzene, toluene, ethylbenzene and xylenes) at indoor and outdoor of houses and schools through Perkin-Elmer diffusive samplers for 15 days, which were later analysed by gas chromatography (GC) combined with a mass selective detector (MSD). Moreover, we applied a general and a time-activity questionnaires. Personal exposure to BTEX were estimated through a weighted model including levels of BTEX in different microenvironments and the time-activity variables. Multivariate linear regression models on the log-transformed levels of personal exposure were used. We calculated the ratio of average levels of BTEX between exposed areas and the control zone, adjusted for potential confounding variables (gender, age, frequency and distance of traffic, painting in the last month, ventilation, air conditioning, and use of cleaning products).

**Results:** Information of 58 children in the three study areas were collected. These children spent an average of 58% of their time inside the house, and 80% of their time at school and home. The median personal exposure to BTEX was higher in Puente Mayorga for all compounds measured. One case (6.7%) exceeded  $5 \mu\text{g}/\text{m}^3$  of benzene, the limit value fixed by European normative. The adjusted-ratio of exposure levels were significantly greater than 1 in Puente Mayorga respect to the control zone for all compounds except ethylbenzene: benzene [2.3, 95%CI (1.3–4.0)]; toluene [2.2, 95%CI (1.0–4.9)]; ethylbenzene [1.2; (0.6–2.3)]; m/p-xylene [2.5, 95%CI (1.2–5.2)]; o-xylene [2.8, 95%CI (1.4–5.7)]. There were no significant differences in the exposure levels between Guadacorte and Tarifa.

**Conclusions:** Children resident in Puente Mayorga were exposed during the study period to more than twice the levels of BTEX than those living in the control zone. There were no significant differences in exposure between Guadacorte and Tarifa. The finding of an excess in the personal exposure in Puente Mayorga after adjusting for other potential sources of exposure, suggest that might be related to industrial emissions, a fact reinforced by the dominance during the study period of west winds that displace emissions to that area. However, the fact of having a single measurement of a specific period does not allow us to extend these findings to what happens on average throughout the year.

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#### ISEE-837

#### Genomic DNA Methylation, Cardiovascular Disease, and Short-Term Exposure to Traffic Air Pollution

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**Background:** Short-term exposure to particulate air pollution has been associated with increased hospitalization and death, particularly from cardiovascular disease (CVD). CVD-related processes, such as oxidative stress, atherosclerosis and aging, are associated with lower genomic DNA methylation content in blood DNA. Whether DNA methylation is modified by air particle exposure, and whether such alterations are associated with cardiovascular disease is undetermined.

**Objectives:** In a cohort of elderly men in the Boston area, we sought to determine whether: i) recent exposure to black carbon (BC), a marker of traffic particles, was associated with decreased genomic DNA methylation content estimated in LINE-1 and Alu repetitive elements; ii) decreased genomic DNA methylation was associated with cardiovascular factors, including arterial blood pressure, serum levels of intercellular adhesion molecule-1 (ICAM-1) and vascular cell adhesion molecule-1 (VCAM-1), diagnosis of Coronary Heart Disease (CHD) and stroke, and statin use.

**Methods:** We conducted a repeated measure investigation of DNA methylation in 718 subjects from the Normative Aging Study. Each subject was examined 1–3 times, for a total of 1,097 visits. Ambient BC hourly concentrations were measured at a monitoring site located approximately 1 km from the site of the examination. Repetitive element DNA methylation was measured on bisulfite-treated blood DNA using high-precision quantitative PCR-Pyrosequencing analysis. We used linear mixed regression models to obtain standardized regression coefficients (beta) expressing the fraction of a standard deviation change in LINE-1 or Alu methylation, after adjusting for multiple clinical and environmental covariates.

**Results:** LINE-1 methylation decreased in association with higher BC ambient level. The association was significant when the average of the last four hours or of the day before the exam were considered, with stronger effects when BC average levels were measured over longer time windows (2–7 days) [e.g., beta = -0.11; 95%CI -0.18, -0.04;  $P = 0.002$  for the 7-day moving average of BC levels]. Alu methylation showed no significant association with BC levels. Lower LINE-1 methylation was associated with higher systolic (beta = -0.06; 95%CI -0.12, -0.00,  $P = 0.04$ ), diastolic (beta = -0.08; 95%CI -0.14, -0.01,  $P = 0.03$ ), and mean (beta = -0.08; 95%CI -0.14, -0.01,  $P = 0.02$ ) arterial blood pressure. LINE-1 methylation was also inversely associated with serum VCAM (beta = -0.07; 95%CI -0.14, -0.01,  $P = 0.03$ ), but not with serum ICAM (beta = -0.00; 95%CI -0.09, 0.08,  $P = 0.96$ ). Lower LINE-1 methylation was found in subjects with CHD (beta = -0.29; 95%CI -0.44, -0.14,  $P < 0.001$ ), and stroke (-0.31; 95%CI -0.57, -0.05,  $P = 0.02$ ). Current use of statins, a class of medications that have been shown to have antioxidant effects and abrogate cardiac effects of air particles, was associated with increased LINE-1 methylation (beta = 0.18; 95%CI 0.04, 0.32,  $P = 0.01$ ). Alu methylation showed no association with arterial blood pressure, serum VCAM and ICAM, CHD, stroke, and statin use.

**Conclusions:** Genomic blood DNA methylation estimated in LINE-1 repetitive elements, is reduced after short-term exposure to traffic particles. Such changes may reproduce epigenetic processes related to cardiovascular disease and may represent a mechanism by which particulate air pollution affects human health.

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#### ISEE-841

#### Short-Term Variation of Inflammatory Markers in Chronic Obstructive Pulmonary Disease (COPD) Patients

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Germany; ‡University of Ulm, Medical Centre, Cardiology, Ulm, Germany; §Environmental Science Centre, University of Augsburg, Augsburg, Germany; and ¶Rochester School of Medicine and Dentistry, Rochester, NY, USA.

**Background:** Growing evidence indicates that ambient air pollution is associated with exacerbation of chronic diseases like chronic obstructive pulmonary disease (COPD). A prospective panel study was conducted to investigate short-term changes in blood markers of inflammation and coagulation in COPD patients in response to daily changes in air pollution in Erfurt, Germany.

**Methods:** Blood parameters such as fibrinogen, e-selectin, Prothrombin fragment 1+2 and von Willebrand factor antigen (vWF) were measured up to 12 times in 38 male patients with COPD during winter 2001/2002. Fixed effects linear regression models were applied, adjusting for trend, weekday and meteorology. Hourly data on ultrafine particles (UFP, 0.01–0.1  $\mu\text{m}$ ), accumulation mode particles (ACP, 0.1–1.0  $\mu\text{m}$ ),  $\text{PM}_{10}$  (particulate matter <10  $\mu\text{m}$ ), elemental (EC) and organic carbon (OC) and gaseous pollutants were collected at a central monitoring site and meteorological data were received from an official network. Individual 24-hour averages of pollutants immediately preceding the blood withdrawal (lag 0) up to day 5 (lag1–4) and 5-day running means were calculated.

**Results:** Between 349 and 380 blood samples were analysed, depending on the blood marker. Increased levels of fibrinogen were observed with lag 3 for an increase in one interquartile range of UFP,  $\text{PM}_{10}$  and EC (% change from the mean: 3.1, [95% confidence interval (CI): 0.9; 5.4], 2.4 [CI: 0.6; 4.3] and 2.6 [CI: 1.0; 4.1], respectively). E-selectin increased in association with ACP and  $\text{PM}_{10}$  with a delay of one day. Prothrombin fragment 1+2 decreased with lag 3, lag 4, and the 5-day-mean with all particulate pollutants. vWF showed a consistent decrease in association with almost all air pollutants with all lags except for lag 0.

**Conclusion:** Elevated concentrations of air pollution were associated with changes in blood markers of inflammation and coagulation in patients with COPD. High fibrinogen levels are considered to be associated with a faster decline in lung function. Therefore, elevated levels of air pollution might lead to a more rapid lung function decline in these patients. The clinical implications of the other findings need further investigation.

#### ISEE-842

#### Skin Barrier Alteration Associated with Chromium Exposure and Smoking Amongst Cement Workers

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**Background:** Most cement and concrete workers suffer from skin diseases due to frequent contact with cement which contains chromium, a documented skin irritant. Because the skin barrier is one of the essential protection mechanisms for human beings, pathological skin as well as normal skin barrier function of cement workers should be noticed to avoid environmental hazards from dermal route. On the other hand, smoking, a hygienic behavior, has long been considered for workers as a risk factor of health concern. Little research has been done on the relationship between the chromium exposure with smoking habits and skin barrier function alteration in cement workers.

**Methods:** One hundred and eight cement workers who have active work in constructing buildings were recruited as subjects in this study. Urinary chromium concentration was used to characterize the exposure level in cement workers. According to the urine analysis results, we divided all participants into two groups: urinary chromium concentration small than

biological exposure index (BEI, 25 µg/L) as low exposure group ( $n = 63$ ) and urinary chromium concentration higher than BEI as high exposure group ( $n = 45$ ). Transepidermal water loss (TEWL) was used as an index to assess the skin barrier function among cement workers.

**Results:** TEWL of cement workers was showed a significant increase in high chromium exposure group than low chromium exposure group ( $P = 0.048$ ). In addition, positive correlation was postulated between urinary chromium concentration and TEWL ( $R = 0.11, P < 0.001$ ). The results indicated that chromium exposure induced skin barrier disruption was dose-dependent among cement workers. In multivariate analysis, we found both urinary chromium concentration and smoking habit revealed significantly correlation with TEWL, indicating not only chromium exposure but smoking status was revealed impact to skin barrier disruption among cement workers. Both smokers and nonsmokers showed the significant positive correlations between urinary chromium concentration and TEWL. However, slopes in smokers and in nonsmokers were 0.15 and 0.07, respectively, indicating over 2-fold of TEWL increased in smokers comparing with non-smokers when cement workers received the same chromium exposure.

**Discussion and Conclusions:** Chromium exposure could induce the skin barrier disruption, possibly due to the direct chromium skin contact and the ROS induced during chromium metabolism. In addition, smoking might be a significant enhancer of skin barrier perturbation among cement workers with chromium exposure. For the workers health concern, decreasing the chromium skin exposure level and smoking cessation should be encouraged at work to reduce the skin barrier function perturbation.

#### ISEE-843

#### Indoor and Outdoor BTEX Exposure in Children Living in a Petrochemical Area in Spain

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**Objectives:** To quantify and compare indoor and outdoor BTEX (benzene, toluene, ethyl benzene, m/p-xylene, o-xylene) exposure in houses and schools of children living in two industrial communities of Campo de Gibraltar (Puente Mayorga and Guadacorte-Cortijillos), with respect to a child population not exposed to industrial activity (Tarifa).

**Methods:** Cross-sectional study of exposure to BTEX in 8–12 aged children living in two communities of the Campo de Gibraltar exposed to petrochemical industry (Puente Mayorga and Guadacorte-Cortijillos), and in a control zone (Tarifa). BTEX levels were measured from indoor and outdoor at schools and houses, for a period of 15 days, using Perkin-Elmer diffusive tubes. The samples were analysed by gas chromatography (GC) combined with a mass selective detector (MSD). Additionally, a general questionnaire was filled out by children' parents to obtain information about socioeconomic characteristics, sources of exposure to BTEX at home, parental occupational exposure to BTEX and infant respiratory health. Meteorological data of the area of study corresponding to this period was obtained from National Institute of Meteorology and CLIMA. For statistical analysis, we calculated the median levels of BTEX, the 10<sup>th</sup> percentile and the 90<sup>th</sup> percentile. Also, we contrasted the potential difference between areas through non-parametric test of Kruskal-Wallis and obtained Pearson correlation coefficient between indoor and outdoor concentrations for each compound.

**Results:** A total of 58 children whose parents agreed to participate were recruited for the study (15 in Puente Mayorga, 18 in Guadacorte-Cortijillos and 25 in Tarifa). Higher BTEX levels were observed at indoor and outdoor from schools and houses in Puente Mayorga (outdoor benzene median: Puente Mayorga: 3.0 µg/m<sup>3</sup>; Guadacorte-Cortijillos 0.7 µg/m<sup>3</sup>, Tarifa 0.6 µg/m<sup>3</sup>;  $P < 0.001$ ); (indoor benzene median: Puente Mayorga 3.2 µg/m<sup>3</sup>; Guadacorte-Cortijillos 1.1 µg/m<sup>3</sup>; Tarifa 1.6 µg/m<sup>3</sup>;  $P < 0.001$ ). Indoor and outdoor benzene medians in Puente Mayorga were lower than 5 µg/m<sup>3</sup> (EU ambient air standard for 2010;

2000/69/EC), however, 10% of indoor measurements were greater than 6 µg/m<sup>3</sup>. A strong association was detected between all compounds, with a correlation coefficient ranging between 0.615 y 0.955. As well, a high correlation between indoor and outdoor benzene was found in Puente Mayorga (Puente Mayorga,  $r = 0.798$ ; Guadacorte-Cortijillos  $r = 0.394$ ; Tarifa  $r = -0.276$ ).

**Conclusions:** Indoor and outdoor BTEX levels in Puente Mayorga were significantly higher than in Guadacorte-Cortijillos and Tarifa. The strong correlation between indoor and outdoor concentration in Puente Mayorga may suggest a contribution of the industrial emissions on child population exposure. However, the west wind predominance during the sampling period could have contributed to those results. Therefore, due to the fact that there is only one measurement it can not be concluded that this trend keeps across the year.

#### ISEE-847

#### A Framework for Identifying and Evaluating the Epidemiological and Socioeconomic Impacts of Saline Drinking Water on Rural Livelihoods in the Aral Sea Basin

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**Background:** There is a significant need for improved understanding of the impacts of saline drinking water on human health and welfare. To this end, this paper summarizes a joint initiative between the Center for Development Studies and the Institute for Hygiene and Public Health at the University of Bonn to investigate the linkages between high salinity in drinking water and various health outcomes in rural Uzbekistan. Water-associated infectious diseases claim up to 3 million live each year and the burden of disease from inadequate drinking water is a leading cause of morbidity and mortality among the poor. This paper details the need for a more comprehensive approach to exposure analysis when investigating key factors impacting on the human epidemiological environment. With the use of quantitative and qualitative tools, and combined with biophysical evidence, one can provide improved information to decision makers on the sustainability of existing socioeconomic policies which influence health outcomes. Saline soils occur both naturally and due to anthropogenic activities. Poor irrigation practices and drainage in semi-arid and arid regions have led to the salinization of water and soils around the world. Saline water has direct and indirect costs in terms of health, welfare and the economy. While the role of dietary sodium intake as a risk factor has been extensively reported, water as a source of sodium has only rarely been addressed in epidemiological studies. Official data in the Aral Sea Basin (ASB) of Uzbekistan show high levels of various non-communicable diseases, mainly of cardiovascular pathology. One key difference between those living in this region and the rest of the country is the high level of salinity in the drinking water. It is estimated that over 70% of the drinking water in the ASB does not meet national standards as ground water in some locations averages 3300–4500 mg/litre—or between 300–400% higher than standards recommended by the government of Uzbekistan. Under these highly saline conditions, there is an urgent need to examine the impact of long-term consumption of high levels of sodium on the etiology of cardiovascular and other salt-related illnesses in the region.

**Discussion:** This work will take place within the framework of the long-term project of Economic and Ecological Restructuring of Land and Water Use in the Region Khorezm, Uzbekistan carried out by the Centre for Development Studies at the University of Bonn. The study will proceed in two phases: a health impact assessment will first be completed to investigate the epidemiological linkages between salt/minerals in drinking water and multiple health outcomes. The second phase will utilize the biophysical evidence, combined with socioeconomic data, to

perform a comprehensive environmental impact assessment, including impact of large scale irrigation on drinking water quality. As water is one of the most important resources for human survival and wellbeing, ultimately, the results from this research will improve our overall understanding on the impact of poor drinking water quality on health outcomes, particularly among the poorest and most vulnerable.

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**ISEE-848**
**Air Quality in Subway Platforms and Carriages of Six Major Cities**

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**Background:** Restrictions to vehicular traffic in cities are increasingly implemented in order to reduce pollutant emission. Consequently, an increase in the utilization of public transportation must be encouraged, with an increase of the time spent by people onboard. A strict monitoring of the index of air quality (IAQ) in the public transportation system is then required.

**Objective:** To measure the concentration of particulate matter (PM) in the subway system of six big cities.

**Methods:** A 5 channels (PM<sub>1</sub>, PM<sub>2.5</sub>, PM<sub>7</sub>, PM<sub>10</sub> and TSP) laser-operated portable OPC with temperature/relative humidity sensor (Aerocet 531, MetOne, USA) and a sampling time of 2 minutes, was used. The instrument was been previously calibrated for comparison with a gravimetric reference instrument (FRM). Recordings were taken repeatedly outdoor, on the ticket floor, on the platforms, and onboard of trains in the subways of 5 European cities and one US city.

**Results:** Mean (SD) outdoor PM<sub>2.5</sub> and PM<sub>10</sub> levels ( $\mu\text{g}/\text{m}^3$ ) were 33 (.7) and 308 (11) in Barcelona, 125 (3) and 163 (18) in Milan, 38 (2) and 101 (13) in Rome, 18 (1) and 42 (8) in Paris, 3.4 (.1) and 11.4 (1.4) in Stockholm, 27 (1) and 64 (7) in San Francisco, respectively. Platform PM<sub>2.5</sub> and PM<sub>10</sub> levels were 111 (9) and 489 (44) in Barcelona, 162 (2) and 257 (18) in Milan, 214 (16) and 388 (71) in Rome, 62 (6) and 164 (38) in Paris, 82 (2) and 151 (12) in Stockholm, 55 (3) and 136 (12) in San Francisco, respectively. Inside the carriages PM<sub>2.5</sub> and PM<sub>10</sub> levels were 64 (5) and 229 (26) in Barcelona, 186 (3) and 326 (15) in Milan, 179 (14) and 328 (62) in Rome, 75 (7) and 153 (34) in Paris, 16 (2) and 39 (9) in Stockholm, 16 (1) and 50 (7) in San Francisco.

**Conclusions:** PM<sub>2.5</sub> and PM<sub>10</sub> levels were much higher in train platforms consistently for all the different subways. However, a relevant improvement in air quality was found inside the carriages in Barcelona, Stockholm and San Francisco as compared to platforms. Inside San Francisco carriages the air quality was even better than outdoors'. On the contrary, in the carriages of Milan, Rome and Paris subways we found no significant difference in PM<sub>2.5</sub> and PM<sub>10</sub> levels as compared to platforms, with much more pollution as compared to simultaneous outdoors'. These data indicate that exposures to high levels of PM still happen in subway of important European cities. Improvement in air exchange and filtration efficiency and/or carriage maintenance is envisioned to reduce avoidable exposure to peak PM concentrations of thousand commuters.

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**ISEE-851**
**Exposure Science: Potentials and Challenges**

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**Background and Discussion:** "While changing our society's name will not prevent misconceptions about what exposure research is, it could provide a better perspective on what the members of the society strive to do. The goal of exposure research is to identify and characterize "real world" contacts with and uptake in the body or system of toxic materials that can cause acute or chronic adverse effects, which is more of a

science than an analysis" (Cliff Weisel, President, ISEA, 2007). The foregoing quotation forms the basis of this paper. While it enumerate advantages for the change of name, which ranges from consistency with journal name to expanded scope of responsibilities and collaborations with related field of study, it also argues that the goal of exposure science must go beyond the present trend limits of humans-toxic materials-environment. The imperative issue of climate change for instance, is incomplete without contributions from exposure science. Of the simultaneous equation which climate change solves: the *evolution equation* and the *response equation*, the later being the on tap sphere of activity of Exposure Science. The *response equation* consists of variables representing corollary reactions of natural systems, human and the environment to disturbing and destroying agents. Other factors of immense significance than the hitherto postulates and concern of the earth's exposure to greenhouse gases from human activities are those human activities which lead to the earth's exposures to certain radiation or emanations from (1) human themselves and (2) products of human endeavors (including toxic materials). In this, human population was found to be an exponential variable. The result of a stochastic exposure assessment of these factors showed equal significance as the greenhouse gases and that the contribution of greenhouse gases to climate change is very likely to be <30%. A major challenge for exposure science suggested is the re-defining and re-classification of certain vital conceptions whose misconception and misapplications have been key precursors to practices responsible for adverse exposures hitherto. Amongst these are the concept of Exposure, Nature and Environment, Preservation and Conservation, and Permissible and Tolerable Limits.

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**ISEE-852**
**Biological Monitoring for Carcinogens: Evidence for Exposure and Risk Reduction**

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**Aims:** To review the Health & Safety Laboratory's biological monitoring data on selected carcinogens for evidence of exposure and risk reduction.

**Methods:** Biological monitoring can help to assess systemic exposure to hazardous substances. It has a particular role for substances that can be absorbed through the skin or where control relies on respiratory protection where air monitoring alone may not be sufficient. The Health & Safety Laboratory (HSL) has used biological monitoring for over 30 years to assess exposure to carcinogens and since 1996 has stored the data in a database. In the mid 1990s, HSE developed good practice-based (rather than health-based) biological monitoring guidance values (BMGVs). These were based on the 90<sup>th</sup> percentile of biological monitoring data from workplaces with good control and were intended to trigger an investigation of exposure if the guidance value was exceeded. The database was searched for biological monitoring data on carcinogens with BMGVs, 4,4'-methylene bis-(2-chloroaniline) (MbOCA), methylenedianiline, Chromium VI and poly aromatic hydrocarbons (PAHs).

**Results:** Occupational exposure to MbOCA has shown a gradual reduction over the last 30 years. In 1977 the 90% value for urinary MbOCA was 180  $\mu\text{mol}/\text{mol}$ . This was reduced to 30  $\mu\text{mol}/\text{mol}$  in 1983 (and became a 'Biological Action Limit') and reduced further to 15  $\mu\text{mol}/\text{mol}$  in 1993 when it became a Biological Monitoring Benchmark value. Since then, the 90% value of biological monitoring data has been <10  $\mu\text{mol}/\text{mol}$ . The number of samples varies each year from 175–598 from workers in 15–27 companies. The BMGV for methylenedianiline was set in the early 1990s at 50  $\mu\text{mol}/\text{mol}$  and since 1997 the 90% value each year from 275–859 samples from 4–9 companies has been <30  $\mu\text{mol}/\text{mol}$ . A BMGV for hexavalent chromium of 10  $\mu\text{mol}/\text{mol}$  was adopted in 2004 based on the 90<sup>th</sup> percentile of data from a HSL study and is close to levels found in people not occupationally exposed. Since

then, each year, we have received between 197 and 342 samples from 18–34 companies and the current 90% value is 6  $\mu\text{mol/mol}$ . A recent HSE study to look at exposure to PAHs also shows significant reductions in exposure compared to a baseline study in 1998 when a BMGV for 1-hydroxypyrene of 4  $\mu\text{mol/mol}$  was adopted.

**Conclusion:** Biological monitoring is a useful aid to the assessment of occupational exposure to carcinogens. Health-based biological monitoring guidance values are clearly desirable but require considerable data and understanding of dose response relationships. Until such data is available guidance values based on the 90<sup>th</sup> percentile of data are pragmatic approaches to assessing exposure, improving control and reducing the risk of cancer.

#### ISEE-853

#### Effects of Asian Dust Storm Events on Daily Admissions for Asthma and Stroke in Seven Metropolitans of Korea

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**Objective:** Windblown dust storm that is originated from the vast desert areas of China and Mongolia and transported to the extensive regions of East Asia in spring is called Asia dust storm (ADS) events. In spite of the recent increased concern for ADS, there are few studies concerning the effects of ADS on people's health. The objective of this study was to assess the associations between ADS and admissions for asthma and stroke in 7 metropolitans in Korea.

**Methods:** From June 1999 to December 2003, in seven metropolitans (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan), daily mean levels of particulate matter <10  $\mu\text{m}$  in diameter ( $\text{PM}_{10}$ ), nitrogen dioxide ( $\text{NO}_2$ ), sulphur dioxide ( $\text{SO}_2$ ), carbon monoxide (CO), ozone ( $\text{O}_3$ ) were obtained from 86 government-run air monitoring sites, and daily mean levels of meteorological data on the temperature and humidity were obtained from the Korea Meteorological Administration. The counts of daily admissions for asthma and stroke were obtained from the National Health Insurance (NHI) Program. Counts of daily asthma and stroke admissions were modeled using Poisson regression. We selected two comparison days for each ADS day, 7 days before ADS days and & 7 days after ADS days. The rate ratio for ADS days versus comparison days was estimated in a Poisson regression model, controlling for temperature, humidity,  $\text{NO}_2$ ,  $\text{SO}_2$ , CO, temperature, and relative humidity.

**Results:** During the period, we identified 302 ADS in seven metropolitans in Korea. The average concentration of  $\text{PM}_{10}$  on ADS days (84.0  $\mu\text{g/m}^3$ ) was higher than that on comparison days (56.3  $\mu\text{g/m}^3$ ), and the average concentration of  $\text{NO}_2$  and relative humidity on ADS days (25.9 ppm, 52.8%) was lower than that on comparison days (29.0 ppm, 56.5%). The levels of other pollutants were very similar. The estimated relative risk (RR) for asthma was 1.072 (95% confidence interval 1.045–1.010) on ADS days, and RR on from lag of 1 days to lag of 3 days were 1.060 (95%CI 1.032–1.089), 1.056 (95%CI 1.028–1.084), 1.019 (95%CI 0.992–1.046) respectively. The estimated relative risk (RR) for stroke was 1.022 (95% confidence interval 0.995–1.049) on ADS days. But RR on lag of 3 days and lag 4 days were 1.046 (95%CI 1.018–1.075) and 1.030 (95%CI 1.004–1.058) respectively.

**Conclusion:** ADS increased admission for asthma and stroke. Preventive preparation to diminish the health effects of ADS will be needed.

#### ISEE-854

#### Developing a Conceptual Model for Risk-Benefit Analysis of Disinfection Byproducts and Microbes in Drinking Water

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**Background:** Supplying a population with safe drinking water represents a cornerstone of public health policy in many countries worldwide. The greatest microbial risks are associated with ingestion of water that is contaminated with human or animal faeces, which can be a source of pathogens. When chlorinating drinking water, waterworks are mandated to optimise treatment processes and the chlorine dose for optimal effectiveness of pathogenic micro-organism removal from water, while minimising the formation of disinfection by-products (DBPs). The presence of DBPs in drinking water is a concern due to potential negative reproductive and carcinogenic health effects. Therefore, increasing the microbial safety of drinking water through disinfection is a trade-off with possible health risks associated with DBPs. While these two types of risks have been studied separately, there is relatively little evaluation of risks and benefits of DBPs versus microbial risks.

**Objective:** The objective of this article is to describe the methods used in developing a quantitative assessment that weighs up risks and benefits of water treatment with a view to securing the maximum benefit to public health. This includes a description of the purpose, boundary definition, and a draft causal diagram used in the assessment. The "pyrkilo" method of open risk assessment was applied as a systematic approach for this study.

**Discussion:** Scoping of the assessment issue was first conducted in order to define the width of the benefit-risk assessment. The scoping process provided a checklist for the assessment and generated a framework for reporting and discussion of assessment results with stakeholders. The purpose of the assessment was defined as the research question: "What is the net human health impact of microbial and disinfectant by-product contamination of drinking water?" Using this as a conceptual guide, we defined the boundaries of the assessment (a single, hypothetical waterworks in Europe), the scenarios to be investigated (business as usual; defined changes in levels of disinfectant use), the intended users and the participants of the assessment (scientists, local public health authorities, water works). We defined the relevant aspects of the assessment issue as relevant quantifiable variables and drew causal relationships between them. Finally, we developed the assessment by delimiting the quantitative methods and data to be used. Data collected for each variable will be combined into an integrated benefit-risk model, which includes source, media, exposure, and health effect sub-models. The model will output the loss of healthy life years in a population, measured in disability-adjusted life years (DALYs). Different types of uncertainty were identified in several aspects of the assessment, such as boundaries (choice of chemicals/health outcomes), causality (exposure pathway for DBPs), variables, and data (extrapolation of animal exposure-response data to humans). We demonstrated that the "pyrkilo" method was an effective tool in benefit-risk assessment.

The work is funded by the HiWATE project (Health Impacts of long-term exposure to disinfection by-products in drinking water—information at [www.hiwate.org](http://www.hiwate.org)) and presented on behalf of the HiWATE consortium. HiWATE is a three-and-a-half year Specific Targeted Research Project, funded under the EU Sixth Framework programme (Contract number: Food-CT-2006-036224).

#### ISEE-856

#### Exposure of Cyclists to Fine and Ultrafine Particles Along Routes of Different Traffic Intensity

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**Background:** Numerous exposure studies have shown that commuters are a group exposed above background levels to traffic-related air pollution. Even though the time spent during commuting is relatively short, the

exposure received during that period can be substantial. Most journeys are made during rush hours, when the increased volume of traffic yields high ambient pollution levels. Few studies have measured ultrafine particles during commuting. The knowledge on health effects of short-term, journey-time exposure to traffic-related air pollution is very limited. We therefore performed a study to assess exposures to ultrafine and fine particulate matter and the potential health effects related to cycling along routes of different traffic intensity.

**Methods:** Participants were cycling for 1 hour during the morning rush hour on two different routes from the Utrecht city centre to the University campus. Both routes were of similar distance. One route was selected along roads with high traffic intensity, the other predominantly along low traffic intensity roads. During 16 sampling days, particle number, mass ( $PM_{10}$ ) and absorbance (marker for soot) data was collected simultaneously on both routes by means of portable Condensation Particle Counters (TSI CPC 3007) and the Harvard Impactors installed on the "cargo" bicycles leading the groups of participants. Together with the collection of exposure data, the measurements of respiratory health of participants (FEV<sub>1</sub>, FVC, PEF, exhaled NO, questionnaires and symptom checklists) were performed before, after, and 6 hours after cycling.

**Results:** The average particle number concentration was 28,000 particles/cm<sup>3</sup> at the "low traffic route" and 45,000 particles/cm<sup>3</sup> at the "high traffic route". Peaks of short duration occurred at both routes, probably related to passing high emission vehicles. The average absorbance was  $4.35 \times 10^{-5}/m$  and  $6.05 \times 10^{-5}/m$  at the "low traffic route" and the "high traffic route", respectively.  $PM_{10}$  concentrations were not different between the two routes (average 44  $\mu g/m^3$ ).

**Discussion:** The results indicate that the largest contrast in exposure related to route occurred for ultrafine particles (61%), with smaller contrasts for soot (39%) and no contrast for  $PM_{10}$ , adding to a literature documenting that  $PM_{10}$  does not capture traffic emissions sufficiently. The contrast in exposure between two realistic routes also suggests that people can influence their exposure substantially by choosing a route with smaller roads.

#### ISEE-857

##### The Influence of Community Noise Exposure on Cardiovascular Risk

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**Background:** Many experimental and epidemiological studies have identified the stressful influence of noise and the consecutive elevated secretion of stress hormones. Noise acts as a stressor activating the mechanisms of stress reactions in the organism. With respect to cardiovascular diseases the overall evidence suggests that noise may be a risk factor for cardiovascular disease. Hypertension, coronary heart disease (CHD), annoyance and sleep disturbance are often discussed.

**Objectives:** Objectives of the present study were to evaluate the influence of community noise exposure on non-auditory health effects factors, community response and the impact on cardiovascular risk.

**Methods:** The study sample ( $n = 661$ ; 36.9% males, 63.1% females, mean age  $22.3 \pm 2.2$  years) included the exposed group to road traffic noise ( $n = 280$ ,  $L_{Aeq,8h} = 67 \pm 2$  dB) and control group ( $n = 379$ ,  $L_{Aeq,8h} = 58.7 \pm 6$  dB). Our respondents—university students, represented a homogenous sample of young healthy individuals concerning age, education and life style. Equivalent noise levels were assessed at the noisy area—dormitory (exposed group) and in the relatively quite residential area (control group) by a standard Brüel-Kjaer measuring technique. Subjective response in our sample was assessed by a validated noise annoyance questionnaire, administered personally. In addition to questions concerning personal (age, gender), life style (smoking, coffee and alcohol drinking) and dwelling (residence) characteristics it contained questions about possible non-auditory noise effects (noise annoyance on verbal scale,

interference with various activities, sleep disturbance). Systolic and diastolic blood pressures (BP), psychogenic stress load and blood lipids in capillary blood were evaluated. Ten year cardiovascular risk based on such risk factors was quantified (SCORE60, Framingham scoring (current risk score and after projection to the age of 60, Relative risk chart to fit our young sample).

**Results:** Students in the exposed group were significantly more annoyed by road traffic noise ( $OR_{MH} = 5.15$ , 95%CI = 4.11–6.97), and also by noise from neighbourhood ( $OR_{MH} = 2.54$ , 95%CI = 2.0–3.30) and from entertainment facilities ( $OR_{MH} = 1.75$ , 95%CI = 1.34–2.38). Cardiovascular risk calculated by several models has been different and in some of them significantly increased in the exposed group. The statistically significant result was found using Framingham scoring after projection to the age of 60 ( $OR = 1.69$ ; 95%CI = 1.08–2.65), SCORE60 ( $OR = 2.00$ ; 95%CI = 1.04–3.86) and Relative risk chart ( $OR = 2.37$ ; 95%CI = 1.43–3.92). Multiple linear regression revealed a significant positive association between the exposure to road traffic noise (exposed versus control area) and Relative risk chart cardiovascular risk expression ( $b = 0.124$ ,  $P = 0.024$ ) taking gender and psychogenic stress into account.

**Conclusions:** Our study confirmed significantly higher risks for road traffic noise annoyance and interference with various activities in the exposed group. Cardiovascular risk models—the Relative risk chart, SCORE60 and Framingham risk60 seemed to be the most suitable for our noise exposure study on young healthy individuals.

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#### ISEE-858

##### Combined Sample Preparation Methods for Selected Pyrethroids, Organophosphates and Polybrominated Diphenyl Ethers in Surface Wipes and Passive Air Samples

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**Background:** In residential measurement studies for multiple classes of chemicals, it is desirable to minimize the number of samples collected while maintaining low detection limits. To do this, new sample processing methods that incorporate multiple classes of environmental contaminants are needed. The current work focuses on the extraction and preparation of indoor air and surface wipe samples for analysis of selected pyrethroids, organophosphates and polybrominated diphenyl ethers (PBDEs). Once samples are prepared, they can be analyzed using optimized conditions developed for each compound class.

**Methods:** Prior to field deployment or laboratory use, all air and surface wipe media are solvent cleaned by Soxhlet extraction and dried in a vacuum oven. The media are analyzed for background levels of target analytes prior to use. Indoor air samples are collected using 5.5" × 0.5" polyurethane foam (PUF) disks. The disks are deployed indoors as passive samplers using a covered steel sampling support. After samples are collected, the disks are stored at freezer conditions in glass jars, protected from light. The disks are extracted using Soxhlet extractors with hexane. The extracts are then concentrated to 1 mL and analyzed. Surface wipe samples are collected using two 4.5" × 4.5" cotton wipes. The two wipes are wetted with a total of 6 mL of isopropanol prior to sampling a 12" × 12" surface area. The wipe samples are then stored at freezer conditions in glass jars, protected from light until they can be extracted. The wipes are extracted with acetone and hexane using a pressurized fluid extractor (PFE). The extracts are concentrated and cleaned-up using solid phase extraction (SPE). During SPE, insecticides and PBDEs are separated, which allows for a separate analytical aliquot for each compound class. Samples are analyzed using optimized conditions for insecticides

(GC/MS/EI) or PBDEs (GC/MS/NCI). The concentrations in each sample are quantified using linear curves generated from the analysis of standard solutions.

**Preliminary Results:** Preliminary data suggest that the combined methods can be used to successfully extract and process samples collected on PUF disks for selected insecticides and PBDEs. The methods are currently being evaluated to determine precision and accuracy across the analytical range (25–1000 ng/sample). The method detection limits (MDLs) for surface wipes range from 0.35 ng to 10.3 ng/sample for insecticides and 0.36 ng to 2.29 ng/sample for most PBDEs. The MDL for BDE 209 is 21.3 ng/sample. Similar detection limits are anticipated with the PUF disk media. Once method performance is demonstrated, samples collected for a recent observational exposure study will be analyzed for insecticide and PBDE levels.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-859

#### Background Incidence of Key Biomarkers of Chemical Exposure within the General UK Population

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**Background:** Several countries undertake national biomonitoring programmes to characterise exposures to different environmental pollutants, identify trends and susceptible populations, to detect emerging chemical risks and evaluate risk reduction strategies (Angerer *et al.*, 2006). The US Centres for Disease Control and Prevention (CDC) provides Biomonitoring data for the large scale National Health and Nutrition Examination Survey (NHANES), which began biomonitoring in 1976 and continues today (Pirkle *et al.*, 2005). The UK does not currently have a national biomonitoring programme and the use of biomarkers in environmental studies has so far been limited.

**Objectives:** The overall aim of this study, sponsored by the European Chemical Industry (CEFIC) was to determine the background incidence of a range of biomarkers of chemical exposure in the general adult population of the UK, together with corresponding data on related occupational and environmental chemical exposures through use of a questionnaire. Biomarker levels for a range of chemical exposures in the general population were determined in the samples to establish population-based, univariate, time-unspecified reference intervals for the biomarkers in question and to identify, where possible, correlations between biomarkers and environmental exposures and consumption of natural products.

**Methods:** The sampling strategy was designed to recruit a random sample of 400 non-institutionalised healthy UK adults, representative of the general population. The General Manchester Local Research Ethics Committee approved the study. Names and addresses ( $n = 18,000$ ) were randomly sampled from the 2005 UK electoral register and then divided into 36 sub-lists sampled at random to select people who were sent information sheets, a consent form and an invitation to participate. Volunteers were sent a sampling pack, instructions, free-post packaging and a questionnaire. Urine samples were analysed for: Creatinine, cadmium, mercury, pyrethroids, dithiocarbamates, naphthalene, phthalates, benzene, chlorinated hydrocarbons, xylene, caffeine and nicotine or their metabolites using GC-MS, or LC-MS methods. Internal quality control samples were run with each batch of analyses and external quality control samples where available.

**Results:** The response rate was 16.4% in the pilot study and fell to 7.5% in the main study. A total of 436 urine samples and questionnaires were received. Fifty five percent of samples came from women (45% from

men) and 59% of all volunteers were aged 40–69. Volunteers came from all over the UK and 12% were smokers with 35% of these smoking <10/day and 35% smoking 11–20/day. Urine samples outside the ‘normal’ range (0.3–30 g/l) were excluded from statistical analysis. A total of 17 biomarkers of chemical exposure relating to 11 different chemicals or chemical groups were analysed. Only cadmium and the Diethylhexyl phthalate metabolite 5-oxo MEHP were detected in urine from 90% of volunteers, whereas mercury, 3-phenoxybenzoic acid, cotinine and 5-hydroxy-MEHP were detectable in 80% of samples. Other biomarkers (cis dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid, deltamethrin, bifenthrin, Ethylenethiourea, methyl hippuric acid S-phenyl mercapturic acid, trichloroacetic acid, 1- and 2-naphthol) were detected in 50% or less of samples.

#### ISEE-861

#### Characterization of the Spatial Impact of Particles Emitted from a Cement Facility to Outdoor Dust in Surrounding Community

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**Introduction:** A study was conducted to determine the contribution of fugitive emissions from the raw cement material stored and used at a Cement Production Facility in Camden, New Jersey to outdoor dust in surrounding community.

**Methods:** To capture the fugitive particulate emissions from the facility and to assess the spatial impact, duplicate deposition samplers, each containing four quartz-fiber filters, were placed at each of the 10–12 key locations for 30 days in the most impacted area within a radial distance of 600 m from the facility downwind, and duplicate surface dusts were instantly sampled from flat surfaces by conventional wipe method from 15 locations within the same radial distance. A remote background site (Gloucester City Park) located approximately 2 km upwind from the cement facility was concurrently sampled. To link the potential source (i.e., raw cement piles) to receptors (i.e., outdoor dust suspended in the air or deposited on surfaces), deposition filter and surface wipe samples as well as raw cement materials collected from the facility were analyzed for elemental concentrations and morphological characteristics.

**Results:** The mass of deposited dust collected in Camden ranged from 0.80 to 1.73 mg, which was higher than the dust sampled in Gloucester City (0.43 ~ 0.56 mg). The %difference between the two co-located deposition samplers was relatively small, with  $10.4 \pm 9.6\%$  for the eight duplicate samples. The loadings measured in the surface dust samples ranged from 85 and 3,794 mg/m<sup>2</sup>. The deposited dust was found to be abundant with natural elements (mostly Al, Ca, Mg, Fe and Zn, ~7.2% of the total particle mass collected) and toxic trace elements (Cd, Cr, Cu, Pb, Sb and V, ~1,000 ng/mg). Similar species were found in surface dust but with higher levels. Morphological analyses showed that the raw cement material was dominant by silicon (55.6%) and calcium (22.5%), and 96.9% of total particles by count were below 10  $\mu\text{m}$  in diameter. The microscopical analyses for deposited filter samples indicated that most particles (>97.1%) were also in fine-sized fraction of 2.5  $\mu\text{m}$  in diameter. The deposited dust consisted mostly of silicon (56.2 ~ 87.9%), calcium (2.6 ~ 6.9%), and iron (3.6 ~ 11.2%), suggesting contributions from cement facility to local dust pollution in the samples. The enrichment factor, the ratio of the abundance of particular element in an enriched material to its abundance in original material, was obtained for various elements in collected dust relative to reference crustal rock or soil elemental compositions. The results for calcium demonstrated the sampling sites (<0.64 km from the facility) were more enriched by the element of calcium (i.e., a factor of 9.44 and 5.76 for deposited filters and surface wipes, respectively) than the control site (8.02 and 1.18, respectively). The Chemical Mass Balance model (US EPA) was

conducted to estimate the contribution of particulate emissions from the facility to outdoor dust in surrounding areas. The contribution of raw cement material piled in the facility to the dust in the neighborhood ranged from 5.3 to 23%.

#### ISEE-862

#### **Environmental Exposure to Perfluoroalkyl Compounds and Thyroid Function Among New York Anglers**

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**Background:** Experimental studies suggest that perfluoroalkyl compounds (PFCs) may influence thyroid function, although few human data are currently available to substantiate or refute this presumption. Great Lakes sportfish anglers represent a population with potentially elevated exposure given the persistence of these compounds *in vivo* and their detection in both the environment and biota of the Great Lakes Basin.

**Methods:** Twenty-seven men and four women who participated in the New York State Angler Exposure Validation Study donated blood and completed questionnaires regarding demographic, health and sportfish consumption information in 1996. Archived sera specimens were analyzed for thyroid stimulating hormone (TSH) and free thyroxine ( $fT_4$ ) as well as perfluorodecanoic acid (PFDA), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonate (PFHS), perfluorononanoic acid (PFNA), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorooctane sulfonamide (PFOSA), and perfluoroundecanoic acid, (PFUnDA).

**Results:** A majority of concentrations exceeded the limits of detection for measured PFCs (i.e.,  $\geq 84\%$ ) except for PFOSA (i.e., 10%) and PFHpA (i.e., none). Values below the LODs were censored as the LOD/2 or the LOD/ $\sqrt{762}$  conditional on proportion. The geometric mean (geometric standard deviation) for the sum of measured PFCs ( $\Sigma$ OPFCs), 23.9 (1.55) ng/mL, was dominated by PFOS, 19.6 (1.65) ng/mL, and PFOA, 1.41 (1.38) ng/mL. Following logarithmic transformation, statistically significant intercorrelations were observed between PFDA and PFNA ( $r = 0.65$ ,  $P < 0.0001$ ), PFOS ( $r = 0.70$ ,  $P < 0.0001$ ), and PFUnDA ( $r = 0.75$ ,  $P < 0.0001$ ), between PFNA and PFOS ( $r = 0.53$ ,  $P = 0.002$ ) and PFUnDA ( $r = 0.78$ ,  $P = 0.001$ ), as well as between PFOS and PFUnDA ( $r = 0.48$ ,  $P = 0.006$ ). These correlations suggest a common source of exposure to these PFCs among study participants. Age (range = 31 to 45 years) was significantly associated with ln TSH ( $r = -0.44$ ,  $P = 0.012$ ) as well as with sera concentrations for ln PFDA ( $r = -0.36$ ,  $P = 0.044$ ), ln PFNA ( $r = -0.56$ ,  $P = 0.001$ ), and ln PFUnDA ( $r = -0.40$ ,  $P = 0.023$ ). Geometric mean PFOA concentrations were significantly greater ( $P = 0.047$ ) among male (1.47 ng/mL), compared to the female (1.05 ng/mL), participants. No significant associations were observed between body mass index (range = 19.0 to 34.4 kg/m<sup>2</sup>) and TSH,  $fT_4$  or the measured PFCs. Employing simple, or multiple (i.e., for ln TSH regressed on PFDA, PFNA, or PFUnDA in which age was suspected as a confounder), linear regression models no statistically significant associations were observed for ln TSH or  $fT_4$  and individually measured ln PFCs or ln  $\Sigma$ OPFCs. Post hoc power analysis suggested that a minimum sample size increase of 11× the current (i.e.,  $n = 330$ ) would be required to detect a statistically significant association, at  $\alpha = 0.05$ , between a measured PFC (i.e., ln PFUnDA) and thyroid function (i.e.,  $fT_4$ ) at the observed effect size (i.e.,  $\beta = 0.057$ ) with 80% power.

**Conclusion:** The results of this cross-sectional pilot study are not supportive of an association between the body burden of measured PFCs and either TSH or  $fT_4$  among a sample of New York State Anglers. A prospective study employing a larger sample of participants will be required to confirm or refute these observations.

#### ISEE-864

#### **Benzene Exposure in Refinery Workers (1976–2006)**

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**Background:** Historical exposures to benzene were quantified for workers at a large U.S. refinery from 1976 to 2006. The purpose of this study was to understand the variability in workers' benzene exposures over time throughout the facility, and during different job tasks.

**Methods:** Air sampling results were divided into different categories according to whether samples were collected during normal refinery operations or turnarounds, and by specific job tasks. The results of more than 7,000 industrial hygiene air samples were evaluated for inclusion in this analysis. Approximately 3,648 non-task ( $\geq 180$  min) personal samples and approximately 1,973 task-based (<180 min) personal samples were considered applicable for statistical evaluation. More than 482 area air samples were also identified, but only used to estimate worker exposures if no personal samples were available. Approximately 36 worker exposure groups were identified and associated with approximately 14 different job tasks.

**Results:** The air sampling dataset was lognormally distributed and the benzene detection frequency was approximately 43% (e.g. 57% of all samples were below the limit of detection). The geometric mean, median and 95 percentile value of non-task samples for all workers at the site were approximately 0.017, 0.015 and 0.55 ppm, respectively. The job categories with the highest potential exposure were laborers working with product streams, tank cleaners and pipefitters working at the reformer unit. The geometric mean, median, and 95 percentile value of the task-based samples were approximately 0.074, 0.054, and 5.4 ppm, respectively. The tasks with the highest air concentrations of benzene were associated with tank cleaning and blinding/breaking lines at the reformer. Tasks associated with exposures near or above the American Conference of Governmental Industrial Hygienists Threshold Limit Value typically involved the use of personal protective equipment including respiratory protection.

**Conclusion:** This study provides a job and task-focused analysis of occupational exposure to benzene during refinery operations, and it should be useful for estimating exposures to benzene for refineries over the past 30 years.

#### ISEE-866

#### **Association Between Lead Exposure and Markers of Global DNA Methylation**

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**Background:** DNA methylation is an epigenetic mark which regulates gene expression and can be modified by environmental factors, possibly including toxic metals. Although their function is unclear, DNA contains large numbers of interdispersed repetitive elements (ALU and LINE-1) that are normally heavily methylated. Global methylation can be measured within these elements and changes in global methylation have been associated with diseases such as cancer and cardiovascular disease. Changes in global methylation may be representative of the effects of environmental factors on epigenetic marks and may explain observed phenomena such as programming and the latencies between exposure and disease onset.

**Methods:** We measured global methylation on a subset of 783 Normative Aging Study subjects (all male) who had archived blood DNA samples.

We measured patella and tibia lead levels by X-Ray fluorescence. Blood lead levels were measured by atomic absorption spectrometry. We determined global DNA methylation averages within CpG repeats of LINE-1 and ALU elements using PCR-Pyrosequencing on bisulfite-treated DNA. We constructed a series of multiple linear regression models using methylation with ALU or LINE-1 as the dependent variable and bone lead (tibia or patella in separate models) as the primary exposure markers. All models were adjusted for age at DNA collection, pack-years of smoking, education and blood Pb at time of DNA collection as covariates.

**Results:** Overall mean (SD) values for global methylation as measured by ALU and LINE-1 were as follows: ALU-26.3% STD(1.1%); LINE-1-76.8% STD(1.8%), respectively. Mean (SD) age was 72.9 (7.6) years. 32% of subjects had more than a high school education. Mean (SD) pack-years of smoking was 23.5 STD(26). In both the bivariate and full model patella lead levels were inversely associated with ALU (standardized Beta = -0.1;  $P = 0.03$ ) but not LINE-1; standardized Beta = -0.04;  $P = 0.4$ ). Results were unchanged if blood Pb was dropped from the model. Among the covariates only age was associated with global methylation (standardized Beta = -0.1;  $P = 0.01$ ). Tibia lead and blood lead did not predict global methylation for either ALU or LINE-1.

**Conclusion:** Patella lead levels inversely predict reduced global DNA methylation within ALU elements. We believe this is the first report in humans of an association between chronic lead exposure and DNA methylation. This finding may have implications for lead's mechanism of action in producing adverse health effects. Changes in DNA methylation could be a mechanism for long term programming effects as well. Further study is needed to confirm these findings and to determine whether DNA methylation marks (global and gene specific) are useful biomarkers of lead toxicity in epidemiologic studies.

#### ISEE-867

##### Investigation of Health Effects in Nanotechnological Industry

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**Background:** Nanotechnology has emerged at the forefront of science research and technology development. There is ever increasing interest to commercially develop nano-scale materials, structures and devices to take full advantage of the unique properties affecting physical, chemical and biological behaviour that result. However, occupational health risks associated with manufacturing and handling of nanoparticles are not clearly understood. There are no epidemiological data available.

**Objective:** The objective of this study was to measure the particle concentration from carbon nanotubes and to explore potential indicators of health effects among workers and academic researchers exposed to nanoparticles.

**Methods:** We conducted a cross-sectional study of 10 exposed workers and 12 office workers as their reference group and 36 exposed and 36 unexposed postgraduate students as a reference group. Air sampling was to detect source emissions for carbon nanotubes and conduct limited characterization of the airborne nanotubes during production and material handling operations. A multi-metric sampling approach was used consisting of number concentration, size distribution, surface area, and mass concentration measurements. A TSI Engine exhaust particle sizer (SMPS) (TSI Model 3090) was used to measure airborne particle number concentration from 6 nm to 523 nm in 32 size channels at 10 seconds interval. Chemical vapor deposition (CVD) and plasma chemical vapor deposition were the two major methods used to synthesize carbon nanotubes at these industry and university research centers. The participants filled in a questionnaire and underwent a medical examination. Urinary 8-hydroxydeoxyguanosine (8-OHdG) was used as a biomarker of oxidative DNA damage. We collected the post-shift spot urine

samples from subjects for the measurement of 8-hydroxydeoxyguanosine (8-OHdG). In the morning of the same day of the end of the working shift, subjects were asked for blood drawing for the blood routine and blood biochemistry examinations.

**Results:** Our study showed a 12 times higher particle concentration, 14 times higher surface area, and 2 times higher mass concentration in occupational settings (exposed workers) compared to university research facilities (exposed postgraduate students). For the vigorous mechanical processes (such as grinding and agitation) of carbon nanotubes (CNTs), the measurement on the CNT working site showed distinguished high particle number concentration on the exhaust air. There were no significant differences between exposed and reference groups in the blood routine, blood biochemistry, and urine routine examinations. There was a significant difference between exposed and reference groups with regard to FEV<sub>1</sub> (%) after adjusting age and smoking habit. No significant differences were found between exposed and reference subjects with regard to respiratory symptoms or urinary 8-OHdG levels.

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#### ISEE-868

##### Influences of Diet and Indoor Environment on Infant Manganese Exposure

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**Objective:** Studies have shown manganese to be an essential nutrient and neurotoxicant to children, but few studies have examined influences of nutrition and environment on manganese exposure during the early stages of life. We conducted an exposure assessment study on infants born from 2004–2006 near a mining-related Superfund site in Oklahoma to examine key routes of manganese exposure.

**Methods:** Umbilical cord blood samples were collected from 42 infants at birth. Whole blood, scalp hair, and household dust samples were collected at approximately one year of age in the same cohort. All samples were analyzed for manganese content using inductively-coupled plasma mass spectrometry. Information on infant feeding practices was collected with a standardized questionnaire.

**Results:** Mean ( $\pm$ SD) blood manganese in infants at one year ( $1.6 \pm 0.77 \mu\text{g/dL}$ ) was significantly lower ( $P < 0.0001$ ) than mean cord blood manganese at birth ( $3.9 \pm 1.7 \mu\text{g/dL}$ ). Blood manganese decreased in 95% of infants in the first year of life. Hair manganese (mean:  $694 \pm 485 \text{ ng/g}$ ) was not correlated with blood manganese at one year. Manganese dust loadings were positively associated with infant hair ( $P = 0.0007$ ) but not blood manganese. Duration of breastfeeding, an indicator of infant diet, was inversely associated with both hair and blood manganese at one year ( $P < 0.05$ ). Infants who were breastfed longer than six months had lower manganese levels than those who were never breastfed or were breastfed for one to six months.

**Conclusions:** These results are consistent with previous studies which found higher levels of manganese in infant formula compared to human breast milk. In conclusion, these results support the hypothesis that the indoor environment and diet play important roles in infant exposure to manganese.

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#### ISEE-871

##### Multivariate Statistical Analysis of Polychlorinated Biphenyl Congener Profiles in Breast Milk

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**Background:** Human exposure to polychlorinated biphenyls (PCBs) results in a “body burden” of these persistent xenobiotics, characterized as the level of individual congeners in adipose, blood, or breast milk. Determinants of body burden include source and route of exposure, age, lactation, and individual toxicokinetics. Recent work has indicated that analysis of congener profiles can provide insight into the importance of these determinants for individual subjects and for populations. The present study employs multivariate exploratory data analysis to compare breast milk profiles for two cohorts of women with no known specific exposure to PCBs.

**Methods:** Breast milk specimens were collected from 21 nursing women living near Springfield, MA (N = 10) or Albany, NY (N = 11). Each woman completed a questionnaire providing information on her age, age of her nursing child, her smoking history, and number of children she previously nursed. Two of 11 Albany women and five of 10 MA women had previously nursed at least one child. A total of 83 PCB analytes (containing 101 congeners) were quantitated by high-resolution GC-ECD for each breast milk specimen.

**Results:** Mothers’ ages ranged from 21 to 40 years; breast-feeding duration for the current child ranged from 3.5 to 67 weeks. ∑OPCB levels in the breast milk of MA and NY women were not significantly different (*i.e.*, 170 and 175 ng/g lipid, respectively). Congener profiles for all women were dominated by the persistent CBs 74, 99, 118, 138[+163+164], 153, and 180. Breast milk ∑OPCB levels were significantly higher in women who had not previously breast fed a child as compared to those who had (*i.e.*, 184 vs. 148 ng/g lipid). In addition, ∑OPCB was positively correlated with age among women who had not previously nursed, while no correlation was seen among women who had nursed a prior child. Relative levels of CBs 74 and 99 were significantly higher in women who had not previously breast fed, while CBs 66 and 90[+101] were higher among women who had. Principal component analysis (PCA) of breast milk congener profiles (with normalization of congener levels to that of CB 180 and range transformation) indicated that PCs 1, 2, and 3 accounted for 77%, 5%, and 4% of model variance, respectively. PC1 was correlated with age of the subject, while PC2 was related to a history of prior breastfeeding. PCA could not effectively distinguish between geographic location of the subjects. In a second PCA model that employed raw congener data and autoscale transformation, PC1 was highly correlated with ∑OPCB. Finally, preliminary modeling of the data by polytopic vector analysis (PVA) revealed three independent PCB patterns (“end-members”) that contributed to the full breast milk PCB profile for these subjects. Patterns 1 and 2, consisting primarily of persistent CBs, dominated the profiles of most subjects. In contrast, several subjects exhibited strong contributions from pattern 3, which was characterized by greater proportions of lightly chlorinated, transient CBs.

**Conclusion:** These data indicate that prior breast feeding can result in changes to PCB body burden that are detectable by alterations in breast milk CB profile.

#### ISEE-874

#### Health Risk Assessment of Urban Agriculture Sites Using Vegetable Uptake and Bioaccessibility Data—an Overview of 28 Sites with a Combined Area of 48 Hectares

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**Background:** Newcastle-upon-Tyne (population 260,000) is the regional capital of NE England (population 2,500,000) with a rich industrial and

mining history stretching back as far as Roman times. Since the industrial revolution Urban Agriculture Sites (UAS) (known in the UK as Allotment Gardens) developed as part of the extension of urban areas reflecting the desire to retain non commercial agriculture. In 2004 we reported that ‘allotment sites in previously industrial urban areas are of potential concern for local authorities because of the tension between supporting allotment gardening as a health promoting activity within deprived areas and protecting public health from exposure to contaminated land and produce.’ In a previous study into effects of ash from an Energy from Waste plant used on paths on UAS (n = 32) we found many sites had soil concentrations of lead and arsenic above UK Soil Guideline Values (SGVs). In 2004 we reported that ‘UK CLEA guidance was weak in guiding decisions for allotments exceeding SGVs and that surveys of consumption habits of allotment gardeners are required as are health and bioaccessibility studies of heavy metals under UK conditions’.

**Methods:** An award from the UK’s Department for the Environment, Farming and Rural Affairs (DEFRA) provided funding to investigate 28 sites listed by the previous reports, with contaminant concentrations above UK and European SGVs. Sites were investigated in accordance with standard UK guidance. Conceptual Exposure Models (CEMs) were developed for each site to determine possible sources, pathways and receptors of contaminants. Detailed Quantitative Risk Assessments (DQRA) were carried out on 12 of these sites including sampling and analysis of vegetable uptake of contaminants and bioaccessibility by Physiologically Based Extraction Test (PBET).

**Results:** From 400+ soil samples lead and arsenic were the two contaminants repeatedly found across the city: lead min = 210, median = 545, US95 = 684, max = 1315, arsenic min = 7, median = 22, US95 = 27, max = 45 all in mg/kg. Local coal contains lead and arsenic. Gardeners have historically used coal fire ash as a soil conditioner to help break up the heavy clay soils. Sites on or near coal mining sites were also found to have higher lead and arsenic. More recently established UASs do not have the raised lead and arsenic concentrations as coal fires were phased out of the city in the 1960s to improve air quality and health. Three sites were legally determined as contaminated land and underwent remediation. The evidence of low vegetable uptake and bioaccessibility of the contaminants led to the decision that all the other sites investigated were suitable for food production.

**Conclusion:** We present novel approaches to balancing health benefits of urban agriculture as part of sustainable urban development for an area with previous industrial history avoiding closure due to over cautious risk assessment.

#### ISEE-876

#### Transferability of Traffic Pollution Land-Use Regression Models Between Canadian Cities

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**Background:** Land use regression (LUR) models are commonly used to assess long-term exposure to traffic-generated air pollution. We have previously evaluated the transferability of a LUR model from Vancouver to Victoria, BC and Seattle WA; here we aim to further evaluate the transferability of LUR models between cities with different topographies and climates. In addition, we aim to develop LUR models of NO and NO<sub>2</sub> in Edmonton, AB and Winnipeg, MB to aid future epidemiologic studies of air pollution and childhood asthma and allergy.

**Methods:** NO and NO<sub>2</sub> concentrations are being measured passively during two-week sampling sessions at 50 locations in Edmonton and Winnipeg; sampling is conducted twice in each city to evaluate temporal changes in spatial pollution patterns. City-specific LUR models of NO and NO<sub>2</sub> will be developed using stepwise multiple linear regression after systematically screening potential predictors. In addition, to evaluate LUR

model transferability, measurements will be compared with concentrations predicted from previously published Vancouver LUR models.

**Results:** The first sampling session in Winnipeg was completed in October, 2007. The mean ( $\pm$ SD) concentrations of NO and  $\text{NO}_2$  were  $12.5 \pm 10.5$  ppb and  $8.3 \pm 2.9$  ppb, respectively (N = 46). NO was log-normally distributed, and preliminary, city-specific LUR models of log(NO) and  $\text{NO}_2$  had coefficients of determination ( $R^2$ ) of 0.75 and 0.56, respectively. Vancouver-based LUR models for log(NO) and  $\text{NO}_2$  did not perform as well when transferred to Winnipeg ( $R^2$ : 0.59 vs. 0.47 for log(NO) and 0.53 vs. 0.38 for  $\text{NO}_2$ ). We also explored the transferability of modified Vancouver-based models developed without elevation as a predictor. For log(NO) the modified model performed similarly when transferred ( $R^2 = 0.50$  vs. 0.45), but the modified  $\text{NO}_2$  model's performance decreased when transferred to Winnipeg ( $R^2 = 0.47$  vs. 0.34).

**Conclusion:** The transfer of LUR models between cities shows promise, although transferred models may not perform as well those developed locally.

#### ISEE-878

#### The Time-Lagged Effect of Exposure to Air Pollution on Heart Rate Variability

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**Objectives:** Long-term exposure to air pollution has been associated with cardiovascular health. We evaluated the temporal course of the association between reduced heart rate variability and past exposure to  $\text{NO}_2$  over one year.

**Methods:** We assessed the effect of past daily variations in  $\text{NO}_2$  on heart rate variability (SDNN, total power, high and low frequency power) of 1408 persons age 50 years and older monitored between August 2001 and February 2003 in Switzerland. We fit constrained distributed lag functions of past  $\text{NO}_2$  levels monitored by fixed stations to the logarithmized HRV data while controlling for seasonal trends, spatial heterogeneity and the individual's health status.

**Results:** All measures of heart rate variability were negatively associated to past exposure to  $\text{NO}_2$  in females. The highest impact, although not statistically significant, was found for a cumulative exposure over the preceding 300 days for SDNN and total power and over 240 days for high and low frequency power. Each increase of 10 micrograms per cubic meter in cumulative  $\text{NO}_2$  exposure over the previous 300 day period, results in a decrease by 3.2 percent (95 percent confidence interval 6.8 to -0.4 percent) in SDNN, by 2.2 percent (95 percent confidence interval 9.7 to -5.9 percent) in total power, by 2.2 percent (95 percent confidence interval 9.5 to -5.6 percent) in high frequency power and by 3.2 percent (95 percent confidence interval 8.9 to -2.9 percent) in low frequency power. No effect between past exposure to  $\text{NO}_2$  and reduced heart rate variability was detected in men.

**Conclusions:** Lower heart rate variability is associated with exposure to air pollution in females. Our results suggest that these effects are not driven by short term exposure but by exposure over almost one year.

#### ISEE-879

#### Association Between Total IgE and Ozone in Asthmatic Adults from the EGEA Study Stratified by Allergic Rhinitis or Atopy

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**Background:** It has been previously shown that Ozone ( $\text{O}_3$ ) was positively associated to IgE in asthmatic adults (ATS 2008). Atopic asthmatics or asthmatics with allergic rhinitis could have a different

susceptibility to air pollutants. The aim of the present study is to assess whether atopy and allergic rhinitis modify the association between IgE and  $\text{O}_3$  in asthmatics adults.

**Methods:** The Epidemiological study on Genetics and Environment of Asthma (EGEA) combines a case-control and a family design. The present analysis includes the 369 asthmatic adults (probands and relatives), from the first survey (1991–1995) of EGEA, with available IgE measurement and modelled air pollution concentrations. Annual air pollution concentrations were assigned to the residential address, using geo-spatial pollutant models developed by the French Institute of Environment for the 1998-year. Generalized estimated equations were systematically performed to take into account familial dependence between observations. Results were adjusted for sex, age, smoking and country living for at least one year. Results were stratified by allergic rhinitis (reported on a questionnaire) or atopy (defined as at least one wheal  $\geq 3$  mm to 11 allergens).

**Results:** The mean age of our sample was 37 years old, 48% were females, 50% never smokers, 73% atopics, 69% reported allergic rhinitis and 55% were both atopics and had allergic rhinitis. The geometric mean of IgE was 161 IU/mL (95% Confidence Interval (95%CI): 10–2554). IgE was independently associated with sex (higher in men), age (decreased with age) and smoking (increased in smokers). In all subjects, IgE increased by 19% (95%CI 2–39) per each  $10 \mu\text{g.m}^{-3}$  of  $\text{O}_3$ . The ozone effect on IgE seemed stronger in non-atopics (31% 95%CI: -6–8) than in atopics (7% 95%CI: -10–27), however the test for interaction did not reach significance (p-value = 0.3). Results were similar in subjects with or without allergic rhinitis, 17 (95%CI -1–37) and 8% (95%CI -15–65) respectively.

**Conclusions:** Results are suggestive of an interaction between ozone and atopy. To better understand the effect of air pollution in relation to allergy, atopy, and rhinitis in asthmatics, further analyses are needed based on larger sample sizes.

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#### ISEE-880

#### First Steps in Exposure Assessment and Management Among the PFC Case in Arnsberg, Germany

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**Background:** In May 2006, high levels of perfluorooctanoate (PFOA) ( $>0.5 \mu\text{g/l}$ ) in drinking water became evident in Arnsberg, Germany. According to current knowledge, farmers had disseminated 27,700 tons of soil conditioner which has been mingled with industrial waste on about 800 agricultural land sites in the catchment of the rivers Möhne and Upper-Ruhr. In June, the German Drinking Water Commission set a health based guidance value for safe lifelong exposure of all population groups of  $0.3 \mu\text{g/l}$  (sum of perfluorooctane sulfonate, PFOS, and PFOA). In July, the waterworks Möhnebogen installed activated-charcoal filters, which efficiently decreased PFOA concentrations in drinking water. A human biomonitoring study performed in autumn 2006 revealed 4–8 times higher PFOA levels in plasma of residents from Arnsberg compared to a reference group.

Analysis of PFC in breast milk showed comparatively low levels which do not pose a risk for infants. Due to high levels of PFOS in fish from contaminated lakes and rivers recommendations for anglers to reduce fish consumption were derived. The duration of the contamination is unclear. As a first approach plasma samples of young adults who had ever lived in the affected area were taken from the German Environmental Specimen Bank for Human Tissues and analyzed for their plasma PFC. Preliminary results show no indications for an increased PFC exposure of residents in Arnsberg in the years 1977–2004. Remediation of the affected area is ongoing and PFC levels in various matrices have decreased.

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#### ISEE-881

#### Parameters Affecting In-Cabin to On-Roadway (I/O) Ultrafine Particle Concentration Ratios

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**Methods:** A mass-balance indoor particle dynamic model was adopted and modified to investigate how on-roadway ultrafine particle (UFP, diameter < 100 nm) concentrations and vehicle ventilation settings affect UFP levels inside passenger cars. Analysis focused on how model input parameters, such as ventilation settings, filtration, penetration, deposition and human inhalation, affect the in-cabin to on-roadway (I/O) ratios.

**Results:** Under different ventilation conditions, i.e., fan off-recirculation (RC) off, fan on-RC off, and fan on-RC on, the average total particle I/O ratios were found to be 0.45, 0.30 and 0.18. The ranges and trends of modeled I/O ratio agree well with experimental data reported by Zhu et al. (2007), and other studies. When fan off-RC off, the modeled I/O ratio increased linearly, up to ~25%, within the literature reported penetration factor range. The I/O ratio was also found to be directly proportional to vehicle speed, increased by ~15% from 20 mph to 70 mph and inversely affected by deposition coefficient for 10–30%. When fan on-RC off, the airflow rate of mechanical ventilation was the dominant factor for I/O ratios, inversely proportional to I/O ratio in the range of 0–108 m<sup>3</sup>/h but directly proportional to I/O ratio in the range of 108–360 m<sup>3</sup>/h. The I/O ratio may increase by 50% when the mechanical supply air rises from 108 m<sup>3</sup>/h to 360 m<sup>3</sup>/h. Penetration factor, deposition coefficient and vehicle speed showed much less effects. When fan on-RC on, the effects of penetration factor (<10%), deposition coefficient (<10%) and vehicle speed (<8%) are similar. Mechanical ventilation was inversely proportional to I/O ratio in the whole range of 0–360 m<sup>3</sup>/h and its effect on I/O ratio is 10%–20% depending on the particle sizes. It usually takes 5 to 210 seconds for the in-cabin UFP concentrations to achieve a new mass balance with respect to on-roadway UFP variations under different ventilation settings.

**Conclusion:** This study provides a foundation for understanding the relationship between in-cabin and on-roadway UFP concentrations and offers insights for reducing commuters' exposure to freeway UFPs.

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#### ISEE-882

#### A Novel Screening Model for Evaluating Exposures to Pesticides Applied as Components of Chalk

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**Background:** Pesticides, both approved and unapproved, are sometimes incorporated into chalk sticks to facilitate application to indoor surfaces,

and it is necessary to evaluate the human health risks posed by such applications. However, no models simulating long-term exposures to pesticides in chalk are available in the open literature. We propose a mathematical model for estimating the average daily dose (ADD) of a pesticide resulting from its long-term application as a component of chalk.

**Methods:** The proposed model consists of a component that describes the transfer of applied pesticide into household dust, termed the "mass loading component," and additional components that describe exposure to applied pesticide due to (1) incidental ingestion of household dust, (2) incidental ingestion of chalk adhering to surfaces, (3) dermal contact with chalk in household dust and adhering to surfaces, and (4) inhalation of household dust. Application of the proposed model was illustrated employing parameter values based on laboratory testing of a single pesticide product undergoing regulatory review, field measurements, results of published investigations, previously employed default values or, in the absence of any of these, our own judgement. All model runs assumed regular chalk applications at a residential apartment.

**Results and Discussion:** ADDs estimated by the model were highly dependent on five parameters: soil/dust ingestion rate, body weight, fraction of dust remaining after housekeeping, uncontaminated (non-chalk) household dust loading per year, and average number of hours of potential contact activities. The fraction of dust remaining after housekeeping appears to be of particular interest to risk assessors as the model is relatively sensitive to that parameter, and there is a high degree of uncertainty associated with it.

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#### ISEE-883

#### Strategies for Improving Exposures and Exposure Distributions: Air Pollution and Environmental Justice in the South Coast

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**Background:** Environmental health policy seeks to reduce exposures and address exposure inequality; for air pollution, these steps involve prioritizing emission reductions among sources.

**Methods:** We modeled changes in average exposure and in exposure distribution attributable to emission reductions for specific sources. We employ a mobility-based exposure model for ~25,000 people in California's South Coast Air Basin, which accounts for daily changes in location (e.g., shopping, commuting) and for time spent indoors, outdoors, and in vehicles. The CAMx air dispersion model, with reactive tracers, was used to quantify spatiotemporal changes in air pollution attributable to reducing emissions from specific sources. We employ the most recent emission inventory (MATES III), and focus on diesel particles (the largest contributor to outdoor air pollution lung cancer risk in the South Coast).

**Results:** The exposure benefit per mass emission reduction varies among sources, because of differences in proximity between sources and people. We have modeled several emitters of diesel particles (e.g., the Los Angeles port, LAX airport) to quantify how average exposures and exposure distributions would be impacted by emission reductions from that source. Exposure efficiency is quantified using intake fraction; exposure inequalities are quantified using inequality indices (Gini; Atkinson) and by comparing results by income and ethnicity.

**Conclusion:** Results are useful for designing equitable and efficient strategies to reduce air pollution exposures in the South Coast.

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#### ISEE-884

#### Associations of Endothelial Dysfunction with Exposure to Ambient Fine Particles in Diabetic Subjects: Are the Effects Modified by Patient Characteristics?

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**Objective:** Exposure to fine airborne particulate matter ( $PM_{2.5}$ ) has been shown to be responsible for cardiovascular and hematological effects, especially in older people with cardiovascular disease. Results of epidemiological studies suggest that subjects with diabetes may be a particularly susceptible population. The purpose of this study was to analyze the short-term effects of  $PM_{2.5}$  on markers of endothelial function in diabetic patients with a focus on effect modification by patient characteristics.

**Methods:** A prospective panel study was conducted on 22 people with diabetes in Chapel Hill, NC, from Nov 2004-Dec 2005. Each subject was studied for 4 consecutive days. Daily measurements of  $PM_{2.5}$  were acquired from the Chapel Hill airport and meteorological data were measured on the rooftop of the patient exam site. Brachial artery flow mediated dilatation (FMD) measured by brachial artery ultrasound and small artery elasticity index (SAEI) measured by a pulsedwave device were assessed during each subject visit. Potential effect modifiers such as body mass index (BMI), glycosylated haemoglobin (HbA1c), homocysteine, adiponectin, myeloperoxidase (MPO) as well as the intake of statins were examined. Moreover, gene-environment interactions were analyzed with regard to the influence of glutathione-S-transferases (GSTM1 null and GSTP1), of a polymorphism of the hemochromatosis gene HFE (H63D) and of the quinone oxidoreductase gene (NQO1) polymorphism P149S. Data were analyzed using random effects models adjusting for season, weekday and meteorology.

**Results:** Results are presented for an increase of  $10 \mu\text{g}/\text{m}^3$   $PM_{2.5}$  as percent changes of mean outcome level with a 95% confidence interval. FMD decreased in association with  $PM_{2.5}$  exposure of the same day ( $-17.3\% [-34.6\%; 0.0\%]$ ). A similar reaction was found for SAEI but with a lag of 1 ( $-17.0\% [-27.5\%, -6.4\%]$ ) and 3 days ( $-15.1\% [-29.3\%, -0.9\%]$ ). Subjects with a BMI over  $30 \text{ kg}/\text{m}^2$ , with HbA1c over 7%, with a homocysteine level over  $12 \mu\text{mol}/\text{l}$  or with adiponectin below  $3700 \text{ ng}/\text{ml}$  showed stronger effects. The FMD reaction was even more pronounced on days when the subject had an elevated MPO-level for same day exposure ( $-43.2\% [-69.4\%; -17.0\%]$ ), with a lag of 1 day ( $-30.7\% [-59.9\%; -1.4\%]$ ) and with a lag of 2 days ( $-34.8\% [-64.9\%; -4.8\%]$ ). The intake of statins did not change the same day association of FMD with PM. Subjects with the null polymorphism of GSTM1 showed a stronger association. The analysis indicated a trend for a stronger FMD effect with each copy of the valine-coding polymorphism of the GSTP1 gene. Having one copy of the aspartic acid-coding variant of the HFE gene also seemed to slightly enhance endothelial dysfunction.

**Conclusion:** These data demonstrate that PM exposure may cause immediate endothelial dysfunction and that certain patient characteristics, such as high BMI, elevated MPO or the presence of the null polymorphism of GSTM1 may make some subjects more susceptible to PM exposure than others.

*This abstract of a proposed presentation does not necessarily represent EPA policy.*

#### ISEE-885

**Short-Term Health Effects of Particulate Air Pollution in Beijing, China**  
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**Background:** While the link between  $PM_{10}$  (particulate matter  $<10 \mu\text{m}$  diameter) or  $PM_{2.5}$  (fine particles (FP), diameter  $<2.5 \mu\text{m}$ ) with mortality is well established, the role of smaller particles is not yet fully investigated, especially in Asia. The purpose of this analysis is to explore the association of several particle size fractions ranging from 3 nm to  $1.0 \mu\text{m}$  and daily cardiovascular mortality in Beijing, China.

**Methods:** Daily counts of cardiovascular deaths for the Beijing urban area were obtained from local health authorities for the period March 2004 to April 2005. During the same period, continuous measurements of aerosol number size distributions were performed by a Twin Differential Mobility Particle Sizer and an Aerodynamic Particle Sizer. Daily means of particle number concentrations were computed for several size ranges including  $0.03\text{--}0.05 \mu\text{m}$ ,  $0.05\text{--}0.1 \mu\text{m}$ ,  $0.003\text{--}0.1 \mu\text{m}$  (ultrafine particles) and  $0.1\text{--}1.0 \mu\text{m}$  (accumulation mode particles). Poisson regression models adjusting for trend, season, calendar effects, air temperature, relative humidity and barometric pressure were used to estimate immediate, delayed and cumulative particle effects. Besides overall cardiovascular mortality, we inspected cause-specific deaths due to “Ischemic heart diseases” (ICD-10 code I20-I25), “Other forms of heart disease” (ICD-10 code I30-I52) and “Cerebrovascular diseases” (ICD-10 code I60-I69).

**Results:** We observed consistent associations between daily cardiovascular mortality and particle number concentrations in the size ranges  $0.03\text{--}0.05 \mu\text{m}$ ,  $0.05\text{--}0.1 \mu\text{m}$  and  $0.003\text{--}0.1 \mu\text{m}$  for a 2-days delay as well as for the 5-day average. For ultrafine particles, an interquartile (IQR) increase of  $12,386 \text{ cm}^{-3}$  was associated with a relative risk (RR) of 1.04 (95%-CI: 1.01 to 1.07) for a 2-days delay. For the 5-day average, an IQR increase of  $10,197 \text{ cm}^{-3}$  was associated with a RR of 1.04 (95%-CI: 1.00 to 1.08). The risk estimates for the size ranges  $0.03\text{--}0.05 \mu\text{m}$  and  $0.05\text{--}0.1 \mu\text{m}$  were of comparable magnitude. In contrast, we did not find associations for number concentrations of accumulation mode particles (RR: 1.02 (95%-CI: 0.99 to 1.05) for lag 2, and 1.01 (95%-CI: 0.98 to 1.03) for the 5-day average). Regarding the cause-specific death categories, similar results were observed, except for the category “Other forms of heart disease”, where no associations were found.

**Conclusion:** Results from this analysis show an elevated risk of cardiovascular mortality from short-term exposure to ultrafine particle number concentrations.

#### ISEE-888

**Neuropsychological Effects of Manganese Exposure on Children Living in Communities Near Processing Plants in Mexico**

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**Background:** Mexico is the second highest Latin-American manganese (Mn) producing country and occupies the fifth place worldwide in Mn production. The Molango mining district is located within the Sierra Madre Oriental, in the state of Hidalgo. Using an ecosystem health approach, we have been studying the factors that determine the population exposure using the interaction between social, environmental and health sciences. Into this framework the neuropsychological assessment is linked with socioeconomic and gender vulnerability and environmental exposure pathways. In a first stage it was determined that high air manganese concentrations were associated with deficit in motor tests performance in adults.

**Methods:** To assess the effect of manganese exposure on IQ, we selected 200 children (100 exposed and 100 not exposed) between 7 and 11 years old and applied the Wechsler Intelligence Scale for Children reviewed for

Mexican population. The chronic exposure to Mn was measured as Hair Manganese (MnH). We performed multivariate linear models to assess the effect of hair manganese (MnH).

**Results:** Mean MnH were significantly different in exposed (14.24 mcg/g) and not exposed (0.73 mcg/g) children. After adjusting for maternal education, gender, age, blood lead levels and nutritional status, hair manganese was significantly associated with deficit in IQ measured as Verbal (beta = -1.5 (95% CI -3.0, -0.08)), Performance (beta = -1.6 (95% CI -3.2, 0.06)) and Total Scales (beta = -1.6 (95% CI -3.1, -0.14)). Most of the subtests showed similar results. A significant interaction was found between MnH and gender and MnH and age related with these effects.

**Conclusion:** The mean MnH concentration was 20 fold higher in the exposed children compared with the control group. The chronic exposure to Mn has a significant negative effect on the IQ according with different scales and subscales in school-aged children. Young girls were identified as the most susceptible subpopulation.

#### ISEE-889

#### Relationships Between Weather, Myocardial Infarction and Stroke in Moscow, Russia

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**Background:** To assess health effects of global warming, it is useful to establish relationships between variation of daily meteorological parameters and variation of daily event rates for certain cardiovascular diseases. If heat waves or cold spells become more severe and frequent because of destabilization of global climate, then increased risks of hospital admissions during such events provides an important and direct link between global environmental changes and health.

**Objectives:** 1) To estimate percentage increase of myocardial infarction (MI) and stroke per unit increases of ambient air temperature, air pressure, geomagnetic activity index, or increase of their daily variation. 2) To estimate increases of emergency hospital admissions during discrete weather events: geomagnetic storms, heat waves and cold spells.

**Methods:** Hospital admissions for myocardial infarction and stroke in two large Moscow hospitals between 1992 and 2005 were considered; 2833 infarctions and 1096 strokes were analyzed. The percentages of variation of daily event rates according to variations of 24-hour mean measures of air temperature, air pressure, and geomagnetic activity, and their first-order differences were preliminary derived using a regression analysis. The relative risks of MI and stroke during geomagnetic storms and temperature waves were estimated using independent samples tests.

**Results:** Analysis of seasonal patterns of morbidity revealed that seasonal oscillations of daily MI rates closely followed those of 24-hour *K*-index of geomagnetic activity ( $K_{24}$ ), with characteristic winter and summer minimums versus autumn and spring maximums; the amplitude of seasonal variations of MI rates could be as high as 36%. Contrariwise, daily stroke rates were significantly higher in winters than in summers, but the relative amplitude of these oscillations was only 8%. The incidence of MI increased by 1.1% (95% CI 0.3 to 1.9) per unit increase  $K_{24}$ ; by 1.9% (0.9 to 2.9) per unit increase of variation of air temperature throughout the day; by 0.9% (0.1 to 1.3) per each 1 mm Hg decrease of pressure in low pressure region (between 729 and 744 mm Hg); by 1.5% (0.5 to 2.5) per each 1 mm Hg increase of pressure in high pressure region (between 749 and 765 mm Hg), and by 0.9% (0.3 to 1.5) per each 1 mm increase of variation of air pressure during the day. The incidence of stroke increased by 1.9% (0.5 to 3.3) per unit increase of  $K_{24}$ ; by 5% per each 1 degree increase of mean daily temperature above 18 °C; by 1.9% (0.3 to 3.5) per unit increase of variation of air temperature throughout the day; by 2.1% (1.1 to 3.1) per each 1 mm Hg decrease of pressure in low pressure region (between 729 and 744 mm Hg); and by 1.5% (0.5 to 2.5) per each 1 mm increase of variation of air pressure

during the day. The incidences of MI and stroke increased by 31% and 23%, respectively, during geomagnetic storms.

**Conclusion:** The results with respect to increased risks of cardiovascular morbidity during heat waves and cold spells were not conclusive, although there are indications that daily event rates do increase during such extreme weather events.

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#### ISEE-890

#### Adult Onset Asthma Among Never-Smokers is Associated with Air Pollution

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**Background:** Traffic related air pollution is associated with asthma onset in children but poorly investigated in relation to adult onset asthma. We used the SAPALDIA cohort study to investigate the association between the 11-year change in annual home outdoor traffic related particulate matter (TPM<sub>10</sub>) and asthma incidence.

**Methods:** TPM<sub>10</sub> at baseline and follow-up was predicted and geographically interpolated by dispersion models using emission and meteo data. Cox proportional hazard models for time to asthma onset were adjusted (age, sex, atopy, education, baseline bronchial hyperreactivity (BHR) & BMI, work place exposure, parental asthma or allergies, area).

**Results:** Among 2725 never-smokers without asthma/COPD at baseline (ages: 18–60 yrs in 1991), 41 reported asthma onset in 2002. Home outdoor TPM<sub>10</sub> concentrations slightly improved (mean: -0.6; range -9 to +10; IQR 0.6 mcg/m<sup>3</sup>) during the interval. Asthma incidence correlated significantly with change in TPM<sub>10</sub> and relative risks (RR) were not sensitive to model specification, ranging from 1.28 [95%CI: 1.01–1.61] (crude) to 1.30 [1.04–1.63] (full adjustment) per 1 unit change in TPM<sub>10</sub>. Interactions did not reach conventional levels for statistical significance but, as a general pattern, subgroups with inherently higher risks to develop asthma (age >40, atopy or BHR at baseline) and those not changing residential address during follow-up were more strongly affected by TPM<sub>10</sub> (e.g. 1.71 [1.12–2.63]).

**Conclusion:** Our data suggest a role for traffic related pollution in adult onset asthma. This needs further investigation.

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#### ISEE-892

#### Perinatal Exposure to Perchlorate, Thiocyanate and Nitrate Compared with Iodide Levels in NJ Mothers and Newborns

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**Background and Methods:** Perchlorate is a thyroid inhibitor with widespread exposure; perchlorate may be actively transported across the placental barrier by the sodium-iodide symporter (NIS) and thus could lead to both increased perchlorate exposure and decreased iodide intake by the fetus. Therefore, we measured levels of three physiologically-relevant NIS-inhibitors (perchlorate, nitrate, thiocyanate) and iodide in

maternal and fetal fluids collected during caesarean-section surgeries on 150 US women.

**Results:** Geometric means of perchlorate, thiocyanate and nitrate levels in maternal urine (2.14, 699 and 35400 µg/L, respectively) were similar to previously published results, while urinary iodide levels (1050 µg/L) were significantly higher ( $P < 0.0001$ ), likely due to prevalent prenatal vitamin use in the study population (74%). Thiocyanate levels were higher in the urine, maternal serum, fetal serum and amniotic fluid of smokers compared with non-smokers ( $P = 0.011$ ,  $P < 0.0001$ ,  $P = 0.032$  and  $P < 0.0001$ , respectively). Perchlorate was detected in most samples: urine (100%), maternal serum (94%), fetal serum (67%), and amniotic fluid (97%). Maternal urinary perchlorate levels were positively correlated with perchlorate levels in fetal serum ( $P = 0.03$ ) and amniotic fluid ( $P < 0.0001$ ), indicating that maternal urine perchlorate is an effective biomarker of fetal perchlorate exposure. Maternal serum perchlorate was generally higher than fetal serum perchlorate (mean ratio 3:1 for paired samples) and maternal urine perchlorate was always higher than fetal amniotic fluid perchlorate levels (mean ratio 22:1); conversely, iodide levels were higher in fetal fluids compared with maternal fluids.

**Conclusion:** We found no evidence of either disproportionate perchlorate accumulation in the fetal compartment or of inhibition of iodine transport across the placenta.

#### ISEE-893

##### Misclassification of Onset Time of Acute Events Leads to Underestimation of Air Pollution Acute Health Effects

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**Objective:** Epidemiologic studies of the short-term effects of ambient particulate matter (PM) on the risk of acute cardiovascular events often utilize data from administrative databases where only the date of hospitalization is known. However, true event onset time may precede hospitalization by hours or days. We have previously shown that exposure assessments based on date of hospitalization rather than time of event onset leads to non-differential misclassification of exposure. We carried out computer simulations to evaluate the impact of this source of exposure misclassification on estimates of PM health effects, using hospitalizations for acute ischemic stroke as an example.

**Materials and Methods:** Our simulations mimic the data available from an ongoing study of ambient air pollution and the risk of acute ischemic stroke in Boston, MA, and assumed that 1100 cases of acute ischemic stroke were identified over a 5 year period. First, we simulated the number of cases observed each hour based on the observed PM<sub>2.5</sub> time series and assuming relative risks of ischemic stroke of 1.00–1.30 per 10 µg/m<sup>3</sup> increase in the 24-hr moving average of PM<sub>2.5</sub>. Next, we assigned to each simulated case a random delay time between event onset and hospital presentation, based on the actual distribution of delay times observed in the ongoing stroke study. Third, we assessed exposure to PM<sub>2.5</sub> based on: 1) event onset time, 2) time of hospital presentation, and 3) date of hospital admission. Finally, for each exposure assessment strategy we evaluated the association between PM<sub>2.5</sub> and rate of hospitalization for ischemic stroke using the time-stratified case-crossover design.

**Results:** Under the null hypothesis of no association between PM<sub>2.5</sub> and stroke hospitalization rates, all three exposure assessment approaches yielded similar unbiased results. However, under the alternative hypotheses of a positive association between PM<sub>2.5</sub> and stroke hospitalization rates, an exposure assessment approach based on date of hospitalization resulted in estimates biased towards the null by 60–66%, while an exposure assessment approach based on time of hospital presentation yielded estimates biased towards the null by 37–42%. We will show that the magnitude of the relative bias depends on the structure

of the PM<sub>2.5</sub> time series as well as the distribution of outcome-specific delay times to hospital presentation.

**Conclusions:** Epidemiologic studies of PM-related risk of acute cardiovascular events which assess exposure based on date of hospitalization likely underestimate the health effects of PM. Moreover, using data on time of hospital presentation rather than date of hospitalization would attenuate but not eliminate this source of bias.

#### ISEE-894

##### Levels of Cadmium and Lead in Human Placentas from Puerto Rico

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**Background:** Exposure to cadmium (Cd) and lead (Pb) at the prenatal stage can be detrimental to the health of fetuses and children. For instance, decreased birth weight and gestational age, as well as cognitive and neurobehavioral impairment have been associated to this exposure. Recent data showed that low birth weight prevalence in Puerto Rico is approximately 12%, 1.5 fold higher than in the United States, and that the rate of preterm births is one of the highest in all states or territories of the United States. Therefore, it is important to determine if prenatal exposure to Cd and Pb, as measured in placenta, is contributing to these high rates in Puerto Rico.

**Objective:** The objective of this pilot study was to determine Cd and Pb levels in placenta of healthy pregnant women living in Puerto Rico, and to associate these levels with newborn anthropometric measurements.

**Methods:** A total of 78 women were recruited and interviewed, from which 56 placentas were collected, representing a 72% sample recuperation rate. A questionnaire was administered to participants at time of recruitment to collect general socio-demographic information, medical and reproductive history, employment and residential history, as well as personal and eating habits. In addition, gestational age, delivery outcome, and newborn measurements were recorded from medical records. Placental trophoblastic tissues from different areas of each sample were removed, oven dried at 80°C until constant weight, and homogenized with a ceramic mortar. Approximately 0.5–0.6 g of dried tissue was acid-digested in a microwave oven, and analyzed by atomic absorption spectrophotometry.

**Results:** Levels of Cd in all 56 placenta samples ranged from 6.0 to 46.4 ng/g dry weight (dw), obtaining an average of  $21 \pm 1$  ng/g dw. Concentrations of Pb varied from below method detection limit to 202.2 ng/g dw, with a mean value of  $44 \pm 4$  ng/g dw. These Cd and Pb levels are similar to levels measured in placentas from different areas of the world.

**Conclusion:** Results showed that 16% of all 56 newborns had low birth weight (<2,500 g) and 20% were premature (born before 37 weeks of gestation). This is the first study in Puerto Rico reporting placental Cd and Pb levels. Future work consists in determining which variables could contribute to placental Cd and Pb concentrations, and to associate these levels with newborn anthropometric measurements and gestational age.

#### ISEE-896

##### Arsenic Exposure Assessment in Fish Consumers from Vieques, Puerto Rico

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**Background:** A human health risk assessment based on fish consumption patterns and levels of arsenic (As) in muscle of fish captured in coastal waters of Vieques predicted adverse human health outcomes, including cancer and systemic effects. Due to the past US military presence in Vieques that may have contributed to environmental contamination by this metalloid, exposure to As from fish consumption is a human health concern. Therefore, the objective of this study was to determine if fish consumption from Vieques is a significant source of exposure to inorganic As and whether the Vieques population is exposed to high concentrations of this metalloid.

**Methods:** At the time of recruitment, a questionnaire was provided to participants to evaluate fish consumption patterns (e.g., type of fish species, frequency of fish meals, and amount of fish consumed), and to differentiate between high and low fish consumers. Arsenic concentrations were determined in urine, nails, and hair samples of women and men with high ( $n = 26$ ) and low ( $n = 26$ ) consumption rates of fish from Vieques. Low fish consumers ate fish 1 day/week or less, while high fish consumers ate fish at least 3 days/week. Urine and nail samples were sent to a private laboratory for arsenic speciation, whereas hair samples were acid-digested and analyzed at our laboratory by atomic absorption spectrometry.

**Results:** After correcting for creatinine urine concentrations, the sum of inorganic As species (As III and V) and their metabolites (monomethylarsonic acid-MMA and dimethylarsinic acid-DMA) was less than 50  $\mu\text{g/g}$  (used as a reference value). Concentrations of As above this value in urine represent high exposure levels. None of the urine samples had concentrations above the reference value. The highest concentration of As in urine was 42.7  $\mu\text{g/g}$ . In nail samples, concentrations of As varied from 0.043 to 0.817  $\mu\text{g/g}$ , while values in hair samples ranged from less than the minimum reporting limit to 0.95  $\mu\text{g/g}$ . Levels of As in nails and hair samples were below the reference value of 1  $\mu\text{g/g}$ .

**Conclusion:** In conclusion, concentrations of As in urine, hair, and nail samples were below reference values, suggesting that acute and chronic exposure to high levels of As were not detected at the time of sampling. Future work consists in determining if fish consumption is a source of inorganic As by comparing As levels measured in biological samples of women and men with high and low fish consumption rates.

#### ISEE-897

#### Evaluation of Background Persistent Organic Pollutant Levels in Human from Taiwan: Polychlorinated Dibenzo-P-Dioxins Dioxins, Dibenzofurans, and Biphenyls

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**Background:** Polychlorinated dibenzo-*P*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs) are a group of chemical substances that are recognized as persistent organic pollutants (POPs) under the "Stockholm Convention". This study was intended to determine the background levels of PCDD/PCDFs and PCBs in the Taiwanese population and to investigate factors potentially related to PCDD/PCDF and PCB levels.

**Results:** The levels of seventeen PCDD/PCDFs in the 251 blood samples collected from the general population in Taiwan ranged from 4.92 to 26.7 pg WHO<sub>1998</sub>-TEQ/g lipid (median: 11.5) and those of the twelve dioxin-like PCBs ranged between 1.74 and 21.6 pg WHO<sub>1998</sub>-TEQ/g lipid (median: 6.14). Five factors, age, gender, region of residence, dietary status, and smoking status, showed statistically significant association with the TEQ level of PCDD/PCDFs. The TEQ level of PCBs was statistically associated with age only, but not with the other four factors. The trends

observed between age and the levels of PCDD/PCDFs and PCBs were not parallel in young subjects (<30 years old) and old subjects (>30 years old). The levels of PCDD/PCDFs and PCBs increased by 0.16 and 0.03 WHO<sub>1998</sub>-TEQ/g lipid per year for subjects above the age of 30, but there was no evidence of any association between age and the levels for subjects below the age of 30 years.

**Conclusion:** These factors should be considered when investigating relationships between background blood levels of persistent organic pollutants and parameters associated with exposure sources or health outcomes.

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#### ISEE-898

#### Data Assimilation for Epidemiologic Air Exposure Assessment

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**Background:** A substantial focus of air pollution epidemiologic research is concerned with the nature of the adverse health effects associated with human exposure to particulate matter (PM). However, ambient monitoring networks are sparse limiting our ability for good assessment of population based daily exposure. Advances in physical models such as EPA's Community Multiscale Air Quality model (CMAQ) have produced potentially valuable air quality assessments at dense spatial and temporal scales. However, these predictions are based on deterministic models of the atmospheric fate and transport of pollutant emissions and are therefore biased. Proper assimilation of the observed and modeled data can enhance population based health studies. This work illustrated a full Bayesian approach for data assimilation on both temporal and spatial scales.

**Method:** We modeled the joint distribution of the two data types through a multivariate hierarchical state space time series. The model handles "change of support" problem and provides estimates of missing daily values of particulate matter, complete spatial surfaces, and the associated uncertainty estimates, within a fully probabilistic framework. Posterior estimation was performed via nested Gibbs algorithm where partial closed form solutions were obtained by Kalman filter.

**Results:** We used the available fine particulate matter PM<sub>2.5</sub> data from the combined network (1100) sites collected in 2001 and daily CMAQ output data. Monitoring network typically records data every third day with small portion of sites collecting daily or weekly measurements. Assimilation model predictions clearly demonstrated added value in the imputation of daily time series across all locations, as well as, the improvements in predictions over the rural areas.

**Conclusion:** Our model established a method for efficient integration of the sparse observed data with dense but biased modeled data for assessment of human exposure to particulate matter. Such information can be readily incorporated with human health data in studies of temporal lag effects and spatial variation of adverse health effects.

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#### ISEE-900

#### German Environmental Survey for Children (GerES IV): Human Biomonitoring and Exposure via House Dust

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**Introduction:** The German Environmental Survey (GerES) is a large scale population study which has been carried out repeatedly since the mid-1980s. Main objectives are to generate, update and evaluate representative data on the exposure of the German population to environmental pollutants. GerES IV was conducted from 2003 to 2006 and is the first survey focusing solely on children. It was performed in conjunction with the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) by the Robert Koch Institute, Berlin.

**Methods:** In GerES IV 1,790 children aged 3 to 14 years were selected randomly from the representative sample ( $N = 17,641$ ) of KiGGS. The participants of GerES IV lived in 150 sampling locations all over Germany. The research program comprised extensive human biomonitoring and monitoring of the domestic environment. Moreover, detailed interviews on exposure relevant behavior of children and parents were conducted. In a random sub-sample of 600 children, chlorophenol and organophosphate metabolites as well as other substances were analyzed in urine. In addition, biocides (e.g. pentachlorphenol (PCP)) were quantified in house dust (content of vacuum cleaner bags, 63  $\mu\text{m}$  fraction).

**Results:** GerES IV provides current fundamental time budget data of German children. On average, German children spend nearly 19 hours/day in their homes. The mean time the 3 to 10 year-old children spend playing on the floor is approx. 2 hours/day. In general, GerES IV data show low concentrations of biocides in house dust. For most substances a large fraction of values is below the limit of quantification. This may be one reason why most correlations with their metabolites in urine are not significant. As an exception, a comparatively low but significant correlation emerges between PCP in urine and PCP in house dust. Multivariate evaluation indicates that—in addition to the PCP concentration in house dust and other predictors—the time the child spends on the floor has a low but significant influence on the PCP level in urine. Particularly for young children, house dust has to be considered as a relevant pathway in exposure assessment.

**Acknowledgements:** We thank all children and parents who have participated in this study. The financial support of the Federal Ministries for the Environment, Nature Conservation and Nuclear Safety and of Education and Research is gratefully acknowledged. Field work was carried out by the Robert Koch Institute, Berlin. Chemical analysis was conducted by the University of Erlangen-Nuremberg and EUKOS Umweltanalytik Nord GmbH, Plön.

#### ISEE-901

#### Spatial Analysis of Soil Lead Concentrations in Los Angeles, California, USA

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**Background:** Lead (Pb) poisoning causes permanent neurologic and developmental disorders. Despite dramatic reductions in environmental lead sources, lead exposure is still an important environmental health problem for U.S. children. This study aims to examine the spatial distributions and sources of soil lead concentrations in the urban areas in south central Los Angeles County, California.

**Methods:** A total of 600 soil samples were collected in 2004. Concentrations of total and bio-available lead were analyzed. We examined soil lead concentrations by land-use patterns (commercial, industrial, residential, parks and open areas) and sample type (near freeways and highways, near major arterials, and in stratified random grids). A matrix of traffic index variables were created at different buffer distances (10 to 5000 m), including total roadway length, distance to the nearest roadway, and distance-weighted traffic counts based on 2005 traffic activity data from California Department of Transportation. Dispersion of traffic emissions was also modeled using a line source dispersion model. Tax parcel data with house age information were used to examine the impact of historical lead paint on soil lead concentrations. Other variables we examined included population density, elevation, and lead emissions from EPA's TRI facilities back to 1988.

**Results:** We found mean total and bio-available lead concentrations were 180 and 130  $\mu\text{g g}^{-1}$ , respectively. Bioavailable lead was highly correlated with total lead after removing an outlier ( $\text{bio-Pb} = -1.2 + 0.74 \times \text{total-Pb}$ ;  $N = 488$ ,  $R^2 = 0.93$ ). Lead concentrations near freeways and major arterials were significantly higher than those collected at random grids. Both traffic and building-age related variables were important in predicting soil lead concentrations, but the predicting power varied by different land use patterns and sample types. Age of the nearest parcel explained 23% of the variance in soil lead concentrations in residential areas ( $N = 152$ ). Age of the nearest parcel and length of small streets within 3000 m explained 54% and 40% of the variance, respectively, in soil lead concentrations in random grid samples at residential areas ( $N = 44$ ). Road length of freeways within 750 m explained 29% of soil lead concentrations in parks and open areas ( $N = 26$ ). Distance weighted traffic counts and modeled pollution dispersion were found to be not as predictive as road length variables likely because we used current traffic count data instead of historical traffic counts.

**Conclusion:** This study implies that both historical lead-based paint and historical traffic contribute to the current soil lead contaminations.

#### ISEE-902

#### Temperature and Air Pollution Effects on ECG-Parameters Transmitted via Telephone

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**Background:** Numerous epidemiological studies have reported associations between exposure to current levels of ambient particulate matter (PM) and various indices of acute cardiopulmonary morbidity and mortality. We tested the hypothesis that myocardial infarction (MI) patients experience changes in heart rate, PQ-interval and repolarization parameters (QT-interval, T-wave amplitude) in association with elevated concentrations of air pollution and in association with temperature changes.

**Methods:** A panel study of 68 current non-smoking post-MI subjects was conducted in Augsburg, Germany, between May 30<sup>th</sup> 2003 and February 1<sup>st</sup> 2004. Participants repeatedly sent an ECG with a personal ECG-transmitter (Viapac) via telephone to the Philips Monitoring Center in Duesseldorf, Germany, and ECG parameters were immediately analyzed. Meteorological data, particulate and gaseous air pollution were acquired from fixed monitoring sites on an hourly basis for the entire study period. Additive mixed models with a random intercept and spatial covariance structure were used for analysis.

**Results:** The analysis of the 1783 observations showed an immediate significant increase in heart rate in association with elevated  $\text{PM}_{2.5}$  0–23 h before ECG transmission (0.8%, 95% confidence interval (CI): 0.1–1.5%). This effect was more pronounced in patients with a body mass index above 30  $\text{kg/m}^2$ . Increased  $\text{PM}_{2.5}$  exposures showed a lagged effect (24–47 h before ECG transmission) on the Bazett-corrected QT-interval (0.5%, 95% CI: 0.0–0.9%). Both significantly positive and negative delayed PM effects were found for the T-wave amplitude. An increase in temperature led to significant decreases in heart rate and T-wave amplitude (5-day-average effect: −14.8, 95% CI: −27.8–1.9%). No effects on the PQ-interval could be detected for PM exposure or temperature.

**Conclusions:** The study showed that PM as well as temperature modify the heart rate and the repolarization phase. It can be speculated that these observed ECG modulations have an adverse health effect on the studied patients.

**ISEE-903****Air Temperature and the Occurrence of Myocardial Infarction in Augsburg, Germany**

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**Background:** Decreasing air temperature, but also extreme heat have been associated with cardiovascular mortality and morbidity. The objective of this study was a detailed examination of MONICA/KORA registry-based myocardial infarction (MI) rates and coronary deaths in relation to air temperature in the area of Augsburg, Germany, over a period of ten years.

**Methods:** Between 1995 and 2004, the registry recorded 9801 cases of MI and coronary deaths, thereof 4838 fatal and 4963 nonfatal cases. Over the same period, meteorology including air temperature, relative humidity and barometric pressure as well as air pollutant concentrations were measured in the study region. Poisson regression analyses adjusting for time trend, relative humidity, season, and calendar effects were used to estimate immediate, delayed and cumulative temperature effects on the occurrence of MIs. Besides using the daily event rate of all MI cases as outcome, we inspected separately fatal and nonfatal events as well as incident and recurrent events. Additionally, we examined the temperature effects stratified by subject characteristics like age, sex, hypertension and diabetes. Furthermore, we compared the effects in cold, medium and warm years. We used penalized splines to examine the exposure response relationship for temperature.

**Results:** A 10°C decrease in 5-day average temperature was associated with a relative risk (RR) of 1.10 (95%-CI: 1.04 to 1.15). The functional form of temperature did not seem to depart from a linear relationship. The effect of temperature on the occurrence of nonfatal events showed a delayed pattern, whereas the association with fatal MI was more immediate. No effects could be observed for recurrent events. Regarding age, the strongest effect was seen for the 55–64 years group (RR: 1.23; 95%-CI: 1.11 to 1.33). No differences were found regarding sex or diabetes stratification, while subjects with hypertension appeared to be more susceptible to temperature influences than subjects without hypertension. Moreover, we observed stronger cold effects in warmer and medium years than in colder years.

**Conclusion:** Our study confirms a previous registry-based analysis that identified an inverse linear relationship between temperature and MI cases. However, we could not find an effect for recurrent events, although MI survivors were hypothesized to be most susceptible. In contrast, middle aged subjects were identified as a susceptible subgroup.

**ISEE-904****Formaldehyde Emissions from Wood Products and Concerns about the Cancer Hazard: Compliance with California's Proposition 65 and Airborne Toxic Control Measure**

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**Background:** Under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), all products that contain significant concentrations of chemicals (e.g., formaldehyde) listed on California's annually published register of chemicals believed to be carcinogenic, cause birth defects, or cause reproductive harm must be marked with a warning. Furthermore, in 2007, a phased regulation known as the Airborne Toxic Control Measure (ATCM) was adopted by the California Air Resources Board (CARB) setting limits on formaldehyde emissions from composite wood products such as hardwood plywood,

particleboard, and medium density fiberboard with the first phase beginning in January of 2009. This study examines the relationship between two decades of ongoing formaldehyde toxicity research, California's Proposition 65 and the new CARB rules.

**Methods:** The hypothetical excess lifetime cancer risks corresponding to each of the Phase I and Phase II CARB standards for hardwood plywood, particleboard and medium density fiberboard were calculated using a simplified version of the U.S. Environmental Protection Agency (EPA)/Versar Formaldehyde Exposure Model to compare those risk estimates to Proposition 65's risk criterion of 1 in 100,000.

**Results and Conclusions:** Using this model, composite wood products with ASTM E 1333-96 (2002) chamber test results of 0.09 ppm or lower at the default ASTM loading rates of 0.13 ft<sup>2</sup>/ft<sup>3</sup> (industrial panels and particleboard), 0.29 ft<sup>2</sup>/ft<sup>3</sup> (wall paneling) and 0.08 ft<sup>2</sup>/ft<sup>3</sup> (medium density fiberboard) were estimated to cause less exposure (e.g., daily intake) than the Proposition 65 safe harbor level for formaldehyde (40 µg/day). Furthermore, it was concluded that based on expected target formaldehyde emission rates (limits that incorporate a margin such that the products emissions are not likely to exceed the applicable standard) hardwood plywood meeting the CARB Phase I emission standards, as well as all products meeting the CARB Phase II emission standards, would cause less exposure (e.g., daily intake) than the Proposition 65 safe harbor level for formaldehyde of 40 µg/day.

**ISEE-905****Association Between Local Traffic-generated Air Pollution and Preterm Delivery in the South Coast Air Basin of California**

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**Background:** A large number of studies have indicated that exposure to traffic-related ambient air pollution is associated with adverse birth outcomes including low birth weight and preterm delivery (PTD). However, the majority have examined birth registry data and used traffic indexes (e.g., distance to busy highways) as individual exposure indicators, which might result in exposure errors.

**Objectives:** We aimed to examine effects of residential exposure to traffic-related air pollution on preterm delivery, using a perinatal database with detailed clinical information and estimated individual exposure to local traffic-generated air pollutants from a line source dispersion model.

**Methods:** We collected 89,640 singleton birth records from a four-hospital network during 1997–2006 in Los Angeles County and Orange County, California. Residential addresses at birth were geocoded using the Tele Atlas geocoding service. The CALINE4 dispersion model was used to estimate monthly individual exposure to local traffic-generated air pollutant. Preterm delivery was defined as delivery before 37 weeks' gestation. We employed logistic regression and a generalized additive model (R) to adjust for linear or potential nonlinear covariates to investigate the associations between PTD and maternal exposure during pregnancy. We adjusted for race, neonatal gender, previous maternal preterm delivery, maternal low weight gain (<15 lbs), maternal high weight gain (>30 lbs), prenatal health care, parity, and kidney infections as dummy variables, and for maternal age and seasonality as continuous covariates with a quadratic polynomial function and a smoothing function. Windows of vulnerability by trimester of pregnancy were also investigated.

**Results:** A total of 83,756 singleton births were successfully geocoded in this study (93.4%). The interquartile ranges (IQR) of maternal exposures during the pregnancy period to local traffic-generated carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), nitrogen oxide (NO<sub>x</sub>), and particulate matter with aerodynamic diameter <2.5 µm (PM<sub>2.5</sub>) were 74 ppb, 3.16 ppb, 5.57 ppb, and 1.34 µg/m<sup>3</sup>, respectively. Odds ratios per IRQ increase in CO, NO<sub>2</sub>, NO<sub>x</sub>, and PM<sub>2.5</sub> were 1.094 (95% confident interval (CI): 1.065, 1.124),

1.035 (95% CI: 1.009, 1.062), 1.088 (95% CI: 1.059, 1.118) and 1.040 (95% CI: 1.013, 1.068), respectively. Pollutants had slightly stronger impacts on PTD during the last trimester than other trimesters.

**Conclusion:** Residential exposure to local traffic-generated ambient air pollution during the pregnancy period was associated with preterm delivery. NO<sub>x</sub> and CO were more strongly associated with PTD than PM<sub>2.5</sub> and NO<sub>2</sub>. This may be because NO<sub>x</sub> and CO are better surrogates for traffic-related combustion aerosols, particularly ultrafine particles < 0.1 μm in aerodynamic diameter.

#### ISEE-906

#### Estimating the Effect of School Indoor Air Quality on Academic Outcomes

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**Abstract:** This paper examines the effect of indoor air quality on academic outcomes. Understanding this relationship is important for two key reasons: first, the U.S.E.P.A. has consistently ranked indoor air pollution among the top five environmental health risks (EPA 1987); and second, almost 20% of U.S. schools, with more than eight million attending students, have reported having unsatisfactory indoor air quality (GAO 1995). While a number of studies have examined the effect of indoor environmental conditions in schools on students' health, test performance, and absenteeism, many suffered from design problems and small sample bias. This paper uses fixed effects estimation to exploit the panel data attributes of a large sample of recently renovated schools in a U.S. school district in order to control for many of the confounding variables that may also affect academic outcomes.

During the past seven years, a bond program aimed at improving students' health funded indoor air quality related renovations at virtually all of the schools in the school district (100 + schools). Renovation projects included mold remediation, ventilation improvements, and repairs to leaking roofs and affected more than 125,000 students. Two key attributes of this sample make it ideal for studying this research question. First, because there are repeated observations on students, we can focus on the differential in attendance and test performance across years as opposed to the absolute values and thereby remove the effect that observable characteristics, such as gender, and unobservable characteristics, such as innate ability and parental involvement, have on academic outcomes. Not controlling for such characteristics is one of the difficulties previous studies have had.

Second, because renovation projects were spread out over the seven-year period, there is a natural control group each year and a natural treatment group. Assuming that schools within the same district follow the same time trend, a comparison of the differential change in academic outcomes between the control and treatment group will remove any time trends from the analysis. In this way, individual characteristics and time trends are controlled for in the analysis so the effect of indoor air quality can be isolated.

Preliminary results indicate that performance on standardized tests is responsive to changes in indoor environmental quality, while attendance rates are much less sensitive. For the average student, scores increased by 1.4%. Furthermore, demographic groups appear to respond differentially to renovations. Math (reading) scores for female students increased by 36 (36) points, which was significant at the 5% level, while math (reading) scores for males increased by only 22 (15) points, which was not significant at the 10% level.

Preliminary results also suggest that students at different points along the testing distribution responded differentially to renovations. Understanding this relationship is particularly important since school districts are often more concerned about improving the performance of the lower end of the distribution as opposed to improving the performance of the average student. Future work will employ quantile regression methods to further examine the distribution of responses to improvements in indoor environmental quality.

#### ISEE-907

#### Effects of Ambient Elemental Carbon and Metals on Wheeze and Cough During Early Childhood

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**Objectives:** Despite evidence linking exposure to traffic-related air pollution to increases in respiratory symptoms, the effects of specific components have not been fully characterized. Our objectives were to examine associations between temporal variations in specific components, including elemental carbon (EC) and metals, and repeated measures of respiratory symptoms in children to age 2.

**Methods:** The study population included participants from the Columbia Center for Children's Environmental Health birth cohort born between 1999 and 2005. Data on presence of wheeze or cough and number of days of wheeze or cough were collected by interviews with subjects' mothers every 3 months, between 3 and 24 months of age. Ambient EC and metals concentrations were obtained for the New York Botanical Garden monitoring site, operated by the New York State Department of Environmental Conservation and located within the study area. In initial assessments, a metals variable was derived by summing elements that can be associated with traffic (bromine, calcium, chlorine, copper, iron, manganese, nickel, lead, vanadium, and zinc). For each subject, 3-month average concentrations of EC and metals were calculated for each symptom reporting period based on the interview date and the preceding 3 months. Associations between EC or metal and symptoms were characterized using logistic or Poisson regression with separate models for each of the 8 symptom reporting periods from 3 to 24 months of age.

**Results:** A 0.5 μg/m<sup>3</sup> increase in EC was associated significantly with increased odds of cough at 6 of the 8 symptom reporting periods. The range of odds ratios was 1.4–3.0. Increases in EC also were significantly associated with increased number of days of cough for 6 of 8 reporting periods. The rate of increase was 2–3 days per 3-month period per 0.5 μg/m<sup>3</sup> increase in EC. Increases in ambient EC were not associated significantly with increased odds of wheeze or number of days of wheeze consistently across ages. In models that predicted wheeze based on sum of 10 metals, associations between metals and the number of days of wheeze were significant for 5 of 8 reporting periods. The rate of increase was 0.2–0.4 days per 3-month period per 0.1 μg/m<sup>3</sup> increase in metals. Associations between metals and presence of cough were consistently significant for 6 of 8 reporting periods. Odds ratios ranged between 1.1–2.0. Associations between metals and number of days of cough were consistently significant for all 8 reporting periods. The rate of increase was 0.2–0.5 days per 3-month period per 0.1 μg/m<sup>3</sup> increase in metals.

**Conclusions:** Preliminary data suggest that increases in ambient traffic-related pollutants, EC and metals are associated with increased probability of cough early in childhood. Increases in metals also were associated with increases in the number of days of symptoms, possibly indicating greater severity of symptoms related to increased exposure to ambient metals. These findings highlight the need for measurement of components especially associated with diesel traffic at fine spatial and temporal scales to identify elements specifically associated with increased risk of respiratory disease in young children living in urban areas.

#### ISEE-908

#### Endothelial Dysfunction and Inflammatory Blood Markers in Association with Exposure to Central-Site and Personally Measured Fine Particles in Diabetic Subjects

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**Objective:** Central-site measurements of ambient fine particulate matter ( $PM_{2.5}$ ) have been associated with cardiovascular and hematological effects. Since non-differential measurement error tends to bias exposure-outcome associations towards the null, more precise measurements of actual personal exposures should produce stronger associations than central-site measurements. However, personal measurements sample particles of both ambient and non-ambient origin. One solution is to apportion particles according to ambient and non-ambient origin by using sulfur as a tracer. This analysis of endothelial function and cytokine measures evaluates central-site measurements of ambient  $PM_{2.5}$  and personal measurement of  $PM_{2.5}$  of ambient origin.

**Methods:** A prospective panel study was conducted on 22 people with diabetes in Chapel Hill, NC, from Nov 2004-Dec 2005. Each subject was studied for 4 consecutive days. Daily measurements of  $PM_{2.5}$  were acquired from the Chapel Hill airport and ambient sulfur and meteorological data were measured on the rooftop of the patient exam site. In addition the subjects carried a personal  $PM_{2.5}$  measurement device over 4 days starting on the day before their first clinical exam. Measured personal PM mass was fractionated into ambient and non-ambient origin by using the ratio of personal to ambient sulfur under the assumption that there are no indoor sources of sulfur. Brachial artery flow mediated dilatation (FMD) was assessed by brachial artery ultrasound during each subject visit. A blood sample was taken at each visit and analyzed for interleukin-6 (IL-6) and tumor necrosis factor alpha (TNF $\alpha$ ). Data were analyzed using random effects models adjusting for season, weekday and meteorology.

**Results:** Results are presented for an increase of 10  $\mu\text{g}/\text{m}^3$   $PM_{2.5}$  as percent changes of mean outcome level with a 95% confidence interval. FMD decreased in association with central-site  $PM_{2.5}$  measurements of the same day (-17.3% [-34.6%; 0.0%]) and IL-6 (11.7% [3.7%; 19.6%] and TNF $\alpha$  (13.1% [1.9%; 24.4%]) increased with a lag of 2 days. Personal PM measurements, both total personal PM and personal PM of ambient origin, were not associated with endothelial dysfunction or cytokine measurements.

**Conclusion:** In our data, the personal measurements of particles of ambient origin were not associated with health outcomes while the central-site measurements of ambient particles showed strong associations. This suggests that personal monitoring has other sources of measurement error that exceed the "error of location" present in the central-site measurements. The correction for ambient and non-ambient origin does not correct this difficulty. Therefore, in our study, personal monitoring for PM of ambient origin was not an effective substitute for central-site measurements of ambient  $PM_{2.5}$ . For coarse particles and constituents of  $PM_{2.5}$  such as ultrafine particles, the use of central-site measurements may be more problematic.

*This abstract of a proposed presentation does not necessarily represent EPA policy.*

#### ISEE-910

#### 'Toxic Ignorance' and the Right-to-Know: Ethical and Scientific Challenges of Reporting Data in Biomonitoring Research

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**Background:** Exposure assessment has shifted from pollutant monitoring in air, soil, and water toward an emphasis on personal exposure

measurements and biomonitoring. These studies are conducted by academic scientists and also increasingly by advocacy and community groups, sometimes in collaboration with academic researchers. This shift, taken together with the paucity of health effect data for many of the pollutants studied, have raised new ethical and scientific issues related to reporting study results to participants and their communities.

**Methods:** We interviewed 26 individuals involved in personal exposure monitoring studies, including academic scientists, scientists and leaders in environmental health advocacy organizations, IRB officials, and study participants; observed meetings where stakeholders discussed these issues; and reviewed relevant literature on the topic to describe emerging ethical, scientific, and policy debates about biomonitoring and the public demand to understand the potential health consequences of chemical body burdens.

**Results:** We identify three frameworks for examining report-back in personal exposure studies: 1) clinical ethics; 2) community-based participatory research; and 3) citizen science 'data judo.' The first approach emphasizes reporting results when the health significance of exposures is known, while the latter two represent new research paradigms in which study participants play a role in interpreting, disseminating, and leveraging results of exposure research to promote community health. We identify 6 key areas for research teams to consider in planning these types of studies.

**Conclusion:** Public deliberation about report-back in exposure assessment research suggests new forms of community-based research ethics and democratic scientific practice.

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#### ISEE-912

#### Relationships Between Cadmium, Lead and Other Metals and Semen Quality: Human Evidence for Molybdenum as a Male Reproductive Toxicant

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**Background:** Metals are found ubiquitously in the environment and arise from natural erosion or as a result of industrial and agricultural activity. Some metals essential for good health, such as copper, selenium and zinc, are harmful once their concentrations exceed certain thresholds. Others, such as lead, cadmium and mercury are not required in the diet, cause adverse health effects at relatively low levels, and are the targets of public health monitoring and interventions. Results of studies on the effects of non-occupational exposure to both essential (e.g. zinc, copper) and non-essential (e.g. cadmium, lead) metals on semen quality are inconsistent, due in part to insufficient study sample size and the inability to account for important covariates.

**Methods:** The present study measured semen quality (sperm motility, morphology and concentration and semen volume) and metals in blood samples (arsenic, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, selenium and zinc) from 219 male partners of couples seeking infertility treatment. Multiple statistical approaches were used to assess relationships between metals and the semen quality parameters while accounting for important covariates and other metals. Sperm parameters were assessed as continuous variables and also dichotomized according to widely used criteria (low sperm concentration, <20 million/mL; low motility, <50% motile sperm; poor morphology, <4% normal sperm).

**Results:** Among a number of notable significant findings involving several metals, the associations involving molybdenum were the most consistent over the various statistical approaches. We found dose-dependent trends between molybdenum and decreasing sperm concentration and normal morphology, even when considering potential confounders and other metals. For example, adjusted odds ratios for below reference semen quality parameters in the low, medium and high

molybdenum groups were 1.0 (reference), 1.4 (95% confidence intervals 0.5, 3.7), and 3.5 (1.1, 11) for sperm concentration and 1.0, 0.8 (0.3, 1.9), and 2.6 (1.0, 7.0) for morphology. Preliminary evidence for interactions between high molybdenum and low copper or zinc was also found. For example, in stratified analyses the adjusted odds ratios in the high molybdenum/low copper group were 14.4 (1.6, 132) and 13.7 (1.6, 114) for below reference sperm concentration and morphology, respectively.

**Conclusion:** In conclusion, we present the first human evidence for an inverse association between molybdenum and semen quality. These relationships are consistent with animal data, but additional human and mechanistic studies are needed.

#### ISEE-913

#### Elevated House Dust and Serum Concentrations of PBDEs in California: Unintended Consequences of Furniture Flammability Standards?

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**Background:** Studies have shown higher house dust and body burden levels of PBDE flame retardants in North America relative to Europe, yet little is known about regional variation within North America, where California is the only state that requires that foam furniture meet fire safety standards.

**Objective:** To assess whether elevated house dust and serum PBDE concentrations are associated with California residence.

**Methods:** For the California Household Exposure Study, dust samples were collected from 49 homes in two communities and analyzed for BDE congeners -47, -99, and -100. Regional variation in PBDE serum concentrations was assessed in 2,040 samples from participants in the 2003–2004 National Health and Nutrition Examination Survey (NHANES), a cross-sectional survey of a random sample representative of the U.S. population. The serum concentrations of six BDE congeners (-28, -47, -99, -100, -153, and -154) associated with the pentaBDE product were summed to create a summary measure for pentaBDE (ÓPBDEs).

**Results:** Dust concentrations [Median (Range) ng/g] in California homes of BDE-47, -99, and -100 were 2,700 (112–107,000), 3,800 (102–170,000), and 684 (<MRL-30,900), respectively, and were four to ten times higher than previously reported levels in North America. Maximum concentrations were the highest ever reported in an indoor dust study. Multivariate regression models showed that residing in California was associated with a nearly two-fold increase in ÓPBDE serum levels [Least square geometric mean (LSGM) ng/g lipid, 95% CI: (69.4 (67.1–71.7) vs. 38.9 (36.8–41.0),  $P = 0.004$ )]. Elevated ÓPBDE serum levels were also associated with male sex, younger age, lower income, and being born in the U.S.

**Conclusions:** Elevated house dust and human serum concentrations of PBDEs in California may reflect the unintended consequences of furniture flammability standards and foreshadow future exposures from chemicals introduced to replace banned PBDE products.

#### ISEE-914

#### A Persistent Worldwide Environmental Hazard: Former Manufactured Gas Plant (FMGP) Sites Association of an FMGP Site with Childhood Neuroblastoma

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**Background:** The birth of manufactured gas plants in the United States occurred late in the 18<sup>th</sup> century and grew in popularity over the 19<sup>th</sup> century. The success of coal gas in the United States quickly spread to

other industrialized nations, including Great Britain and Australia. The manufacturing of gas involved the processing of coal to produce illuminating gas. The unusable waste products of the process, coal tars, were leaked and spilled into the environment and persist today as a worldwide public health problem. It is estimated that there are >50,000 FMGP sites in the US alone, and thousands more in the United Kingdom. Because many FMGP sites were established near waterways and small towns, communities continue to be affected by the persistent hazardous waste in their local environment. As an example, we present an original study of a small town in Illinois affected by this problem.

**Purpose:** Extensive coal tar-related contamination from a FMGP site occurred in Taylorville, Illinois, including extremely high levels of polynuclear aromatic hydrocarbons, volatile organic compounds, and inorganic compounds in multiple on- and off-site environmental media. Disturbance and remediation of the site exacerbated the release of contaminants. Coal tar has been classified as a known human carcinogen by numerous scientific and governmental panels of experts. Community concerns were raised regarding neuroblastoma risk given the proximity of a large, open pit with coal tar to the town playground, and known heightened fetal nervous system sensitivity to carcinogens.

**Methods:** A Standardized Incidence Ratio (SIR) analysis for the period 1986–1991 was conducted, comparing Taylorville and Christian County, IL with four comparison groups: 1) demographically-similar zip codes and counties; 2) demographically-similar zip codes without MGP sites; 3) the state of Illinois; and 4) the entire US. Confounding variables were accounted for by stratification or indirect adjustment. Incident case data for the state of Illinois was obtained from the Illinois State Cancer Registry; population data was obtained from the 1990 US Census; and national reference rates were obtained from SEER.

**Results:** In all comparison groups, the SIR for neuroblastoma ranged from 9.9 to 24.3, with a lower-bounded 95% confidence interval (CI) that did not include 1. Comparisons using the four control groups provided comparable results, with higher SIRs generally seen in the comparison to the demographically similar, non-MGP site zip codes, demonstrating an effect of the MGP sites on cancer incidence.

**Conclusion:** There was a significantly elevated incidence rate of neuroblastoma in children during a time period of heightened ambient exposure to coal tar-related contaminants relative to all comparison populations. There are >50,000 former MGP sites in the US alone; thus, environmental exposure to coal tar is a continuing public health concern that warrants attention from researchers and policy makers regarding the continuing risk to humans and the environment.

#### ISEE-915

#### Early-Life Exposure to Air Pollution and Allergic Sensitization in Children with Asthma

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**Background:** Laboratory studies in humans and animals have shown that air pollutants can enhance allergic inflammation and induce allergic immune responses. People with asthma have higher rates of sensitization and allergy and are more responsive to air pollutants' effects on respiratory health; this is especially true in children. While it has been shown that exposure to traffic-related pollutants negatively impacts respiratory health, studies of the effect on allergen sensitization have not been consistent, perhaps due to differences in the populations studied with respect to age distributions, asthma status, and exposure assessment. The influence of traffic-related air pollutants during the prenatal period has not been investigated, although there is good reason to suspect a role, given the association between traffic-related pollutants and immune modulation.

**Objectives:** An exploratory analysis was conducted to evaluate the association between prenatal and early-life exposures to outdoor air pollutants with allergic sensitization within a cohort of 232 children ages 6–11 years with asthma.

**Methods:** The data were obtained as part of the Fresno Asthmatic Children's Environment Study ( $n = 315$ ) in the Central Valley of California. Only children for whom prenatal air pollution data could be obtained were included ( $n = 232$ ). Prenatal and early-life exposure to ozone ( $O_3$ ), nitrogen dioxide ( $NO_2$ ), carbon monoxide (CO) and particulate matter with a median aerodynamic diameter  $\leq 10 \mu\text{m}$  ( $PM_{10}$ ) was reconstructed for each child. Allergic sensitization was ascertained by skin-prick tests to 14 allergens. Predictive models were developed for sensitization to a) any allergen, b) at least one outdoor allergen, and c) at least one indoor allergen.

**Results:** Nearly all (90%) of the children were born in California and 76% were born in the Fresno area. In multivariable analyses, higher exposure to CO and  $NO_2$  in the 2<sup>nd</sup> trimester was associated with increased sensitization to at least one outdoor allergen. The odds ratio was 1.54 (95% CI: 0.97, 2.45) per interquartile range (IQR) increase of  $NO_2$  during the 2<sup>nd</sup> trimester and OR = 1.61 (95%CI: 0.99, 2.70) for an IQR increase of CO during the 2<sup>nd</sup> trimester. No significant associations with the prenatal or early-life pollutant metrics considered were seen for sensitization to allergens in general or to at least one indoor allergen.

**Conclusion:** In this exploratory analysis of children with asthma, exposure to traffic-related pollutants during the 2<sup>nd</sup> trimester was associated with increased sensitization to outdoor allergens. The prenatal findings suggest the timing of the exposure may be more important than the overall dose and prenatal exposures are not just markers for lifetime or current exposures. This analysis lacked sufficient power to detect possible effect modification by factors such as parental allergen sensitization status, season of birth, gender, or housing characteristics such as gas stoves. Studies among more geographically diverse populations with larger exposure gradients may identify additional effects. Future prospective studies in larger populations are warranted to assess the timing of sensitization and identify possible susceptible subgroups. Studies within non-asthmatic cohorts are warranted.

#### ISEE-916

##### Obesity Linked to the Expression of Genes that Code for Enzymes Involved in Sex Steroid Biosynthesis

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**Objectives:** 1) Providing groundwork for future studies relating PCB and DDE exposure to changes in gene expression and the consequent influences on obesity and other health outcomes. 2) Testing for an association between a change in the gene expressions of aromatase (*CYP19*, 17 $\alpha$  dehydroxylase (*CYP17*), and estrogen receptors  $\alpha$  and  $\beta$  (ER  $\alpha+\beta$ ) and anthropometric measurements in the offspring of participants in the Michigan Fish Eater Cohort Study.

**Methods and Procedures:** Data was analyzed from the Michigan Fish Eater Cohort Study, a two generational cohort where fish-eaters were enrolled and followed between 1973 and 1991, and the offspring of the original participants were followed up in 2001/02 and 2006/07. Information on education, gynecologic and reproductive history, and smoking was gathered via interviews. Information on the birth weight and breastfeeding of the offspring was confirmed against birth registry data. Anthropometric measurements and venous blood were collected and analyzed for gene expression in SSAM (sex steroid activity and metabolism) from the offspring. Gene expression was standardized against 18s ribosomal RNA and RNA Polymerase II expression. Spearman's Correlation was used to assess associations between the anthropometric

outcomes as well as between the target gene expressions. Mixed models were used to account for multiple offspring from one mother.

**Results:** Of 149 women in the study, anthropometric measurements were obtained from 140 women and gene expression was tested in 139. Maternal height and birth weight was available for 138 and 134 women respectively. The three height measurements (standing height, leg length, and trunk length) were strongly correlated ( $>0.75$ ,  $P$ -value  $< 0.0001$ ). BMI and weight were strongly correlated (0.93,  $P$ -value 0.008,  $P$ -value 0.51). *CYP19* and *CYP17* expressions were significantly correlated ( $>0.60$ ,  $P$ -value  $< 0.0001$ ). Standardized against 18s rRNA expression, *CYP19* expression correlated with the expression of both estrogen receptors  $\alpha$  and  $\beta$  (0.25,  $P$ -value 0.0064). ER $\alpha$  and  $\beta$  were strongly correlated (0.69,  $P$ -value  $< 0.0001$ ). For every one unit of *CYP19/18srRNA* expression, BMI and weight were reduced by 16.88 kg/m<sup>2</sup> ( $P$ -value 0.01) and 40.91 kg ( $P$ -value 0.047) respectively. For every one unit of *CYP17/18srRNA* expression, leg length was reduced by 13.60 cm ( $P$ -value 0.03). BMI was observed to drop by 22.42 kg/m<sup>2</sup> ( $P$ -value 0.01) and weight by 61.08 kg ( $P$ -value 0.02) in relation to *CYP17/RNAPolII* expression. Average height and trunk length were not significantly related to the expression of any of the four genes.

**Conclusion:** The results suggest that *CYP19* (aromatase) and *CYP17* (17 $\alpha$  dehydroxylase) expression influence certain anthropometric measurements that are established during an individual's development. These findings are sound intermediate for our investigation of a link between exposure to environmental contaminants and changes in gene expression in SSAM. Future studies that examine the effects PCB and DDE exposure on BMI, early age of menarche, and other health outcomes are well underway.

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#### ISEE-917

##### Improving the Assessment of *E.coli* Exposure Levels Along Un-monitored Stream Reaches

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**Objective:** *Escherichia coli* (*E.coli*) is a widely used indicator of fecal contamination in water bodies. External contact and subsequent ingestion of bacteria coming from fecal contamination can lead to harmful health effects, such as infection, diarrhea and cramping, and possibly death. Since *E.coli* data is oftentimes limited and can contain large measurement error, the objective of this study is to incorporate both secondary information, in the form of turbidity measurements, and measurement error into a geostatistical framework to improve the assessment of *E.coli* along unmonitored river reaches.

**Material and Methods:** The Raritan River Basin in North Central New Jersey is used as a case study. Data for this basin is obtained from the United States Geological Survey (USGS) National Water Information System (NWIS) as well as the EPA-STORET database. We use Bayesian Maximum Entropy (BME) with a river metric for the integration of monitored and predicted *E.coli* data. First, a regression model is developed to predict *E.coli* from turbidity data. This model is then used to generate soft data for *E.coli* at 304 space/time locations where only turbidity was measured. In addition, error associated with *E.coli* analysis is incorporated into each *E.coli* measured value. This resulted in 499 additional data points where *E.coli* was measured to yield BME maps showing the distribution of *E.coli* along all river miles of the Raritan River Basin in New Jersey on the 15th of every month of the 2000–2006 period.

**Results & Conclusions:** Results show a 10% to 18% reduction in overall estimation error when combining data using a space/time geostatistical framework. Additionally more river miles are accurately assessed for *E.coli* contamination. During several times over the study period, the

Raritan Basin was found to exceed the single sample standard at more than 70% of estimation locations with *E.coli* values ranging anywhere from 2× to more than 10× the state standard. Further analysis will be performed to confirm these results and refine this range. This work provides an efficient way to incorporate river distance, measurement error, and secondary information into a comprehensive analysis to better estimate exposure levels for *E.coli*.

#### ISEE-918

#### Social Stress and Susceptibility to Concentrated Particulate Air Pollution (CAPs) in Rats

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**Background:** Recent epidemiological evidence suggests that social stressors (e.g., exposure to violence), may increase individual susceptibility to environmental pollution. This differential susceptibility may occur through stress-induced changes in immune function, or through physiologic pathways impacted by both stress and air pollution (e.g., oxidative stress). The case of traffic-related air pollution is particularly complex, as this complex pollutant mix is often spatially correlated with noise and other stressors. Epidemiologic methods alone are unlikely to fully disentangle these effects, as spatial auto-correlation may create residual confounding, and the physiologic mechanisms for stress-related susceptibility remain unknown.

**Methods:** We used a rat model of social stress to compare respiratory response to inhaled concentrated ambient particles (CAPs) between chronically stressed and non-stressed animals. Twenty-four 12-week old male Sprague-Dawley rats were randomly assigned to four exposure groups (Stress/ CAPs; Stress/ Filtered Air (FA); Non-stress/ CAPs; Non-stress/ FA). Stress group animals were individually introduced into the home cage of an older male for 20 minutes twice per week, to establish physiological conditions concomitant with chronic stress. CAPs were generated using a Harvard ambient particle concentrator, which draws real-time ambient fine particles in an urban area and enriches concentrations by approximately 30 times without substantially changing physico-chemical characteristics. Test animals were exposed to CAPs or FA in single-animal phethysmographs for 5 hours/day on 10 days. Three rats from each group were exposed each day to account for daily PM<sub>2.5</sub> variability, and exposures were initiated at the same time each day to account for diurnal variability in PM<sub>2.5</sub>. Continuous respiratory data was collected using the Buxco system. Blood was drawn at sacrifice and is now being analyzed for serum corticosterone, C-reactive protein (CRP), and other markers of stress and systemic inflammation. Lungs were fixed at constant pressure and random slices obtained for histological analysis. Continuous PM<sub>2.5</sub> was measured using a TEOM, and black carbon (BC) by aethelometer. Integrated filters will be on- and off-weighed to validate total PM<sub>2.5</sub> and reflectance analysis for BC.

**Results:** Continuous concentrated PM<sub>2.5</sub> across all study hours averaged 363.3 µg/m<sup>3</sup> (SD = 247.6 µg/m<sup>3</sup>) BC averaged 10.1 µg/m<sup>3</sup> (SD = 8.5 µg/m<sup>3</sup>). Most stress interactions involved some physical aggression, and a range of defensive behaviors were observed among the test animals, including hiding, vocalizing, and playing dead. Preliminary longitudinal analyses indicate that end expiratory pause was increased with stress exposure, decreased with CAPs exposure, and the group exposed to both showed a net decrease. End inspiratory pause was decreased with stress, and further decreased with CAPs. Frequency was increased in the combined stress/CAPs group, which also showed decreases in inspiratory time and expiratory time. Other respiratory measures were consistent with the changes described, and are now being analyzed in detail.

**Discussion:** To our knowledge, this is the first toxicological data to examine combined effects of social stress and air pollution on health outcomes in animals. Results may help to elucidate pathways through

which social stressors (e.g., poverty, violence) may shape population susceptibility to pollution exposures.

#### ISEE-919

#### Occupational EMF and Leukemia and Brain Cancer: An Update to Two Meta-Analyses

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**Objective:** To update past meta-analyses on occupational electromagnetic fields (EMF) and adult brain cancer and leukemia.

**Methods:** We collected and evaluated all relevant 1993–2007 publications. Summary estimates were obtained using various weighting schemes. To explore sources of heterogeneity, study characteristics were examined using regression analysis.

**Results:** Overall, for new studies, both brain cancer and leukemia showed small increases in risk estimates, 10% and 13%, respectively. Notably, pooled risk estimates were lower than in past meta-analyses, and leukemia subtypes showed no consistent pattern when past and present meta-analyses were compared.

**Conclusions:** The lack of a clear pattern of EMF exposure and outcome risk does not support a hypothesis that these exposures are responsible for the observed excess risk. Findings were not sensitive to assumptions, influential studies, weighting schemes, publication bias, study characteristics or funding source.

#### ISEE-920

#### Estimation of Prenatal Exposure to Glyphosate-Based Formulations Using Maternal Exposure Assessment Techniques—a Preliminary Investigation

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**Introduction:** Since its registration in 1974, glyphosate has been heavily used globally to control weeds in many landscapes including agriculture, horticulture and home gardens. Glyphosate works by interfering with the synthesis of amino acids in the shikimic acid pathway, a pathway that is present in plants and some microorganisms but not in animals. Although regulatory studies evaluated glyphosate as being practically harmless to humans, laboratory experiments in recent years have shown the potential for glyphosate-based formulations to disrupt fundamental biological processes in animal tissues. In spite of its widespread use, the exposure of the general population to glyphosate has not been assessed directly. Given the vulnerability of embryos and foetuses to environmental chemicals *in utero*, this study aims to estimate prenatal exposure to glyphosate from maternal dietary intake and maternal home gardening activities. The results presented here are estimates of maternal exposure to glyphosate through diet. Prenatal exposure to glyphosate is currently being estimated.

**Methods:** We recruited 43 urban-dwelling, non-occupationally exposed pregnant women (mean age 32), mainly through hospital antenatal clinics, who normally eat a diet of conventionally grown food. Food frequency questionnaires were used to calculate daily maternal food intake and subsets of 24-hour table-ready composite food samples provided by participants were analysed for glyphosate by electrospray ionisation-liquid chromatography-tandem mass spectrometry. Maternal exposure was estimated by multiplying daily food intake by the concentration of glyphosate residues in food, divided by maternal body weight, and compared with the Acceptable Daily Intake for glyphosate, which is 0.3 mg/kg body weight.

**Results:** Out of 19 food samples analysed, 79% contained quantifiable residues of glyphosate (mean 0.08 mg/kg; range 0.002 to 0.5 mg/kg). Based on analytical results for concentrations of glyphosate residues in

food, maternal food consumption and maternal body weight, the mean estimated maternal daily dietary exposure to glyphosate is 2 µg/kg body weight/day (range 0.02 to 7 µg/kg body weight/day), which represents 0.5% of the Acceptable Daily Intake for glyphosate.

**Conclusion:** These findings show that the estimated daily dietary exposure to glyphosate residues of the study population is less than 2.5% of the Acceptable Daily Intake for glyphosate and all exposures are well below the applicable health standard.

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#### ISEE-921

#### Time-Series Analysis of Particulate Air Pollution and Mortality in Four Chinese Cities

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**Background:** Some studies have reported the short-term adverse health effect of particulate air pollution on mortality and morbidity, especially the multi-city analysis conducted in U.S and Europe. But few multi-city analyses have been reported on the health effects of particulate air pollution in higher level areas, especially in Asia. The purpose of this analysis is to exploring the association between PM<sub>10</sub> and mortality in four megacities of China, i.e. Beijing, Shanghai, Tianjin and Guangzhou.

**Methods:** Daily 24-hour average concentrations of particulate matter less than 10 µm in aerodynamic diameter (PM<sub>10</sub>) were obtained from the local environmental monitoring center from Jan 1<sup>st</sup> 2005 to Dec 31<sup>st</sup> 2007. The daily meteorological variables, including 24-hour mean temperature and relative humidity, were available on the China Meteorological Data Sharing Services System for the same period. And the daily counts of deaths for urban residents in four cities were obtained from the National Death Cause Registration and Report Information System of China, and the deaths for external causes were excluded. The death counts were classified into cardiovascular mortality (I00-I99) and respiratory mortality (J00-J99) according to the International Classification of Disease (ICD-10). Generalized linear Poisson regression models were used to estimate the city-specific relative risk adjusting for trend, seasonality, and day of week, temperature and relative humidity. And then two-stage analytic approach was used to pool the city-specific estimates taking into account the heterogeneity between the four cities.

**Results:** We observed consistent association between PM<sub>10</sub> concentration and total non-accidental mortality and respiratory mortality on concurrent day (lag0). An increase of 10 µg/m<sup>3</sup> in PM<sub>10</sub> daily concentration on concurrent day was significantly associated with 0.20 percent increase (95% CI: 0.14, 0.27) in non-accidental mortality and 0.13 percent increase (95% CI: 0.09, 0.35) in respiratory mortality. And an increase of 10 µg/m<sup>3</sup> in PM<sub>10</sub> daily concentration on previous two day (lag2) was corresponded to 0.19 percent increase (95% CI: 0.16, 0.22) in cardiovascular mortality. The PM<sub>10</sub> effect on the other lag days did not show significance.

**Conclusion:** It suggests that ambient PM<sub>10</sub> concentration was positively associated with the total non-accidental mortality, cardiovascular and respiratory mortality in these cities of China.

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#### ISEE-922

#### Conducting Risk Assessments of Chemicals in Consumer Products

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**Background:** Although the last two decades have witnessed a significant increase in our understanding of chemical exposure and risk, there are major gaps in the literature about how to robustly and accurately characterize the risk posed by chemicals in consumer products. From a public health point of view, there are a number of complex issues to properly characterize exposure of chemicals in consumer products. There has been increasing emphasis globally on protecting consumers, in particular children and potentially susceptible subpopulations, from potential adverse health effects due to exposure to chemicals over the life cycle of which they reside in consumer products. Risk assessments of chemicals such as formaldehyde, methylene chloride, benzene, toluene, arsenic and various flame retardants from consumer products have been highlighted over the last 20 years. During this time, the assessments have evolved from mostly screening level exercises to those that involved detailed analyses of specific product use scenarios.

**Discussion:** This paper presents a state of the art review of various methods for conducting risk assessments of chemicals in consumer products. The framework presented herein is generally applicable to both existing and new products. We systematically evaluate key consumer exposure and risk models, as well as propose a framework for conducting product risk assessments. A case study involving formaldehyde and composite wood products will illustrate our proposed approach.

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#### ISEE-923

#### Microsomal Epoxide Hydrolase Polymorphisms, Cessation of Work, and Chronic Respiratory Disease in Cotton Textile Workers

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**Objective:** Occupational exposure to endotoxin in organic dust may induce chronic respiratory disease and airway obstruction. A previous study of cotton textile workers showed that genetic polymorphisms in the microsomal epoxide hydrolase (*meH*) gene, a gene associated with metabolism of reactive oxidative species, modifies the association between endotoxin exposure and chronic pulmonary function loss. We investigated whether *meH* polymorphisms affect subsequent development of chronic airway obstruction (CAO) and chronic bronchitis (CB) after cessation of exposure to dust and endotoxin following retirement from the cotton textile industry.

**Methods:** We performed a survival analysis using a 20-year prospective cohort study of 283 cotton textile workers exposed to cotton dust and endotoxin, and 275 unexposed silk textile workers. Lung function measurements, self-reported respiratory symptoms, and work history information were collected during 5 surveys over the 20 year period. For this analysis, follow-up began at date of retirement and ended at the 2001 survey or survey in which CAO (percent predicted forced expiratory volume in one second less than 80%) or CB was identified. *meH* *Tyr113His* and *His139Arg* polymorphisms were genotyped by the 5' nuclease Taqman assay on an ABI 7900 sequencer. Using Cox regression, we estimated rate ratios (RR) for CAO and CB in separate models as a function of years since retirement adjusting for important covariates. Models were stratified by presence of CAO (or CB) before retirement and by exposure status. We tested for interaction between years since retirement and genotype status by inserting an interaction term in each of the models.

**Results:** There were 52 and 62 workers identified with CAO and CB, respectively, at end of follow-up. Polymorphisms in the *His139Arg* gene

were not found to be significant predictors or effect modifiers in all analyses. For CAO, we identified a marginal interaction between *His/His* genotype of the *Tyr113His* polymorphism and years since retirement ( $P = 0.09$ ) among exposed workers. Years since retirement was marginally inversely associated for workers with this genotype (RR: 0.55, 95% CI: 0.29–1.05) but not without (HR: 1.04, 95% CI: 0.89–1.23). Among non-exposed workers with absence of CAO, the interaction between the minor allele and years since retirement was marginally significant ( $P = 0.09$ ). Years since retirement was positively associated with CAO for workers with the minor allele (RR: 1.28, 95% CI: 1.03–1.59) but inversely associated for workers without (RR: 0.94, 95% CI: 0.65–1.63). For CB, the minor allele of the *Tyr113His* polymorphism was identified as a significant predictor (RR: 3.05 95% CI: 1.14–8.16) among exposed workers. Among non-exposed workers, the interaction between years since retirement and the *His/His* genotype was marginally significant ( $P = 0.06$ ). Workers with the variant genotype were much more likely to have CB per every year after retirement (RR: 3.67, 95% CI: 0.55–24.37) compared to workers without (RR: 1.08, 95% CI: 0.92–1.26).

**Conclusion:** The *Tyr113His* polymorphism of the *mEH* gene may modify the association between cessation of work and CAO and CB. The data also suggests that no longer exposed, but genetically susceptible workers are still at risk for developing disease after leaving work.

#### ISEE-924

##### Cancer Incidence and Arsenic in Soil in a Gold Mining Area of Australia

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**Introduction:** Arsenic is elevated in some soils and mine waste in the historic goldfields region of Victoria, Australia. This geographical correlation study investigated the exposure potential of arsenic in soil in relation to cancers with an *a priori* association with arsenic in drinking water, between 1984 and 2003.

**Methods:** The study area included 61 Statistical Local Areas (SLAs). We used incident cancers recorded by the Victorian Cancer Registry, georeferenced to SLA of residence at time of diagnosis. Geographic data manipulation was undertaken to convert cancer and demographic data to a common SLA boundary definition, enabling estimation of age-sex standardised incidence ratios (SIRs). Spatial empirical Bayes (SEB) smoothing was applied to reduce variance instability inherent in raw SIRs. Two soil arsenic exposure metrics were derived from available geochemical datasets: 1) predominantly geometric mean arsenic concentrations, with kriging predictions assigned to unsampled SLAs (range 1.4 to 1857 mg/kg); 2) kriging predictions only ('smoothed' metric; range 12 to 299 mg/kg). Links between SIRs and natural logarithmic transforms of the exposure metrics were investigated using spatial autoregressive modelling, adjusting for spatial trends detected. SLAs were also aggregated by quintiles of metric 1, and SIRs estimated.

**Results:** Raw and SEB smoothed SIRs of all cancers among males were significantly associated with interactions between both soil arsenic exposure metrics and a dichotomised score reflecting socio-economic disadvantage. For all female cancers, the significance of these interactions was slightly less consistent. The magnitude of effect per 2.7-fold increase in metric 1 was similar for raw and SEB smoothed SIRs of all cancers, although less than effects estimated using the smoothed exposure metric. SEB smoothed SIRs of individual cancers gave more conservative effect estimates, which are reported here. In more disadvantaged SLAs, risk of cancer overall increased for males and females ( $\beta = 0.049$  [95% confidence interval [CI] 0.016–0.082] and  $\beta = 0.037$  [0.009–0.065], respectively). Prostate cancer ( $\beta = 0.043$  [0.013–0.073]) and female melanoma ( $\beta = 0.052$  [0.017–0.087]) also increased in more disadvantaged SLAs, while male melanoma ( $\beta = 0.047$  [0.012–0.081])

increased when adjusted for disadvantage. Although linear trends were not evident, significant excess risks of all cancers (SIR 1.09 [95% CI 1.07–1.12] and 1.06 [1.04–1.09], and melanoma (SIR 1.13 [1.04–1.23] and 1.22 [1.12–1.31]) for males and females, respectively, and male prostate cancer (SIR 1.08 [1.03–1.13]), were found in the uppermost quintile of metric 1.

**Discussion and Conclusions:** We found consistent evidence of small but significantly increased risks of all cancers, melanoma and prostate cancer among males, and some evidence of increased risk among females of all cancers and melanoma, in association with increasing soil arsenic levels in spatial autoregressive models. The robustness of this geospatial analysis is corroborated by excess risks observed among aggregated SLAs in the uppermost quintile of soil arsenic level.

#### ISEE-931

##### Heterophyidiasis: A Re-emerging Disease in Davao Region

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**Background:** Fish-borne trematode infections tend to go unnoticed and hence under-reported, not least because the symptoms are mild and non-specific, and may be mistaken for a range of other infections and conditions. The mode of transmission is by ingestion of raw or undercooked freshwater fishes with metacercariae. Heterophyids are minute flukes that live in the intestines of fish eating hosts including humans, mammals, and birds causing heterophyidiasis. The prevalence of heterophyidiasis in the Philippines is low and its distribution is spotty. Based on the 1984 nationwide surveys, less than 1% of 30,000 stools examined were found positive for heterophyid ova. In 2004, the municipality of Carmen, Davao del Norte had an infection rate of 1.6%. However, most of these cases were only from the eight (8) barangays covered by the Schistosomiasis Control Teams, which is about 14% of the total population of this municipality.

**Methods:** This descriptive study sought to determine the true prevalence and intensity of infection of heterophyidiasis and describe the knowledge and practice of the respondents on heterophyidiasis. The survey was conducted in six (6) randomly selected barangays of Carmen, Davao del Norte from August 1–31, 2005. With the kato-katz method, heterophyid eggs were counted and classified as light, moderate and heavy infection. Key informant interviews were also conducted to describe the knowledge and practice that possibly expose the local residents to infection. Samples of freshwater fishes were collected and forwarded to the Bureau of Fisheries and Aquatic Resources for identification and examination of the larval stages of heterophyid fluke.

**Results:** A total of 152 out of 1465 individuals were found to have heterophyidiasis. The over-all infection rate was 10%. Eighty percent (80%) had light infection, 18.4% were moderately infected and 1.3% was heavily infected. The range of counts of heterophyid eggs among infected respondents was from 11.63 to 1512 eggs with an arithmetic mean egg count of 107.18 which fall within the range of moderate infection. The level of knowledge was generally low. Ninety-five percent (95%) have eaten freshwater fishes and mostly tilapia *Oreochromis niloticus* (91%). Seventy six percent (76%) claimed *paksiw* as their food preference. They took most of these freshwater fishes from the rivers, irrigation canals, and private fishponds. Seventy-eight percent (78%) are utilizing toilets. However some of these toilets were located within their rice fields, near irrigation canals or rivers. All fish samples were negative for the presence of larval stage of heterophyid fluke. Case analysis revealed upper abdominal discomfort as the most common complaint (67%).

**Conclusions:** In conclusion, the prevalence of heterophyidiasis had greatly increased from 1.6% in 2004 to 10% in 2005. The major factor that influence the prevalence of heterophyidiasis is the habit and traditional popularity of eating raw or inadequately cooked fish and aquatic animals. The study recommended for both health end environmental control

measures. Information and education campaign should focus on the use of sanitary latrines, proper cooking of freshwater fishes, disposal of fish offal and use of human or animal wastes as fertilizers or fish foods should be discontinued.

## ISEE-932

**Cigarette Smoking Can Increase the Decline of Lung Function Due to Air Pollution**

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**Background:** Cigarette smoking and air pollution are contributing factors to the impairment of the respiratory system. Smoking can cause higher airway inflammation response and structural changes of airway, and air pollutants can cause irritation and tissue damage by stimulating the membranes of the respiratory system. More evidence suggests links between smoking or air pollution and adverse respiratory events, but little is known about the combined effect of smoking and air pollution on respiratory system. In this study, we hypothesized that respiratory function in smoker might be susceptible to the exposure to air pollution and compared the changes in lung function between smoker and non-smoker by air pollution.

**Methods:** Data were collected from family health examinations performed in a Korean community. The study population included 368 male and 499 female subjects, aged 20–86 years (mean, 52.2 years). The subjects responded to an interview about their general characteristics and completed lung function test using a spirometer (Vmax series 2130; Sensor Medics, USA) according to American Thoracic Society criteria. The measurement included forced vital capacity (FVC) and forced expiratory volume in 1 s (FEV<sub>1</sub>). Monitoring data were obtained from the Environmental Management Corporation, which is part of the Korean Ministry of the Environment, during the period of the lung function measurement. We compared general characteristics and lung function in smokers and nonsmokers and conducted linear regression analysis to evaluate the association of lung function with PM<sub>10</sub> and NO<sub>2</sub> exposure in smokers versus nonsmokers, after adjusting for age, height, sex, and a diagnosis of asthma.

**Results:** We found that exposure to PM<sub>10</sub> and NO<sub>2</sub> produced a greater decline of lung function in smokers compared with nonsmokers. Specifically, FVC and FEV<sub>1</sub> in smoking group began to decline after exposure, and this effect continued for approximately 24 h. These associations have not been elucidated, but smoking appears to promote the decline of lung function by impairing defensive mechanisms and to make more susceptible to pathophysiological changes in respiratory system due to air pollution.

**Conclusion:** Although our result has some weaknesses owing to cross-sectional design and the lack of a personal biomonitoring, this finding suggests that the combined effect of smoking and air pollution may be much more harmful than the separate exposure of them, and high-risk population may be endangered by such effect.

## ISEE-934

**The Experience in Assessing Individual Environmental Exposure of Children in the Sverdlovsk Region of the Russian Federation**

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**Methods:** From 2003–2008 environmental exposure assessments on the individual level have been performed for 228 children living in 7 towns with high levels of environmental pollution situated in the Sverdlovsk Region of the Russian Federation. For a child to be chosen as a subject for the exposure assessment it was necessary that he or she lived and attended a kindergarten in an environmentally polluted area, had an environment-related pathology, or belonged to a risk group with the highest total toxic body burden according to results of bio-monitoring. Samples were collected following the same pattern and in accordance with QC/QA procedures. The sampling period was established experimentally and generally lasted 4–5 days. Formaldehyde was measured using passive samplers of CHEMEXPRESS (USA); NO<sub>2</sub> and SO<sub>2</sub>—using OGAWA Co. (Japan) passive samplers; volatile organic compounds (benzene, xylene, toluene, ethyl benzene, trichloroethylene, tetrachloroethylene)—using 3 M organic vapor monitors 3500. The dust load was determined using “Briz-1”, a personal sampler made in Russia, with the following measurements of lead, copper, zinc, cadmium, arsenic, nickel, chromium and other metals on the exposed filters. To assess individual health risk factors, we used questionnaires and a time and motion study of daily activities of a child during the sampling period.

**Results:** Results showed that children spent 14.0% of their time outdoors, 33.0%—in the kindergarten, 51.8%—at home, and the rest 2.9% of time—inside other premises like schools of development, shops, etc. Children's exposure to formaldehyde and nitrogen dioxide, with account for the pattern of daily activities, was mainly attributed to indoor air concentrations of those chemicals in homes, while exposure to sulfur dioxide—to both indoor and ambient concentrations. Thus, the concentration of formaldehyde as established by personal sampling was 3–17 µg/m<sup>3</sup>, in indoor air at home—6–19 µg/m<sup>3</sup>, in the kindergarten—0.4–2 µg/m<sup>3</sup>, and in ambient air—0.8–6 µg/m<sup>3</sup>. Exposure to toxic metals was attributed to high concentrations of lead (364.0 mg/kg), zinc (1,713.0 mg/kg), nickel (94.2 mg/kg), cadmium (2.9 mg/kg), arsenic (2.1 mg/kg) found in dust samples taken in homes, playrooms and bedrooms of kindergartens. Besides, allergenic Pyroglyphidae ticks were found in 20–50% of all dust samples. Vegetables grown by 60–80% of families in their vegetable gardens significantly contributed to the chemical body burden of children. It was established, for instance, that in carrot the average concentration of lead was 0.17 mg/kg, that of cadmium—0.04 mg/kg, and in beet—0.06 and 0.1 mg/kg, respectively.

## ISEE-935

**Exposures to PM<sub>2.5</sub> and Polycyclic Aromatic Hydrocarbons from Burning of Incenses from Four Countries**

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**Background:** Burning incense produces particulate matters (PM) and toxic compounds such as polycyclic aromatic hydrocarbons (PAHs). It is an important exposure source to people who has an incense-burning habit for either religion or relaxation purpose in many countries. In this work, the particulate PAH exposure to worshipers during incense-burning were estimated based on laboratory assessment and field campaigns.

**Methods:** The emission factors of PM<sub>2.5</sub> and particulate PAHs of 48 kinds of incenses were assessed in a laboratory setting. These incense sticks were purchased from the USA, Taiwan, India, and Indonesia. Joss sticks were burned inside a 44 cm long elutriator simulating the real household burning conditions. Personal Environmental Monitors mounted with Teflon filters were used to take particulate samples of incense smoke. Samples were analyzed for 16 PAHs by Gas Chromatography–Flame Ionization Detector. These PAH emission factors combined with PM concentrations assessed during incense-burning periods in an actual

household to estimate the particulate PAH exposures during incense burning periods.

**Results:** It was found that the one gram of incense produced  $222 \pm 828 \mu\text{g}$  of  $\text{PM}_{2.5}$  and  $11.7 \pm 18.2 \mu\text{g}$  of particulate PAHs. There were significant differences among incenses purchased from different countries. Incenses from USA had significantly higher  $\text{PM}_{2.5}$  emission factor than incenses from the other three countries. In terms of particulate PAH exposure during the incense-burning period, people would be exposed to  $8.49 \pm 13.1 \text{ ng/m}^3$  and  $2.09 \pm 3.24 \text{ ng/m}^3$  at a distance 0.5 m from the burning-incense under the closed and ventilated conditions, respectively.

**Conclusion:** These results suggest that incense burning is a significant PM and particulate PAH exposure source. Emission factors obtained in this work can be used in indoor air models to estimate PM and PAH exposures in different conditions.

#### ISEE-937

#### The Hygiene Hypothesis in Juvenile Idiopathic Oligoarthritis: A Case-Control Study

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**Objective:** In the context of the hygiene hypothesis the protective effect of infant contact with farm related microbial compounds on respiratory allergies is well established. We have previously shown that infant (farm) animal contact is also inversely related to inflammatory bowel disease (IBD) while we could not show an association with diabetes mellitus type 1 (DM1). Some of the environmental predictors for juvenile idiopathic oligoarthritis are similar to those established for respiratory allergies; i.e., its marked geographical variation, maternal smoking during pregnancy, and having more affluent parents. This suggests that (farm) animal contact in infancy might also contribute to the aetiology of juvenile idiopathic oligoarthritis. The aim of this case-control-study was to test this association.

**Patients and Methods:** Parents of prevalent cases with juvenile idiopathic oligoarthritis registered at the Hospital for Paediatric Rheumatology were asked to complete a written questionnaire. This referral centre mainly covers the South-West of Germany. Therefore, children who underwent strabismus surgery at six referral centres for ophthalmology in South-West Germany served as controls. All children age 6 to 18 years born in Germany without malformations were included (238 cases of juvenile idiopathic oligoarthritis and 832 controls, response 86% in either group). Data were analysed using logistic regression models after adjusting for potential confounders.

**Results:** Cases were significantly younger and more likely to be female than controls. Neither place of living (urban area, rural town, village), living on a farm, nor regular farm animal contact (adjusted odds ratio 0.79; 95% confidence interval 0.42–1.47) or pet contact (0.79; 0.55–1.14) during infancy were related to case status. Allergic rhinitis was inversely related to juvenile idiopathic oligoarthritis (0.57; 0.34–0.95).

**Conclusions:** Contact with farm environments in infancy might not be associated with juvenile idiopathic oligoarthritis. This finding as well as the inverse association between allergic rhinitis and juvenile idiopathic oligoarthritis are consistent with our previous study on DM1. However, they contradict the findings for IBD. The underlying causes have yet to be elucidated.

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#### ISEE-938

#### A Time-Series Study on the Effects of $\text{PM}_{2.5}$ on Daily Mortality in Shanghai

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**Methods:** Air samples were collected at two typical functional areas (A site represents traffic district, B site represents industrial district) during four seasons in shanghai urban district in the year of 2002. A time series Poisson regression in a generalized additive model (GAM) was used to analyze the relationship between particulate matter pollution and daily mortality in urban residents in B district in order to explore the short-term adverse effects of particulate matter. An exposure-response relationship was established.

**Results:** The results of field monitoring show that the pollution of  $\text{PM}_{2.5}$  in winter is quite serious in two sampling sites according to US EPA standards. The rates of exceeding the standards are 52.9%, 56.9% respectively for two sampling sites. The results of spatial variation analyses show that the levels of particulate matter in summer in traffic zone are higher than industrial zone. ( $P < 0.05$ ) There is a significant linear relationship between  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ . The results indicate that fine particles account for 63.2% of total  $\text{PM}_{10}$ . The results of epidemiological investigation show significant association between daily mortality and ambient particulate matter pollution. The exposure-response relationship was almost linear with no evidence of safe-threshold level. The adverse effects are evaluated by single pollutant model, controlling for long-term temporal trend, season, weather and other factors. The results show that a  $10 \mu\text{g/m}^3$  increase in  $\text{PM}_{10}$  was associated with a 0.57% [0.18%, 0.96%] increase in total mortality, a 1.08% [0.33%, 1.83%] increase in cardiovascular mortality, a 1.23% [0.40%, 2.06%] increase in respiratory mortality, a 0.57% [0.18%, 0.96%] increase for elderly ( $\geq 65$  years old) people. A  $10 \mu\text{g/m}^3$  increase in  $\text{PM}_{2.5}$  was associated with a 0.85% [0.32%, 1.39%] in total mortality, a 1.54% [0.37%, 2.72%] increase in cardiovascular mortality, a 2.02% [1.14%, 2.91%] increase in respiratory mortality, a 1.11% [0.55%, 1.67%] increase for elderly people. The adverse health effects of both  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  are statistically significant and show similar trend. The relative risks (RR) for respiratory mortality are the highest, next cardiovascular mortality, total mortality other mortality. The RRs for total mortality in older people are higher than overall population and people younger than 65 years old. Both  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  show significant health effects in overall population both in warm and cold season. While the RR estimated in cold season are higher than warm season. In different age group, by different season, the RR estimated for  $\text{PM}_{2.5}$  are higher than  $\text{PM}_{10}$ , indicating that  $\text{PM}_{2.5}$  have greater harmful effects on health than  $\text{PM}_{10}$ . The correlation analyses between the chemical components of  $\text{PM}_{2.5}$  in winter and daily mortality were also performed. Due to limited samples, only a qualitative assessment was evaluated. The relationship between ions of sulfate and nitrate in  $\text{PM}_{2.5}$  and daily mortality shows some linear trend existed. The smooth curve shows a clear exposure-response relationship. With the increase of concentration of the ions of  $\text{PM}_{2.5}$ , the risks for daily mortality increased.

#### ISEE-939

#### Indoor Residual Spraying (IRS) with DDT is Associated with Urogenital Birth Defects in Newborn Venda Boys from South Africa

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**Background:** Residential exposure of pregnant women to DDT may include various human health impacts, including fetal loss, still birth and

hortened lactation (Longnecker, 2005; Damstra et al., 2004), while exposure during the first two years of life may delay neurodevelopment in children (Eskenazi et al.; 2006). In utero exposure to DDT can adversely affect the testis and epididymis and it was suggested that it may also cause hypospadias (opening of the urethral meatus along the shaft of the penis) (Damstra et al., 2004). DDT was introduced in 1945 to the study area in the north-eastern part of South Africa and has since been used annually for malaria vector control (MVC). We determined the risk of urogenital malformations (micropenis, chordee, undescended testes, hypospadias and ambiguous genitalia) in newborn boys to mothers living in DDT-sprayed houses in Limpopo Province, South Africa.

**Methods:** This study was a hospital-based study, performed at Tshilidzini Hospital, Thohoyandou, Limpopo Province. Two trained professional nurses examined 7145 newborn babies for external urogenital birth defects from May 2004 to April 2006. Of these, 3198 boys were born to mothers belonging to the Venda Tribe. They were living in similar ethnic and socio-economic conditions in both DDT-sprayed or non-sprayed villages.

**Results:** Of the 3198 newborns, 328 (10.2%) had one or more urogenital malformations. Exposure to DDT was associated undescended testes ( $P = 0.016$ ) and with hypospadias ( $P = 0.08$ ). Being a homemaker, versus having a job or being a student was also an important predictor in some cases. Exposure to DDT appears to significantly increase the risk of presenting with UDT (OR = 2.17; 1.15–4.1).

**Conclusion:** Maternal exposure by living in a village where DDT had been sprayed previously significantly increased the risk of having offspring with urogenital birth defects. In addition, spending more time at home seemed to further increase the risk. This study may be useful as a first step in conducting further studies that could yield more specific and high quality information, such as a nested case control study.

#### ISEE-940

##### Evaluation of As, Cd, Cu and Ni Exposure and Health Risks in People Living Near a Cu-Ni Smelter

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**Background:** Metals are natural and ubiquitous constituents of the environment and many of them function as essential trace elements in humans. However, at high levels of exposure all metals can cause toxicity and unacceptable health risks. People most at risk from environmental exposure perspective are often those living near metal industry sites.

**Objective:** The objective of this study was to estimate daily intake levels of arsenic, cadmium, copper and nickel via different environmental media in people living in the vicinity of a copper and nickel smelter located in South-West Finland, and to evaluate risk for carcinogenic and non-carcinogenic health effects. The industrial activity, operative since 1945, has resulted in considerable metal pollution in the local environment. Emissions have declined significantly in the last few decades, but the contaminants accumulated in the soil can still serve as a constant source of exposure.

**Methods:** To define the degree and main sources of uncertainty in the exposure assessment, the average daily metal intake for both adults and children was modelled probabilistically using Monte Carlo simulation. Calculations were based on a synthesis of environmental data collected from the area in previous studies, as well as on parameter values and probability densities taken from literature. Exposure pathways included in the assessment were outdoor and indoor air inhalation, consumption of drinking water and local food plants, involuntary ingestion of soil and surface water, and skin contact with household water, surface water and soil. Background exposure from overall diet or smoking was not included. Risk of non-carcinogenic health effects was evaluated by comparing the daily metal intake to a reference value considered to represent a safe level of intake (As 0.3, Cd 0.5, Cu 140, and Ni 50  $\mu\text{g}/\text{kg}/\text{d}$ ).

**Results:** For arsenic, cadmium, and nickel, all known respiratory tract carcinogens, a lifetime cancer risk for inhalation exposure was calculated based on measured ambient air metal concentrations in  $\text{PM}_{10}$  from 2004 to 2006 and cancer unit risk (As 1.5E-3, Cd 1.8E-3, and Ni 3.8E-4 per  $\mu\text{g}/\text{m}^3$ ). In the most polluted area, calculated intakes (95th percentile) of As, Cd, Cu and Ni were for adults 27, 20, 6, and 6% and for children 67, 46, 33, and 24% from the level of daily intake considered safe for general toxicity. In general, consumption of local food plants and soil ingestion were the most significant exposure pathways. Lifetime cancer risks for As, Cd and Ni inhalation were 3E-5, 6E-6 and 1E-5, respectively.

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#### ISEE-941

##### Chemical and Physical Characterization of Particles Emitted from Hardcopy Devices

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**Background:** Several publications have recently appeared which describe the release of ultra-fine particles (UFP; size < 100 nm) from hardcopy devices not only in chamber tests but also under real room conditions. Due to assumed health impacts attributed to UFPs this subject currently receives substantial public attention. Regarding the occurrence, the source and the chemical nature of UFPs a large number of questions are still open.

**Discussion:** For the characterization of emitted UFPs from laser printers, different test methods (box chamber tests, flow chamber tests, furnace tests) and analytical techniques (SMPS, FMPS, VHTDMA, GC/MS, ICP/MS, Headspace/MS, thermography, etc.) were applied. It could be shown that the release of UFPs from hardcopy devices is often not a continuous process which extends over the entire printing sequence. Instead, the emission is characterized by a short-term "initial burst" ("non-constant" emitter). When a rapid sequence of cascade measurements is taken, there is often a considerable reduction in emissions from one print to the next. With another type of printer ("constant" emitter) emission behavior over time is on the other hand more even. Measurements with modified devices have demonstrated that particles can also be released without any toner and paper being present. From furnace experiments and thermography it is assumed that the fuser unit and the fuser temperature appear to be important factors being involved in the creation of the UFP emissions. The presence of water (paper humidity) also influences the emission of UFP. In the test chamber, the size distribution of the particles shows one mode at 10–20 nm, which is caused by toner and fuser, and one mode at 80–100 nm, which is caused by paper. VHTDMA experiments provided information about the nature of the particles (primary or secondary). The vapor pressure of the particles could be estimated from temperature vs. concentration curves. GC/MS analysis proved that some organic compounds of printer components can also be found in sampled particles. The evaluation and comparison of all obtained results gives a good picture on the formation and chemical constitution of particle emissions from laser printers.

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#### ISEE-942

##### The Influences of Municipal Solid Waste Incineration on the Biological Mercury Exposure

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**Background:** The main methods of waste disposal has been changed from landfill to the incineration and recycling because of the used-up of available landfill area, municipal solid waste incinerators are becoming a reasonable means by which communities can dispose of their solid waste in Korea. Incineration has been pointed as one of the major facilities

emitting mercury into environment. Although much more attenuated than in the very beginning of the adoption of incineration, the influence on the environment as well as on populations residing in the vicinity of incinerators still raises public and scientific concern for these reasons nowadays.

**Methods:** Two metropolitan municipal waste incineration facilities that situated in Gwangju and Pusan, another two area for the control in which there was not incineration facility were chosen for this study. 136 adults and 126 elementary school children participated in the Hg exposure and health study.

**Results:** Average Hg levels in blood of adult and children residing near incineration facilities were  $3.33 \pm 1.34$  ppb,  $2.48 \pm 0.85$  ppb respectively. Those were  $3.91 \pm 1.38$  ppb,  $2.77 \pm 1.15$  ppb in control areas. There were not big differences in the mercury exposure level in urine and hair as in blood between two investigation areas. Fishery diet such as preference for fish, amounts and frequency of fish intake mainly influenced on the Hg exposure and out-door activity, indirect smoking, dental amalgam treatment partly contributed in the exposure levels.

#### ISEE-943

##### Exposure to Traffic Air Pollution and Early Childhood Atopic Disorders

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**Background:** The adverse impacts of air pollution on non-allergic respiratory diseases are well-known. However, the effects of air pollution exposure on allergies in the early life still remain a debate.

**Objective:** The purpose of this study was to evaluate the influence of long-term exposure to air pollution on atopic dermatitis (AD) and recurrent wheezing in the first 18 months of life.

**Methods:** We used the multistage stratified systematic sampling to recruit 2,048 mother-child pairs from the Taiwan National Birth Registry in 2003. Risk factors for atopy were gathered by questionnaires at 0 and 18 months of age. Air pollutants ( $O_3$ ,  $PM_{10}$ ,  $NO_2$ , and CO) were measured at nearby air quality monitoring stations of long-term residents. We excluded highly polluted areas surrounding factories or incinerators and focused on traffic air pollution. Children with congenital defects or premature birth were also kept out. Total 477 children from 11 towns in Taiwan were enrolled. Marginal models were applied to assess the association between 18-month-averaged concentrations of air pollutants and children atopic outcomes.

**Results:** The concentration of  $O_3$ ,  $PM_{10}$ ,  $NO_2$ , and CO (mean  $\pm$  SD) were  $34.08 \pm 5.03$ ,  $66.33 \pm 15.84$ ,  $20.45 \pm 5.84$  ppb, and  $0.61 \pm 0.12$  ppm, respectively. After adjusting for gender, duration of breast feeding, environmental tobacco smoke, family history of atopy, and residence, AD was found to be positively related to an increase in the exposure to  $PM_{10}$  ( $\beta = 0.011$ ; SE = 0.003). Recurrent wheezing was associated with an increase in the exposure to CO ( $\beta = 2.159$ ; SE = 0.921) and  $NO_2$  ( $\beta = 0.044$ ; SE = 0.016). The results did not change very much after adjustment for the highest correlated air pollutant.

**Conclusions:** Exposure to traffic air pollution was associated with an increased prevalence of atopic disorders in young children.

#### ISEE-944

##### Studies on the Mechanisms of Smoking-Induced Carcinogenic Effects in Human Breast Cancer Cells

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**Background:** Tobacco-smoking is one of the well understanding carcinogenic factors involved in breast cancer formation.

**Method:** The expression of the nAChR mRNA levels in tumor tissues from 157 cases of breast cancer patients in Taiwan and human breast cancer cell lines were determined by real-time PCR analysis. The receptor binding activity assay was performed by treatment of human cancer cell lines with  $^3H$ -nicotine.

**Results:** In this study, we first demonstrated that the of nicotinic acetylcholine receptors (nAChRs) were detected in breast cancer cell lines including MCF-7 and MDA-MB-231. The expression levels of  $\alpha 9$ -nAChR was higher in most of the tumor tissue when compared to the normal tissues which dissected form the tumor margin. The receptor binding activity was performed and demonstrated that  $\alpha 9$ -nAChR significant binding to nicotine in a concentration as low as  $7 \mu M$ . The  $\alpha 9$ -nAChR expression in breast cancer cells was knocked-down by SiRNA technique and demonstrated that Akt-p (ser<sup>473</sup>) signaling regulatory pathways play an important role in nicotine-mediated breast cancer cells proliferation. We further demonstrated that the  $\alpha 9$ -nAChR expression was significantly upregulated in the promoter level by nicotine and sex hormone (estradiol, E2) as evidenced by luciferase reporter assay. In vivo study was performed by nude mice model and demonstrated that the  $\alpha 9$ -nAChR-mediated cancer cell proliferation may play a major role in response to nicotine-induced breast tumor formation.

**Conclusion:** Our results implied that  $\alpha 9$ -nAChR and its cooperative role with sex hormone (such as E2) may be significant in nicotine-mediated breast tumor carcinogenesis.

#### ISEE-945

##### Toward a Sentinel Pet Network of Environmental Exposure and Health Risks: Exploratory Study on 200 Healthy Dogs

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**Objective:** Like children, dogs may be more sensitive to pollutants and toxics and so can be used as sentinels of exposures and early effects. We are testing the feasibility and the relevance of a sentinel dog network, using the companion animals of French families whose children are included in the French longitudinal study (ELFE cohort) from childhood to 20 years of age, starting in 2010 at the national level. As a first step we are carrying out an exploratory study on 200 healthy dogs recruited at the Alfort National Veterinary School in order to describe pollutant values distribution in their blood according to age, sex, breed, and physiological parameters.

**Material and Methods:** Dogs were recruited between January and June 2008 in the vaccination or reproduction clinics. Only healthy dogs were selected, including very young (under 1 year old but weighing more than 10 kg), adult and old ones of any breeds. After obtaining the consent of the owner, a questionnaire was administered. A clinical examination and a blood sample were performed on the dogs by a veterinarian. A 10 mL blood sample was used for toxicological analyses for lead, organochloride, organophosphate and pyrethroids insecticides. A 3 mL blood sample was used for biochemical analyses including 20 biochemical parameters and

thyroxine. A 1 mL blood sample was used for haematological analyses (blood cell formula). The questionnaire was designed to help linking toxicological values to possible risk factors or confounding factors. Data on residence (urban or rural), housing characteristics, food habits, pesticide and chemical product uses were collected. A descriptive analysis and a multivariate analysis on the questionnaire data and biological parameters will be performed.

**Results:** Data collecting will end in June, 2008. The first results of this exploratory study will be presented at the ISEE meeting.

#### ISEE-947

##### Genetic Damage by the Environmental Exposure to c-PAHs: Bus Drivers

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**Objective:** The capital city of Prague becomes one of the most polluted localities of the Czech Republic. Therefore, the effect of exposure to carcinogenic polycyclic aromatic hydrocarbons (c-PAHs) adsorbed onto respirable air particles ( $PM_{2.5}$ ,  $<2.5\text{ }\mu\text{m}$ ) on DNA adducts and chromosomal aberrations was repeatedly studied in a group of policemen working in the downtown area of Prague. Additionally, we studied a group of bus drivers, who were expected to be exposed to the higher level of c-PAHs due to the traffic pollution.

**Material and Methods:** The impact of c-PAHs on biomarkers was repeatedly studied (winter 2005-summer 2006-winter 2006) in a group of bus drivers (males, aged 50 years,  $N = 50$ ) and a group of controls (matched by gender and age,  $N = 50$ ) working in the traffic polluted area of Prague, all subjects were nonsmokers. Personal exposure to c-PAHs was evaluated using personal samplers for  $PM_{2.5}$  during 48 h before blood sampling. DNA adducts were analyzed in lymphocytes by  $^{32}\text{P}$ -postlabeling assay, chromosomal aberrations by conventional cytogenetic analysis and fluorescent in situ hybridization (FISH). Polymorphisms of metabolic genotypes (GSTM1, GSTP1, GSTT1, EPHX1, CYP1A1-MspI) and DNA repair genotypes (XRCC1 and XPD) were determined by PCR-based RFLP assays.

**Results:** The personal exposure to B[a]P in bus drivers was  $1.25 \pm 0.66$ ,  $0.22 \pm 0.14$ , and  $1.02 \pm 0.48\text{ ng/m}^3$ , respectively, in controls  $1.75 \pm 1.02$ ,  $0.25 \pm 0.16$ , and  $0.76 \pm 0.36\text{ ng/m}^3$ , respectively. The level of PAH-DNA adduct was in bus drivers  $1.72 \pm 0.56$ ,  $1.22 \pm 0.45$ , and  $1.62 \pm 0.59$  adducts/ $10^8$  nucleotides, respectively, in controls  $2.15 \pm 0.61$ ,  $1.18 \pm 0.36$ , and  $1.90 \pm 0.79$  adducts/ $10^8$  nucleotides, respectively. Using FISH technique and probes for chromosomes 1 and 4 (Cambio, UK) the genomic frequency of translocations calculated as  $F_G/100$  was in bus drivers  $1.62 \pm 1.17$ ,  $2.18 \pm 1.77$ , and  $1.77 \pm 1.31$ , respectively, in controls  $1.65 \pm 1.49$ ,  $1.35 \pm 1.02$ , and  $1.87 \pm 1.29$ , respectively. Using conventional cytogenetic analysis the observed frequency in bus drivers was  $1.30 \pm 1.15$ ,  $1.43 \pm 1.02$ , and  $1.30 \pm 1.04\%$  ABC, respectively, in controls  $1.17 \pm 0.94$ ,  $1.47 \pm 1.00$ , and  $1.52 \pm 1.12\%$  ABC, respectively.

**Conclusions:** No significant differences were observed between the groups of bus drivers and controls, the observed changes corresponded to the level of exposure to c-PAHs in both groups. DNA adducts were repeatedly proved to be a sensitive biomarker of exposure to c-PAHs. It may be speculated that c-PAHs concentrations expressed as B[a]P higher than  $1\text{ ng/m}^3$  represent a significant risk as it induces genetic damage and therefore may significantly affect human health. All results indicate that molecular epidemiology studies should be done in a very complex manner using simultaneously biomarkers of exposure, effect and susceptibility.

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#### ISEE-949

##### Constructing and Validating Modelled Concentration Surfaces for Black Smoke and Sulphur Dioxide Across GB, 1955–2001

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**Objective:** The aim of this project is to generate a retrospective time series of annual average black smoke (BS) and  $\text{SO}_2$  concentrations for Great Britain, from 1955–2001, as a basis for exposure assessment, that can be applied to existing British cohort studies in particular as part of the Chronic Health Effects of Smoke and  $\text{SO}_2$  in the UK (CHESS-UK) project. To do this, different GIS methodologies are being employed. This abstract relates to methodology currently under development to estimate historical spatial distributions of BS and  $\text{SO}_2$  concentrations for key years across the study period (1961, 1971, 1981, 1991, 2001).

**Methods, Results, and Discussion:** Monitored BS and  $\text{SO}_2$  levels from the Smoke and Sulphur Dioxide National Survey comprising 3100 monitoring stations in operation over the time period are used as a set of core data. Ordinary kriging of monitored annual BS concentrations for sample years (1962, 1971, 1981 and 1991), including data from stations with concentrations available for  $\geq 75\%$  of days in the year was conducted to provide a ‘benchmark’ method. Kriging models were developed using 75% of the data with remaining data reserved for validation. Models worked well for 1962 and 1971 ( $r^2$  0.6 and 0.6, RMSE 49.3 and 18.8) but were less reliable for later years ( $r^2$  0.5 and 0.4, RMSE 7.8 and 6.6) when monitoring station numbers fell from around 700 to less than 200. Highest concentrations were consistently observed in northern England (Liverpool, Manchester and Tyneside), with lowest values in Scotland and the South-West. BS concentrations declined markedly over time with 90th percentile values falling from  $270\text{ }\mu\text{g/m}^3$  in 1962 to  $25\text{ }\mu\text{g/m}^3$  in 1991. Additional GIS methods currently being evaluated include: regression-based methods and affinity zone stratification. In initial trials these methods have shown to have good potential where appropriate covariate data is available. A range of input data has been investigated and a small-area database of geo-referenced data across the time series has been compiled as a basis for air pollution modelling. Data include emission maps (generated with AEA Technology Ltd for 1961, 1971, 1981 and 1991) and proxies for emissions (e.g. land cover, road traffic, industrial emission sources), information on environmental factors that might influence dispersion of the air pollutants (e.g. topography, meteorology) and information on population distribution and population characteristics that might act to determine exposures to ambient air pollution. Additional historical datasets identified for use in modelling include lichen surveys and smoke control areas (related to domestic fuel use). The ‘best performing’ methods for each decade will be selected and used to produce small area (1 km grid where possible) air pollution maps of GB for each of the target years to develop individual exposure estimates for participants in the UK longitudinal survey and potential for interpolating to intervening years will be assessed. In conclusion, kriging was found to provide reasonable ‘benchmark’ maps against which the further GIS ‘smart’ modelling (with covariates) methodologies can be compared. A range of datasets including air pollution concentrations are available to aid modelling of historical exposures to air pollution in the UK.

#### ISEE-951

##### Time-Series Analysis of Air Pollution and Cardiovascular Mortality in Beijing, China

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**Background:** A consistent association between particulate matter and mortality was observed by the studies conducted in some western countries, but less was known about in China, the host country of the Olympics 2008. This study is to investigate the association between ambient concentration of air pollutants and cardiovascular mortality in Beijing, China, with special consideration on particles.

**Methods:** Daily counts of cardiovascular death in urban area of Beijing from January 1 to December 31, 2001 were obtained from the Beijing CDC. Daily cardiovascular mortality were coded according to the 10<sup>th</sup> revision of the international classification of diseases (ICD-10), and were constructed for mortality from 'all diseases of cardiovascular system' (I00–I99) and its subsets, ischemic heart diseases (I20–I25) and cerebrovascular diseases (I60–I69). Air pollution data including daily average concentration of sulphur dioxide ( $\text{SO}_2$ ), nitrogen dioxide ( $\text{NO}_2$ ) and particulate matter <10  $\mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{10}$ ), and meteorological data for the same period were obtained from the Beijing Environmental Protection Monitoring Center and the Beijing Meteorological Bureau, respectively. A Poisson regression of concentration of daily air pollutants on daily cardiovascular mortality was constructed using the semi-parametric generalized additive model. Daily concentration of  $\text{SO}_2$ ,  $\text{NO}_2$  and  $\text{PM}_{10}$  were introduced into the final model with linear forms respectively. The relative risks (RR) and its 95% confidence intervals (95%CI) of cardiovascular mortality for a 10  $\mu\text{g}/\text{m}^3$  increase in the concentration of each pollutant were then calculated.

**Results:** The annual levels of ambient  $\text{PM}_{10}$  and  $\text{SO}_2$  in Beijing were  $140.81 \pm 79.09 \mu\text{g}/\text{m}^3$  and  $60.29 \pm 56.15 \mu\text{g}/\text{m}^3$ , respectively in 2003. After controlling the potential confounding effects of time trend, seasonal variations, temperature and humidity, significant associations were found between cardiovascular mortality and the concentrations of all pollutants in single-pollutant model. An increase of 10  $\mu\text{g}/\text{m}^3$  of  $\text{SO}_2$ ,  $\text{NO}_2$  and  $\text{PM}_{10}$ , corresponds to 0.4% (0.1%~0.8%), 1.3% (0.2%~2.4%) and 0.4% (0.2%~0.6%) increase of cardiovascular mortality, respectively in the exposed population of Beijing.  $\text{PM}_{10}$  showed a lagged effect on cardiovascular mortality, and was strongest at lag one day.

**Conclusions:** Cardiovascular mortality risks were observed significantly at current concentrations of the ambient air pollutants in Beijing ( $P < 0.05$ ). The cardiovascular effects of the exposed population associated with  $\text{PM}_{10}$  and other gaseous pollutants in Beijing were basically consistent with studies in other places of China and other countries.

#### ISEE-953

#### Influence of Ambient Fungal Concentrations on Hospital Visits for Allergic Respiratory Diseases

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**Background:** The prevalence of allergic diseases and asthma are increasing in developed countries. Ambient allergens, such as fungal spores, are essential risk factors for development of allergic respiratory diseases and exacerbation of allergic respiratory symptoms. Fungal allergen exposure is of particular concern in Taiwan, where subtropical climate with high temperature and relative humidity provides excellent environmental conditions for microbial growth. Therefore, we conducted a study to examine the characteristics and health risk of ambient fungi in Taipei, Taiwan from May to December 2007.

**Methods:** We monitored ambient fungal spores 7 days per month in Taipei metropolis using a Burkard seven-day recording volumetric trap during the study period. Health data was collected from a nearby medical center including numbers of daily outpatient and emergency visits for allergic respiratory diseases. Daily meteorological and air pollution data were provided by Taiwan Environmental Protection Administration.

**Results:** According to our results, the most prevalent fungi in Taipei included ascospores, basidiospores, *Cladosporium* and *Aspergillus/Penicillium*. In multiple regression analysis, fungal levles were positively associated with temperature, rainfall and relative humidity, and negatively

related to wind speed. Higher fungal concentrations were also detected under westerly or southwesterly wind conditions. After adjusting for the effects of holidays, meteorological factors and air pollutants, the concentrations of total fungi and several fungal spores were positively correlated with daily outpatient and emergency visits for allergic rhinitis and asthma.

**Conclusions:** In conclusion, ambient fungal levels increase with higher temperature and relative humidity, and with poor ambient dilution, which might exacerbate allergic respiratory diseases. Patients should be aware of the potential health risks and avoid related exposures by staying indoors or wear mask. Future studies are suggested to develop forecast models of ambient fungal concentrations in order to decrease exposure and health risks in Taiwan.

#### ISEE-955

#### Health Risks of Heavy Metals from Long-Range Transported Air Pollution in Europe

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**Background and Discussion:** The heavy metals cadmium, lead and mercury are common air pollutants, being emitted mainly from various industrial activities. Although the atmospheric levels are low, they contribute to the deposition and build-up in soils. Heavy metals are persistent in the environment and bioaccumulate in food-chains. Long-range transboundary air pollution is only one source of exposure to these metals but, because of their persistence and global atmospheric transfer, atmospheric emissions affect even the most remote regions. Long-range transport has been recognized as an important factor affecting ecosystems and human populations. The United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP) is a powerful international instrument aimed at reducing and preventing air pollution. A recent risk assessment update by the Convention Task Force on Health, based on contributions from an international group of experts, reviewed the available information on the sources, chemical properties and spatial distribution of environmental pollution with cadmium, lead and mercury caused by long-range transboundary air pollution, and evaluated the potential health risks in Europe. In spite of the 50% decrease in cadmium emissions since 1990, ambient air concentrations and deposition, recently published data do not show a decrease in the cadmium body burdens in non-smokers in the last decade. Studies on the cadmium balance in the top layers of arable soils indicate the inputs still exceeding its removal. The annual lead inputs from LRTAP and from the addition of organic and inorganic fertilizers to topsoil are roughly similar in magnitude, depending on the area and agricultural activities. Since 1990 the emissions have decreased by 90% and the inputs are relatively small in comparison with the existing accumulations, natural sources and resuspension. However, LRTAP contributes to the lead content of crops through direct deposition on the plants. Anthropogenic emissions of mercury in Europe decreased by approximately 65% after 1990, and a similar decrease is predicted by modelling and limited monitoring data on the deposition of mercury in the region. Nevertheless, corresponding decrease in the concentration of methylmercury in freshwater fish has not been observed. Little information is available on methylmercury in marine fish and on the contribution of long-range transport to the process. Existing evidence shows increasing levels of mercury in marine fish and mammals in the Arctic due to the long-range transport.

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#### ISEE-956

##### Mechanistic Insights: Cardiovascular Events During Hot Weather

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**Background:** The adverse health effects of heat-waves and other periods of high ambient temperatures have been clearly demonstrated in many settings. Prominent among those health effects is an increase in cardiovascular mortality. The mechanism that underlies this vulnerability remains unclear, however. To investigate this further, we compared patterns of heat-related outcomes in London, UK, including analysis of data on acute myocardial ischaemia that may be presumed to reflect thrombotic processes.

**Methods:** Analyses were based on two principal data sets: (i) daily cardiovascular mortality data, 1993–2003, subdivided into deaths from acute myocardial infarction (AMI) and other cardiovascular deaths, and (ii) daily hospital admissions for acute myocardial ischaemia, 2003–2006, derived from the Myocardial Infarction Audit Project (MINAP). MINAP is a national register for England and Wales of hospital admissions for myocardial infarction and other forms of acute myocardial ischaemia. It includes detailed clinical data, including presenting symptoms, electrocardiographic and enzyme changes and treatments, that allows patients with unequivocal ST-elevation and non-ST-elevation myocardial infarction to be identified. Using regression analysis of daily time-series data we quantified the relationship between these categories of cardiovascular events and both temperature and air pollution ( $PM_{10}$ , ozone) adjusting for other time-varying covariates. The heat relationship was modelled using temperature averaged across values lagged by 0–1 day, and cold effects using values lagged by 0–13 days.

**Results:** There was clear evidence of an increase in risk for cardiovascular mortality as a whole at both high and low temperatures. However, with regards to the heat effect, there was no increase in mortality specifically from AMI: Relative risk of 1.001 (0.981, 1.021) per degree Celsius increase above the heat threshold. On the other hand, CVD deaths from all other causes were significantly elevated: 1.053 (1.041, 1.064). For hospital admission for ST-elevation myocardial infarction the relative risk per degree change was 1.025 (0.974, 1.079) for the heat effect, but was much larger for cold: 1.114 (0.991, 1.252). Pollution effects were also evident.

**Conclusions:** These findings suggest that the risk of acute myocardial infarction is increased by both cold (and air-pollution), but not appreciably by heat. Thus, the overall increase in cardiovascular mortality observed during periods of heat appears to arise through largely non-thrombotic mechanisms. We speculate that the important pathophysiological processes may relate to cardiovascular decompensation in people with compromised cardiovascular function.

#### ISEE-957

##### Phthalate Exposure in Uterus and Its Relationship to Thyroid Function in Newborn

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**Background:** Negative correlations between thyroid hormones and urinary phthalate monoesters in pregnant women at the second trimester and in adult men were recently reported. Probable thyroid-like function and ability of certain phthalates to penetrate placenta phthalates have raised concern about prenatal phthalate exposure on fetal thyroid hormone.

**Objective:** This study aims to investigate the association of phthalate monoesters among maternal and fetal serums, and their thyroid hormones.

**Materials and Methods:** After signing a consent form, maternal and cord blood samples were collected at delivery from 61 pregnant women during 2006 in Tainan, Taiwan. Five phthalate monoesters, including mono butyl phthalate (MBP), mono ethylhexyl phthalate (MEHP) and mono-ethyl phthalate (MEP), in maternal and fetal serums were measured by liquid chromatography electrospray ionization tandem mass spectrometry. Thyroid hormones including TSH,  $T_3$ ,  $T_4$ , and free  $T_4$  (FT $_4$ ) were analyzed in maternal and fetal serums, respectively.

**Results:** Median age and gestation period of our participants were  $34.0 \pm 3.5$  years and  $39.0 \pm 1.2$  weeks. Median levels of three phthalate monoesters in the maternal and fetal serums were 158 and 256 ng/mL for MBP, 21.0 and 24.7 ng/mL for MEHP, 2.8 and ND ng/mL for MEP. MBP and MEHP contributed over 95% of five phthalate exposure in maternal and fetal serum. The median ratios of MBP and MEHP between fetal and maternal serums were 1.55 and 1.22, respectively. It is indicated that MBP and MEHP, long-chain phthalates, are able to penetrate the placenta and potentially accumulate in fetus. Possible mechanism is that phthalate monoesters may penetrate placenta by free form and accumulate in fetus with conjugated form. Since we found no significant correlation between phthalate monoesters and thyroid hormones in maternal serum, marginally significant negative correlations between MBP in fetal serum and TSH ( $R = -0.277$ ,  $P = 0.052$ ), and MBP and  $T_4$  ( $R = -0.157$ ,  $P = 0.055$ ) were observed. In addition, we found significant negative correlation between fetal TSH  $\times$   $T_4$  and MBP in fetal serum ( $R = -0.23$ ,  $P < 0.05$ ). After adjusting for maternal age, gestational age, and MEHP in fetal serum, negative association among MBP levels in fetal serum, TSH,  $T_4$  and TSH  $\times$   $T_4$  were still existed. It is revealed that prenatal MBP exposure may alter thyroid hormone in newborns. Further studies are needed to evaluate the influence of lower thyroid function on the development of newborns.

**Conclusion:** Phthalate exposure may occur in uterus and decrease thyroid hormone in newborn.

#### ISEE-959

##### Lung Cancer Risk in Black-coal Miners with Pneumoconiosis in the Czech Republic

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**Objective:** In 1997 the International Agency for Research on Cancer evaluated dust containing crystalline silica as carcinogenic to humans (Group 1). The results of a great number of epidemiological studies confirm a statistically significant increase of lung cancer in the workers

from various production areas with the risk of silicosis. The possibility of the increased risk of lung cancer in black-coal miners cannot be explicitly, according to the present knowledge, either confirmed or eliminated. Epidemiological investigation of association between silica exposure and lung cancer risk in workers with pneumoconiosis from all industries and settings with occupational exposure to silica is supported by grant of Czech Ministry of Health. The goal of this study is analysis of lung cancer risk between black-coal miners with pneumoconiosis and general population of the Czech Republic.

**Material and Methods:** The sample consisted of 2,511 black-coal miners with pneumoconiosis. These workers were registered in the National Register of Occupational Diseases from 1992 to 2001. The data on individual and occupational history of workers were linked with the data from the National Cancer Register and the National Population Register. Population data were retrieved from Institute of Health Information and Statistics of the Czech Republic. Lung cancer risk was calculated as standardized morbidity ratio (SMR) with 95% confidence interval (CI) by 5-age groups based on the data on lung cancer incidence over a period 1992 to 2006, first group was 30–34 years and last group 85 years and more. Program Stata v.9 was used for data analysis.

**Results:** Coal workers' pneumoconiosis was diagnosed in average age of 48.8 years ( $SD = 12.5$ ). Average time of exposure was 21.1 years ( $SD = 7.9$ ) based on information about exposure found in 76.5% of sample. Concentration of  $SiO_2$  in the black-coal mine's dust was less than 5% in 90% of sample and 5–10% in the rest of sample. Data on smoking habits were available from 73% of workers of those 65.6% were smokers or ex-smokers. In this sample 492 persons died in period 1992–2006 and average age of death was 67.0 years ( $SD = 12.2$ ). Of those, lung cancer was the cause of death in 14.4%. The main causes of death were cardiovascular diseases (39.4%). In total 91 lung cancer cases were diagnosed with average age of 63.6 years ( $SD = 9.2$ ). Calculated SMR for lung cancer in miners with coal workers' pneumoconiosis was 2.2 (95%CI 1.8–2.8) comparing with the general Czech male population.

**Conclusion:** This study found significantly higher lung cancer risk in workers with pneumoconiosis who were working in a mine comparing with general Czech population. More detail analysis of risk factors will follow.

**Acknowledgment:** The study has been supported by the Czech Ministry of Health—Nr. 8556 Longitudinal prospective study on carcinogenic risk in workers exposed to dust with content of crystalline form of silica dioxide in the Czech Republic (2005–2009).

#### ISEE-960

#### Health Risk Assessment of Indoor Mould Exposure

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**Background:** Because possible health effects due to mould exposure can not be excluded with final safety, indoor mould growth may not be tolerated from the hygienic point of view. All activities aiming at the decontamination of microbial contaminations require a detailed risk assessment with respect to the extent and the duration of measures to be taken.

**Methods and Results:** Based on the current knowledge, semi-quantitative risk matrices were compiled concerning the three principal health effects related to moulds (1. sensitization/allergy, 2. infection, and 3. intoxication) and the corresponding predisposing factors in humans. The microbial and human preconditions are described below and are graphically displayed in risk matrices. 1. Risk for sensitization/allergy due to indoor mould exposure. Microbial preconditions: basic requirement for a sensitization and/or allergic reaction is the production of allergens which depends on both genetic

determination and environmental conditions, e.g. the substrate. Human preconditions: familial disposition to atopic diseases, preexisting sensitization and/or existence of one or more atopic disease(s) are predisposing factors for exposed persons. The relevance of these predispositions increases in the order given above. In case of sensitization and/or atopic diseases, the predisposition is the more distinct the more mould-specific the sensitization and/or atopic disease(s) are. 2. Risk for infection due to indoor mould exposure. Microbial preconditions: first of all the fungi must be able to penetrate the target organ and, secondly, be able to grow at body temperature (32–37°C). Moreover, pathogenicity factors such as adhesines, enzymes, toxins, and melanin play an essential role for the infectious potential of fungi. Human preconditions: the most important predisposing factor for fungal infections is an immunosuppression of exposed persons, because mycoses caused by moulds are opportunistic infections. Intensive care patients and patients with transplants, AIDS, cancer or mucoviscidosis bear the highest risk for mould infections. 3. Risk for intoxication due to indoor mould exposure. Microbial preconditions: the basic condition for an intoxication risk is that genetically determined toxin-producing fungi occur. Environmental conditions, especially the substrata available, determine whether a toxin-producing mould species will produce the toxin or not. It is still under debate, whether mycotoxin concentrations in indoor air are toxicologically relevant. No information on possible predisposing factors for humans concerning the risk for intoxication is available. Nevertheless, predisposing factors concerning the target organ are most likely to occur. It is thus conceivable that a liver damage could be a predisposing factor for organ-specific aflatoxin effects.

**Conclusion:** In conclusion, the risk matrices presented here indicate the need for further research in this field, e.g. on immune-modulatory effects of primary and secondary metabolites of fungi, actinomycetes, and other bacteria. The suggested matrices for risk assessment must be further evaluated in experimental and epidemiological studies.

#### ISEE-961

#### Application of GIS Mapping Tools to Prioritize Community Air Pollution Issues

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**Background:** In response to the growing attention on the connections between air pollution and adverse health effects, communities have begun to express concern over air quality levels and interest in addressing local air pollution issues. In light of these concerns and local issues, community groups and individual residents want to know how to systematically identify and prioritize the key air pollution stressors in their communities to better evaluate and reduce health risk. Geographic information system (GIS) maps of air pollution data can be useful tools for communities in their assessment of air pollution-related risks and how to best mitigate them. Maps that provide community-level information on criteria pollutants, and hazardous air pollutants/air toxics could provide relevant information for communities to assess potential exposures from multiple sources. Data from the U.S. EPA's National-scale Air Toxics Assessment, Air Quality System, National Emissions Inventory, and Toxic Release Inventory are mapped at the appropriate spatial and temporal resolutions for identifying risks of exposure to multiple pollutants. These data combine monitored and model-simulated pollutant and exposure information to identify pollution hot spots and define at-risk groups.

**Discussion:** This paper utilizes GIS mapping tools (e.g., ArcGIS, Google Earth, and U.S. EPA's EnviroMapper) to provide community-level information on air pollution exposures and issues of concern. Findings from this case study analysis will assist U.S. EPA researchers in developing tools to assist communities with cumulative risk assessment and issue prioritization.

Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

#### ISEE-963

#### Effects of Source-specific Emissions of Ambient Particulate Matter on Respiratory Symptoms Among Asthmatic Children in Detroit, Michigan

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**Methods:** We observed 298 children (5–11 years of age) with asthma residing in Detroit, Michigan during 2-week seasonal assessments from Fall 1999 to Spring 2002 as part of the Community Action Against Asthma (CAAA) partnership. Daily self-reports of asthma symptoms were obtained from study diaries and compared with source-specific ambient fine particulate matter ( $\leq 2.5 \mu\text{m}$ ) contributions from specific emission sources using generalized estimating equations. Models considered effect modification by maintenance corticosteroids (CS) usage as recorded in a daily diary. Study participants were predominantly African American and Hispanic from low income families, and >75% were categorized as having persistent asthma. All analyses were controlled for participant-specific variables (age, race, sex, and baseline height) and potential time-dependent confounders (day of week and season).

**Results:** In both single-source and multiple-source models, significant associations were found between exposure to ambient PM<sub>2.5</sub> from coal combustion, motor vehicle and industrial sources and asthma symptoms (nighttime wakeup, short-acting bronchodilator use, shortness of breath, wheezing and chest tightness). In addition, significant associations were found between asthma symptoms and coal combustion and industrial sources among children not using CS, and between asthma symptoms and traffic, crustal and industrial sources for children using CS.

**Conclusion:** The results presented in this analysis support the associations between PM<sub>2.5</sub> mass and asthma symptoms in Detroit found previously by CAAA. Our findings suggest that specific sources of fine particle pollution in Detroit aggravate symptoms of susceptible asthmatic children.

Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

#### ISEE-965

#### A “Natural Experiment”: Preterm Delivery Rates Drop During Utah Valley Steel Mill Closure

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**Background:** Prior studies have linked the Utah Valley Steel Mill closure from August 1986 through September 1987 to improvement in several health outcomes. So-called “natural experiments” ease concerns over confounding and exposure misclassification, common concerns in studies of air pollution and pregnancy outcome.

**Methods:** Utah birth records for singleton infants of non-Hispanic white mothers who were married at the time of delivery (88% of Utah Valley mothers, 79% of other Utah mothers) were used to examine preterm birth and term birthweight. Utah Valley outcomes during mill closure (August 1986–September 1987) were compared to outcomes from similar calendar intervals for two years before and after closure in Utah Valley and from the rest of Utah. For example, mothers who began pregnancy from August

1986 through May 1987 have a full first trimester during the mill closure; comparison groups were mothers who began pregnancy during the same interval in different years (August through May 1984–85, 85–86, 87–88, 88–89).

**Results:** Mothers who were pregnant around the time of mill closure were less likely to deliver prematurely than mothers who were pregnant before or after. Effects were statistically significant when exposure was defined by the second trimester (risk ratio(RR) = 0.86, 95%confidence interval (CI) = 0.75–0.98) and lower, but not significant, when defined by the first trimester (RR = 0.94, CI = 0.81–1.08). In contrast, among Utah births outside the Utah Valley, corresponding RR for the same time periods were not lower (second trimester RR = 1.01 CI = 0.95–1.07 and first trimester RR = 1.03 CI = 0.97–1.10). Differences were more pronounced comparing mothers within the Utah Valley to mothers outside the Utah Valley; for second trimester exposure, e.g., the RR during closure (RR = 0.81, 95%CI 0.71–0.93) was stronger than the RR not during closure(RR = 0.95, 95%CI = 0.90–1.01). No patterns for birthweight were observed.

**Conclusions:** These results support other studies that have found effects of air pollution exposure in pregnancy on preterm birth.

#### ISEE-966

#### Effect Modification of Interleukin-6 Response to Ambient Carbon Monoxide Levels by Fibrinogen and Interleukin-6 Polymorphisms

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**Background:** Both interleukin-6 (IL-6) and fibrinogen have independently been associated with increased cardiovascular morbidity and mortality. In vitro and in vivo experiments have demonstrated that increased fibrin or fibrinogen stimulate IL-6 production. Ambient air pollution has been associated with increases in inflammatory blood markers such as IL-6. This study aimed to examine the possibility of genetic modification of this response by polymorphisms in the interleukin-6 (*IL6*) and fibrinogen beta chain (*FGB*) genes.

**Methods:** In 973 myocardial infarction survivors from 6 European cities, plasma IL-6 levels were determined in repeated samples (N = 5639). Baseline blood samples were genotyped and specific single nucleotide polymorphisms (SNPs) in the *IL6* and *FGB* genes that showed associations with plasma levels of IL-6 and fibrinogen in our sample were selected. City-specific analyses were performed assessing the influence of air pollution on IL-6 levels using additive mixed models adjusting for patient characteristics, time trend and weather. Gene-environment interactions were estimated for each SNP in models including the main effect of the SNP, the main air pollution effect, and an interaction term between air pollution and SNP where SNPs were coded using an additive genetic model. City-specific results were pooled using meta-analysis methodology.

**Results:** An interquartile range increase (0.34 mg/m<sup>3</sup>) of carbon monoxide (CO) at urban background monitors during the preceding 24 hours, was associated with a 0.57% (95% confidence interval [CI] –0.63–1.79%) increase in the level of IL-6. We found evidence of an interaction effect for *FGB* rs1800790 and CO (*P*-value for interaction 0.0098) where the air pollution effect seemed to be limited to the homozygous minor allele

genotype leading to a 8.0% (95%CI 1.1–15.4%) increase in overall geometric mean of IL-6. For *IL6* the strongest interaction effect was found for rs2069832 (*P*-value for interaction 0.029). Here the air pollution effect was limited to the homozygous major allele genotype where a 2.1% (95%CI 0.4–3.8%) change in the geometric mean of IL-6 was seen. Results from analyses of nitrogen dioxide and particle number concentration showed similar but weaker associations. Highly correlated *IL6* SNPs (rs1554606, rs1800795, rs2089845) showed similar patterns of association.

**Conclusions:** In spite of the weak effects of air pollution in the whole study population we found an association between air pollution and IL-6 in a genetically determined subpopulation. These results need to be confirmed in future studies.

#### ISEE-968

#### The Current Situation about the Traffic Pollution of CO in Xi'an City and the Analysis for the Reasons

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**Objective:** Investigate the current status about pollution of CO in city traffic during the several years recently in Xi'an city, and analyze the factors briefly.

**Method:** Classify the roads in the city according to the different features, choose the sections according to typical principles, make sampling and monitor the concentration of CO between Oct.9 and Oct.18 in 2007.

**Result:** 1) The daily average concentration in the central point of the bending roads and crossings is 9.501 mg/m<sup>3</sup>, which is 1.38 times more than the national second order daily mean standard (4.000); the range of the centers of the roads is between 7.703 mg/m<sup>3</sup> and 14.531 mg/m<sup>3</sup>, with 100 percentage of over standard rate of the national second order daily mean standard. 2) The daily average rate of CO in all the roads, bending roads and crossings is 8.001 mg/m<sup>3</sup>, which is 1.00 time than the national second order daily mean standard; the concentration in the sidewalks is 5.031 mg/m<sup>3</sup> to 12.969 mg/m<sup>3</sup>, having an 100 percentage of over standard rate. 3) The daily average rate of CO of the background points in all the roads, bending roads and crossings is 6.894 mg/m<sup>3</sup>, with 72 percentage of over standard rate of the national second order daily mean standard, the range is between 4.833 mg/m<sup>3</sup> and 9.719 mg/m<sup>3</sup>, the over standard rate is 100 percentage. 4) The rule of the change of the pollution of CO is that in the time period between 7 and 19 o'clock is some kind of U letter, the highest data is collected in the mornings or the nights, the same as the highest time of the traffic.

**Conclusion:** The current situation of over standard rate of CO in city traffic is actually very serious in Xi'an city. This is because of the rapid development of the retention of motor cars in Xi'an city recently, and of the lack of the thinking of environmental protection and the traffic rules; It is very important to enlarge the vigor of government, and the owners of cars should enlarge their own environmental protection in minds, so that they can face the problem of CO together.

#### ISEE-969

#### Housing Environment and Health in Saharanpur City, India

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**Background:** The firsts and basic frame of environment in which humans live is their house. Housing through ecological linkages affects human health in many ways. The most affected groups by poor housing are children, women and elderly, especially of low income groups who have neither access to better housing nor health care in urban India. The idea of town planning though not new to India but almost all the towns and cities in the country show an organic growth. The British imposed on them some new planned elements like civil lines and cantonments. Only lately

have State governments started to enact legislations and prepare a Master Plan. However, all these legislations and plans, formulated to improve the housing environment due to high population growth, are flouted. The result is an appalling overall environmental quality of housing. As a consequence, an overwhelming majority of big and medium size cities of the country must face environmental challenges of inadequate housing.

**Discussion:** The prevailing conditions in the neighborhood are also important, but the present study focuses mainly on the quality and quantity of water, sanitation facilities, ventilation, fuels used, crowding, house materials, drainage and planning status. All these together affect personal hygiene, sanitation, temperature, humidity, presence of vectors of diseases, indoor air quality etc., which all together affect human health. Several indices of housing conditions have been worked out using standard scores in this study. Inquiries from households and cross verification, in many cases from dispensaries and hospitals, have shown that the most prevalent diseases in study area are diarrhea, cold and cough, skin infections, malaria, asthma, respiratory infections, typhoid, enlargement of liver and spleen, blindness, TB and pneumonia, in that order.

**Conclusion:** The analysis clearly indicates that these diseases and many indices of housing conditions have high and statistically significant relationships in Saharanpur.

#### ISEE-970

#### Residential Outdoor NO<sub>2</sub> Levels During Pregnancy and Birth Weight and Length in the INMA Cohort in Valencia, Spain

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**Objective:** To assess the association between residential exposure to outdoor NO<sub>2</sub> during pregnancy with anthropometric measures at birth in a general population mother-infant birth cohort (INMA) in Valencia, Spain.

**Methods:** Between 2004 and 2005, 855 pregnant women attending the prenatal population-based screening program at the reference Hospital were included in the study. From them 35 had a spontaneous abortion or fetal death and 33 withdrew or were lost to follow up, and 787 delivered a live infant. Outdoor concentrations of NO<sub>2</sub> were monitored in a grid of 93 sites of the study area, in 4 campaigns during pregnancy period. Universal kriging was used to predict NO<sub>2</sub> levels in sites not monitored, i.e. women addresses. Then GIS data (traffic, land use, and altitude) were used to improve the NO<sub>2</sub> spatial estimations. Using daily information from the monitoring network, those NO<sub>2</sub> estimations were adjusted to correspond with the pregnancy period for each woman. In order to explore critical exposure windows an air pollution indicator for each trimester of pregnancy was built. To assess the relationship with measures at birth, three NO<sub>2</sub> exposure categories were defined, i.e. <30, 30–40, and >40 µg/m<sup>3</sup>. Outcome variables were birth weight (in grams) and birth length (in centimeters). Both were standardized for sex and gestational age using the residuals method. We defined small for gestational age (SGA) as a birth weight or length below the 10<sup>th</sup> percentile using standard percentile charts for sex and gestational age from Spanish population. Association between exposure to residential outdoor NO<sub>2</sub> and anthropometric measures was assessed by linear regression for continuous variables and by logistic regression for SGA controlling for gestational duration, sex, maternal variables (tobacco, caffeine and alcohol consumption, size and pre-pregnancy weight, education, occupational status, country of origin), paternal length, and season of delivery.

**Results:** Exposure to outdoor NO<sub>2</sub> was assessed for 785 out of the 787 mother-child pairs in the study. Among them, NO<sub>2</sub> mean level correspondent to the 785 pregnancy periods was 36.8 µg/m<sup>3</sup> (25, 50, and 75<sup>th</sup> percentiles, 29.4, 37.8, and 45.3). Adjusted birth length decreased

0.32 cm (95%CI 0.07–0.57) with a NO<sub>2</sub> exposure above 40 µg/m<sup>3</sup> at first trimester compared with exposure below 40 µg/m<sup>3</sup>. Birth weight was only marginally associated with NO<sub>2</sub> exposure [a reduction of 40.0 grams in birth weight (95%CI –17.5–97.3) for the same comparison]. The adjusted odds ratio (OR) of a SGA for birth weight associated with an NO<sub>2</sub> exposure >30 vs <30 µg/m<sup>3</sup> during the whole pregnancy was 1.68 (95%CI 0.93–3.03), and 2.10 (95%CI 0.92–4.78) for birth length for a similar comparison during the third trimester.

**Conclusion:** Our results suggest an association between maternal exposure to outdoor air pollution and birth outcomes. Birth length seems to be more clearly associated with NO<sub>2</sub> than birth weight. We did not find a clear time of exposure-effects pattern. Outdoor NO<sub>2</sub> could be only a proxy of other pollutants, i.e. fine particulates, and this needs to be investigated.

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#### ISEE-971

##### Gender and Alcohol Drinking Modify the Association Between Myeloperoxidase Polymorphism and Risk of Coronary Artery Disease

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**Background:** Myeloperoxidase (MPO) is an oxidant for low-density lipoprotein (LDL), which plays an important role in the atherosclerotic process. A polymorphism G-463A in the promoter of MPO gene has been associated with the risk of coronary artery disease (CAD), whereas results are controversial. In addition, the gene-environment interaction of CAD risk has not been determined. This hospital-based case-control study was designed to estimate whether the MPO G-463A polymorphism contribute to the CAD risk and interact with environmental factors to modify disease risk.

**Methods:** A total of 1262 participants receiving coronary angiography were recruited from a hospital in Taiwan between Nov. 2001 and Jun. 2004. Subjects with one or more coronary artery narrowed over 50% were defined as cases, others as controls. Genomic DNA isolated from whole blood was used for genotyping by a real-time PCR assay based on TaqMan technology. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated by logistic regression.

**Results:** Genotypes were available for 670 subjects (457 cases and 213 controls). The risk for CAD appeared to decrease 33% in individuals with the GA+AA genotypes compared to those carrying the GG genotype (OR = 0.67, 95%CI = 0.43–1.05), but did not reach significance. This association was slightly modified by use of alcohol. Among non drinkers, GA+AA genotypes enhanced the protective effect (OR = 0.59, 95%CI = 0.35–0.99). In addition, men with the GA+AA genotypes also inherited less susceptibility to CAD than those with the GG genotypes (OR = 0.35, 95%CI = 0.35–0.99).

**Conclusion:** These data suggest that the MPO G-463A polymorphism may reduce the risk of coronary artery disease in the Taiwanese population, especially among non-drinkers and man.

#### ISEE-972

##### Exposure Pattern Assessment—the NOMIRACLE and the MILAGRO Project—Importance of Indoor VOC for Allergic Symptoms/Eczema

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Research, Leipzig, Germany; ‡Joint Research Centre EU Ispra, Ispra, Italy; and §Universidad Nacional Autónoma de México, Mexico City, Mexico.

**Background:** Results of epidemiological studies have shown an influence of VOC (volatile organic compounds) on allergies. For example within the LISS study (Leipzig infection, allergy and airway diseases study among school starters, involving 2536 children) the effect of indoor exposure on physician-confirmed eczema and allergic symptoms could be shown. Exposed children showed a significant effect on allergic disorders compared with a control group of not exposed children. The lifetime prevalences were for allergic symptoms 9.3 vs. 17.2% and for eczema 11.5 vs. 20.4%. Adjusted for confounders, the VOC burden led to odds ratios of 1.8 (95%CI: 1.3–2.6) for allergic symptoms and 1.9 (95%CI: 1.4–2.7) for eczema. The question is whether this kind of exposure is also relevant in other geographical regions and/or what kind of measurements give us the best assessment to reflect the personal exposure respectively to assess the real exposure (dose).

**Methods:** Within different studies, including the EU funded NOMIRACLE project (Novel Methods for Integrated Risk Assessment of Cumulative Stressors in Europe), and including the MILAGRO (Megacity Initiative: Local and Global Research Observations, Mexico City) project, the VOC indoor load has been determined with different methods (active and passive sampling with several passive sampling systems) and at different places (home, kindergarten/schools and close to the persons—using passive sampling systems). The substances have been detected using GC-MS.

**Results:** It can be stated that the measurement methods are comparable (differences not statistically significant).

- The patterns of exposure are similar independent from the locality.
- Comparing the exposure close to humans (the personal exposure) with the stationary measurements in homes and public buildings it can be concluded that the assessment in the homes reflect as best the personal exposure.
- The indoor exposure dominates the total exposure. The levels of most VOCs are typically higher inside residences and buildings than in outdoor microenvironments. Only benzene can be assigned to an outdoor source. The source strength of indoor emissions has got a stronger influence than the infiltration of outdoor air for many pollutants.
- In the southern countries the ratio between indoor and outdoor is not so pronounced compared with central and northern Europe. This ratio is related with a higher number of local mobile sources, emissions from gas stations and industries and a higher ventilation rate due to a lack of building's isolation.

**Conclusion:** A time-weighted model of exposure using all measured microenvironments and time-activity data can provide information about the daily uptake of VOC and can be used for personal risk assessments. The exposure against VOC seems to be a common (general) problem. From that point of view VOCs are a common problem as far as allergies are concerned.

#### ISEE-973

##### Lung Cancer Risk in Workers with Silicosis in the Czech Republic

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**Objective:** Many epidemiological studies identified increased lung cancer risk in workers exposed to dust with content of crystalline form of silica dioxide. The aim of this study was to compare lung cancer risk between workers with diagnosed silicosis and general population of the Czech Republic.

**Material and Methods:** The study sample included 797 workers exposed to crystalline silica dust who were as well as registered with silicosis in the National Register of Occupational Diseases in 1992–2001. These workers came from metallurgic, ore-mining, stone-cutting, ceramics and porcelain industry. The most frequent professions were metallurgists, ore-miners, breakers, stonecutters, grinders, tool sharpeners and bricklayers. The data on individual and occupational history of workers were linked with the data from the National Cancer Register and the National Population Register. Data about general male population by 5-age groups were retrieved from Czech health statistics. Lung cancer risk was calculated as a standardized morbidity ratio (SMR) with 95% confidence interval (CI) based on the data about incidence of lung cancer from 1992 to 2006; for people of the age 30 years and older. Stata v.9 was used for data analysis.

**Results:** Average age of study sample in time of diagnosed silicosis was 60.4 (SD 10.7), average exposure in years was 24.2 (SD 10.5). In period 1992–2006, 158 workers (19.8%) contracted cancer; of those the most frequent diagnosis was lung cancer—61 cases. Average age in time of diagnosed lung cancer was 67.2 years (SD = 8.6). In this period 335 (42.0%) workers died, average age in time of death was 70.8 years (SD = 9.8). The most frequent causes of death were cardiovascular diseases (43.0%), all causes cancer without lung cancer (17.3%), respiratory diseases (16.7%) and lung cancer (15.8%). Study sample contains 31% smokers, 19% non smokers, in 50% lack of information on smoking. No significant association was found between the level of seriousness of silicosis and exposure characteristics—exposure duration, dust intensity, concentration of crystalline form of silica dioxide in dust. No association was identified between lung cancer incidence among workers with silicosis and all occupational dust exposure characteristics. Positive association was confirmed between smoking and incidence of lung cancer in workers with silicosis ( $P < 0.01$ ), but high proportion of workers without information on smoking (50%) was weakness of this result. Significantly higher lung cancer risk SMR = 2.8 (CI: 2.2–3.8) was confirmed in workers with silicosis comparing with general Czech population.

**Conclusion:** The results of this study demonstrate significantly higher lung cancer risk in workers exposed to dust containing crystalline silica and having silicosis comparing with general population in the Czech Republic. Significant association was found neither between occupational dust exposure characteristics and degree of seriousness of silicosis, nor incidence of lung cancer in study sample.

**Acknowledgment:** The study was financed by the Czech Ministry of Health—Nr. 8556 Longitudinal prospective study on carcinogenic risk in workers exposed to dust with content of crystalline form of silica dioxide in the Czech Republic (2005–2009).

#### ISEE-974

#### Factors Important to Defining Susceptibility of the Aging Population to the Effects of Environmental Exposures to Environmental Pollutants

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**Background:** The changing age demographic of the United States indicates that by mid-century, nearly 25% of the US population will be 65 years old or older. This has fueled an increase in scientific research in the field of aging and health. Although knowledge of the biology and physiology of aging has advanced, especially with regard to medical and therapeutic applications, an understanding of the unique factors associated with aging and how they affect exposure has not kept pace. Numerous studies and surveys have shown that as individuals age, their activities change; the level of physical activity, types of activities (e.g., driving), locations (i.e., microenvironments) where these activities take place, and durations of these activities are likely to affect their potential exposures. In addition, broader lifestyle changes can be affected by health and general mobility. In turn, health conditions might require medications that further affect activity and lifestyle. All of these factors can contribute alone or in combination to changes in activity and lifestyle patterns that might affect exposures. It is readily apparent that this matrix becomes quite complex, yet an overall view of the interrelatedness is critical if we are to classify the aging into subpopulations that are most at risk for adverse outcomes from environmental exposures.

**Objective:** The objective of the current study is to evaluate the potential impact these factors, alone and in combination, have in identifying subgroups of the aging that are susceptible to the adverse effects that result from exposures to environmental pollutants.

**Methods:** Our initial investigation of potential factors that might affect the classification of the aging population into groups included identifying and categorizing the number and types of chronic diseases, body mass index, lower extremity disease and mobility, functional limitations (Activities of Daily Living and Instrumental Activities of Daily Living), cognitive functioning (Digit Symbol Substitution), and use of prescription drugs, painkillers, antacids, and dietary supplements as available from NHANES.

**Results:** The number of chronic conditions reported generally increased with age rising from 1.43 among 65–69 year olds, peaking at 1.74 for 80–84 year olds. The proportion of the population reporting no chronic conditions fell steadily with age, from 23% for individuals aged 65–69 to 15% for individuals aged 80–84 year olds. With regard to cognitive scores, older men scored slightly lower than women on average, and scores consistently declined with age. The percentage of individuals aged 65+ who had taken at least one type of prescription drug, painkiller, antacid, or dietary supplement in the past month was 95% and 68% were on more than one prescription drug. In general, elderly women take more prescription drugs and dietary supplements than men (3.4 vs. 2.9). Ongoing data compilation includes information related to housing, dietary changes, and microenvironmental influences.

**Conclusion:** This information will help to classify the aging population into subgroups that may potentially be at risk for increased environmental exposures.

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#### ISEE-975

#### Secondhand Smoke In Casinos: Nonsmokers' Exposure, Dose, and Risk

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**Methods:** I assessed area secondhand smoke (SHS) exposures in 5 casinos, using respirable particle (RSP) concentrations ( $PM_{2.5}$ ) and particle-bound polycyclic aromatic hydrocarbons (PPAH), and personal SHS exposures using a biomarker, to estimate SHS air pollution, odor, and irritation for patrons and workers, and mortality risk to casino workers. I deployed real-time area monitors for RSP and PPAH indoors

and outside of 3 casinos. I measured smoking prevalence, smoker density, and carbon dioxide levels to generalize results. I employed urine cotinine to estimate personal RSP exposure in 7 volunteers visiting 3 casinos before and after casino visits via pharmacokinetic modeling. Air pollution levels were compared to the color-coded U.S. air quality index (AQI) for PM<sub>2.5</sub> and to contemporaneous measurements from the State's real-time PM<sub>2.5</sub> outdoor network. Risks to casino workers were assessed by dose-response risk models. The Pennsylvania casinos: Mohegan Sun, Philadelphia Park, and Harrah's (RSP & PPAH) and The Meadows, Philadelphia Park, and Presque Isle Downs (cotinine).

**Results:** RSP in all casino smoking areas ranged from 2.5 to 11 times outdoors, while PPAH ranged from 2.5 to 6 times outdoors. Nonsmokers gambling for ~5 hours had 10 to 20 fold increases in urine cotinine. Smoking prevalence ranged from 15% (weekday) to 30% (holiday weekend), compared to Pennsylvania's smoking prevalence of 25% (23% to 29%). This occurred despite the fact that ventilation rates per occupant in all cases exceeded ASHRAE Standard 2001, the last standard to recommend ventilation rates for casinos with smoking. Personal RSP exposures averaged 160 µg/m<sup>3</sup> (SD 81) [cotinine 1.77 (SD 0.83) ng/ml], outdoor levels averaged 13.6 µg/m<sup>3</sup>, while measured area RSP levels averaged 106 µg/m<sup>3</sup> (SD 25) compared to measured outdoor RSP levels averaging 18 µg/m<sup>3</sup> (SD 9). PPAH indoors averaged 4 times higher [20 ng/m<sup>3</sup> (SD 8)] inside casinos than outdoors [5 ng/m<sup>3</sup> (SD 3)]. Casino air quality ranged from Unhealthy (Code Red) to Hazardous levels (Code Maroon) of RSP due to SHS. SHS-RSP irritation thresholds were exceeded by factors of 10 to 100 in all smoking areas, and by 99.9% of the levels measured on the nonsmoking floor of one casino, while adverse SHS odor thresholds were exceeded by factors ranging from 10- to 1000-fold in the smoking areas and from 3- to 200-fold in the nonsmoking areas. Nonsmoking casino patrons who visited the casinos in the early evening during weekdays, experienced personal RSP exposures (calculated from cotinine using a pharmacokinetic model) ranging from Very Hazardous to Unhealthy levels of air pollution, and averaging Very Unhealthy (Code Violet), according to the AQI. Contemporaneous RSP as measured by Pennsylvania's outdoor air quality monitoring network was Good (Code Green). Risk assessment based on cotinine dosimetry for the 12,364 casino workers ultimately expected for Pennsylvania's gaming industry, yields an estimated 8 deaths from SHS-lung cancer and heart disease per year. Risk from SHS for the average casino worker exceeds OSHA's Significant Risk level by an estimated 27 fold.

**Conclusion:** Air pollution from RSP and PPAH from smoking in casinos is a significant threat to both public and worker health.

#### ISEE-977

#### Socioeconomic Position and Lifestyle Characteristics as Determinants of Health Status in Elderly Men of a Medium Size City in Brazil

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**Objective:** The purpose of the study was to identify characteristic health behaviors and analyze social inequities in health status and health care utilization in elderly men.

**Methods:** This cross-sectional study was based on a sample of 2 910 men, 60 years of age and older, participating in the 2006 influenza vaccine campaign in a medium size city in Brazil. A structured questionnaire was used for interviewing the participants. Two-stage cluster analysis was used to divide the subjects into groups (clusters), in such a way that those within a cluster were more similar in relation to socioeconomic, demographic and lifestyle characteristics than subjects in different clusters. The descriptive characteristics of each cluster were compared and patterns of health behavior were identified for each group. Prevalence ratios (PR) and its 95% confidence intervals (CI) were estimated to evaluate possible associations between self-reported health status and independent variables considering the different clusters.

Multivariate analysis was performed using Poisson regression. Three clusters were identified. Cluster 1 (socioeconomically vulnerable) was characterized by a high proportion of aged men and widowers, low income and few years of schooling, with reduced physical activity. Cluster 2 (socioeconomically active) was characterized by younger men, with wages as their source of income and who had an intermediate pattern of health behaviors. Cluster 3 (socioeconomically protected) was characterized by a high proportion of married men, high average income and more years of schooling, with low prevalence of tobacco smoking and more physically active subjects.

**Results:** In relation to the men in the **socioeconomically protected** group, those in the **socioeconomically vulnerable** group had a high probability of referring poor health (PR = 1.54; 95% IC 1.34–1.77), of reporting four or more chronic conditions (PR = 1.03; 95% IC 0.92–1.16) and regular use of medication (PR = 1.10; 95% IC 1.03–1.17) and of having been recently admitted into a hospital (PR = 1.61; 95% CI 1.29–2.01). Men in the **socioeconomically active** group had a low probability of referring poor health (PR = 0.86; CI 95% 0.71–1.04), of reporting four or more chronic conditions (PR = 0.77; 95% IC 0.65–0.90) and regular use of medication (PR = 0.84; 95% CI 0.77–0.92) compared to those in the **socioeconomically protected** group. Multivariate analysis within each cluster showed that men reporting regular use of medication, four or more chronic conditions, a recent admission into a hospital and utilization of the public health system had a high risk of self-reported poor health status.

**Conclusion:** Although factors that determined self reported health status in members of each cluster were the same, the observed risk estimates varied among the groups. As each cluster differed in relation to socio-economic characteristics and lifestyle patterns related to health behaviors, these findings are in accordance with other studies that indicated a role for these factors as determinants of health status among the elderly.

#### ISEE-978

#### Ambient Air Pollution Affects Birth and Placental Weight. A Study from Lombardy (Italy) Region

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**Rationale:** The possible role of air pollution in adverse pregnancy outcomes has emerged in recent studies showing a relationship between high levels of air pollutants and low birth-weight (LBW), preterm delivery (PTD) and intrauterine growth restriction. LBW and PTD are the main responsible of perinatal morbidity and mortality in western countries. Importantly, the “fetal programming” hypothesis suggests that growth delay in-utero may influence also the risk of cardiovascular and metabolic diseases in adulthood. By now, results regarding the relationship between air pollution and fetal growth are partially discordant. Conflicting evidence may reflect inadequate control of confounders, variation in population characteristics, exposure assessment strategies and period of pregnancy considered.

**Methods:** We investigated all singleton live births from mothers resident in Lombardy Region (Italy, 9.4 million inhabitants) delivered by caesarean section in the largest Obstetric Hospital in Milan during the period 2004–2006 (n = 3692). Neonatal outcomes and maternal characteristics were derived from: i) regional recorded birth certificates and ii) clinical records. Birth-weight, head circumference, Apgar score, placental weight were the investigated outcomes. Detailed information about duration of gestation, baby gender, maternal age at delivery, parity, maternal illnesses, BMI and weight gain during pregnancy, parental education and occupation, were collected. Maternal air pollution exposure during pregnancy was estimated based on monitoring stations data from the Regional Environmental Protection Agency. Daily mean concentration of PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub>, CO and O<sub>3</sub> were obtained along with daily data on

humidity and temperature. The region was divided in 9 areas with homogeneous average air pollution levels. Each woman was assigned to one area according to her residence at the time of delivery. Time variables were dealt with to represent the exposure time-window considered relevant for the different health outcome of concern. Effects were evaluated using multiple regression models controlling for the mentioned confounding factors.

**Results:** Pregnant women were exposed to considerable levels of pollutant (mean  $PM_{10} = 49 \mu\text{g}/\text{m}^3$ , IQR = 26–63), with important seasonal variability ( $PM_{10} = 84 \mu\text{g}/\text{m}^3$  in January and  $23 \mu\text{g}/\text{m}^3$  in August). We observed an inverse relationship between birth-weight and  $PM_{10}$  and  $\text{NO}_2$  exposure levels. The magnitude of the effect seems to vary according to windows of exposure during pregnancy: we observed a decrease of 12 and 8 grams in birthweight for  $10 \mu\text{g}/\text{m}^3$  increase in  $PM_{10}$  during the fourth and the fifth month of pregnancy respectively ( $P = 0.001$  and  $P = 0.03$ ). We also observed an increased risk of LBW ( $<2500 \text{ g}$ ) related to higher levels of exposure at fifth months of gestation ( $\text{AdjOR} = 1.006$ ,  $P = 0.04$  for  $PM_{10}$  and  $\text{AdjOR} = 1.012$ ,  $P = 0.05$  for  $\text{NO}_2$ ).  $PM_{10}$  and  $\text{NO}_2$  exposure during the two months before delivery resulted also associated with a decreased placental weight ( $\beta$  for  $PM_{10} = -3$ ,  $P = 0.03$ ;  $\beta$  for  $\text{NO}_2 = -7$ ,  $P = 0.02$ ). CO seemed not to influence any of the examined outcomes.

**Conclusions:** Our preliminary results show that current air pollution levels in urbanised areas might affect fetal growth giving further support to rapid and efficient policy to decrease atmospheric pollutant levels.

#### ISEE-981

#### Repeated Measures of Inhalation and Dermal Exposure to Jet Fuel Among Air Force Personnel

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**Objectives:** The primary objectives of this study were to characterize inhalation and dermal exposure to jet propulsion fuel 8 (JP-8) based on measured levels of total hydrocarbons, naphthalene, benzene, toluene, ethylbenzene, and xylene (BTEX) in personal air and dermal tape-strip samples. We evaluated potential differences in exposure between *a priori* designated exposure groups, identified significant determinants of inhalation and dermal exposure to JP-8 constituents, and evaluated the relationships between total hydrocarbons, naphthalene, and BTEX.

**Methods:** The study population included 24 Air Force (AF) personnel recruited from an active USAF base. Based on job title and a review of job activities, participants were recruited from three *a priori* designated exposure groups (low: 6 office workers with no regular exposure to JP-8; moderate: 9 workers with fuel distribution jobs with intermittent exposure to JP-8, and high: 9 workers from fuel systems maintenance with regular exposure to JP-8). In January 2007, personal air samples were collected from the breathing zone of each worker over three consecutive work-shifts ( $n = 72$ ) and analyzed for total hydrocarbons via GC/FID, as well as BTEX and naphthalene via GC/MS. Dermal tape-strip samples were collected post-shift over three consecutive work-shifts ( $n = 72$ ) and analyzed for the same analytes. Linear mixed effects models were used to evaluate the exposure data.

**Results:** The geometric mean air concentrations for participants in the low, moderate, and high exposure groups were  $0.3$ ,  $1.7$ ,  $5.1 \text{ mg}/\text{m}^3$  for total hydrocarbons and  $0.3$ ,  $0.4$ ,  $0.9 \mu\text{g}/\text{m}^3$  for naphthalene, while results for BTEX were similarly ordered. The correlations between THC and the other analytes were strong as indicated by correlation coefficients ranging from 0.83 to 0.95. Significant predictors of inhalation exposure to JP-8 included the *a priori* assigned exposure categories (low, moderate, high) and task (working in the hangar, hangar office, refueling maintenance, fuel handling, other). Among highly exposed workers, time spent in the hangar was a significant predictor of inhalation exposure to JP-8. In this group, inhalation exposure

appeared to be affected by job (entrant, attendant/runner, other) and purpose of work (inspect, find leak, repair leak, other), though the results for these variables were not statistically significant. For all analytes, dermal tape-strip concentrations were below the limit of detection in  $>75\%$  of the samples.

**Conclusions:** Total hydrocarbons exposure was strongly correlated with naphthalene and BTEX, suggesting that exposures came from the same source. Significant determinants of inhalation exposure levels were the *a priori* exposure groups and the worker's task.

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#### ISEE-984

#### The Relationship Between Blood Serum Dioxin Levels and Breast Feeding

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**Background:** Studies of blood and breast milk from mothers have demonstrated that dioxins are eliminated from the body during breast feeding. The purpose of this paper is to explore the relationship between dioxin levels in blood and breast feeding for participants in a large population-based exposure study. The focus is on exploring 1) the effects of breast feeding a first child compared to additional children and 2) a time period interaction related to the changing levels of dioxins in the environment over time.

**Methods:** The data come from the University of Michigan Dioxin Exposure Study (UMDES) which was conducted to identify exposure pathways by which dioxin contamination in the environment contribute to dioxin concentrations in blood. Blood samples were collected from 946 study participants in Midland, Saginaw, Bay, Jackson, and Calhoun counties in Michigan in 2004–2005. Information on pregnancy and breast feeding were obtained during an hour-long interview of each study participant. Linear regression models were run for the log<sub>10</sub> of the blood TEQ (calculated based on the WHO 2005 TEFs), adjusting for all other covariates in the UMDES model including age, body mass index, smoking status, food consumption, and recreational activities.

**Results:** 532 of the study participants were women, 442 of the women had at least one child, and 240 of the women with at least one child breast fed for at least one month. After adjusting for covariates, breast feeding a first child and additional children were both significantly associated with a lower TEQ in blood. The effect of breast feeding a first child was larger than the effect of breast feeding additional children. The parameter estimates indicate that each six month increase in breast feeding a first child was associated with a 7.6% decrease in blood TEQ and each six month increase in breast feeding additional children was associated with a 2.3% decrease in blood TEQ.

**Conclusion:** In general, breast feeding before 1959 was significantly associated with a higher TEQ in blood while breast feeding from 1960–1979 and after 1980 were significantly associated with a lower TEQ in blood. This suggests that breast feeding during the historic period when the dioxin content in the food supply was high was not associated with reductions in blood TEQ, whereas breast feeding more recently when the women were eating less contaminated foods was associated with reductions in blood TEQ.

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#### ISEE-985

#### Inflammation of Airways Occurs Soon After Inception of Exposure to Flour Dust and Airborne Irritants in Bakery, Pastry Cooking and Hairdressing Apprentices: A Follow-Up Study of the Risk of Occupational Asthma

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France; and <sup>#</sup>INRS, Epidemiology department, Vandoeuvre-les-Nancy, France.

**Background:** Inception of occupational asthma (OA) may start soon after exposure to airborne allergens and irritants but its precocious natural history is poorly known. Early development of airways inflammation was investigated among hairdressing, bakery and pastry cooking apprentices.

**Methods:** Apprentices enrolled in 6 professional schools were followed-up every 6 months along their 2 years training programme (4 visits). Airways inflammation was evaluated by clinical examination and through spirometry, metacholine challenge tests (MCT), fractional exhaled nitric oxide (FENO) measurements and cell counting (especially eosinophils) in nasal lavage liquid. Sensitization to common and occupational allergens (alkali persulfates for hairdressers; flour allergens and alpha amylase for bakers and pastry cooks) was assessed by skin prick tests. Personal exposure levels were measured among a subgroup of 34 bakery and pastry cooking apprentices (flour dust air concentrations), and 28 hairdressing students (ammonia, hydrogen peroxide and persulfates) and repeated over two seasons. The study is still ongoing.

**Results:** Among 343 students who completed 3 successive medical visits (16.9 years old at visit 1 on average; mean time elapsed between V1 and V3 = 12 months), a statistically significant 2 to 3-fold increase in the prevalence of rhinitis was observed, up to 19–27% according to the apprentice group, along with a comparable but later and milder evolution of allergic eczema. Using a categorical variable (positive MCT = fall in FEV<sub>1</sub> ≥ 20%), the prevalence of bronchial hyperresponsiveness (BHR) exhibited a non significant increase from 7.1% to 9.3%. However, using a non-censored, continuous variable (linear Dose Response Slope; DRS = % fall in FEV<sub>1</sub> at last dose/total dose given) disclosed a significant ( $P = .009$ ) aggravation, especially among atopic subjects (OR = 2.6,  $P = 0.03$ ). Such aggravation of BHR was inversely related to smoking (OR = 0.30,  $P = 0.04$ ) in a multiple logistic regression, suggesting that occupational exposure rather than smoking, was the cause. FENO concentrations were increased during this one year follow-up (+3.6 ppb,  $P = 0.003$ ), and more so among atopics relative to non atopics (+6.1 ppb,  $P = 0.02$ ), and among those who had rhinitis (+5.8 ppb,  $P = 0.004$ ), in a multiple linear regression model that accounted also for smoking and training tracks. Whether respectively exposed to aeroallergens or to airborne irritants, bakers, pastry makers and hairdressers exhibited the same patterns. Skin prick tests associated with occupational allergens were more frequently positive among hairdressers ( $P = 0.05$ ), but not among bakers and pastry makers ( $P = 0.31$ ). No modification of the allergic profile of nasal lavage cells (percentage of eosinophils) was observed from V1 to V3.

**Conclusions:** These results show a high incidence of airways inflammation after a short period of exposure to known or suspected allergens and irritants at levels not greater than current occupational limit values. This observation of concern will be checked after completion of the 4<sup>th</sup> visit but might represent an early warning for the risk of OA. A new study will assess the time course of incidence of OA over the first years of activity of these “at risk” populations.

#### ISEE-986

#### PM Exposure Increases Coagulation Function. A Study Among Highly Exposed Steel Workers in Italy

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**Background:** Particulate air pollution (PM) has been associated with increased mortality and morbidity from cardiovascular diseases but the mechanism linking PM inhalation with health effects is not completely understood. There is a growing burden of evidence that PM could produce alveolar and systemic inflammation and increase blood coagulation and risk of thrombosis. In a previous study we observed a shortened Prothrombin Time (PT) and no variation on Activated partial thromboplastin time (aPTT) in association with high ambient PM<sub>10</sub> levels among healthy subjects in Milan, Italy. We investigated effects on blood clotting in a group of steel workers with well characterized exposure to high levels of PM.

**Methods:** We enrolled 38 male workers employed in a steel production plant in Italy. Blood drawings in the first and in the last day of the working-week were obtained. Detailed individual information on occupational and medical history, smoking, life style and non-occupational exposure to PM were collected from either the existing plant medical records or personal interview. Measures of PM<sub>10</sub>, PM<sub>5</sub> and PM<sub>1</sub> were obtained during the working-week, using a GRIMM 1100 light-scattering dust analyzer, in 11 work areas of the steel production plant. Individual exposure was calculated as the average of PM concentration weighted by the time spent in each area by the subject. Mixed models were fitted to analyse the relation between PM exposure and coagulatory and inflammatory indexes, after adjustment for age, BMI, education, smoking and NSAIDs consumption.

**Results:** Study subjects were exposed to PM levels 2–20 times higher than those to which general population is exposed (mean PM<sub>10</sub> = 233 µg/m<sup>3</sup>, range = 73–1220, mean PM<sub>1</sub> = 8 µg/m<sup>3</sup>, range = 2–30). We found elevated levels of inflammatory markers (intracellular adhesion molecules I-CAM and V-CAM) that further increased during the working week ( $P$  value for V-CAM = 0.002 and for I-CAM = 0.03). Average personal PM<sub>10</sub> exposure was significantly associated with an increase of C-Reactive Protein levels ( $\beta$  for 10 µg/m<sup>3</sup> of PM<sub>10</sub> = +0.03,  $P = 0.01$ ) and with shortened PT ( $\beta$  = −0.02,  $P = 0.02$ ). The same trend was confirmed considering PM<sub>5</sub> and PM<sub>1</sub> exposure. We observed no effects on aPTT.

**Conclusions:** Our results show for the first time in an occupational setting that exposure to PM increases systemic inflammation and affect coagulation function, confirming the hypothesis that enhanced blood clotting may mediate air particle related cardiovascular effects in the general population.

#### ISEE-987

#### Exposures to Criteria Air Pollutants and Preterm and Small-for-Gestational-Age Births in the Detroit Metropolitan Area: Long-Term Trends and Associations

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**Background:** A growing number of studies have reported associations between ambient air pollutants and adverse birth outcomes, including low birth weight, preterm birth, and to a lesser extent small for gestational age. These studies have limitations, including incomplete control of temporal trends in exposure and individual risk factors such as maternal smoking, and their results are often inconsistent.

**Methods:** We investigated the relation between ambient air pollutants and small for gestational age (SGA) and preterm birth (PTB) outcomes among 155,000 singleton births in Detroit, Michigan between 1990 and 2001. SO<sub>2</sub>, CO, NO<sub>2</sub>, and PM<sub>10</sub> exposures were used in single and multiple pollutant logistic regression models to estimate odds ratios (OR) for these outcomes, adjusting for the infant's sex and gestational age; the mother's

race, age group, education level, smoking status and prenatal care; the birth season; site of residence; and long-term exposure trends.

**Results:** SGA was associated with NO<sub>2</sub> (OR = 1.11, 95% confidence interval = 1.03–1.21) and CO (1.14, 1.02–1.27) exposures in the first month and with PM<sub>10</sub> exposures in the third trimester (1.22, 1.03–1.46). Maternal exposure to SO<sub>2</sub> was associated with PTB (1.07, 1.01–1.14).

**Conclusions:** This appears to be the first U.S. study to associate SGA with air pollutant exposures, and effects were observed at concentrations below current air quality standards. The study design addresses many of the limitations in the earlier studies, and it highlights the importance of accounting for long-term trends and individual risk factors.

#### ISEE-990

#### Urinary 1-Hydroxypyrene in Young Children is Associated with Exposure to Polycyclic Aromatic Hydrocarbons Due to Vehicle Traffic and Indoor Sources

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**Background:** Exposure to polycyclic aromatic hydrocarbons (PAH), major compounds present in polluted urban air is of concern for children's health. Human exposure to PAH can be assessed by monitoring 1-hydroxypyrene (1-OHP), a metabolite of pyrene, in urine samples; therefore, in the present study we measure urinary 1-OHP levels in 174 children 4-year-old living in urban and rural areas in Southern Spain, and we investigate the association between these levels and PAH exposure-related factors, such as vehicle traffic emissions, second-hand smoke and domestic heating and cooking.

**Methods:** Urine samples were collected from Monday to Friday, between April 2005 and June 2006. At the same time, environmental measures of traffic-related air pollution (NO<sub>2</sub>) were carried out and a questionnaire about indoor and outdoor residential environment was filled out by parents. Urine samples were analyzed by HPLC with fluorescence detection. Non-parametric tests and multiple regression analyses were used to identify environmental factors that influence 1-OHP excretion.

**Results:** Mean 1-OHP concentration was 0.061 μmol/mol creatinine, ranging between 0.004 and 0.314 μmol/mol. 1-OHP levels tended to increase among children living in urban areas (0.006–0.302 μmol/mol vs. 0.004–0.209 μmol/mol for children living in rural areas;  $P = 0.23$ ) and among those exposed to second-hand smoke (0.006–0.302 μmol/mol vs. 0.004–0.196 μmol/mol for non-exposed children;  $P = 0.17$ ), but differences were not significant. Non-parametric tests and regression analysis showed positive and significant associations ( $P < 0.10$ ) between 1-OHP and self-reported residential vehicle traffic, cooking device (electric/gas) and individual predicted exposure to NO<sub>2</sub> based on environmental measures and geostatistical analysis.

**Conclusion:** Concentrations of urinary 1-OHP were slightly lower than those generally reported for children living in "non-polluted" areas from different Western European countries and the US. We found positive but weak associations between 1-OHP and some of the studied factors. Higher exposure to PAH due to traffic-related air pollution and indoor sources may explain these findings. Other routes of exposure such as food that contribute substantially to overall PAH intake are currently being evaluated.

#### ISEE-996

#### Residential Proximity to Industrial Facilities and Risk of Non-Hodgkin Lymphoma

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**Background:** Industrial pollution has been suspected as a cause of non-Hodgkin lymphoma (NHL), based on clues from occupational studies and because the rates of this cancer increased dramatically during the latter half of the 20<sup>th</sup> century, lagging slightly behind a period of expanded industrial production in the United States. Despite compelling hypotheses, few studies have examined the relationship between NHL and residential proximity to specific types of industry. Such studies are now feasible using geographic information systems (GIS) coupled with publicly-available georeferenced databases of industry location.

**Methods:** We conducted a case-control study of residential proximity to industrial facilities and risk of NHL in four SEER regions of the United States. Industry locations were obtained from facility reporting to the Environmental Protection Agency's Toxics Release Inventory (TRI) for the years 1988–2000. Geocoded residential locations were used to characterize proximity of participants to industrial facilities during a 10-year period prior to the NHL diagnosis year or a reference year for controls. We included in our analysis 864 cases and 684 controls with relatively precise residential location information covering more than 7 of the 10 years. For each type of industry (by 2-digit SIC code), we evaluated the risk of NHL associated with having lived within 2 miles of a facility, the distance to the nearest facility (categories of ≤0.5 mile, >0.5–1.0, >1.0–2.0, >2 as referent), and the duration of residence within 2 miles (0 years as referent, 1–9, 10) using unconditional logistic regression with adjustment for age, sex, race, education, and SEER region.

**Results:** Living within 0.5 mile of a facility and/or residence of 10 years within 2 miles of a facility were associated with increased risk of NHL for several industry types, although for most the estimates were not statistically significant, including lumber and wood products (SIC 24, ≤0.5 mile: odds ratio [OR] = 2.2; 10 years: OR = 1.9), printing, publishing, and allied industries (SIC 27, ≤0.5 mile: OR = 4.9; 10 years: OR = 2.3), petroleum refining and related industries (SIC 29, ≤0.5 mile: OR = 0.9; 10 years: OR = 1.9), and rubber and miscellaneous plastics products (SIC 30, ≤0.5 mile: OR = 2.7; 10 years: OR = 0.9). Residential proximity to lumber and wood product facilities was more clearly associated with diffuse large B-cell lymphoma than follicular lymphoma, for having lived within 2 miles (OR = 1.7, 95% confidence interval [CI] = 1.0–3.0), lived ≤0.5 mile (OR = 2.5, 95%CI = 0.3–20.2, p-trend with decreasing distance = 0.09), and residence for 10 years within 2 miles (OR = 2.5, 95%CI = 0.8–7.8, p-trend with increasing duration = 0.05).

**Conclusion:** These data suggest that living close to certain types of industry may increase the risk of NHL, although studies with greater numbers of exposed persons are needed to further evaluate the relationship.

#### ISEE-997

#### Prenatal Phthalate Exposure is Associated with Altered Neonatal Behavior in a Multiethnic Pregnancy Cohort

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**Background:** Concern is mounting that a family of chemicals, called phthalates, may pose human health risks based on numerous animal studies and a limited number of observational studies in humans. There have been no studies to investigate the relationship between phthalates and neurodevelopment. The Mount Sinai Children's Environmental Health Center undertook an investigation of maternal prenatal phthalate exposure on pregnancy outcome and child neurodevelopment in an inner-city multiethnic cohort between 1998 and 2002.

**Methods:** The majority of participants were Black or Latina women aged 25 years or younger who were unmarried at the time of enrollment and had a relatively low educational attainment. Severely preterm births were excluded by design; therefore, most delivered term babies (92.9%) of normal birthweight (97.8%). The Brazelton Neonatal Behavioral Assessment Scale was administered before hospital discharge ( $n = 311$ ). All babies were evaluated by 5 days of age, the majority by day 2. Maternal third trimester urine samples were analyzed by the Centers for Disease Control and Prevention (CDC) for ten phthalate metabolites. Metabolites were summed into three groups: di(2-ethylhexyl) (DEHP) metabolites, monoester metabolites of high ( $>250$  dalton) (high-MWP) and low ( $<250$  dalton) (low-MWP) molecular weight. Groups were chosen to represent similar molecular structure, biological activity, and sources of exposure.

**Results:** In multivariate adjusted generalized linear models, third trimester log-DEHP was associated with poorer neonatal orientation ( $\beta = -0.20$ , 95%CI  $-0.40$ ,  $-0.01$ ), and log high-MWP was associated with poorer regulation of state ( $\beta = -0.21$ , 95%CI  $-0.39$ ,  $-0.04$ ). There was a significant interaction among infant gender, log low-MWP, and the infant motor domain, such that increasing log low-MWP was associated with better motor performance among boys, but worse motor performance among girls (interaction  $P$ -value = 0.04). Infant gender, log high-MWP and orientation interacted such that increasing log high-MWP was associated with significantly worse orientation among girls ( $\beta = -0.45$ ,  $P = 0.01$ ), with no effect among boys (interaction  $P$ -value 0.02).

**Conclusion:** These data suggest that third trimester maternal phthalate metabolite urinary concentrations may be predictive of measures of neonatal behavior as measured shortly after delivery, and may indicate the importance of phthalates in human neurodevelopment.

*Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.*

#### ISEE-1000

#### PCB Exposure and Damage Cell, Dermal in an Ex- Occupational Population Sample in Alpuyeca Morelos

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**Background:** PCBs belongs to a chemical group called Persistent Organic Pollutants (POPs) that have a particular concern because of its hazardous characteristics and the high risk of their use for human health and environment. POPs are chemicals that persist in the environment, accumulate in the fatty tissues of living organisms, can be transferred through the food chain and have a high potential for long-range transport, which determines that might cause pollution in remote areas, which have never been produced or used. Exposure to organochlorines has been linked to cancer and genotoxic damage due to its severe toxicity and persistence, recent studies have found environmental inconsistent.

**Objective:** To investigate the exposure to organochlorines and its association with genotoxic and dermal damage through comet assay in former workers from a company which produced capacitors for water pumps as well as cells for power poles where PCBs or chlorinol was used as a raw material in the construction of that products in the city of Alpuyeca, Morelos.

**Materials and Methods:** A medical history was made to observe signs and symptoms, a working history was asked to each subject and a risk map to locate the capacitors who are outdoors was made too, blood samples to assess genotoxic damage by comet assay were taken, cell viability by FDA and skin lesions on forearms, face, neck. A liver profile was taken to correlate the damage cell. The damage was evaluated through averages and standard deviation to see the lengthening of the tail.

**Results:** The living cells measured by the FDA were 90.1% and 9.9% killed in cell samples. The migration of DNA in subjects exposed grew correlating significantly with years of occupational exposure ranging from 4 years to 17 years, and migration was  $19.4$  to  $66.4 \mu$ . It measured migration to two subjects during the sampling period (controlling for smoking and alcoholism negative) and had a migration of  $4.6 \mu$ .

**Conclusions:** Organochlorines in the environment cause continued exposure and have important risks that, when added to occupational exposure, involves serious cell damage. The sample studied had damage to DNA more than 20 years after they left work but continued to be exposed to organochlorines.

#### ISEE-1001

#### GExFRAME—a Web-Based Framework for Accommodating Global Consumer Exposure Data, Scenarios and Models

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**Background:** Consumer exposure simulation models are used to estimate route-specific exposures to chemicals released from the use of consumer products. Specific mathematical algorithms are used to generate exposures. The input requirements for the algorithms include product-specific parameters, parameters specific to chemicals in the products, product use profiles, characteristics of product use locations, and human receptor parameters. Based on the availability of inputs, it is possible to estimate exposures at different degrees of complexity (priority setting versus assessment). A simple approach could involve deterministic calculations that result in single value outputs whereas a complex approach could involve probabilistic calculations based on Monte Carlo sampling techniques that result in distributional outputs. Multiple approaches can be implemented in a framework to conduct exposure assessments in a tiered manner.

**Discussion:** GExFRAME is a web-based scientific data and model management framework that has been developed to accommodate exposure related information. The current version has three branches in its Explorer-type tree, i.e., Data, Models, and Scenarios. The Data branch contains a collection of exposure related databases and the Model branch contains a collection of individual pathway-specific exposure algorithms. The Scenarios branch contains a list of product-specific scenarios that have pre-assigned exposure pathway-specific algorithms already connected to accept appropriate inputs in a deterministic or a probabilistic simulation. The data and models contained in GExFRAME are truly global in nature. Algorithms present in models such as CONSEXPO (RIVM), CARES (CropLife America), PROMISE (ACC), and CEM (US EPA) have been included in GExFRAME. The framework in GExFRAME is being constructed to be compatible with data and tools developed as part of the European Union's regulatory framework for the Registration, Evaluation and Authorisation of Chemicals (REACH) and the General Product Safety Directive (GPSD, 2001/95/EC). In this presentation, the design, development, and layout of the GExFRAME web-based exposure

modeling tool will be presented. In addition, the product-oriented and scenario-based approaches will be highlighted.

#### ISEE-1002

#### Modelling Short-Term Ultraviolet Exposure as an Alternative to Individual Dosimetry

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**Background:** Excessive exposure to solar Ultra-Violet (UV) light is the main cause of most skin cancers in humans. Factors such as the increase of solar irradiation at ground level (anthropic pollution), the rise in standard of living (vacation in sunny areas), and (mostly) the development of outdoor activities have contributed to increase exposure. Thus, unsurprisingly, incidence of skin cancers has increased over the last decades more than that of any other cancer. Melanoma is the most lethal cutaneous cancer, while cutaneous carcinomas are the most common cancer type worldwide. UV exposure depends on environmental as well as individual factors related to activity. The influence of individual factors on exposure among building workers was investigated in a previous study. Posture and orientation were found to account for at least 38% of the total variance of relative individual exposure. A high variance of short-term exposure was observed between different body locations, indicating the occurrence of intense, subacute exposures. It was also found that effective short-term exposure ranged between 0 and 200% of ambient irradiation, suggesting that ambient irradiation is a poor predictor of effective exposure. Various dosimetric techniques enable to assess individual effective exposure, but dosimetric measurements remain tedious and tend to be situation-specific. As a matter of facts, individual factors (exposure time, body posture and orientation in the sun) often limit the extrapolation of exposure results to similar activities conducted in other conditions.

**Objective:** The research presented in this paper aims at developing and validating a predictive tool of effective individual exposure to solar UV.

**Methods:** Existing computer graphic techniques (3D rendering) were adapted to reflect solar exposure conditions and calculate short-term anatomical doses. A numerical model, represented as a 3D triangular mesh, is used to represent the exposed body. The amount of solar energy received by each "triangle" is calculated, taking into account irradiation intensity, incidence angle and possible shadowing from other body parts. The model takes into account the three components of the solar irradiation (direct, diffuse and albedo) as well as the orientation and posture of the body. Field measurements were carried out using a forensic mannequin at the Payerne MeteoSwiss station. Short-term dosimetric measurements were performed in 7 anatomical locations for 5 body postures. Field results were compared to the model prediction obtained from the numerical model.

**Results:** The best match between prediction and measurements was obtained for upper body parts such as shoulders (Ratio Modelled/Measured; Mean = 1.21, SD = 0.34) and neck (Mean = 0.81, SD = 0.32). Small curved body parts such as forehead (Mean = 6.48, SD = 9.61) exhibited a lower matching. The prediction is less accurate for complex postures such as kneeling (Mean = 4.13, SD = 8.38) compared to standing up (Mean = 0.85, SD = 0.48). The values obtained from the dosimeters and the ones computed from the model are globally consistent.

**Conclusion:** Although further development and validation are required, these results suggest that effective exposure could be predicted for a given activity (work or leisure) in various ambient irradiation conditions. Using a generic modelling approach is of high interest in terms of implementation costs as well as predictive and retrospective capabilities.

#### ISEE-1003

#### Radiofrequency Electromagnetic Fields in Our Everyday Environment: Can We Perceive It?

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**Background:** The term electromagnetic hypersensitivity (EHS) relates to individuals attributing symptoms to exposure to electromagnetic fields (EMF). A substantial part of EHS individuals claims to be able to perceive EMF in their daily life immediately or within a few minutes after exposure. This has been repeatedly investigated by so-called provocation studies in a double blind, randomised manner in laboratories.

**Methods:** I performed a meta-analysis of these provocation studies. Peer-reviewed articles published before August 2007 were identified by means of a systematic literature search. I included studies that were conducted in a laboratory and were of a double-blind, randomized design. The exposure of interest had to be in the radiofrequency (RF) EMF range. English or German articles were considered. For each study I retrieved the number of observed (O) and expected (E) correct EMF discriminations (presence and absence of EMF). I calculated the correct EMF discrimination rate ((O-E)/E) including 95% confidence intervals (95%-CI). In the absence of between-study heterogeneity ( $P = 0.90$ ;  $I^2 = 0.0\%$ ), I used fixed-effects meta-analysis to combine the studies. Meta-regression was performed to evaluate whether the correct EMF discrimination rate was associated with the study collective (EHS vs. non sensitive study participants), exposure source (mobile phone vs. base station) or exposure duration.

**Results:** In total, 182 EHS individuals and 332 non-sensitive subjects were included in 7 provocation studies. The pooled correct field discrimination rate was 4.2% higher than expected by chance (95%CI: -2.1 to 10.5). According to a meta-regression neither type of study participant (EHS vs. non sensitive:  $\beta = 0.050$ ; 95%-CI: -0.08 to 0.18) nor exposure source (mobile phone vs. base station:  $\beta = 0.07$ ; 95%-CI: -0.07 to 0.20) or exposure duration ( $\beta = 0.01$ ; 95%-CI: -0.19 to 0.21) were associated with better performance in selecting the correct field status.

**Conclusions:** This meta-analysis showed that the large majority of EHS individuals, who claim to be able to perceive low-level RF-EMF, are not able to do so under double blind conditions in a laboratory. It may be helpful to offer such an experiment to afflicted individuals. To experience the failure to perceive low-level RF-EMF in a therapeutic context could be helpful. However, this has to be evaluated first. Given the lack of individual based studies, i.e. testing the same individual manifold (>15 times), one cannot completely rule out that a small minority exists who can indeed perceive low-level EMF. This would be indicative of a biological mechanism, which is not known so far. However, such individuals have not been identified yet.

#### ISEE-1004

#### Associations Between Arsenic in Drinking Water and Pterygium

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**Background:** Pterygium is a fibrovascular growth of the bulbar conjunctiva and underlying sub-conjunctival tissue that may cause blindness. The mechanism of pterygium formation is not yet fully understood, but pterygium has some tumor-like features. To evaluate the association between arsenic exposure through drinking water and the occurrence of pterygium, we conducted a study in southwestern Taiwan.

**Methods:** We recruited participants over 40 years of age from three villages in the endemic area of arseniasis in southwestern Taiwan (exposure villages) and four neighboring non-endemic villages (comparison villages). Each participant received an eye examination and a

questionnaire interview. Photographs of both eyes were taken, which were later graded by an ophthalmologist for the status of pterygium. A total of 223 participants from the exposure villages and 160 from the comparison villages were included in the analyses.

**Results:** The prevalence of pterygium was higher in the exposure villages across all age groups in both genders and increased with the cumulative arsenic exposure. There was a significant association between cumulative arsenic exposure and the prevalence of pterygium. We found that working under sunlight and working in sandy environments were also risk factors for developing pterygium. After adjusting for age, gender, working under sunlight, and working in sandy environments, we found cumulative arsenic exposure of 0.1 to 15.0 mg/L-year and  $\geq 15.1$  mg/L-year were associated with increased risks of developing pterygium, and the odds ratios were 2.04 (95% confidence interval [CI]: 1.04 to 3.99) and 2.88 (95%CI: 1.42 to 5.83), respectively.

**Conclusion:** We conclude that chronic exposure to arsenic in drinking water was related to the occurrence of pterygium, and the association was still observed after adjusting for exposures to sunlight and sandy environments.

#### ISEE-1006

#### Does Rhino-Conjunctivitis Exist as Early as in Infancy? Evidence from the Paris Birth Cohort Study

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**Objective:** The Paris prospective birth cohort study was undertaken to determine the incidence of respiratory/allergic manifestations in Paris children up to the age of 6 and assess the impact of behavioural/environmental factors. While describing the occurrence of respiratory/allergic manifestations in the first year of life, we particularly focused on symptoms indicative of rhino-conjunctivitis and tried to identify their risk factors.

**Material and Methods:** Data were collected by short-interval self-administered standardised questionnaires. Questions dealt with asthma-like symptoms, eczema, symptoms suggestive of food allergy and of rhino-conjunctivitis such as “problem with sneezing or a runny or blocked nose apart from a cold or the flu” associated with “itchy-watery eyes” whether coupled with allergen exposure or not. Infectious diseases were also recorded. Cumulative incidences were estimated in the first year of life. A multivariate logistic regression was achieved to determine the relations with various risk factors: results were expressed as adjusted OR with their 95% confidence interval (OR<sub>a</sub> [<sub>95%CI</sub>]).

**Results:** Results are given for 2,698 infants. Wheeze and shortness of breath were respectively noted for 21.6% and 4.2% of infants, mostly boys; dyspnoea with sleep disturbance and nocturnal dry cough respectively concerned 23.7% and 14.5% of infants, without gender difference. Eczema occurred for 17.9% of infants, mainly boys. Symptoms of food allergy and of rhino-conjunctivitis were noticed for 2.9% and 8.2% of our population. As for infectious diseases, only 7.9% of infants did not suffer from any cold before age one; 42.6% and 42.2% of infants suffered from  $\geq 1$  ear infections and from  $\geq 1$  lower respiratory infections before their first birthday. No association of symptoms of rhino-conjunctivitis with gender, season of birth and mode of delivery was noted. Conversely, parental history of allergy clearly discriminated infants with rhino-conjunctivitis (OR<sub>a</sub> [<sub>95%CI</sub>] (vs no parental allergy) for one allergic parent: 1.98 [1.39–2.83] and both allergic parents: 2.64 [1.58–4.39], as compared to infants without rhino-conjunctivitis). Allergic manifestations in the infant were also strongly linked to the rhino-conjunctivitis phenotype (OR<sub>a</sub> [<sub>95%CI</sub>] in case of eczema (vs no): 1.57 [1.08–2.29]; in case of food allergy (vs no): 2.75 [1.44–5.25]). Wheeze tended to be positively related to rhino-conjunctivitis and other bronchial obstructive symptoms were clearly related to this outcome (OR<sub>a</sub> [<sub>95%CI</sub>] for +1 obstructive symptom: 2.72 [2.16–3.41]). No associations were observed for any infectious disease. Mouldy smell (yes vs no) doubled the risk of rhino-conjunctivitis (OR<sub>a</sub> [<sub>95%CI</sub>]: 2.05 [1.07–3.90]). Postnatal (yes vs no) but not prenatal exposure to environmental tobacco smoke (ETS) predicted the risk of rhino-conjunctivitis onset (OR<sub>a</sub> [<sub>95%CI</sub>]: 1.43 [1.00–2.05]). Lastly, severe health events in a proxy family member (yes vs no) almost doubled the risk of rhino-conjunctivitis (OR<sub>a</sub> [<sub>95%CI</sub>]: 1.96 [1.33–2.88]).

**Conclusions:** Rhino-conjunctivitis phenotype concerned 8% of infants, which is sparsely described, due to the lack of consensual definition at this age group. Several identified risk factors are consistent with a propensity for allergy for infants with this rhino-conjunctivitis phenotype. Further follow-up of our birth cohort will elucidate the future clinical of these infants suffering from symptoms evocative of rhino-conjunctivitis before one-year of age.

#### ISEE-1005

#### The German Environmental Survey for Children (GerES IV): Questions on Exposure Factors—an Interactive Poster

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**Background:** Nation-wide German Environmental Surveys (GerESs) have been carried out in Germany for more than twenty years. Exposure to various pollutants has been analysed via human biomonitoring (blood and urine samples) and household monitoring (drinking water, house dust and indoor air samples). Sampling has been accompanied by extensive questioning on exposure-related behaviours and living conditions. The main aims of the questionnaires have been: to cover exposure factors determining the body burden of pollutants, to describe the environmental exposure of the German population and to provide data for exposure modelling. All GerESs have been performed in conjunction with the corresponding German National Health and Examination Surveys conducted by the Robert Koch Institute.

**Discussion:** Results of the evaluation of questionnaire data from the current German Environmental Survey for Children (GerES IV) are presented on the poster. A representative sample of 1,790 German children aged 3 to 14 years was examined in GerES IV from 2003 to 2006. The parents and the older children were interviewed. The questionnaires covered mainly the following subjects: residential area, housing, decoration of flat, time budget, contact to dust and earth, road traffic, leisure activities, use of household products and biocides, nutrition, drinking water, and tobacco smoke. On the poster each of the above subjects is presented in a hexagon. The main questions asked on this subject are outlined in the hexagon as well. Each hexagon can be lifted, revealing an important finding depicted in a diagram. The interactive character of the poster shall be explained by an example: Whoever is interested in the time budget of children can lift the corresponding “time budget” hexagon and will find a diagram indicating that German children spend 18.8 hours per day in their home, 2.4 hours in other buildings and about 2.8 hours outdoors at weekends in winter. In addition, the time spent at these places in summer and at school days is shown. GerES IV data will be available as a scientific use file by the end of 2008.

**Acknowledgements:** The financial support of the Federal Ministries for the Environment, Nature Conservation and Nuclear Safety, and of Education and Research is gratefully acknowledged. Field work for GerES IV was carried out by the Robert Koch Institute, Berlin.

**ISEE-1008****Low-Dose Heavy Metal Exposure and Aging in Humans**

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**Background:** Exposure to high levels of heavy metals is known to be associated with protein damage, and this may lead to accelerated development of age-related disease and disability. The presence of low levels of such toxins in adult humans is very widespread and detectable levels are typically present in over 90% of the population. Impaired physical (walking) mobility is a marker of age-related decline in a range of organisms; in humans it is predictive of hospitalization and mortality. It can be assessed using self-reports of problems with walking or through measured physical performance, e.g. gait speed.

**Objective:** To assess the effects of low-level heavy metal exposure on age-related physical mobility impairment in a population-representative human population.

**Methods:** Data from the National Health and Nutrition Examination Survey (NHANES) were used to evaluate the association of urinary levels of antimony, barium, beryllium, cadmium, cesium, cobalt, lead, molybdenum, platinum, thallium, tungsten, and uranium with self-reported and measured mobility problems in 1480 adults aged 50+. Models were adjusted for age, sex, race/ethnicity, smoking, level of education, income, and body mass index.

**Results:** In models adjusted for potential confounders problems walking quarter of a mile were associated with elevated levels of cadmium, cobalt, lead, and uranium, and slower walk speed (timed over a 20-foot course) associated with higher levels of cobalt and tungsten. Cobalt was the only metal associated with both outcomes: the odds ratio of reporting walking problems associated with a 1-point increase in logged cobalt levels was 1.40 (95%CI 1.16 to 1.67), and the change in gait speed associated with this change in cobalt levels was 0.19 (95%CI 0.06 to 0.32), approximately equivalent to the effect of 2.5 years of age-related decline.

**Conclusion:** Because exposure to low levels of heavy metals is widespread, their implication in the aging process poses major public health concerns.

**ISEE-1009****Nitro-Polycyclic Aromatic Hydrocarbon Concentrations in Urban Air Particulate Matter and Their Implications for Source Apportionment in Shenyang, China**

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**Methods:** A series of particulate matter (PM) air filter samples including both PM<sub>10-2.5</sub> and PM<sub>2.5</sub> filters were collected from four sampling locations during August of 2007 in Shenyang, China. The samples were collected as part of a study of traffic related PM exposures in a cohort of 24 Chinese taxi drivers in Shenyang. Teflon filters were collected at three locations associated with each of the subjects: "Inside Car", "Outside Car", and "Home". Additional samples were collected at a central fixed site—the Center for Disease Control building in Shenyang. Quartz filters for determination of the elemental carbon (EC) and organic carbon (OC) exposures were also collected inside the subjects' vehicles (the "Inside Car" location) and at the CDC location. The filters were analyzed for PM mass and 3 nitro-polycyclic aromatic hydrocarbons (NPAHs). The NPAH analysis employed a 2-dimensional high performance liquid chromatography tandem mass spectrometry (2D-HPLC-MS/MS) method.

**Results:** The NPAH species detected in the filters were 1-nitropyrene (1NP), 2-nitropyrene (2NP), and 2-nitrofluoranthene (2NFL). All 3 NPAH species were quantified with the same internal standard, deuterated (*d*<sub>4</sub>) 1NP (1dNP). 1NP is considered to be a specific marker for primary emissions of diesel combustion, whereas 2NP and 2NFL can be used as indicators of atmospherically produced NPAH. The average split of NPAH compounds between the 2 PM sizes, PM<sub>2.5</sub> and PM<sub>10-2.5</sub>, were as follows: [2NFL]: 92.05 ± 0.84% in PM<sub>2.5</sub>, [2NP]: 91.37 ± 1.14% in PM<sub>2.5</sub>, [1NP]: 89.41 ± 3.55% in PM<sub>2.5</sub>. The concentrations of 2NFL and 2NP did not vary significantly with sampling location, whereas the concentration of 1NP was much lower at the sampling sites located away from heavy traffic areas. The ratio of 2NFL:2NP was used to evaluate the relative importance of atmospheric formation processes in the formation of 2NFL. The average value of [2NFL]/[2NP] over all sampling locations, 3.78 ± 0.49, indicates that the reaction conditions favor OH radical initiated formation of 2NFL at all sampling locations during the sampling period. This conclusion is supported by the correlation of [2NFL] vs. [2NP] as well as the low variation in the [2NFL]/[2NP] ratio over all 4 sampling locations. The ratio of [2NFL]/[1NP] was examined to evaluate the relative importance of atmospheric chemical reactions versus primary emission sources for ambient NPAH concentrations. The values of [2NFL]/[1NP] for each sampling location indicate that atmospheric processes were relatively more prevalent than primary emissions for ambient NPAH concentrations in Shenyang during the sampling period.

**ISEE-1010****Case Study of Public Health Intervention at an Urban Agriculture Site in Newcastle-Upon-Tyne, UK**

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**Background:** Initially investigated as a control in the context of another study this urban agriculture site was found to have concentrations of lead and arsenic well in excess of UK Soil Guideline Values (SGVs). This led it to be prioritised for further investigation, results of which we are presenting here.

**Methods:** A desk study and interviews were followed by development of a conceptual site model identifying potential contaminant sources, pathways and receptors. A sampling plan was created using the SPLUS environmental statistical package and subsequently intrusive soil sampling and collection of winter vegetable samples was undertaken. A second tier of sampling was undertaken to investigate the bioaccessibility (by Physiology Based Extraction Technique (PBET)) of lead and arsenic in the soil, lead in tap water at the site and lead and arsenic in summer vegetables at the site.

**Results:** The desk study revealed a colliery site and saw mill, which existed from 1836 until 1860, immediately to the northern boundary of the site and Victorian terraced housing to the east. The northern section of the site was an infilled stream valley with high groundwater levels and occasional flooding. Interviews and site walk-over revealed extensive historic usage of coal fire ash as a soil conditioner and lead pipework used for water distribution at the site. Initial soil sampling again indicated concentrations of lead (min = 620, median = 1100, US95 = 1315, max = 2000 all mg/kg) and arsenic (min = 20, median = 23, US95 = 25, max = 32 all mg/kg) above UK SGVs. Concentrations of lead and arsenic in winter vegetables indicated negligible uptake. Bioaccessibility results were low as would be expected for aged contamination. However, analysis of tap water indicated concentrations of lead of up to a hundred times the value prescribed in UK water supply regulations. Summer vegetables watered with tap water were found to have higher concentrations of lead than the winter vegetables but still well within the

UK contaminants in food regulations safe concentrations. Analysis of groundwater showed no significant contamination.

**Discussion:** The results indicated that tap water from the lead pipes could pose a significant possibility of significant harm if used as drinking water but not if used only for watering vegetables. An incident group with members from the local government, health authorities and Newcastle University was convened to discuss the way forward. Risk from soil at the site was considered to be manageable by public health and personal hygiene methods. As the site was not owned by the local authority no funds were available for the replacement of lead pipes and as such plot holders have been strongly advised not to drink water from taps at the site and adopt a range of public health measures to reduce possible intake via potential soil ingestion pathways.

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#### ISEE-1011

#### Evaluation of Bystander Exposure to Asbestos: Review of the Literature (1950s–Present)

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**Background:** For many years, asbestos was utilized in various industries as a flame retardant and for thermal protection purposes. Beginning in the 1950s and 1960s, there was some concern regarding indirect (or “bystander”) asbestos exposures among persons working in industries with considerable potential for exposure to the raw fiber (e.g., asbestos mining and manufacturing). Many of these earlier studies considered any coworker not directly involved in the specific asbestos handling task to be a bystander. By the 1970s, the concern about exposures distant from the point source had expanded to include so-called “end users” of asbestos-containing products such as insulators, construction workers, or automobile mechanics; however, very little quantitative data were collected in an attempt to characterize these airborne concentrations. One of the major challenges in estimating bystander exposure is the fact that some of them may also, during a given day, personally handle asbestos-containing materials (ACM). Similarly, a lack of information regarding concurrent or prior exposures of these persons has made it difficult to interpret studies where asbestos-related disease is reported among so-called bystanders.

**Discussion:** This paper presents a comprehensive review of the published literature (1950s to the present day) as it relates to the evolution of the term “bystander.” Nearly 100 published studies of persons working with asbestos were evaluated; those that provided air concentrations of asbestos at some distance from the source or that measured exposures of persons who worked in close proximity to workers handling asbestos-containing materials were summarized. Two types of bystanders were considered: 1) craftsmen working in close proximity to workers performing activities with a higher potential for exposure (e.g., insulation work); and 2) maintenance workers and building occupants. The distance from the primary worker or activity and ventilation (local and dilution) are, of course, important determinants of bystander exposure. The information gathered from the various miscellaneous reports, the strengths/weaknesses of the data, and suggestions for targeted future research are presented.

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#### ISEE-1012

#### Estimating Error in Using Ambient PM<sub>2.5</sub> Concentrations as Proxies for Personal Exposures: A Meta-Analysis

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**Background:** Several methods have been used to account for measurement error inherent in using the ambient concentration of

particulate matter <2.5 μm (PM<sub>2.5</sub>, μg/m<sup>3</sup>) as a proxy for personal exposure. A common feature of such methods is their reliance on the estimated correlation between ambient and personal PM<sub>2.5</sub> concentrations (*r*). However, extant studies have yet to be systematically and quantitatively assessed for publication bias or heterogeneity.

**Methods:** With the help of a health sciences librarian, we therefore searched seven electronic reference databases (PubMed, Web of Science, BIOSIS previews, Environmental Sciences and Pollution Management, Toxline, and Dissertations & Theses on November 12, 2007 and EMBASE on December 14, 2007) for studies of the within-participant, ambient-personal PM<sub>2.5</sub> correlation. The search identified 567 candidate studies, sixteen (3%) of which met inclusion criteria and were abstracted by two epidemiologists.

**Results:** The studies (median *r* = 0.54; range: 0.02–0.86) represented 448 non-smoking participants (age range 6–93 years) from 13 cities in the United States and Europe. There was little evidence for publication bias of Fisher's z-transformed *r*, either overall (funnel plot symmetric; log rank test *P*<sub>Begg</sub> = 0.7; regression test *P*<sub>Egger</sub> = 0.8), or when stratified by study and participant characteristics. Heterogeneity was high overall (*P*<sub>Cochran</sub> = 0.001; I<sup>2</sup> = 57%), although variable after stratification. Earlier publication dates, higher mean ambient PM<sub>2.5</sub> concentrations, and eastern longitudes were associated with higher *r*.

**Conclusion:** Collectively, these findings imply that the within-participant ambient-personal PM<sub>2.5</sub> association depends upon multiple factors that should be considered when using the ambient PM<sub>2.5</sub> concentration as a proxy for personal exposure.

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#### ISEE-1013

#### Social Factors and Nutritional Status of Children and Adolescents

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**Objective:** The many current studies dealing with the relationship among socio-economic factors and developmental parameters of children are particularly aimed at obesity risk. Criteria for obesity screening in children and adolescents are always in dispute. Body mass index (BMI) and circumference measures have been accepted as important indicators of nutritional status in children and adolescents. The purpose of the study was to evaluate these indicators in relation to social factors of family and ethnicity.

**Methods:** We assessed BMI (kg/m<sup>2</sup>), waist circumference and upper arm girth on the basis of 5th and 6th Slovak nation-wide cross-sectional anthropometric surveys (1991, 2001), which were realized on representative samples (118400 and 35600 children and youth) from all ages and both genders. Socio-economic data of families (education and occupation of the parents) and ethnicity were obtained on the basis of a questionnaire. The programs Microsoft Excel and S-Plus were used for analysis.

**Results:** The Slovak BMI standards for 7–18 year old boys are 15.8–21.8 kg/m<sup>2</sup>, for 7–18 year old girls 15.9–21 kg/m<sup>2</sup>. In 2001, the number of 7–18 year old boys with overweight and obesity has been in total 12.5% and in the same age group of girls 12.1%. The increase during last decade has been 2.5% in boys and 2.1% in girls. Prevalence of overweight and obesity in Slovak girls and boys has increased. Nevertheless the comparison has revealed, this prevalence belong to the lowest in Europe. The results have shown significant negative relationship between BMI and occupation and educational level of parents in older children and adolescents (*r* = 0.100, *P* < 0.01). In younger children significant associations have not been revealed. The relationships between social factors and circumference measures are also not significant. The impact of ethnicity has been confirmed only in younger children. Positive relationships among nutritional status of children and nutritional status of

parents have shown not only the genetic influences, but also influence of life style habits in the family.

**Conclusion:** Results have confirmed the strong association between overweight/obesity and social factors of family. Using simple measures for evaluation of nutritional status is precondition of the fast intervention, which has to be family oriented.

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#### ISEE-1015

##### Summary of EPA Programs and Exposure Tools Relevant to Community-Based Cumulative Risk and Exposure Assessments

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**Background:** The National Exposure Research Laboratory (NERL) in the U.S. EPA's Office of Research and Development (ORD) has developed a research program to advance the science of exposure tools that facilitate the understanding of cumulative risk to communities and individuals. *Exposure tools* is a general term that describes informational or analytical resources such as general information or strategies, exposure models, databases, sampling methods, and maps generated with geographic information systems (GIS). A thorough summary of EPA programs and exposure assessment tools was developed to understand the state-of-the-science, identify exposure tools that are currently available, and develop methods for developing new tools. Selected commonly used non-EPA community tools and programs were also examined. Attributes of relevant tools were compiled into summary tables, including EPA programs & guidance documents, community environmental issues, GIS exposure assessment tools, national databases, and exposure models. Other tools that are addressed in less detail in this presentation include sampling methods and fate & transport models.

**Discussion:** The summary addresses several research questions that will guide the development of new and improved tools:

- How well do databases intersect with community issues?
- Which tools are available for community-based environmental initiatives and how could they be used?
- In general, what are the strengths and limitations of currently available tools?
- What are the specific needs for additional models, measurements, methods, GIS maps, and other tools?
- Where do collaborations potentially exist for current tools or the development of new tools?

Summary tables will be provided to partners such as the EPA Community Action for a Renewed Environment (CARE) program and will be made publicly available via the CARE website. Summary tables will also assist in developing the ORD NERL community cumulative risk research program, Exposure Tools to Advance the Science and Understanding of Cumulative Risk to Communities and Individuals, by identifying current research needs, as well as the potential to build upon existing tools. Results presented here focus on information in the summary tables that address the research questions in order to advance the science of community-based cumulative risk and exposure assessments.

*Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1016

##### California Elementary School Ventilation Study: Study Design and Methods

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**Background:** Recent evidence suggests that lower ventilation rates (VRs) in school classrooms are associated with increased student absence and decreased performance. Studies show consistently that as VRs increase within the range below 20 cubic feet per minute (cfm) per occupant, significant health benefits are apparent. However, research has not yet documented the minimum school VRs needed to avoid adverse health, attendance, and performance effects. The current ASHRAE VR guideline (minimum 15 cfm per occupant) is based on studies of controlling odors, not of protecting human health. There is thus a need to provide scientifically defensible standards for minimum ventilation rates that adequately protect human health. On the other hand, because ventilation, heating and cooling energy in K-12 schools in the U.S. cost over \$3 billion annually, there is a need to define sufficiently health protective ventilation rates that do not unnecessarily consume energy. Beginning in the summer of 2008, we will begin collecting data to investigate associations between classroom ventilation rates and student illness absence (as an indicator for health), to help set minimum health-protective classroom VRs.

**Discussion:** In our presentation, we will give an overview of our three-year study and project tasks. Our overview will include the scope of our work, our sampling design, and methods. In addition, we will present our experience with early data collection efforts. As part of our study design, we have analyzed climate zone data in California to select the school districts from which to select elementary schools for our study. Our sampling design is intended to include a fairly representative sample of schools, based on climate zone location, population, and socio-economic status of students as given by the percent of students participating in the free lunch program offered at each school. Each school will have multiple real-time CO<sub>2</sub> monitors installed, one indoors in each participating 4<sup>th</sup>-5<sup>th</sup> grade classroom, and one outdoors at the school. The CO<sub>2</sub> monitors, connected to the internet, will allow remote, unusually easy and inexpensive, monitoring of collected data in large numbers of classrooms. Based on an algorithm we have adapted, we will use daily steady-state indoor-minus-outdoor CO<sub>2</sub> concentrations to estimate daily average VR/person for each classroom. Analysis of these VRs with daily illness absence data, in up to 300 classroom-years of data, will allow one of the most detailed examinations available on this association.

#### ISEE-1017

##### An Integrated Spatiotemporal Approach to Improve Mercury Estimation and Exposure Assessment

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**Background and Objective:** Mercury in surface waters and the subsequent bioaccumulation potential in fish tissue is a critical issue around the globe. Susceptible populations, such as pregnant women and young children, who consume fish that contain mercury could be exposed to toxic levels causing permanent neurological damage. Mercury can be introduced into surface waters via land and air. Once it enters the water, a number of factors influence the degree to which mercury is converted to methylmercury (MeHg); it is this toxic, biologically-available form that is accumulated in fish tissue. The objective of this study is to use novel geostatistical techniques to incorporate spatial and temporal data from water and fish tissue analyses and create more accurate estimations and models of fish contamination.

**Methodology:** We use Bayesian Maximum Entropy (BME) with a river metric for the data integration of surface water monitoring and fish tissue analysis on a case study for largemouth bass in North Carolina waters. Using data from multiple sources, we construct maps of estimated mercury levels in North Carolina waterbodies and highlight regions of potential harmful exposure based on bioaccumulation potential.

**Results and Conclusion:** The results of this study provide a comprehensive visualization of mercury in the environment and the potential for it to bioaccumulate. Our results show that the integration of data from multiple sources using the BME geostatistical methods can improve the accuracy of estimations at un-monitored locations by up to 15%. This information is valuable to environmental and health planners, as well as the public, to better assess potential exposure and develop more targeted fish-consumption advisories.

#### ISEE-1018

##### EPA's Community-Friendly Exposure and Risk Screening Tool

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**Background and Discussion:** EPA/ORD's National Exposure Research Laboratory (NERL), in collaboration with the EPA Community Action for a Renewed Environment (CARE) Program, is developing a Community-Friendly Exposure and Risk Screening Tool (C-FERST) to assist communities with the challenge of environmental issue identification and prioritization for exposure/risk reduction efforts. This web-based application will be developed through ORD/NERL's Research Program "Exposure Tools to Advance the Science and Understanding of Cumulative Risk to Communities and Individuals". The C-FERST is being developed as a state-of-the-science tool that builds upon and/or links to the best available EPA information and tools relevant to community risk characterizations. Initial C-FERST development is based on the draft 2006 EPA CARE Workbook for Community Screening of Environmental Risks and other community guidance tools, which lead the reader through a series of steps and decision tree questions, illustrate community environmental profiles through GIS maps, and provide EPA information to help communities plan risk-relevant actions. C-FERST will incorporate human exposure science including data, maps, model results, and local data collection methods. The C-FERST user will be able to:

- identify environmental issues of concern for a community via decision tree screens and/or selection from a list of issues;
- link relevant fact sheets, data, and maps to help inform decisions;
- view a GIS-based community-profile based on available national, local, or proxy databases;
- link to EPA's Envirofacts Warehouse/Window to My Environment, EPA's TRI-NATA Explorer Tool, and other available EPA databases;
- link to guidance/methods/tables on how to obtain local data for key exposure/risk factors, and enter new data if desired;
- view a characterization of screening level exposure-based health risks for a community, for selected issues with available data; and
- explore (e.g., with tables and/or GIS maps) exposure/risk factors for selected issues and/or information (e.g., fact sheets) to assist with developing reduction actions.

Science aspects for C-FERST development include:

- identifying environmental issues to include in the tool;
- identifying existing exposure and risk information for each issue;
- identifying key exposure/risk factors for each issue;
- compiling relevant and needed data for exposure factors;
- translating existing risk information (e.g., national, other proxy) to given community using exposure factors and available local data; and
- developing new exposure/risk estimates where needed.

#### S188

Initial development and testing of the C-FERST is being conducted through application to several initial case studies (Holyoke, MA CARE Level I and Detroit, MI CARE Level I) and several high risk community environmental issues (e.g., radon, criteria pollutants, air toxics, childhood lead exposure) in close collaboration with project partners and stakeholders (CARE program, Community-Based Technical Support Forum, EPA Program and Regional Offices). This presentation gives an overview and status of the C-FERST, and summarizes information learned from the initial case studies and environmental issues considered.

*Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1020

##### Occupational Exposure in Italian Swimming Pools and Self-Reported Health Conditions

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**Background:** In indoor swimming pools both chemical substances in water and air and microclimate parameters influence health status and well-being of subjects employed in these environments. In order to investigate on the possible detrimental impacts of occupational exposure for trainers, lifeguards and facility operators 20 indoor swimming pools in Emilia Romagna have been visited in 2007 and 133 workers were enrolled in the study.

**Methods:** Microclimate parameters (dry and radiant air temperature, air speed, relative humidity, illumination levels) were measured by a multi-data logger (BABUC A-LSI Lastem) equipped by a software (InfoGAP) aimed to calculate microclimate indices for moderate environments, taking into account personal clothing. Disinfection By Products (DBPs) such as trihalomethanes (THMs) and residual combined chlorine were evaluated in pool water: THMs were analysed in indoor air and in alveolar air samples collected from 115 workers. Head space gaschromatography was used for THMs in water samples, while THMs both in indoor air and alveolar air samples were analysed by direct injection. Information about personal data and job description was collected. Self-reported health conditions were recorded by a questionnaire: upper respiratory symptoms (runny nose, nasal obstruction, voice loss, etc), lower respiratory symptoms (wheezing, asthma, etc), ocular symptoms (itchy, red and watering eyes) and ever presence of fungal diseases, warts and dermal irritative symptoms were registered, together with self-reported information about dermal comfort/discomfort.

**Results:** On the whole, microclimate parameters are within the range of values suggested by the Italian guidelines for indoor swimming pools. In 19 environments (95%) illumination levels were in agreement with the above guidelines ( $\geq 150$  lux); similarly, air speed values and relative humidity levels were adequate ( $\leq 0.1$  m/s and  $\leq 70\%$  respectively) for 14 (70%) and 13 (65%) swimming pools. 14 swimming pools (70%) showed dry air temperature values lower than water temperature, and so associated with a thermal discomfort condition. The Predicted Mean Vote (PMV) is a thermal index which scores the comfort/discomfort level for workers, taking into account dry air temperature, relative humidity and air speed levels. The values showed a generally acceptable thermal condition shifted towards a warm sensation. The most prevalent health symptoms were nasal obstruction (21.1%), voice loss (17.3%) and mucosal irritative symptoms (15.8%), followed by red eyes (13.5%), itchy eyes (12.8%) and watery eyes (6%). THMs in indoor air (range: 1.7–187.5 mcg/m<sup>3</sup>) were highly correlated with THMs in alveolar air samples (range: 1.0–123 mcg/m<sup>3</sup>) ( $r = 0.68$ ;  $P = 0.001$ ). Chloroform, the most prevalent compound, and dichloro bromo methane (DCBM) were detected in all indoor air samples, while they were present in 98.3% and 82.6% of alveolar air samples respectively. Swimming pools have been splitted according to the suggested Italian guideline for combined chlorine in

water ( $\leq 0.4$  mg/l) assumed as the source of trichloramine, volatile irritative compound in indoor air. Subjects working in environments (15 swimming pools) where combined chlorine levels were above 0.4 mg/l experienced more symptoms of nasal obstruction and ocular irritative symptoms compared to those employed in swimming pools with lower levels in water.

#### ISEE-1021

##### Assessing Aggregate Human Exposure to Toluene In Europe

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**Background:** Toluene is one of the most predominant volatile organic compounds (VOC) observed in indoor and outdoor environments. It is a toxic solvent widely found in consumer products such as paints, inks, dyes, paint thinners, varnishes, glues, cleaning solutions, shoe and nail polish, carpets, vinyl flooring, wood boards, electronic devices, etc. Toluene is also emitted from petrol vehicles and tobacco smoking. It is readily absorbed by inhalation, ingestion and (to a lesser extent) skin contact, and tends to be deposited in tissues that are fatty or have a rich blood supply (brain, liver and kidney). There is inadequate evidence for the carcinogenicity of toluene in humans, but chronic exposure via inhalation and/or ingestion has been associated with dysfunction of the central nervous system, as well as with heart, liver, kidney, and lung damage. Acute exposure may cause impaired neuropsychological function, headache, dizziness, sleepiness and eye irritation. As its use as a substitute for the more toxic solvent, benzene, has increased in recent years, there is concern that human exposure levels in Europe may have substantially increased.

**Materials and Methods:** An aggregate, multi-source and multi-route exposure assessment of residential exposure to toluene has been carried out in three European countries (UK, Serbia, France). Three policy scenarios have been evaluated: (i) business-as-usual scenario (before the implementation of EU Directive 76/769/EEC); (ii) scenario based on EU Directive 76/769/EEC limiting the use of toluene in adhesives and spray paints; (iii) total ban of toluene in household products scenario. We have used the consumer exposure model ConsExpo (RIVM) and the indoor air quality model RISK (USEPA) to estimate aggregate personal exposure related to normal use of household products and appliances, environmental tobacco smoke and outdoor pollution. Exposure factors, such as housing conditions, ventilation rates, consumption of consumer products and time spent in different microenvironments, have been obtained from the European Exposure Factors (ExpoFacts) database and national databases. Outdoor, workplace and transient microenvironment exposures have been estimated from ambient air quality monitoring data and other datasets available in literature. A sensitivity analysis has been carried out in order to identify the most sensitive input variables and quantify the uncertainty associated with the exposure estimates.

**Results and Discussion:** The results of this study indicate likely levels of toluene exposure for adults and young children in three European countries. Toluene exposure levels have been stratified for three types of residence location (urban, suburban, rural) and different time-activity patterns. Although large variations in toluene exposure within each country and differences between countries were observed, it is unlikely that the USEPA reference concentration for chronic inhalation exposure  $RFC = 5$  mg/m<sup>3</sup> or the reference dose for chronic oral exposure  $RfD = 0.08$  mg/kg-day would be exceeded for any of the considered scenarios/countries. Only extreme personal exposure events may lead to acute neuropsychological effects. The outcomes of this study are important in estimating the impact of different policies on aggregate exposure to toluene in Europe.

This research was undertaken within INTARESE project, funded under the EU 6th Framework Programme.

#### ISEE-1022

##### New Approaches and Emerging Sciences Shape the Update to the EPA Risk Assessment Forum's Guidelines for Exposure Assessment

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**Background and Discussion:** The practice of exposure assessment has been evolving rapidly and has changed significantly since the Guidelines for Exposure Assessment were first published by the Agency in 1992. The science has advanced in numerous areas, including personal and environmental monitoring, modeling applications, understanding activity patterns, observational studies, and addressing susceptible populations and life stages. The EPA has published specific guidance in such areas as probabilistic analyses, exposure factors, aggregate exposure and cumulative risk, and community-based research which will be referenced in updating the Guidelines. Input on specific topics to include in the updated Guidelines was sought from internal and external exposure assessors, including other federal agencies, and members of the Society for Risk Analysis and International Society for Exposure Analysis. The updated Guidelines will take a more interdisciplinary approach to exposure science than the 1992 Guidelines. The updated Guidelines will recommend that the exposure assessor first confer with various experts, as well as risk managers, to scope the problem to be considered. The presence of particular sensitive populations or life stages may drive the exposure assessment, or those groups may provide information invaluable to refining exposure or risk estimates. Determining the scope of the assessment, and data and resources available, helps the assessor determine which tools to use. The draft Guidelines stress the importance of planning and scoping when addressing all exposure assessments especially highly uncertain situations, such as acute or catastrophic exposure events. The updated Guidelines will describe how cumulative, population or community-centered approaches can be used for exposure assessment to better address the overall goals of protecting public health. The section on addressing uncertainty and variability, and the use of probabilistic methods for analysis of both is expanded in this update. Finally, the updated Guidelines will include a section on emerging sciences that hold promise for refining exposure assessment, e.g., by addressing the variability in human exposure and risk. Topics include the various “-omics,” nanoscale materials, and computational biology and toxicology. This presentation will describe how the authors of the EPA’s updated Guidelines for Exposure Assessment have integrated a multidisciplinary approach and new and emerging methodologies into a forward-looking guidance.

Although this work was produced with good care and reviewed and approved for publication by EPA, it may not necessarily reflect official Agency policy.

#### ISEE-1023

##### Seasonal and Regional Short-Term Effects of Fine Particles on Hospital Admissions in 202 U.S. Counties, 1999–2005

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**Background:** Links between short-term exposure to fine particulate matter (PM<sub>2.5</sub>) and increased risk of mortality and hospitalizations are well established; however, recent studies suggest that the effects of airborne

particles vary by location and season. This study quantifies the evidence of spatial and temporal heterogeneity in the health effects of short-term exposure to particles.

**Methods:** Multiple statistical approaches were applied to investigate the short-term effects of PM<sub>2.5</sub> on hospitalizations in Medicare enrollees by season and by geographical region of the U.S. We used a national database of hospital admissions for the period 1999 to 2005 based on Medicare enrollees age 65 years and older for 202 U.S. counties with populations of 200,000 or more persons. We fit three types of time-series models: (1) a main effect model assuming consistent PM effect across the year; (2) a seasonal interaction model allowing different effects of PM by season; and (3) a harmonic model allowing smoothly varying effects of PM throughout the year. For each model structure, a two-stage Bayesian hierarchical model was used to estimate the association between daily PM<sub>2.5</sub> and hospitalization rates on average across the 202 US counties. We also identified which PM<sub>2.5</sub> chemical components had higher levels for the regions and seasons with higher effect estimates, compared to regions and seasons with lower effect estimates.

**Results:** We found statistically significant evidence of seasonal and regional variation in PM effect estimates. Results from the harmonic model were consistent with the seasonal interaction model. Respiratory disease effect estimates were highest in winter, with a 1.05% (95% posterior interval 0.29, 1.82%) increase in hospitalizations per 10 µg/m<sup>3</sup> increase in same day PM<sub>2.5</sub>. Cardiovascular diseases estimates were also highest in winter, with a 1.49% (1.09, 1.89%) increase in hospitalizations per 10 µg/m<sup>3</sup> increase in same-day PM<sub>2.5</sub>, with associations also observed in other seasons. The strongest evidence of a relationship between PM<sub>2.5</sub> and hospitalizations was in the Northeast for both respiratory and cardiovascular diseases. Heterogeneity of PM<sub>2.5</sub> effects on hospitalizations may reflect seasonal and regional differences in emissions and in particles' chemical constituents.

**Conclusions:** This study demonstrates regional and temporal patterns in the associations between PM<sub>2.5</sub> and cardiovascular and respiratory hospital admissions, with the strongest evidence of a relationship between PM<sub>2.5</sub> and hospitalizations found in the Northeast and in winter for both respiratory and cardiovascular diseases. The clear finding of heterogeneity provides a rationale for further work to understand its basis. Our results can help to guide the development of hypotheses and further epidemiological studies on potential heterogeneity in the toxicity of constituents of the PM mixture.

#### ISEE-1024

#### Impact of Improved Cookstoves on Indoor Air Pollution and Adverse Health Effects Among Honduran Women

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**Objective:** Elevated indoor air pollution levels associated with the burning of biomass fuels in developing countries are well established. Improved wood-burning cookstoves have the potential to substantially reduce these exposures. Studies examining the relationship between stove use and adverse health effects have been inconsistent, relying mostly on proxies of exposure, such as type of stove or time spent cooking. Several respiratory endpoints have been associated with biomass-derived indoor air pollution in developing countries, although little research has been performed on cardiovascular health.

**Methods:** We conducted a cross-sectional survey among 79 non-smoking Honduran women living in two communities, one rural and one semi-urban. Thirty-eight women cooked with traditional stoves and 41 with improved stoves with chimneys. Among a subgroup of these women (N = 54–58), carbon monoxide and particulate matter (PM<sub>2.5</sub>) levels were assessed via eight-hour indoor monitoring, as well as eight-hour personal

PM<sub>2.5</sub> monitoring. Pulmonary function testing (Forced Expiratory Volume in One Second and Peak Expiratory Flow) was performed and respiratory and headache symptoms were assessed. Finger-stick blood samples were collected and dried on filter paper to measure concentrations of C-reactive protein (CRP), a biomarker of inflammation and a predictor of cardiovascular disease risk. We evaluated the relationship of stove type and air pollution levels with the health outcomes (pulmonary function, symptoms, and CRP) in multiple regression models.

**Results:** The use of improved stoves resulted in a 63% decrease in personal PM<sub>2.5</sub>, a 73% decrease in indoor PM<sub>2.5</sub>, and a 90% decrease in indoor carbon monoxide levels as compared to traditional stoves. Women using traditional stoves reported symptoms of cough (odds ratio (OR), 7.99; 95% confidence interval (CI), 1.59 to 40.09), phlegm (OR, 3.83; CI, 0.86 to 17.14), headache (OR, 5.59; CI, 1.73 to 18.06), and shortness of breath (OR, 2.33; CI, 0.83 to 6.57) more frequently than those using improved stoves, although associations may have been influenced by reporting bias. Associations remained, although attenuated, for indoor PM<sub>2.5</sub> and carbon monoxide with symptoms. Estimates for cookstove exposures and lung function or CRP were consistent with null associations.

**Conclusion:** While indoor and personal air pollution levels were reduced, associations with health outcomes were mixed. The ease and convenience of collecting, storing, and transporting dried blood spot samples may provide a useful tool for large-scale investigations, especially in developing countries.

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#### ISEE-1025

#### Community-Based Risk Assessment and Capacity Building for Community Decision-Making: Meeting the EPA/OPPTS Tribal Strategic Plan Objective

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**Background:** A key part of the EPA OPPTS Tribal Strategic Plan (2003–2008) is “Protecting Human Health and The Environment in Indian Country and Other Tribal Areas Including in Alaska.” To that end, EPA has produced new exposure and risk assessment software and databases focused toward community-based assessments using community-specific information, even with atypical information formats.

**Discussion:** The framework of these technical products will be presented using Alaskan Tribal community examples for illustration of the principles of the assessment and database construction. Most importantly, we will share the EPA experience in attempting community-based assessments, particularly the results of the available case studies, as “lessons learned”. In order to accomplish the tool development, database development, and assessments, we have proposed fundamental principles and priorities which we will discuss and offer for conversation. These include the principles of relevance and transparency, and the definition of “expert” in the context of peer review. The experiences in meeting the objectives of the OPPTS Tribal Strategic Plan have provided an opportunity for EPA leadership and meaningful collaboration to promote sensible risk reduction strategies. As it is now possible to incorporate the best and most relevant information into exposure/risk assessments, we can more accurately predict real impacts of risk mitigation options. Opportunities now exist to harmonize technical approaches, databases, and technical tools, thereby enhancing our cost efficiencies and upgrading everyone’s technical capabilities.

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#### ISEE-1026

#### Predictors of Heterogeneity in Airport Emissions of Air Toxics Associated with Individual Cancer Risk Thresholds

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**Background:** In recent years, communities surrounding airports have expressed increasing concern about the potential contributions of airport air toxics emissions to health risks, and it would be valuable to be able to predict the exposure and health risk implications of emissions or emissions changes at a defined airport, both from an individual and a population perspective. In this study, we apply a high-resolution atmospheric dispersion model (AERMOD) to a sample of 33 airports across the U.S., including small and large airports in urban and rural settings in different areas of the country.

**Methods:** We estimate the emission rates required at these airports to exceed a specified individual risk threshold (i.e., 10<sup>-6</sup> for the lifetime cancer risk for the maximally exposed individual), and we additionally determine the total population risk associated with these emissions, to determine whether prioritization based on maximum individual exposure and risk would correspond with prioritization based on total population exposure and risk. We additionally develop models to explain the heterogeneity in these emission rates across airports, based on meteorological and population data. To provide a realistic characterization of pollutant fate and transport, airport emissions are modeled based on time-varying operational profiles as several vertically-layered area sources. We focus on air toxics with different chemical characteristics and varying cancer potency evidence—benzene, 1,3-butadiene, and particle-bound PAHs. We apply AERMOD and estimate incremental concentrations from airports at the centroids of census tracts or block groups within 50 km. We estimate the emissions required to exceed the individual risk threshold using previously-published inhalation unit risk factors, and we combine incremental concentrations with population estimates at the population centroids to calculate the total population exposure due to the airport emissions.

**Results:** Our findings indicate that the minimum emissions threshold varies significantly across airports, predicted by covariates for local meteorology and population distributions as well as airport activity patterns, and that optimization based on individual exposure and risk thresholds will differ from optimization based on total population exposure and risk.

**Discussion:** These results allow communities and other stakeholders to quickly but reasonably determine the likelihood of public health impacts of concern for airport modifications or expansions, and can be expanded to include non-cancer or criteria pollutant effects in future assessments.

#### ISEE-1027

#### Comparison of Exposure Estimates for Chlorpyrifos Using Three Different Sets of Algorithms

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**Background:** Human exposure is often estimated using algorithms that mathematically combine media-specific concentrations and exposure factors.

**Methods:** A comparison between three different sets of algorithms was performed using multimedia measurements, activity patterns, and other supplemental information collected in an observational measurement study conducted during 2001 in Duval County, Florida. These data were used as inputs to estimate residential exposures to chlorpyrifos (CPF) and its urinary metabolite, 3,5,6-trichloro-2-pyridinol (TCPy), for nine young children using three models: 1) *Draft Protocol for Measuring Children's Non-Occupational Exposure to Pesticides by all Relevant Pathways* (Draft Protocol), 2) equations defined for the *Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants* (CTEPP) Study, and 3) the *Stochastic Human Exposure and Dose Simulation* (SHEDS-Multimedia) Model. The children's exposures and absorbed

doses of CPF were estimated for all routes (inhalation, ingestion, dermal) of exposure.

**Results:** For inhalation, the median absorbed dose levels were 3.2 ng/kg/day (Draft Protocol), 6.5 ng/kg/day (CTEPP), and 5.8 ng/kg/day (SHEDS). Median absorbed doses for dietary ingestion were 8.6 ng/kg/day (Draft Protocol), 8.6 ng/kg/day (CTEPP), and 14 ng/kg/day (SHEDS). The indirect ingestion median absorbed dose estimates were 0.03 ng/kg/day (Draft Protocol), 0.13 ng/kg/day (CTEPP), and 4.5 ng/kg/day (SHEDS). Median absorbed doses for the dermal exposure route were 10 ng/kg/day (Draft Protocol), 9.9 ng/kg/day (CTEPP), and 0.10 ng/kg/day (SHEDS). The median amount of TCPy excreted in the children's urine was measured at 280 ng/kg/day. To account for the uncertainty for exposure to TCPy in the environment, SHEDS estimates were adjusted for each environmental medium with a TCPy/CPF ratio using data available from CTEPP, assuming that TCPy is absorbed in the same proportion as CPF. The median excreted amount of urinary TCPy was estimated by SHEDS to be 124 ng/kg/day. While the key inputs were the same, the assumptions required to calculate the exposure and dose estimates differed for all three models. The dominant route of exposure estimated by method was dietary ingestion for SHEDS, and dermal for the Draft Protocol and CTEPP. This model-to-model comparison relied on real-world environmental measurement data to estimate the internal dose of chlorpyrifos via the inhalation, ingestion, and dermal exposure pathways.

**Conclusion:** The results from this project will help researchers and regulatory scientists by providing a framework to identify: similarities and differences in model estimates; correlations of exposure and environmental measurements; and uncertainties in model exposure estimations.

*Although this work was reviewed and approved by EPA, it may not necessarily reflect official Agency policy.*

#### ISEE-1030

#### Estimated Burden of Blood Lead Levels $\geq 5 \mu\text{g}/\text{dl}$ in 1999–2002 and Declines from 1988–1994

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**Background:** There is no 'safe' clinical threshold of blood lead levels (PbB). The Centers for Disease Control and Prevention (CDC) defines PbB  $\geq 10 \mu\text{g}/\text{dl}$  as 'elevated'. In light of recent data suggesting adverse health effects at PbB  $< 10 \mu\text{g}/\text{dl}$ , lowering the current definition of elevated blood lead ( $\geq 10 \mu\text{g}/\text{dl}$ ) has been recommended. To ascertain the population level impact of such a change, we calculated the prevalence of blood lead levels (PbB)  $\geq 5 \mu\text{g}/\text{dl}$  in 1 to 21 year old population in the United States. Furthermore, we characterized changes in PbB between 1988–1994 and 1999–2002.

**Methods:** We analyzed data from the National Health and Nutrition Examination Survey (NHANES) III (n = 10,755) and NHANES 1999–2002 (n = 8,013).

**Results:** In 1999–2002, approximately 91.7% of study children, who were between 1 to 21 years old, had detectable levels of lead in the blood. Among them, 7.3%, 2.8%, and 1.0% children and adolescents between 1–5 years, 6–11 years, and 12–21 years, respectively, had PbB between 5  $\mu\text{g}/\text{dl}$  and 9.9  $\mu\text{g}/\text{dl}$ . This number translates to approximately 2.4 million individuals. Among children 1–5 years and 6–11 years of age, non-Hispanic blacks, children with low household income, whose parents/primary caregivers were not home owners, and children residing in pre-1950 housing had higher burden of PbB  $\geq 5 \mu\text{g}/\text{dl}$  compared to non-Hispanic whites, children with higher household income, home owners, and who resided in newer houses (built in 1978 or after), respectively. For the oldest age group, males and children without health insurance had

higher prevalence of PbB  $\geq 5 \mu\text{g}/\text{dl}$  compared to their counterparts. Between 1988–1994 and 1999–2002, the geometric mean PbB declined from  $2.88 \mu\text{g}/\text{dl}$  to  $1.94 \mu\text{g}/\text{dl}$  in children 1–5 years,  $1.80 \mu\text{g}/\text{dl}$  to  $1.36 \mu\text{g}/\text{dl}$  in children 6–11 years, and  $1.24 \mu\text{g}/\text{dl}$  to  $1.02 \mu\text{g}/\text{dl}$  in children and adolescents 12–21 years of age. Also, the prevalence of PbB  $\geq 5 \mu\text{g}/\text{dl}$  declined from 25.7% to 8.8%, 12.8% to 3.0%, and 7.5% to 1.2% in these age groups, respectively.

**Conclusions:** A substantial proportion of children may be at risk for adverse health effects from lead exposure below  $10 \mu\text{g}/\text{dl}$  and a large number of children will be classified as having ‘elevated’ PbB if  $5 \mu\text{g}/\text{dl}$  is considered the threshold. Significant public health resources will have to be mobilized for intervention, screening, and case management of these children. However, since no levels of PbB can be considered ‘safe’, these estimates are an underestimation of the actual number of children affected by environmental lead exposure.

#### ISEE-1031

#### Trihalomethane Levels in Exhaled Breath as Indicators of Exposure to Disinfection By-Products in Indoor Swimming Pools Using Chlorine and Bromine as Disinfectants

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**Background:** Water disinfection is extremely important for the protection of public health. However, disinfectant products are highly reactive and generate undesired molecules by reaction with organic matter. Chlorine, the most used, generates complex mixtures of chemicals in which trihalomethanes (THMs) predominate. Epidemiological studies have found associations between long term THMs exposure and increased risk of cancer, mainly in bladder. Water ingestion is commonly considered as the most usual route of exposure to disinfection by products (DBPs). But the high volatility and dermal permeability of these compounds point to inhalation and dermal absorption as additional significant pathways for THMs uptake. These three exposure routes may be important upon indoor swimming pool activity. In previous studies, the significance of these pathways has been assessed from the analysis of blood, urine and alveolar air in swimmers. However, no data is available for attendants to swimming pools in which bromine is used as disinfectant. Interestingly, bromine-containing DBPs have been reported to be more cytotoxic and mutagenic than their chlorine equivalents.

**Methods:** Taking these considerations into account, environmental and biological THMs monitoring was performed in two indoor swimming pools which used different disinfection agents, chlorine (chlorinated swimming pool (Cl-SP)) and bromine (brominated swimming pool (Br-SP)). THMs uptake was assessed by exhaled breath analysis in 58 subjects before and after 40 min of exposure. A portable system collecting end-exhaled breath by adsorption on TENAX was used for this purpose. THMs concentration in swimming pool water and indoor air were monitored during all exposure experiments. In the Cl-SP, subjects were divided into three groups in order to evaluate the influence of the different exposure routes: inhalation (10 subjects standing outside the water), physical activity (32 subjects swimming during the whole exposure period) and non-physical (8 subjects inside the pool but without swimming). In the Br-SP, only the physical activity experiment was performed (12 subjects swimming during 40 min).

**Results:** Total THMs levels in air were in the ranges of  $44\text{--}125 \mu\text{g m}^{-3}$  and  $63\text{--}125 \mu\text{g m}^{-3}$  in Cl-SP and Br-SP, respectively, whereas water concentrations ranged between  $35\text{--}75 \mu\text{g L}^{-1}$  (Cl-SP) and  $54\text{--}67 \mu\text{g L}^{-1}$  (Br-SP). Chloroform and bromoform were the most abundant compounds detected both in water and air of the Cl-SP and Br-SP, respectively. They were also the dominant compounds in the corresponding exhaled breath samples. Statistically significant differences were observed in THMs

concentrations in exhaled breath of all subjects before and after exposure. Significant correlations were found between concentrations in exhaled breath and levels in water and air for dibromochloromethane (DBCM) in Cl-SP, and chloroform, bromodichloromethane (BDCM) and DBCM in Br-SP. In both cases, the strongest correlations were found between levels in exhaled breath and indoor air, suggesting that inhalation is the main exposure route in indoor swimming pools. Physical activity experiments resulted in higher increments of all compounds (between 5.6–16.4 times for after/before exposure ratio) when compared to inhalation (1.3–5.3 times) and non-physical (1.2–4.6 times). These results suggest increasing THMs exposure with increasing pulmonary ventilation as consequence of physical activity and therefore, prevalent THMs uptake by inhalation.

#### ISEE-1032

#### Short Term Effects of Fine and Ultrafine Particulate Matter on Mortality in Rochester, NY, USA

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**Methods:** Using data collected in the Rochester, NY area during the years 2001–2005, the association between daily mortality and exposure to fine and ultrafine particles was explored. Daily counts of non-accidental and cardiopulmonary deaths were obtained from the New York State Department of Health for the city of Rochester and its adjacent towns.  $\text{PM}_{2.5}$  mass concentrations and carbon monoxide were measured by The New York State Department of Environmental Conservation. Sub-micron (0.01–0.47  $\mu\text{m}$ ) particle number concentrations (NC) were measured from 2002 to 2005 at the same site. Assuming spherical particles of a constant density, we calculated mass concentrations (MC) from NC and combined each into three size bins (0.01–0.05  $\mu\text{m}$ , 0.05–0.10  $\mu\text{m}$ , and 0.10–0.47  $\mu\text{m}$ ). Due to instrument issues, and its later start of operation, we had only 976 days of NC, and MC data versus 1732 of  $\text{PM}_{2.5}$  data. Approximately 500 days of missing accumulation mode particles data ( $\text{MC}_{0.1\text{--}0.47}$ ) were subsequently filled in using multivariate regression based imputation with  $\text{PM}_{2.5}$  temperature and seasonality as predictors. Using generalized additive Poisson regression models we estimated the association between daily mortality and  $\text{PM}_{2.5}$ , NC, MC, and CO adjusting for trend, season, day of the week, and temperature.

**Results:** We found a statistically significant association between non-accidental mortality and  $\text{PM}_{2.5}$  at a 2-day lag (relative risk (RR) 1.012, 95% confidence interval (CI) 1.002–1.023) and a 5-day average lag (RR 1.021 (95%CI 1.003–1.040) per  $5 \mu\text{g}/\text{m}^3$ . Similar associations with  $\text{PM}_{2.5}$  were seen for cardiopulmonary mortality. No significant associations of mortality with NC or CO were observed.  $\text{MC}_{0.1\text{--}0.47}$  estimates from analyses that included the imputations had a similar pattern as  $\text{PM}_{2.5}$ .

**Conclusion:** In conclusion, these results confirm previous studies on the association of fine particles and mortality.

#### ISEE-1033

#### Urinary Concentrations of Pyrethroid Metabolites in the General U.S. Population, NHANES 1999–2002

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**Background:** Pyrethroid insecticides are replacing home and some agricultural uses of organophosphorus and carbamate insecticides. Like many other classes of insecticides, the pyrethroid insecticides are acute neurotoxicants, and although dissimilar in structure and environmental persistence to p,p'-dichlorodiphenyltrichloroethane (DDT), their modes of action are strikingly similar. Pyrethroid insecticides, as with DDT, modulate the function of voltage-gated sodium channels. Although studies

in humans demonstrate that pyrethroid insecticides are absorbed readily following exposure by inhalation, oral, and dermal routes, the primary exposure route in humans is thought to be through dietary intake. However, because of their burgeoning use in common household insecticide products such as spray insecticides, aerosol bombs and pet shampoos, low-level episodic exposures from household use are probable. Exposures from household use in colder areas likely occur in the spring and summer when household pests are at their peak; however, in warmer climates, pyrethroid insecticides may be used in homes year-round. Furthermore, the use of pyrethroid insecticides, particularly permethrin, in lice treatments and shampoos may allow for direct exposure to certain pyrethroid insecticides in children. Mammalian animal studies have identified several important metabolites of pyrethroid insecticides. 3-Phenoxybenzoic acid (3PBA) is a common metabolite resulting from the oxidation of the hydrolytic product of many pyrethroid insecticides, 3-phenoxybenzyl alcohol. Chrysanthemic acid derivatives are also obtained after pyrethroid insecticide metabolism. *Cis*- and *trans*-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-1-carboxylic acid (*cis*-DCCA; *trans*-DCCA) are metabolites of permethrin, cypermethrin and cyfluthrin. Animal and human studies suggest these metabolites are good biomarkers for exposure to pyrethroid insecticides.

**Discussion:** We report urinary concentrations of metabolites of pyrethroid insecticides in 1,998 persons of the general U.S. population aged 6 to 59 years in 1999 and 2000 and 2,539 persons aged 6 and older in 2001 and 2002. Specifically, we report urinary concentrations of 3PBA with geometric means (GM) of 0.29 ng/mL (71%) and 0.32 ng/mL (79%) in the two sampling cycles, respectively, and 95<sup>th</sup> percentile distribution estimates of 4.3 ng/mL and 3.3 ng/mL, respectively. Levels were significantly higher among non-Hispanic blacks than other racial/ethnic groups in 2001–2002. *cis*-DCCA and *trans*-DCCA were detected in less than 40% of the samples tested and their 95<sup>th</sup> percentile estimates were 0.89 ng/mL and 2.5 ng/mL, respectively, for the 2001–2002 sampling cycle. Other metabolites were detected more infrequently. The data we report are representative of the civilian, noninstitutionalized U.S. population and are stratified by sex, age, and race/ethnicity. In addition, we compare our results with results from other population-based or targeted population studies.

**Results:** Preliminary results showed that the FLEC/Interscan combination was comparable to the small chamber/DNPH method in the determination of formaldehyde emissions. The FLEC/Interscan formaldehyde measurements were found to be comparable to the FLEC/DNPH measurements in the range of 50–300 µg/m<sup>3</sup> ( $r^2 \sim 0.97$ ), however, Interscan measurements underestimated concentrations by about 10% compared to DNPH methods. It was also determined that increasing air temperature from 25 to 32 °C increased emission rates by 27% and resulted in higher drift of the Interscan measurements, whereas increasing relative humidity from 50 to 75% resulted in an increase in emission rates by 11%. These findings support the utility of this protocol as a method for real time determination of formaldehyde emission from composite wood products.

#### ISEE-1036

#### Air Pollution Exposure Model for Individuals in Health Studies: Parameter Estimates for PM<sub>2.5</sub> from Research Triangle Park PM Panel Study

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**Background:** Air pollution epidemiologic panel studies aid in developing our understanding of the relationship between individual exposures to air pollutants and health outcomes. These health studies often use measurements from central ambient monitoring sites as exposure surrogates. The relationship between ambient concentrations and corresponding individual exposures can depend on many factors, including physical and chemical properties of the air pollutant, local stationary and mobile ambient sources, indoor sources, building characteristics, meteorology, climate, season, and time-activity patterns. To estimate individual exposures for health studies, we are adapting population-based exposure models to incorporate questionnaire information that can include time-activity patterns, housing characteristics, heating and air conditioning system operation, window opening behavior, and potential indoor pollutant sources. An important aspect of our exposure model is its modular design customized for specific health outcomes. Each module will include the multiple air pollutants associated with the specific health outcomes (e.g., asthma, cardiovascular effects, and adverse pregnancy outcomes), and the exposure factors appropriate for the health study.

**Methods:** The current physics-based exposure model predicts the total and apportioned (indoor-generated and outdoor-generated) individual exposure to PM<sub>2.5</sub> at home. The residential air exchange rate (AER) is estimated from questionnaire information and meteorological data that includes wind speed and indoor-outdoor temperature differences. Using an iterative optimization algorithm, model parameters were estimated with the questionnaire and exposure data from the EPA Research Triangle Park (RTP) PM Panel Study. This study measured daily residential AERs and personal, residential indoor, residential outdoor and ambient PM<sub>2.5</sub> concentrations for seven consecutive days during each of four seasons for 38 individuals in 37 homes within the RTP area of North Carolina. Computer simulations were performed to compare individual model-predicted and measured PM<sub>2.5</sub> concentrations. The model-predicted residential indoor concentrations of PM<sub>2.5</sub> closely correspond to the observed data.

**Discussion:** Our model will improve the understanding of the relationship between ambient concentrations and individual exposures by estimating ambient and non-ambient source contributions to exposures, and by identifying key exposure factors to help design questionnaires for health studies. Furthermore, the model will demonstrate the benefit of individual exposure estimates for development of more accurate, cost-effective, and less burdensome exposure metrics in support of health studies.

*This work was reviewed by the U.S. EPA and approved for publication but does not necessarily reflect Agency policy.*

#### ISEE-1034

#### Development and Evaluation of a Field Protocol for Real-Time Measurement of Formaldehyde Emission from Composite Wood Products

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**Background:** In April 2007, the California Air Resources Board approved a new regulation setting formaldehyde emission limits for all composite wood products sold in California starting in 2009. The intent of this regulation is to reduce public exposure to formaldehyde. The regulation sets emission limits that are comparable to standards currently used in Europe and Japan. To support this regulation, a protocol is being developed for field screening that will allow enforcement staff to rapidly identify possible non-complying products for follow-up laboratory testing and possible enforcement action.

**Methods:** The proposed protocol utilizes a Field and Laboratory Emission Cell (FLEC) coupled with a real-time formaldehyde monitor (Interscan 4000 formaldehyde analyzer, Interscan Inc.). Comparisons were made to existing ASTM testing chamber methods (small and large chambers) under a variety of environmental conditions (i.e., temperature, relative humidity), sampling flow rates, and wood product properties. Studies were conducted to evaluate equilibration time, precision, and correlation to ASTM test methods.

**ISEE-1039****Application and Evaluation of an Aggregate Physically-Based Two-Stage Monte Carlo Probabilistic Model for Quantifying Children's Residential Exposure and Dose**

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**Background:** Critical voids in exposure data and models lead risk assessors to rely on conservative assumptions. Risk assessors and managers need improved tools beyond the screening level analysis to address aggregate exposures to pesticides as required by the Food Quality Protection Act of 1996. Thus, there is a need for developing probabilistic aggregate and cumulative source-to-dose models for assessing realistic multimedia, multipathway exposure and risk to pollutants and populations of concern. EPA/Office of Research and Development (ORD)'s aggregate Stochastic Human Exposure and Dose Simulation model for multimedia, multipathway pollutants (SHEDS-Multimedia) is a physically-based probabilistic model designed to estimate likely values of human exposure and dose to selected multimedia/multipathway pollutants. SHEDS-Multimedia combines actual human activity data (from national time/activity diary surveys and videography studies) with residue and concentration measurements in media contacted and pathway-specific exposure factors (e.g., surface residue transferability to skin). The model then predicts, for user-specified cohorts, exposures incurred via eating contaminated foods or drinking water, inhaling contaminated air, touching contaminated surface residues, and ingesting residues from hand- or object- to-mouth activities. The modeled exposure time series are input to dose estimation models.

**Discussion:** This poster will discuss the predictive SHEDS-Multimedia equations, algorithms, and assumptions for incidental ingestion, dermal, and inhalation residential exposure pathways/routes. To illustrate model capabilities, an aggregate case study for young children and a range of typical indoor concentration/residue levels was conducted, and modeled predictions were evaluated using available biomonitoring data. Non-dietary ingestion was found to be an important route for shorter post-application time periods; dietary ingestion for longer post-application time periods. Despite current data limitations and model assumptions, the model predictions of exposure and dose compared well with available real-world data, and provided useful insights to the relative importance of exposure routes and critical model inputs.

*Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

**ISEE-1041****Environmental Exposures and Breast Development in Urban Minority Girls**

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**Background:** Environmental exposures may alter the timing of breast development, a risk factor for reproductive function, breast cancer, and other chronic diseases. Mount Sinai is one of three Breast Cancer and Environment Research Centers (BCERCs) sites investigating the role of environmental exposures in puberty. We are studying inner city minority girls who are at risk for obesity and early development.

**Methods:** We have established a cohort of 412 girls (60% Hispanic, 40% black; 6–8 years old at baseline [BL]). At first annual follow-up (FU1) we have seen 254 girls as of March 10, 2008. Breast stage was assessed by health providers (BL, FU1); dietary isoflavone and energy intake, urinary biomarkers of phthalates, phenols, and phytoestrogens were measured at BL.

**Results:** Breast development (stage B2+ vs B1) was present in 22% of girls at BL, and in 35% at FU1. Many girls were at-risk-for- or were overweight (40% at BL). Baseline isoflavone and energy intakes were lower among girls who were B2+ vs B1 at BL as well as at FU1 (not significant). Baseline low-molecular-weight phthalate urinary metabolites (LMWPH) were higher among girls who were B2+ vs B1 at FU1; however they did not differ by BL breast stage (unadjusted). Age- and ethnicity-adjusted prevalence ratios (PR) for B2+ at FU1 were 1.14 per log-LMWPH (95%-CI 0.996–1.30). Other urinary biomarkers had near-null main effects with breast stage at BL or FU1 (benzophenone, bisphenol A, 2,5-dichlorophenol, triclosan, genistein, daidzein, enterolactone, high-molecular-weight phthalate monoesters). Interaction models indicate that prevalence of breast stage may vary by adiposity for several biomarkers including phthalate metabolites, benzophenone, bisphenol A, and enterolactone.

**Conclusions:** In summary, preliminary results from this longitudinal study suggest few main associations of hormonal environmental exposures with breast development, although effects may be limited to underweight or overweight girls. Further analyses with complete follow-up and appropriate longitudinal hazards models may provide additional insights.

*Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.*

**ISEE-1043****Fish Consumption Patterns and Advisory Awareness Among California Women**

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**Background:** Although the consumption of fish provides many health benefits, it also poses health risks from exposure to mercury, a particular concern for women and children.

**Methods:** Questions on fish consumption patterns and advisory awareness were added to the 2005 California Women's Health Survey, a random-digit dialing telephone survey on health behaviors among California women.

**Results:** While 84% of respondents ate commercial fish and 17% ate sport fish, overall intake (all sources) was low (8.2 g/d). African American and Asian/Pacific Islander women reported significantly higher intakes than other ethnic groups. Overall fish intake increased with age, level of education and income, and birth place outside the US. However, intake of sport fish only was higher among women at lower education and income levels. Nearly 4 in 5 women of childbearing age ate less fish than recommended by the American Heart Association ( $\geq 6$  ounces per week). While only 8% of women exceeded federal advisory limits, African American and Asian/Pacific Islander women were more likely to exceed these limits than other ethnic groups. About half of California women reported awareness of health advisories on fish. Awareness was significantly lower among foreign-born, African American, and White, non-Hispanic women, as well as among women with lower income and education levels.

**Conclusion:** While most California women could benefit by eating more fish, some women still exceed advisories for mercury intake. Disparities continue to exist in health risks from fish and advisory awareness, pointing to the need for improved education for some populations.

**ISEE-1044****Fish Consumption and Mercury Exposure Among Pregnant Women at a Sacramento Clinic**

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**Background:** Due to the legacy of historic gold and mercury mining, elevated levels of mercury in fish have been found throughout the Sacramento-San Joaquin Delta watershed in California's Central Valley. State health advisories recommend limited consumption for many types of fish in this region. Because mercury is most harmful to the developing fetus, these advisories are most restrictive for pregnant women. Yet fishing and fish consumption is culturally important to many of the ethnically diverse residents in this region.

**Methods:** We sought to understand how fish consumption practices are related to the blood mercury concentration in a population of pregnant women. We collaborated with an OB/GYN medical provider serving low-income women in Sacramento, California. We characterized fish consumption practices, including both sport caught and commercially obtained fish, through a survey. Blood was tested for mercury in the majority of participants. Medical assistants fluent in Hmong and Vietnamese were trained to conduct interviews and provide educational sessions. A counseling protocol based on mercury levels was developed to guide clinical staff in communicating blood mercury test results to women.

**Results:** We interviewed 180 women and received 165 blood tests. The majority of participants were either Asian/Pacific Islanders (45.6%) or Black (30%), almost 78% of respondents had household income of less than \$20,000, and 31.3% never completed high school. Nearly all women reported eating commercial fish. Shark, swordfish, king-mackerel, and tilefish are considered to have the highest mercury contamination, and pregnant women are advised not to eat these species. Approximately 7% of participants reported eating any of these four fish in the past 30 days. Almost 12% of respondents reported eating any sport fish in the past 30 days. 11% of participants had mercury blood levels above the USEPA reference dose ( $>5.8 \mu\text{g/L}$ ), and all elevated women were either Vietnamese or Chinese. While this population's awareness of advisories was very poor, the counseling the women received was effective at raising their overall their awareness and understanding of this issue.

#### ISEE-1046

##### Long-Term Exposure to Particulate Matter and All-Cause and Cause-Specific Mortality in Japan: Shizuoka Study

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**Background:** Recent epidemiologic studies have evaluated the effects of short-term exposure to air pollution all over the world and demonstrated the positive association between air pollution and mortality. In contrast, studies of the effects of long-term exposure have been limited to the United States and Europe, and the evidence remains sparse in Asian population. In the present study, we evaluated the health effects of long-term exposure to Suspended Particulate Matter (SPM), including all-cause, cardiopulmonary, lung cancer, and pneumonia mortality in Shizuoka, Japan. In Japan, among air pollutants, particulate matter is regulated as SPM, which is almost the same as PM<sub>8</sub> (particles less than 8  $\mu\text{m}$  aerodiameter).

**Materials and Methods:** In December 1999, a total of 300 residents each, who were stratified on both sex and age groups (65 to 74; 75 to 84), were chosen randomly from all the 74 municipalities in Shizuoka (n = 22,200). Then, the questionnaires were distributed to the subjects and returned from 14,002 residents (Response rate: 63%). They were followed in December 2002 and March 2006 using the same questionnaires, and 8,636 survivors and 1,368 deaths were identified until March 2006. We defined the 14,002 respondents at the baseline as Shizuoka cohort. Among the cohort, we targeted the subjects who lived in 1 km diameter from the monitoring stations for the present study. Subsequently, 1,208 subjects

were analyzed. Exposure data (SPM) were available from the Environmental Database managed by the National Institute for Environmental Studies in Japan. We assigned the subjects the mean concentration of the nearest stations during 2000–2005. Furthermore, vital statistics for determining causes of death of participants were obtained from the database of the Ministry of Health, Labor and Welfare. The underlying causes of death were coded according to the 10th International Classification of Disease (ICD-10). In the statistical analysis, the multivariate adjusted relative risks (RRs) of air pollutants were estimated using the Cox proportional hazards model. We adjusted for age, sex, smoking category (never-, ever-, current smoker), and Socioeconomic status. All confidence intervals (C.I.s) were calculated at the 95% level. SPSS software (SPSS Japan Inc., version 14.0 J) was used for the analysis.

**Results:** The mean SPM concentration during 2000–2005 was 29  $\mu\text{g/m}^3$  (SD 3.6). Totally, there were 101 deaths, including 54 cardiopulmonary, 6 lung cancer, and 7 pneumonia deaths. Relative risks (95% C.I.) for a 10- $\mu\text{g/m}^3$  increase in SPM concentration were 1.8 (1.1–3.0) for all-cause, 2.3 (1.2–4.7) for cardiopulmonary, 1.2 (0.1–11) for lung cancer, and 5.5 (1.9–16) for pneumonia mortality.

**Conclusions:** Long-term exposure to SPM increases the risk of all-cause and cause-specific mortality in Japan. Our research needs to be replicated in further studies with larger number of participants using more sophisticated exposure modeling.

#### ISEE-1049

##### Concentration of Airborne Viruses in Pediatrics Department Measured using Real-Time qPCR Coupled to an Air-Sampling Filter Method

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**Background:** Children, more than the general public, tend to be more vulnerable to viral infections. Current qualitative assays do not provide comprehensive information regarding viral concentrations in air.

**Methods:** This study attempted to develop a quantitative assay to collect viral aerosols in the pediatrics department at a medical center in Taipei. The filtration method combined with real-time qPCR was applied to detect influenza A virus (INFAV), human adenovirus (HAdV), and enterovirus.

**Results:** Of the 33 aerosol samples collected from the emergency room of the pediatrics department, 24% (8/33) were found positive for INFAV, 36% (12/33) for HAdV and 15% (5/33) for enterovirus. The virus loadings for these three were 168–5,020 copies/ $\text{m}^3$  for INFAV, 10–362 copies/ $\text{m}^3$  for HAdV and 44–30,000 copies/ $\text{m}^3$  for enteroviruses, respectively. Airborne INFAV and HAdV levels were found to be significantly correlated with number of URI patients in the pediatrics department.

**Conclusion:** The filter/real-time qPCR can demonstrate extremely sensitive and rapid for quantifying airborne viruses. Enteroviruses have the highest viral load and may be transmitted via aerosols.

#### ISEE-1050

##### Serum Concentrations of Organochlorines and Risk of Melanoma: Results of a Prospective Analysis

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**Background:** The incidence of malignant melanoma has increased in the last several decades, especially among whites, with annual increases in incidence of about 3–7%. While greater exposure to sunlight/UV and increased screening are believed to explain much of this increase, this does not rule out a role for other factors. Limited evidence from occupational cohort studies suggests that exposure to polychlorinated biphenyls (PCB) may also contribute, although results have been inconsistent. We conducted the first biospecimen-based epidemiologic study of the possible association between risk of melanoma and body burden of selected PCBs and organochlorine pesticides, using a nested case-control design in a large, general population cohort.

**Methods:** We measured prediagnostic serum concentrations of 34 PCB congeners and 11 organochlorine pesticides or pesticide metabolites from 166 incident cases of malignant melanoma and 785 matched controls from a prospective cohort of adults in Norway. All sera used in this study were collected in the 1970s and were stored frozen since that time. We used unconditional logistic regression to calculate age- and sex-adjusted odds ratios (OR) and 95% confidence intervals (95% CI) for the relations between lipid-corrected serum concentrations of each chemical and risk of melanoma. Each of the top three quartiles of serum concentration was compared to the bottom quartile (i.e., reference) and tests for trend were assessed using log-transformed values as continuous measures.

**Results:** There was some evidence of weak dose-response trends among all study subjects for increasing quartiles of PCB congener #28 (ORs = 1.0, 1.3, 1.4, 1.8; P-trend = 0.068) and of the pesticide beta-hexachlorocyclohexane (ORs = 1.0, 1.1, 1.2, 1.6; P-trend = 0.035). Among males, the pesticide dieldrin showed a non-significant dose-response trend (ORs = 1.0, 1.0, 1.4, 2.4; P-trend = 0.224). Among females, dose-response trends were seen for PCB congeners #170 (OR = 1.0, 1.6, 1.6, 2.0; P-trend = 0.021), #180 (OR = 1.0, 1.8, 1.3, 2.5; P-trend = 0.017), #194 (OR = 1.0, 1.6, 1.8, 2.3; P-trend = 0.004), #196 (OR = 1.0, 1.4, 2.1, 2.2; P-trend = 0.006), #199 (OR = 1.0, 2.2, 2.1, 2.8; P-trend = 0.005), and #206 (OR = 1.0, 1.1, 1.6, 2.1; P-trend = 0.003), and for the *p,p'*-DDT metabolite *p,p'*-DDE (OR = 1.0, 1.1, 1.6, 2.0; P-trend = 0.019). We observed no clear patterns when analyses were stratified by median time from blood collection to cancer diagnosis.

**Conclusions:** We found only limited evidence of associations between melanoma risk and serum concentrations of specific PCB congeners and organochlorine pesticides. Most associations were relatively weak and/or were restricted to one sex. Some of the associations that we observed may be due to the moderate to strong correlations between serum concentrations of many of these chemicals. In addition, potential confounding by factors such as correlated exposures to other unmeasured organochlorines or other bioaccumulating compounds needs to be further evaluated.

#### ISEE-1052

#### Health Risk Profile of Vietnamese Nail Salon Workers in Alameda County, California

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**Background:** The nail salon industry has been one of the fastest growing professions in the U.S.. California alone has over 300,000 licensed nail technicians. Health concerns have been particularly pronounced for these workers because they are exposed daily to an array of potentially hazardous compounds associated with nearly every nail care service they provide. Little is known about the health of these workers. Additionally, nearly 60% of California manicurists are Vietnamese women who may face socio-cultural barriers that may compromise their understanding of workplace safety and their access to health care.

**Objective:** This community-research collaborative pilot project was designed to systematically collect baseline data that would characterize the Vietnamese female nail salon workers in Alameda County, in order to help inform future targeted health interventions and to reduce occupational exposures in this immigrant worker population.

**Methods:** *Focus Groups:* We conducted two focus groups, each with ten Vietnamese nail salons workers, to identify health concerns and work conditions in nail salons as well as help inform our strategies for effective survey participation. We stratified the two groups by years of U.S. residency ( $\leq 5$  years versus  $> 5$  years), a proxy measure for acculturation, to examine potential differences in attitudes towards the profession and health concerns.

*In Person Surveys:* We conducted surveys with a convenience sample of 201 Vietnamese nail salon workers at 74 salon shops in Alameda County, California. Survey questions included demographics, immigration history, reproductive history, work history, health experience, health concerns, health care utilization and work environment. Surveys were conducted by current and former nail salon workers trained in survey administration.

**Results:** *Focus Groups:* More-recent workers were less satisfied with their profession than longer term workers. However, both groups reported high levels of concern about chemicals-of-use and acute health effects.

*Face-to-face Surveys:* Of the workers surveyed, nearly all are immigrants born in Vietnam. Over half of the survey participants had worked in the nail salon industry for more than five years, and 23% had worked for more than ten years. With respect to safety equipment, a large majority reported wearing gloves (72%) and masks (84%) while providing nail care services. Overall, 62% of the women reported experiencing some type of health problem after they began working in this sector. Ninety-four workers (47%) reported health symptoms that may be associated with solvent exposure, including skin irritations, breathing problems, numbness, and eye and throat irritations. More than half of the shops included in the survey have five or more workstations, yet less than half of these shops were using a local exhaust ventilation and one third of the shops only had a door to allow indoor-outdoor air exchange to improve the air quality.

**Conclusions:** The combination of chronic exposure to toxic compounds, high prevalence of acute health symptoms and predominance of immigrant workers underscore the need for further investigation into the chronic health of nail salon workers, particularly their cancer risk since they are exposed to carcinogens and endocrine-disruptors. Due to the recent popularity of nail services worldwide, this research topic may be of global interest.

#### ISEE-1053

#### Ethnic Difference in the Effect of Asthma on Pulmonary Function in Children

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**Background:** Asthma is the most common chronic disease in children. The impact of asthma on both acute and chronic lung function deficits is well known, but there has been little study of how these effects of asthma vary by race or ethnicity. One possible reason for paucity of research on this topic is the limited statistical power of previous studies to detect gender- and race/ethnic-specific differences.

**Methods:** We evaluated ethnic differences in the effect of asthma on lung function among 3245 (1099 Hispanic and 2146 non-Hispanic White) school children with at least two spirometric tests during 8 years of follow-up in the Children's Health Study. The large sample size and yearly assessment of asthma and lung function in the population-based sample were major strengths of the study. Gender-specific mixed-effects regression spline models were fitted separately for each ethnic group and for both groups combined.

**Results:** In boys, asthma was associated with greater deficits in lung volume (FVC) in Hispanic ( $-1.30\%$ ) than in Non-Hispanic Whites ( $0.63\%$ , interaction  $P$ -value 0.047). In girls, Hispanics with asthma had greater deficits in flow rates than Non-Hispanic Whites. For example, the asthma-associated deficit in MMEF was  $-5.13\%$  among Hispanic girls and  $-0.58\%$  among non-Hispanic white girls (interaction  $P$ -value 0.009). A bigger impact of asthma in Hispanic girls was also found for FEV<sub>1</sub>, FEF<sub>75</sub> and PEFR (interaction  $P$ -value 0.04, 0.07, and 0.005, respectively). The impact of ethnicity on lung function also varied by age at asthma diagnosis. FVC deficits occurred largely in Hispanic boys diagnosed under age 5, while larger deficits in flow rates occurred among Hispanic girls with later onset, compared to non-Hispanic Whites.

**Conclusion:** We conclude that the impact of asthma on lung function was larger in Hispanic than Non-Hispanic White children, and that these effects varied by gender and age of diagnosis. Further study is warranted to understand the reasons for these differences.

#### ISEE-1054

#### The Impact of Cold Wave on Mortality in Seoul, South Korea from 1994 to 2006

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**Background:** Temperature related mortality studies have been largely reported. In particular, the high temperature mortality associations and thresholds that mortality risk begins to rise as the temperature increases were suggested in a Korea study. In this study, we evaluated the shape of low temperature mortality associations and analyzed the effects of low temperature on mortality in winter (December, January, February) of Seoul from 1994 to 2006.

**Methods:** We obtained mortality and meteorological data between 1994 and 2006 from the governmental agencies. After adjusting the time-trend, day of the week and holidays, and relative humidity, we explored the associations between mortality and various temperature indicator of winter in Seoul, Korea. First, we fitted non-parametric smoothing regression models to check the shape of associations and then fitted threshold models (including two different slopes in a model) to estimate the thresholds and the effects by the AIC criteria.

**Results:** The graphical associations between cardiovascular disease related deaths and  $\Delta T$  ( $=T_{\min}, \text{the current day} - T_{\min}, \text{one day before the current day}$ ) were observed. We confirmed the threshold and the statistical significance of the effect above the threshold according to lag structure (lag = 0, lag = 1, lag = 2). Thresholds were estimated as  $-3.2^{\circ}\text{C}$  for all aged population,  $-2.8^{\circ}\text{C}$  for  $65+$  on  $\Delta T$  of current day and as  $-2.8^{\circ}\text{C}$  for all aged population,  $-3.0^{\circ}\text{C}$  for  $65+$ ,  $-4.0^{\circ}\text{C}$  for  $65-$  on  $\Delta T$  of lagged one day and as  $-2.3^{\circ}\text{C}$  for  $65-$  on  $\Delta T$  of lagged two days. Estimated percent increases as  $1^{\circ}\text{C}$   $\Delta T$  decreases below the thresholds were  $1.79\%$  for all aged & lag = 1,  $1.59\%$  for  $65+$  & lag = 0,  $1.26\%$  for  $65+$  & lag = 1 and  $3.82\%$  for  $65-$  & lag = 1 in daily cardiovascular mortality. These estimated percent increases were statistically significant at  $\alpha = 0.05$ .

**Conclusion:** Our results indicate that cardiovascular disease related deaths is sensitive to  $\Delta T$ . We suggest that the public health programs to prevent cold wave effects on daily mortality should be considered as important as to prevent heat wave effect.

#### ISEE-1055

#### Air Pollution and Myocardial Infarction—a Small-Area Case Crossover in Strasbourg, France Influence of Individual and Area Characteristics

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Pollution in Alsace, Schiltigheim, France; and §University Medical School, Strasbourg, France.

**Background and Objectives:** Many studies have shown that daily air pollution is associated with cardiovascular diseases, but its specific effect on myocardial infarction (MI) onset remains comparatively little studied. We investigated this association between ambient air pollution levels and the occurrence of MI events on a small-area scale (census block) and evaluated the influence of individual and area characteristics.

**Methods:** This study setting is the Strasbourg metropolitan area, a French urban area composed of 190 census blocks and 450,000 inhabitants. From January 2000 to December 2003, 1,193 cases of MI (first and recurrent episodes) occurred among subjects aged from 35 to 74 years, were obtained from the local population-based coronary heart disease registry. Each of them was georeferenced to his block of residence. Individual information such as age, sex, history of previous ischemic heart disease (IHD) was available. Hourly ambient air pollutants levels (PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO and O<sub>3</sub>) during 2000–2003 were modeled at the census block level by the local air quality monitoring association using ADMS-Urban air dispersion model. Block-level socioeconomic status was estimated using a socioeconomic deprivation index, constructed from census data. We used a time-stratified case crossover design adjusted by influenza case counts and meteorological factors to assess the association between MI events and daily average air pollutant levels. For O<sub>3</sub> the maximum 8-hour average has been taken into account for the only summer season (April–September). We tested several single-day lags (0, 1, 2 and 3 days) as well as cumulative-day lags (0–1, 0–2 and 0–3). The influence of cases' characteristics (age, sex, IHD history and block-level socioeconomic status) was analyzed through stratified analyses. Results are expressed in Odds Ratios (OR) based on an increment of exposure corresponding to the interquartile range of each pollutant and only the most relevant lag times are presented.

**Results:** A positive and significant association was found between SO<sub>2</sub> (lag01) and the MI risk (OR = 1.100 95% CI [1.002–1.207]). The other pollutants were positively but not significantly associated with MI risk (PM<sub>10</sub> (lag01) OR = 1.019 95% CI [0.930–1.116]; CO (lag0) OR = 1.034 95% CI [0.955–1.121]; NO<sub>2</sub> (lag0) OR = 1.038 95% CI [0.939–1.147]), except O<sub>3</sub> for which no association did appear (O<sub>3</sub> (lag0) OR = 0.916 95% CI [0.767–1.095]). The associations tended to be stronger among people older than 55, among women, among subjects with a previous IHD and among those living in the most deprived census blocks.

**Conclusions:** These results suggest a short-term adverse effect of ambient air pollution on MI onset. In this study population, the elderly, the women, people with IHD history and living in the most deprived areas would be potentially at greatest risk and more susceptible to air pollution effects.

#### ISEE-1056

#### Minute Ventilation During Commuting by Bike, Car and Bus

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**Background:** In the Netherlands people commute one hour a day on average, mostly during peak hours with high levels of air pollution. These exposures may lead to respiratory and cardiovascular health effects. In the TRAVEL project the exposure to air pollution of volunteers commuting by car, bus and bike is measured. In addition, short-term effects of these exposures are examined on lung function, air way resistance, exhaled nitrogen oxide levels and blood markers. We studied minute ventilations of the volunteers to be able to take into account difference in inhaled air and thus inhaled air pollution doses between commuting by bike and commuting by bus or car.

**Methods:** On the study days, the subjects travel between 8 and 10 am by car, bus or bike, accompanied by researchers with equipment to measure fine and ultrafine particle concentrations. During the journey, heart rates of the subjects are collected using personal heart rate monitors. For each subject the relation between heart rate and minute ventilation is established by letting the participants cycle on a bicycle ergometer at increasing intensity. Heart rate and minute ventilation are measured simultaneously.

**Results:** The relation between heart rate and minute ventilation as established by the tests on the bicycle ergometer was different for each individual ( $n = 22$ , 14 male, 8 female, mean age 40.2 years, mean body mass index  $24.7 \text{ kg/m}^2$ ). The relation was linear for the range of heart rates that occur during commuting, we did not perform tests at maximal intensity. We calculated minute ventilations of 148 trips of 2 hours, 50 trips by bike, 43 trips by car, and 55 trips by bus. Minute ventilation levels while commuting by bike were on average  $26 \text{ l/min}$  (range: 12–48), by car  $11.5 \text{ l/min}$  (range: 5–24), by bus  $13 \text{ l/min}$  (range: 4–30). The individual ratio of minute ventilation of cyclists compared to bus or car passengers ranges between 1.5 to 6.8 (average 2.3). Minute ventilations of bus and car passengers were comparable.

**Discussion:** In studies where exposures to air pollution and related health effects of groups of commuters are compared, the difference in minute ventilation should be taken into account, in order not to underestimate the exposure of bicyclists and pedestrians. The factor to use to correct for the difference in minute ventilation, is different for each individual. In studies on health effects of exposure to air pollution of commuters this factor should be calculated for each individual. In the only other study that calculated the ratio of minute ventilation of travelling by bike compared to by car (Van Wijnen et al 1995), the average ratio was also found to be 2.3. Two other factors possibly of influence to the amount of inhaled air pollution are the increased ratio of mouth to nose breathing and the deeper inhaling during exercise.

#### ISEE-1057

#### Spatiotemporal Variations of Traffic-Related Air Pollution in the Taipei Metropolis, Taiwan

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**Background:** Several studies showed that exposure to traffic-related air pollutants, such as nitrogen dioxide ( $\text{NO}_2$ ) and particulate matter, are associated with respiratory symptoms, especially in urban areas. In addition to the meteorological factors, the distributions of traffic-related air pollution were also affected by surrounding geographic variables, such as land use or road type.

**Methods:** This study was conducted to investigate the distributions, spatiotemporal variations, and determinants of ambient nitrogen dioxide ( $\text{NO}_2$ ) and particulates with aerodynamic diameters less than or equal to  $2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ) in a subtropical city. Ambient concentrations of  $\text{NO}_2$  and  $\text{PM}_{2.5}$  were collected at six monitoring stations of the Taiwan Environmental Protection Administration (Taiwan EPA) in Taipei metropolis, Taiwan.

**Results:** The average concentration of  $\text{NO}_2$  and  $\text{PM}_{2.5}$  in Taipei were  $22.25 \text{ ppb}$  and  $29.56 \mu\text{g/m}^3$ , respectively, over the study period of 2007. The highest concentration of  $\text{NO}_2$  and  $\text{PM}_{2.5}$  were both found in ChongShan station ( $31.63 \text{ ppb}$  vs.  $34.67 \mu\text{g/m}^3$ ), located in the city center in Taipei with heavy traffic. We found clear seasonal variations of  $\text{NO}_2$  and  $\text{PM}_{2.5}$  during the study period at all the six monitoring stations. Their concentrations were high in winter and spring and low in summer and fall. The wind speed was negatively correlated with these two pollutants (Spearman correlation coefficient =  $-0.13$  and  $-0.37$ ,  $P < 0.01$ ). Positive correlations between  $\text{PM}_{2.5}$  and  $\text{NO}_2$  were found over the entire

year, indicating that  $\text{PM}_{2.5}$  and  $\text{NO}_2$  originated from similar sources (i.e., traffic emissions). We are currently using Geographic Information Systems (GIS), combining geographic data and air pollution measurements, to identify the most significant effect factors for  $\text{NO}_2$  and  $\text{PM}_{2.5}$ .

#### ISEE-1058

#### Apples: A Standard Food for Determining Potential Residential Pesticide Transfers

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**Background:** Children's unstructured eating behaviors lend themselves to potential dietary exposures to pesticides applied in the home. To determine the potential excess dietary exposure of children from handling food during consumption, a standard food has been developed to be used in the field as a measure of transfers of pesticides. The standard food of choice was the Red Delicious apple because of its consistent transfer efficiencies for a range of pesticides and its ease of analysis. Since this type of apple may not be available everywhere, various types of apple were studied to determine if the type impacted the transfer of pesticides from contaminated Formica®. The goal was to develop a standard operating procedure to be used in the field for residential monitoring of potential excess dietary exposures of children.

**Methods:** Seven varieties of apples (Red Delicious, Fuji, Golden Delicious, Pink Lady, Gala, Granny Smith, and Braeburn) were evaluated for transfer of pesticides from a pesticide-treated Formica® surface. Eight pesticides (permethrin, cypermethrin, cyfluthrin, deltamethrin, bifenthrin, fipronil, malathion, and chlorpyrifos) were mixed in an aqueous solution and uniformly sprayed across the surface. Apples were uniformly sliced and cut to a specific surface area. Surfaces were wiped with isopropanol moistened gauze pads to determine the amount of pesticides available for transfer to the apples. Each apple slice was placed on the contaminated surface. Pesticide concentrations were determined in surface and apple samples with an analytical method which utilized pressurized fluid extraction, clean-up with solid phase sorbents, and GC/ $\mu$ ECD detection. Transfer efficiencies were determined from the amount of the pesticides in the apples as compared to the amount wiped off the Formica®.

**Results:** Transfer efficiencies for all apple types ranged from 40 to 95% of the applied pesticides. The other types of apples were not as efficient as the Red Delicious, thereby, making the Red Delicious the best choice for use as a standard food.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1059

#### Influence of Activity on Transfer of Pesticides from Contaminated Formica® to Foods

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**Background:** Total dietary intake of pesticides by children should take into account the potential exposure from foods contacting contaminated surfaces. Children's unstructured eating habits and activities may lead to excess dietary exposures not traditionally taken into consideration. The influence of these activities on the transfer of pesticides from contaminated Formica® was studied.

**Objective:** The objective was to perform simulation experiments in which four foods (bread, apple slice, bologna, and sugar cookie) were exposed to contaminated Formica® under specific conditions.

**Methods:** Two activity-based factors were varied: the time interval between surface contamination and contact (1 hr., 6 hr., and 24 hr.) and the frequency of contact (four touches with no recontamination of the surface). Pesticides used during the experiments included chlorpyrifos, malathion, permethrin, bifenthrin, cyfluthrin, cypermethrin, and deltamethrin. Data generated from the analysis of samples will be used as input parameters for the Children's Dietary Intake Model (CDIM). An aqueous solution of all pesticides was uniformly sprayed on Formica® at a loading rate of 0.5 µg/cm<sup>2</sup>, dried for the required time, and then contacted with the individual foods for 10 min. A separate sprayed surface and foil were wiped with an isopropanol-moistened gauze pad to measure the available amount of pesticides. Pesticide concentrations were determined with an analytical method which utilized pressurized fluid extraction, clean-up with solid phase sorbents, and GC/µECD detection. Transfer efficiencies (TE) were based on the amount of the pesticides in the foods as compared to the amount wiped off the Formica®.

**Results:** Pesticide transfer from surface to bread and cookies was less efficient than to bologna and apple. For the bread and cookies, all pyrethroids ranged from below detectable levels to <4% TE. A combined average of 33–57% and 36–40%, respectively, was transferred to bologna and apple for the 1, 6, and 24 hr contact times. The organophosphate transfers were only slightly higher, ranging from 39–79% for both bologna and apples combined. The TE of the varied time intervals indicated that increased time between contamination and contact showed little difference for the four foods. The absolute transfer was decreased as the time increased and the transfers became more variable; however, the TE for all seven pesticides remained consistent.

**Conclusion:** As long as pesticide levels are measurable on surfaces in the field, the same TE will take place. This is valuable information for input into the CDIM.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1060

##### Exposure Informed Testing under REACH

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**Background:** On June 1, 2007, the new European legislation on industrial chemicals, REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) entered into force. The consequence of REACH is that in a relatively short time period the risk of a large group of chemicals has to be assessed, which implies that also a large amount of information on the fate and effects of chemicals has to become available. To deal with the information requirements and tight timelines set by REACH, in 2007, the OSIRIS project was launched. OSIRIS stands for Optimized Strategies for Risk Assessment of Industrial Chemicals through Integration of Non-Test and Test Information and aims at the development of Integrated Testing Strategies (ITS). ITS are meant to increase the use of non (animal) testing information for regulatory decision making of chemicals, taking uncertainty and variability into account. The envisaged decision theory framework includes alternative methods such as chemical read-across, in vitro results, in vivo information on analogues, quantitative and qualitative structure-activity relationships, thresholds of toxicological concern and internal and external exposure-based waiving. Identification, reduction and management of uncertainties are key elements.

**Discussion:** Exposure is one of the decision elements in ITS. Testing can be waived or triggered on the basis of exposure considerations. The Exposure Pillar of OSIRIS aims to develop a mechanism built upon definitions, criteria and assessment methods to support the decision-

making process on situations regarded as "non relevant exposure" (further testing can be waived) or "relevant exposure" (further testing is required). The Exposure Pillar consists of three Work Packages (WP), i.e., WP 3.1 on environmental exposure (including indirect human exposure), WP 3.2 on direct human exposure (consumer and worker) and WP 3.3 on internal exposure. Each WP will analyse, define, make operational and quantify criteria for exposure-based waiving and triggering under the REACH regulation. This presentation will explain the exposure informed testing concept under REACH and presents the first preliminary results.

#### ISEE-1061

##### The Application of Biomonitoring Data in Risk Assessment: An Expanded Case-Study with Benzene

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**Background:** Improved analytical methods permit the measurement of low levels of chemicals in human tissues. Despite evidence that chemicals are absorbed, it is unclear whether the relatively low levels detected in human tissue represent a potential adverse health risk. Furthermore, without exposure pathway information, it is difficult to relate biomonitoring results back to sources of exposure and to develop effective risk management strategies. To provide more perspective on approaches for integrating biomonitoring data into a risk-based framework, the Biomonitoring Technical Committee of the ILSI Health and Environmental Sciences Institute developed a case study of the relationship of human biomarker data to risk. The committee selected benzene as an example, but the goal is to develop an approach applicable to other chemicals.

**Discussion:** Existing biomonitoring data for benzene was evaluated relative to the current toxicology database for this chemical. In addition, there are cancer epidemiology data for benzene. The biomarkers of exposure for benzene are trans, trans-muconic acid and S-phenylmercapturic acid in urine along with parent compound in blood. Several published biomonitoring datasets are available for benzene. The availability of epidemiology, biomonitoring, and toxicology data offers the opportunity to relate health outcome with known toxicological effects. Ambient air levels of benzene are reported to be in the average range of 0.04 µg/m<sup>3</sup> in urban settings to about 3 µg/m<sup>3</sup> in occupational settings. The current biological exposure index (BEI) for occupational benzene exposure is 25 µg/g creatinine based on S-phenylmercapturic acid or 500 µg/g creatinine based on trans, trans-muconic acid. The published biomonitoring data based on trans, trans-muconic acid indicate that non-occupational exposures to benzene are in the range of 1–270 µg/g creatinine depending on smoking status, and some occupational exposures are in the range of 171–264 µg/g creatinine. The available published biomonitoring data suggest that long-term non-occupational exposure and the reported occupational exposures to benzene are substantially below the BEI for benzene.

#### ISEE-1062

##### Development of a Meta-Analysis-Based Model to Explain the Variability in the Reported Uptake of PAHs by Plants

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**Background:** Polycyclic aromatic hydrocarbons (PAHs) are common soil contaminants that are known to be taken up by plants, including vegetables, but the extent of reported uptake varies substantially within and between studies.

**Objective:** The aim of this study was to develop a model to explain the variability in reported plant PAH concentration with soil PAH concentration and other important factors.

**Methods:** We developed a database with 1811 observations from 31 studies that included 44 parameters to indicate potentially important chemical-related, soil-related, plant-related, and experimental characteristics. We divided the dataset into two subsets: a training dataset with 67% of randomly selected observations that was used to develop a model for plant uptake, and a validation dataset with the remaining 33% of observations used to test the predictability of the model. Potential predictors for plant uptake were identified based on biological plausibility, representation in the training dataset, significance of bivariate associations with plant/soil concentration ratios, and independence from one another. In addition to Log soil concentration (Log Csoil), 12 potential predictor variables were selected for entry in a forward stepwise regression.

**Results:** The resulting significant model explained 64% of the variance in the Log of plant concentration (Log Cplant) in the training dataset with Log Csoil, the log organic carbon partition coefficient, the fraction of organic matter, and dichotomous variables representing spiked/unspiked soils, peeled/unpeeled plant parts, and root/non-root plant parts. The model, applied to the validation dataset, resulted in a mean predicted-to-observed plant concentration ratio of 1.02 ( $\pm SE = 0.15$ ), and approximately equal numbers of underestimated and overestimated values.

**Conclusion:** This analysis identified important determinants of PAH plant uptake, and explained a substantial amount of the variability within and between studies.

**Disclaimer:** Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

#### ISEE-1066

#### A Space/Time Analysis Framework for Fecal Indicator Bacteria in a North Carolina Estuary

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**Background:** The Newport River Estuary (NPRE) is a high priority shellfish harvesting area in eastern North Carolina that is impaired due to fecal contamination, specifically exceeding recommended levels for fecal coliforms. Fecal indicator bacteria (FIB) serve as proxies for fecal pollution and potential human pathogens. When FIB concentrations are above recommended water quality standards a potential public health risk exists for consumption of shellfish. We have developed a mean trend model predicting levels of commonly used FIB, *E. coli* (EC) and *Enterococcus* (ENT), for waters used for shellfish harvesting and recreational purposes, respectively. The goal of this work is to produce maps showing the space/time distribution of FIB across the NPRE over the sampling period.

**Methods:** Water samples were collected from the NPRE (453 km<sup>2</sup>) at least thrice each season from August 2004 to September 2006. Samples were collected at sites geographically dispersed throughout the estuary, and during times that ensured capture of a wide range of hydrological conditions, i.e. spanning a range of storm events and dry periods. All samples were tested for EC and ENT using the defined substrate technology test kits, Colilert®-18 and Enterolert® from IDEXX Laboratories, Inc. The Bayesian Maximum Entropy (BME) method of non-linear geostatistics was used to generate maps of EC and ENT across the NPRE for conditions of "no rainfall" (0 cm) and "storm" (>2.54 cm).

**Results:** The generated space/time maps of EC and ENT integrate knowledge from meteorology (rainfall), hydrography (distance to shore), monitoring (bacterial concentration) and analytical MPN measurement error (as characterized by confidence intervals). The results showed winter FIB concentrations meeting water quality thresholds for recreational and shellfish harvesting waters, with the exception of EC concentrations at near land sites during "storm" conditions. Summer space/time maps reveal escalated EC concentrations regardless of "no rainfall" or "storm" conditions. However, ENT met water quality standards during the summer in "no rainfall" conditions but exceeded during the "storm" conditions.

**Conclusion:** Space/time maps produced have the potential to be useful tools for assessment of systemwide estuarine water quality and as visualization tools for management.

#### ISEE-1067

#### Community-Based Activity Profiles: Impact on Aggregate Exposure Assessment for an Insecticide Given Different Assumptions about Temporal and Spatial Aspects of Individuals' Activity Profiles in Focused Populations

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**Background:** The key parameters defining exposure to a chemical in a person's environment are the activities of that person in that environment and the kinetics of the transfer of the chemical from the environment into the person. Eating can be treated as one activity with some unique considerations.

**Discussion:** This work shows the relative importance of several parameters in the calculation of exposure: variable activities of persons in

#### ISEE-1063

#### Using Pesticide Screening Questions to Identify the More Highly Exposed Participants in a Larger Cohort

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**Background:** Researchers continually strive to develop questionnaires that can successfully identify more highly exposed subpopulations with respect to the general population. Compared to environmental and biological sampling, questionnaire administration is less burdensome for the participants and less time-consuming and less costly for the researcher.

**Objective:** A primary objective of an observational measurement pilot study conducted in Jacksonville, FL (USA) in 2001 was to determine if a short questionnaire could be used to select a subpopulation of children who were relatively more highly exposed to residential pesticides.

**Methods:** A questionnaire was administered and a urine sample was collected from 203 participants in the first tier (biomonitoring component) of the study. The effectiveness of the questionnaire and the applied scoring scheme was investigated by comparing the urinary biomarker concentrations of the 42 participants who were selected to progress to the second tier (environmental screening component) of the study against those not selected. Nonparametric one-sided Wilcoxon Rank Sum Tests on four different pyrethroid metabolites were conducted.

**Results:** Results suggest that the individuals selected for the second tier by their questionnaire scores were indeed more highly exposed to pyrethroid pesticides, based on group averages. The levels of significance for the differences between the two groups varied by biomarker and ranged from strong ( $P < 0.05$  for 4F3PBA and *cis*-DCCA) to only moderate ( $P < 0.1$  for *trans*-DCCA and 3PBA). The selection scheme may be insufficient for capturing the most highly exposed individuals, however, as only 4 of the 10 highest ranked participants were selected.

**Conclusion:** This analysis suggests that the information obtained in the administered questionnaire may be useful for selecting a group with somewhat elevated exposures but may not be effective at identifying the most highly exposed individuals.

a community, different types of surfaces, work-day versus holiday activities, different locations of the contaminant within the environment. The research employs different activity profile databases to illustrate how these databases deal with these same parameters. Dietary exposure via both commercial and non-commercial foods are included in the aggregate exposure assessment and the consideration of the drivers of the exposure.

#### ISEE-1069

#### Predicting Risk for Early Infantile Atopic Dermatitis by Hereditary and Environmental Factors

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**Background:** Interaction between hereditary and environmental factors in predicting risk of early onset atopic dermatitis (AD) has not been totally understood. We conducted a birth cohort study to evaluate the early risk factors for infantile AD at the age of 6 months.

**Methods:** In 2005, sampling of a representative sample of mother-child pairs was done by multistage, stratified systematic sampling from the Taiwan national birth registration. Information on hereditary and environmental risk factors was obtained by phone interview when babies were 6 months old. Multivariate regression analysis was applied to estimate significant risk factors for AD in babies.

**Results:** Out of the 24,200 candidates, a total of 21,248 (87.8%) mother-child pairs participated in this study, and 20,687 (97.4%) pairs completed the study satisfactorily. AD was diagnosed in 7.0% of the infants by physicians by 6 months of age. Parental asthma, atopic dermatitis, and allergic rhinitis, and maternal age at childbirth were risk factors for AD in infants. Among those environmental factors, fungi on walls of the house and renovation/painting in the house during pregnancy were also significantly associated with early infantile AD. Using these factors, the risk probability of having infantile AD at age of 6 months can be estimated and grouped into low, high, and very high. With five runs of tests in mutually exclusive subsets of this population, the likelihood of AD for 6-month-old babies were all consistent with our expectation. Among boys and girls, the highest predictive probability of AD was 67% in boys with maternal age >25 years old, both parents with AD, renovation and painting of the house during pregnancy, and fungus on wall at home. The lowest probability was 4% in girls with none of above factors.

**Conclusion:** This investigation provides technique for predicting infantile risk of AD by hereditary and environmental factors that can be used for developing early preventive measures against AD, especially among those children with family history of atopy.

#### ISEE-1070

#### Effect of Particulate Matter in Asian Dust on the Peak Expiratory Flow Rate of the Schoolchildren in Inner Mongolia of China

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**Background:** Some studies have proved that the Asian Dust has adverse impacts on the environment and human health, but it remains unclear

what effects of particles and other gaseous pollutants from Asian Dust may have on the lung function of exposed schoolchildren. The purpose of this study is to explore adverse effects of Asian Dust on the pulmonary function (peak expiratory flow rate) of the subject schoolchildren.

**Methods:** A panel study was conducted for 107 schoolchildren in Inner Mongolia of China. The peak expiratory flow rate (PEFR) of the subject children was measured by themselves three times a day for 40 days in the spring season. The personal information of the subject children was collected with the designed questionnaire for gender, age, height, weight, disease history, dietary habits, passive smoking, etc. The daily ambient concentrations of particulate matter <2.5  $\mu\text{m}$  ( $\text{PM}_{2.5}$ ) and particulate matter <10  $\mu\text{m}$  ( $\text{PM}_{10}$ ) in aerodynamic diameter were measured by the filter air samplers nearby the subject school. We also collected the data on the daily concentration of nitrogen dioxide ( $\text{NO}_2$ ) and sulfur dioxide ( $\text{SO}_2$ ), as well as meteorological conditions from the local environmental protection agency and meteorological agency. Linear mixed-effect models were used to estimate the association between air pollution exposures and PEFR values after adjusting the age, gender, BMI, and disease history of subject, as well as for temperature and relative humidity.

**Results:** Daily concentration of the air pollutants during dust weather periods reached 50–742  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$ , 78–1257  $\mu\text{g}/\text{m}^3$  for  $\text{PM}_{10}$ , 0.011–0.053  $\mu\text{g}/\text{m}^3$  for  $\text{NO}_2$ , and 31–145  $\mu\text{g}/\text{m}^3$  for  $\text{SO}_2$ , respectively. We found that the mean PEFR value was significantly decreased in association with daily average  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$  exposures in a lag 0–4 days in our models. The health effects were shown mostly two days after exposure to ambient particulates. For a 10  $\mu\text{g}/\text{m}^3$  increase in the daily average  $\text{PM}_{2.5}$  concentration, the mean PEFR value decreased by 0.255 L/min for a 2-day lag, and the value was 0.177 L/min for a 10  $\mu\text{g}/\text{m}^3$  increase of the  $\text{PM}_{10}$ .

**Conclusion:** Results suggest that the level of particulate matter from Asian Dust are closely associated with a short-term decrement of PEFR value.

#### ISEE-1073

#### The Effect of the Neighborhood Built Environment on the Diets of Urban Children

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**Objective:** Previous investigators have demonstrated that disparities in the placement of food stores and restaurants are associated with neighborhood wealth and racial composition, particularly in the United States. Although some researchers have shown the availability of supermarkets to be associated with healthier diets among adults, little research exists measuring the impact of neighborhood availability of local food stores on children's diets. Therefore, we measured the association between the presence of specific types of food stores and dietary intake of children living in East Harlem, New York.

**Method:** During 2003–2007, a cross sectional study was conducted where East Harlem children ages 6–8 years old were recruited through neighborhood hospitals and community based organizations. Three hundred twenty-four children participated in the study by providing demographic information and dietary information (through a 24-hour recall). A team of medical students surveyed East Harlem on foot, determining the locations and types of food stores and restaurants located in the area. Racial segregation of each Census block was defined as areas where the population was 75% black, 75% Latino, or racially mixed. Children's residential addresses were geocoded to 2000 U.S. Census blocks, used as a proxy for neighborhoods. In addition, addresses of food store and restaurants were address matched then geocoded to Census blocks. Food stores and restaurants were summed by type for each block thereby characterizing the neighborhood food environments of the participants.

**Results:** The majority of the children were Latino (66%) or Black (18%); and the majority lived on blocks that were racially mixed (75%) or predominately Latino (24%). Thirty-three percent of the children lived on city blocks where the only type of food store or restaurant was fast food. In comparison, only 3% of the population lived on city blocks where only supermarkets or grocery stores were the only food establishments. Children living in areas with a supermarket have slightly higher intake of fruit (mean servings ( $M$ ) = 2.2; standard deviation ( $SD$ ) = 2.1 versus  $M$  = 2.0  $SD$  = 1.9) and vegetables ( $M$  = 1.7,  $SD$  = 1.9 versus  $M$  = 1.2,  $SD$  = 1.1). However, percent of calories from fat were higher among the children living on blocks with supermarkets (Mean percent of calories from fat ( $M_{calf}$ ) = 30.5,  $SD$  = 9.2 versus  $M_{calf}$  = 29.2,  $SD$  = 7.9).

**Conclusion:** Our findings that the association between the availability of supermarkets and intake of produce is consistent with other studies that suggest that the physical availability of specific types of food stores and restaurants influence food choices and, presumably, diet related health outcomes.

#### ISEE-1074

##### Birth Characteristics and Breast Cancer in Young Women

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**Background:** Most known risk factors for breast cancer are thought to be mediated by estrogen exposure. During fetal development, when in utero estrogen levels can be several-fold higher than those experienced during normal non-pregnant adult life, mammary tissue undergoes rapid cellular proliferation making it especially susceptible to environmental insults. This observation has led to interest in the role of prenatal factors in breast cancer etiology.

**Objective:** The objective of our study is to evaluate the relationship between breast cancer risk and selected birth characteristics thought to be proxy measures for prenatal estrogen exposures, including maternal age, maternal pre-eclampsia, twinning, infant birth order, infant birth weight and gestational age at birth.

**Methods:** We conducted a population-based case control study among young California women. Invasive breast cancer cases diagnosed 1988–2004 were identified from the California Cancer Registry (CCR). Cases were restricted to women living in California at baseline who were born in the 1960s with either a California or unknown birthplace listed in the CCR. Population controls were selected from California birth records, frequency matched to cases 2:1 on year of birth. Population controls were linked to death files to remove any women who died prior to the start of cancer follow-up. A set of cancer controls were chosen from the CCR diagnosed 1988–2004, excluding smoking-related cancers and cancers of the female reproductive system. Cancer controls also had to be born in the 1960s and have a California or unknown birthplace in the CCR data. Through probabilistic record linkage, cases and cancer controls were linked to their California birth records. Data on birth characteristics for cases and both sets of controls were extracted from their birth records. Odds ratios (ORs) and 95% confidence intervals were calculated for each of the birth characteristics of interest in separate models, adjusting for age, race, and maternal age.

**Results:** Overall 50% of our eligible cases and cancer controls were linked to a California birth record (77% success for CCR records with California birthplaces; 38% for records with birthplace = unknown). Analysis was conducted on 3,799 cases of breast cancer, 7,418 cancer controls and 8,789 population controls. Our study population was very young (age range for cases = 22 to 44 years) and predominantly white (87% white, 8% black, 3% Asian/PI). Preliminary results suggest that women with breast cancer were significantly more likely to be born to mothers 35 years or older than those in the statewide population. Breast cancer cases were also less likely to be born post-term (gestational age > 42 weeks) than either cancer controls or population controls. Compared to

the population controls, breast cancer cases were more likely to be first born, although a similar relationship was not seen when compared to the cancer controls. No significant relationship was observed for any other birth characteristic examined.

**Conclusion:** While some birth characteristics may be associated with breast cancer risk among young women, our results do not consistently support the hypothesis that pre-natal estrogen exposure is the mechanism by which such risks are mediated.

#### ISEE-1075

##### A Comparison of Estimated Versus Actual K-Anonymity When Geomasking Sensitive Health Data

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**Background:** In spatial epidemiology, public health surveillance data often must have the addresses stripped before analysis for research purposes. Rather than aggregating cases to a politically-defined region, we recommend geomasking the data to maintain the spatial distribution for in-depth analyses. A common measure of privacy protection for this method is the average k-anonymity, which is defined as the number of people by which a de-identified case is displaced geographically and cannot be reversely identified. This measure is usually estimated by assuming that the population is uniformly distributed throughout a census block group. We calculated both the estimated and actual k-anonymity and compare them to evaluate this assumption.

**Methods:** The state of North Carolina has maintained a database of cases of sexually transmitted infections (STIs) diagnosed since 1994. In addition to the STI data, we obtained a GIS shapefile with detailed information on the state's census block groups as well as E911 files that contain locations of actual households (case and non-case) in 18 counties. We geomasked cases of gonorrhea and syphilis in a random direction by more than a specified minimum distance, but less than a maximum distance, while retaining the address in its original census block group. The estimated k-anonymity for each case was calculated as  $k = \pi^*(\text{displacement distance})^2/\text{household density}$ . The actual k-anonymity was calculated as the number of actual households from the E911 file that were closer than the distance of displacement.

**Results:** The estimated k-anonymity provides a relatively unbiased estimate of the actual k-anonymity on average, but with some over and under estimations at particular locations. Over estimation of the actual k-anonymity was more common for areas with very heterogeneous population density.

**Conclusion:** If household locations are available, calculating the actual k-anonymity is preferred since it is based on the physical population distribution in a census block group rather than the assumption that the population is distributed homogeneously. When this cannot be done, one should be careful when geomasking in areas with heterogeneous population density since protecting privacy based on an estimated k-anonymity might not be sufficient.

#### ISEE-1076

##### A Review and Synthesis of EPA Exposure Models

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**Background:** Models are often used to estimate chemical concentrations and exposure levels for use in risk assessments and epidemiology studies and to support regulatory standards. Over the last several decades, the U.S. Environmental Protection Agency (EPA) has developed and

supported a number of models that can be used to evaluate the environmental fate and transport of chemicals and resulting exposure point concentrations as well as human and ecological exposures and risks. However, there is little guidance available on the general use, interpretation, and evaluation of these different models.

**Discussion:** The purpose of the current presentation is to provide a review and synthesis of more than 30 exposure models developed or commonly used by EPA. Topics related to these models that will be covered include their (1) historical rationale and intended purpose, (2) potential application and misuses, (3) level of analysis and routes of exposure, (4) key data inputs and outputs, (5) temporal and spatial resolution, (6) treatment of variability and uncertainty, (7) degree of evaluation, (8) level of internal and external peer review, (9) interactions or duplicity with other models, and (10) strengths and limitations. Similarities and differences among exposure models, including underlying datasets and key assumptions, will be highlighted. Examples demonstrating the application or evaluation of selected exposure models will also be presented. Our evaluation should serve as a useful resource to modelers and practitioners both within and outside the EPA.

*Disclaimer: The views expressed are those of the authors and do not reflect the policies of the U.S. EPA.*

#### ISEE-1077

#### Modeling Human Exposure to Cadmium and Arsenic in the Northern Campine Region

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**Background:** The Northern Campine region in north-east Belgium has a long history harboring the zinc smelting industry. In the last decades, increasing environmental and health concerns have resulted in measures to limit or eliminate the heavy metal pollution associated with these activities. A recent study showed a significant correlation between cadmium exposure and lung cancer incidence in the area. In order to assess the present situation with regards to cadmium and arsenic pollution and human exposure, a large-scale monitoring campaign was set up in participation with stakeholders from the local community and locally active environmental health workers. The campaign involves a population sample of about 1200 subjects in a study area including the municipalities of Mol, Balen, Lommel, Overpelt, Neerpelt and Hechtel-Eksel. Human measurements are available for all participants and environmental measurements were carried out at the homes of 100 individual participants. The participants filled out a questionnaire inquiring about current and past home locations, work and other activities, life style and consumption patterns.

**Methods:** In this contribution, we describe the development and implementation of a human exposure model based on these data. The exposure model aims to capture the transfer and exposure dynamics for the 100 participants with individual environmental measurements and for several subgroups of the population sample. The subgroups are based on relevant confounders like age, home location and smoking behavior. Several pathways are considered for human exposure to Cd and As. Exposure by inhalation is estimated by combining information on time expenditure within and outside the study area with corresponding metal concentration data. Measurements are available from the monitoring

campaign itself and from other sources and literature. Exposure by food and water consumption is calculated based on consumption patterns indicated in the questionnaire and direct measurements in food products. Home-grown versus purchased products are considered separately given the relevance of the local soil cadmium concentration to the concentration in vegetables. Where direct food product measurements were not available for vegetables, previously established models relating soil and plant concentrations are used to estimate the concentration. Other pathways considered are soil ingestion, active and passive smoking and the consumption of water from differing sources. Since urinary cadmium concentrations are a marker for lifetime exposure, the model takes into account the historical exposure. To this end, the model relies on historical data, if available, and on reasonable extrapolations of current consumption and time use patterns. The model is validated against the biomonitoring data acquired during this campaign. On this basis, it allows us to identify the main pathways contributing to human exposure to Cd and As and to refine the focus of possible regulatory guidelines. Also, a sensitivity analysis is performed to identify the impact of specific decisions in the modelling process.

*The study was initiated, financed and substantively steered by the Flemish government (Flemish Agency for Care and Health; Department of Environment, Nature and Energy; Flemish Environment Agency; OVAM) with the support of UMICORE and different representatives of administrative and scientific bodies of the Flemish regional and local level.*

#### ISEE-1079

#### Study Design and Baseline Findings from an Evaluation of Integrated Water, Sanitation and Hygiene Interventions in Rural Tamil Nadu, India

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**Background:** Between 2003 and 2007, a demand-driven water/sanitation/hygiene improvement program was implemented in 12 rural Indian villages. Here, we present the design and initial baseline survey results from a yearlong, prospective cohort study to evaluate health and economic impacts of the interventions. The cohort was assembled after the program ended, from 12 intervention villages and 13 control villages. Choosing an appropriate control group is difficult in this setting because the intervention was targeted and community demand driven. To address this design challenge, we selected control villages from a set of 240 potential candidates using a three-stage procedure that included restriction, propensity score matching (using pre-intervention characteristics), and in-field validation.

**Methods:** The cohort includes 1,173 children under age 5 living in 900 households. Based on village-level, secondary data collected prior to the intervention, the control selection method improved balance in numerous potentially confounding variables, such as per-capita income, female literacy, and scheduled caste population. Intervention and control villages balance on more than 20 important demographic, socioeconomic, and environmental exposure-related characteristics, but remain imbalanced at the start of the intervention period for two characteristics: latrine ownership (15% in intervention versus 9% in control villages) and agricultural working population (33% in the intervention versus 21% in the control).

**Results:** Preliminary analysis of our baseline survey provides an initial view of the current water and sanitation situation in the intervention and control villages:

**Water access:** Households in intervention villages have benefited from the intervention programs (26% of households in intervention villages have

received new access to improved water sources in the last 5 years, as opposed to 18% in control villages). However, overall access to public and private taps is equivalent in both cohorts. This equivalency indicates that other efforts, particularly government programs, are also driving water supply improvements in this area.

**Sanitation:** 47% of households have private latrines in intervention villages as opposed to 20% in control villages, however, 77% of households in the intervention villages still practice some level of open defecation (as opposed to 88% in control villages), suggesting that changes in sanitation behavior must be reinforced.

**Selected social and anthropometric indicators:** Improved water access is correlated with a perceived time savings in both intervention and control villages, however, villagers did not perceive links between water improvements and increases in income earning potential. Anthropometric measurements indicate that childhood nutrition is poor in this region of India and has not been improved by the intervention programs.

**Conclusions:** Our baseline survey suggests that the interventions have occurred against a background of other water and sanitation activity that, potentially, masks some of the benefits of these selected programs. This analysis may help target scarce resources for water and sanitation and highlights the importance of evaluating intervention impacts and sustainability by comparing current water use, sanitation practices, and hygiene knowledge between study and control communities. An additional 11 rounds of data collection through January 2009 will provide detailed information on diarrhea, respiratory infections, school attendance and water quality.

#### ISEE-1081

##### Space/Time Analysis of Cholera and Shigella Incidence Rates Across a Region of Bangladesh

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**Background:** Diarrheal diseases are the cause of an estimated 4–6 million deaths in developing countries each year. In these countries, ground water is generally a safer drinking water source compared with surface water since ground water is less contaminated with microbial pathogens. As a result, over 10 million tube wells have been installed since the 1970's in Bangladesh in an effort to improve the quality of the water consumed. However, diarrheal diseases remain a severe problem across the population. One possible explanation is that poor sanitation in densely populated villages may have resulted in microbial contamination of shallow aquifers. To elucidate the mechanism of diarrheal disease outbreaks, careful investigation of the spatial patterns of the rate of diarrheal diseases is essential.

**Methods:** We conducted a space/time mapping analysis of two types of diarrheal diseases, Cholera and Shigella. The diarrheal disease data we used consist of Cholera cases reported over a 10 year period in Matlab, approximately 50 km south-east of Dhaka, as well as Shigella cases reported over a three year period. We calculated the village level incidence rate based on the yearly aggregated reported cases. However, crude rates directly calculated as the ratio of observed counts over population may often produce unstable rates in villages with small populations, which leads to an observational noise that may mask important spatial patterns, and is sometimes referred to as the small number problem. In this study we applied the Bayesian Maximum Entropy (BME) method of modern Geostatistics to take into account this effect and produce maps of yearly diarrheal disease incidence rates adjusted for this observational noise. Based on these adjusted maps, we then conducted a cluster analysis using a Poisson distribution test to detect outbreaks of the diarrheal diseases.

**Results:** The yearly BME maps of diarrheal disease incidence rates have a smoother spatial distribution than the crude rate maps, particularly in villages with small populations where the observational noise is

significantly reduced. Several statistically significant clusters of villages with significantly greater rates than the region are found, particularly in the southern part of the study area.

#### ISEE-1083

##### PM<sub>10</sub> Air Pollution Exposure During Pregnancy and Term Low Birth Weight in Allegheny County, PA 1994–2000

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**Background:** Low birth weight has been associated with increased risks of mortality and/or morbidity in childhood and adulthood. Epidemiological studies suggest that maternal exposure to air pollution, especially particulate matter during pregnancy, is associated with an increased risk of delivering a low birth weight infant.

**Objectives:** The aim of this study is to explore the association between exposure to particulate matter (PM<sub>10</sub>) during pregnancy and term low birth weight (LBW: birth weight <2,500 g and gestation age ≥37 weeks).

**Methods:** Birth data from the Allegheny County Health Department, Pittsburgh PA and PM<sub>10</sub> air data generated with inverse-distance interpolation by RAND's Center for Population Health and Health Disparities, were obtained. The study population consisted of all term singleton live births (gestational age ≥37 weeks) born between Jan 1<sup>st</sup>, 1994 to Dec 31<sup>st</sup>, 2000. Infants with birth weight <2,500 g were classified as LBW. Robust logistic regression was performed to estimate the odds ratios of LBW per inter-quartile range increase in PM<sub>10</sub>.

**Results:** The results showed that the odds ratios of term LBW per inter-quartile range increase in PM<sub>10</sub> were 1.13 (95%CI: 1.02–1.25) during the first trimester and 1.10 (95%CI: 1.00–1.22) during the second trimester after adjustment for other important covariates, respectively.

**Conclusions:** The findings of the study support the hypothesis that exposure to PM<sub>10</sub> is associated with increased levels of term LBW. Further studies are warranted to corroborate these findings.

#### ISEE-1084

##### Polychlorinated Biphenyls in Human Milk

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**Background:** Polychlorinated Biphenyls (PCBs) as contaminants belonging to the group of Persistent Organic Pollutants (POPs) have the ability to accumulate in environmental media and lipid tissues of animals and humans (e.g., breast milk of nursing mothers).

**Objectives:** The aim of the study was to trace the PCBs in the specific food chain essential for children. Breast-milk is still considered the optimal food or even the most nutritive and safe source of food for infants worldwide. However, there is evidence that due to breastfeeding infants can be subject to pollutants' exposure.

**Methods:** The cohort under study involved 27 mothers residing in region of Armenia. By means of gas chromatography samples of human breast milk were analyzed for PCBs content in order to reveal possibility of "mother-infant" transfer of chemicals.

**Results:** PCB residues were detected in all samples ranging from 10.78 mcg/L to 267.97 mcg/L. The average level made 65.57 mcg/L. Taking into account the importance of cow milk and some dairy products for children of any age, monitoring was also held on PCB residues in these foodstuffs. PCBs were revealed in samples of milk from agricultural region of Aravir marz making 7.45–2.12 mcg/L. In samples of milk taken in industrial Lori marz (districts of Gugark and Alaverdi) PCBs content was at the level of 5.13–1.13 mcg/L, and 4.53–2.04 mcg/L, accordingly. POPs residues in bio-media (breast-milk) testifies to their

continuing circulation in biomaterial. The residues of POPs are insignificant; however, chronic long-term exposure to and the intake by human organism can become the reason of morbidity increase. Clinical manifestation of the after-effects is non-specific and hardly diagnosed.

**Conclusion:** Data presented signify to the fact that PCBs can penetrate into the human organism with milk and other dairy products.

#### ISEE-1085

#### Spatial Analysis of the Distribution of Bacterial Pathogen Indicators Across Shallow Aquifers in Bangladesh

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**Background:** Ground water is generally less contaminated with microbial pathogens than surface water. In Bangladesh, over 10 million tube wells have been installed since the 1970s in an effort to improve the quality of the water consumed. However, switching the water source from surface water to ground water has lead to an increased exposure to naturally occurring dissolved arsenic. In addition, diarrheal diseases remain a severe problem. One possible explanation is that poor sanitation in densely populated villages may have resulted in microbial contamination of shallow aquifers. In order to investigate this unfortunate link, we need to understand the spatial pattern of the microbial contamination of shallow aquifers.

**Methods:** We analyzed the spatial autocorrelation of a bacterial pathogen indicator, *E.coli*, in three different sites in Araihazar, Bangladesh, during the dry and wet seasons. We then constructed maps of shallow well microbial contamination over the area. The data used in the spatial analysis includes water samples from shallow wells (<65 ft deep) obtained in September 2006, March 2007, and January 2008. *E.coli* concentrations were measured by culturing and enumerating the bacteria using standard commercial kits and the concentration was reported as a most probable number (MPN) of colony forming units and an associated 95% confidence interval (CI). We conducted a spatial analysis of the data using the Bayesian Maximum Entropy (BME) method of modern Geostatistics. In the BME analysis developed in this work, we use a soft data model that accounts for the averaging of repeated measurements as well as the aggregation of their corresponding CI. We then use that information to obtain maps showing the distribution of microbial contamination across shallow wells in the study area.

**Results and Discussion:** The analysis indicates that the variability in *E.coli* concentrations is dominated by high temporal contrasts and that spatial autocorrelation occurs over longer distances in the wet season than in the dry season. Sadly, the proportion of shallow wells contaminated with *E.coli* is higher where groundwater arsenic concentrations are low. Further analysis including new data collected in 2008 will be performed to confirm these results. This work will be useful to study their connection with diarrheal disease cases and arsenic concentration in future work.

#### ISEE-1087

#### Exposure to High Levels of Magnetic Fields and the Risk of Poor Sperm Quality

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Parenthood Research, Shanghai, China; and ‡Department of Urology and Andrology, Shanghai Human Sperm Bank, Renji Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China.

**Background:** A significant world-wide decline in semen quality has been observed in recent years, and the cause of such a decline remains unknown.

**Methods:** To determine whether increased exposure to high levels of magnetic fields (MFs) decreases sperm quality, we conducted a population-based case-control study among seemingly healthy sperm donors in the Shanghai metropolitan area. The donors with abnormal sperm motility or morphology were identified as cases. Controls were those with no abnormal sperm indices. All participants were asked to wear an EMDEX-LITE meter for 24 hours to capture their daily MF exposure from all sources.

**Results:** After controlling for confounders, exposure to high MF levels was associated with an increased risk of poor sperm quality: compared to those whose 90th percentile of 24-hour MF level <1.6 mG, those whose 90th percentile of MF level ≥1.6 mG had a two-fold increased risk of poor sperm quality. Increasing duration and amount of exposure above 1.6 mG increased the risk further, a dose-response relationship with a statistically significant trend test. Importantly, the association and dose-response relationship were further strengthened with more accurate measurement reflecting MF exposure during spermatogenesis: odds ratio (OR) = 2.6, 95% confidence interval (CI): 1.2–5.5 for 90th percentile ≥1.6 mG for any duration, and OR = 3.9, 95%CI: 1.3–12.1 for MF exposure ≥1.6 mG lasting more than 6 hours.

**Conclusion:** Our study has demonstrated for the first time that exposure to high levels of magnetic fields may decrease sperm quality. If this finding is further confirmed in future studies, the new finding will have significant public health implications due to the ubiquitous nature of MF exposure.

#### ISEE-1088

#### Exploring the Untapped Potential of the “Ranch Hand” Data and Biospecimens

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**Background:** The US Congress has directed the Institute of Medicine (IOM) of the National Academy of Sciences to take responsibility for the data and biologic assets collected in the course of the Air Force Health Study, popularly known as the Ranch Hand Study. The study—which was originally focused on the possible influence of wartime exposure to herbicides—has collected serial biologic samples, and voluminous health status, demographic, and SES data from ~2300 Vietnam veterans in a longitudinal effort spanning over twenty years. Data from physical examinations include blood draws, urine and semen collections, skin and fat biopsies, stool smears, spirometry, chest X rays, electrocardiograms, dermatology and peripheral vascular examinations, neurological assessments, psychological testing, and many other clinical endpoints. Questionnaires eliciting information on education; employment; income; marital and fertility history; child and family health; health habits; recreation, leisure, and physical activities; toxic substances exposure; military experience; and wartime herbicide exposure were also administered. Data were also gathered and coded on the subjects' offspring: ~9,900 conceptions and 8,100 live births. A companion mortality study followed over 20,000 Vietnam War-era veterans with service in Southeast Asia for nearly 25 years.

**Discussion:** Much of the information, which is detailed in the 2006 IOM report “Disposition of the Air Force Health Study”, has never been analyzed. The IOM plans to make these materials available to the research community for study in 2008. This presentation will address: (1) the characteristics of the Ranch Hand data and biospecimens; (2) the scientific merit of their future study; and (3) potential research opportunities.

**ISEE-1089****Community-Based Participatory Exposure Assessment in an Environmental Justice Community: Preliminary Results and Communication**

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**Objective:** An emerging and critical component of community-based participatory research (CBPR) in environmental health is reporting results back to individual study participants and to the broader community. As personal exposure assessment methods detect ever-lower concentrations of more chemicals, corresponding animal and cell studies may indicate troubling biological effects, yet exposure sources, health effects, and exposure pathways remain poorly understood. In short, scientific capacity to detect precedes its capacity to interpret, and this situation poses unique challenges to developing effective report-back and communication strategies for CBPR projects that seek to empower communities to take action to reduce pollution exposures.

**Methods:** For the California Household Exposure Study, paired indoor and outdoor air samples were collected from 40 homes in a predominately low income, urban, minority community neighboring a large oil refinery and major transportation corridors; and from 10 homes in a comparison, rural, higher SES community with no proximate industrial emission sources. Samples from both study sites were tested for 155 compounds originating from industrial sources, mobile sources, and consumer products with a focus on understanding personal and indoor chemical exposures. Study results are being disseminated through bilingual community meetings, report-back materials, and individual home visits with study participants.

**Results:** A total of 84 analytes were detected in the outdoor air and 112 analytes were detected in the indoor air. Given the large number of compounds analyzed, report-back materials and communication with study participants aimed to elucidate which sources are amenable to individual versus collective approaches to exposure reduction. Distinctions were made between pollutants emitted from mobile, transportation sources (e.g. fine particulate matter) and pollutants that are likely emitted from industrial sources that have been a focus of community concern (e.g. ammonia). Report-back on pollutants with well-defined health effects and originating from major outdoor emission sources pointed to collective strategies to reduce community exposure. Conversely, study results also highlighted consumer products as another common source of indoor air pollutants. In this situation, report-back strategies distinguished between those pollutants that are amenable to individual action to reduce exposures (e.g. home use pesticides) versus those compounds that are not (e.g. phthalates) because their sources are ubiquitous and exposure pathways are poorly understood. This latter category of pollutant suggests the need for broader policy action to improve regulatory strategies that reduce pollutant exposures from consumer products.

**Conclusions:** Despite scientific uncertainties regarding the health effects, sources, and exposure pathways of air pollutants, communities are concerned about the cumulative impacts of multiple exposures to compounds from diverse sources. Currently, there is little guidance for effectively reporting individual and community-level exposure data to study participants, yet report-back protocols can balance the need to acknowledge scientific uncertainty while also elucidating opportunities for collective and individual action to reduce pollutant exposures.

**ISEE-1090****Residential Exposure to Polychlorinated Biphenyls and Organochlorine Pesticides and Risk of Childhood Leukemia**

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**Background:** The etiologic role of persistent organochlorine chemicals in childhood cancer risk has not been evaluated in population-based studies. House dust is a reservoir for chemicals used in the home and in the nearby environment. We estimated the risk of childhood leukemia in relation to exposure to organochlorine chemicals using carpet dust as an exposure indicator.

**Methods:** We studied 184 acute lymphocytic leukemia (ALL) cases 0–7 years of age and 212 birth certificate controls in Northern California from 2000 through 2006. Using a specialized high volume surface sampler (HVS3) vacuum, we sampled carpets or rugs that were present in the home before the diagnosis/reference date. We measured concentrations (ng/g) and loadings (ng per square meter of carpet) of six polychlorinated biphenyl (PCB) congeners (105, 118, 138, 153, 170, 180) and other organochlorine chemicals including the pesticides chlordane, DDT and its metabolite DDE, methoxychlor, dieldrin, lindane, heptachlor, and pentachlorophenol. Odds ratios were calculated using unconditional logistic regression analysis adjusting for demographics, age of the residence, and breastfeeding.

**Results:** A significant positive trend in ALL risk was apparent with increasing concentrations of total PCBs ( $P$  for trend = 0.02). We observed a 2.8-fold increased risk (95% confidence intervals [CI] 1.4–5.5) for the highest versus lowest quartile of total PCBs. We observed significant positive trends in risk associated with concentrations of the PCB congeners 118, 138, and 153 ( $P$  for trend = 0.018, 0.026, 0.017, respectively). The associations with PCBs were stronger among non-Hispanic Whites, despite a similar distribution of exposure among all ethnic/racial groups. We observed no significant association with concentrations of chlordane, DDT, DDE, other organochlorine insecticides or pentachlorophenol.

**Conclusion:** Exposure to PCBs but not organochlorine insecticides in the home was associated with an increased risk of childhood leukemia. Our findings suggest that PCBs may represent a previously unrecognized risk factor for childhood leukemia.

**ISEE-1091****Development and Application of Immunoaffinity Column Chromatography for Coplanar PCBs in Soil and Sediment**

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**Background:** Immunoaffinity (IA) column chromatography is based on specific interactions between an immunosorbent and an analyte allowing the selective isolation of the target compound(s) from complex sample matrices. The technique can be used as a cleanup procedure prior to instrumental or bioanalytical analysis. Five types of column support materials were investigated for nonspecific binding of co-planar polychlorinated biphenyls (PCBs).

**Methods:** Materials tested were: (1) Poros resin, (2) Protein-Pak, (3) Affigel 102 (aminoalkyl agarose), (4) silica gel, 3-aminopropyl functionalized, and (5) HiTrap NHS Sepharose resin. Control IA columns of each material were prepared using a nonspecific rabbit IgG antibody. Nonspecific binding of co-planar PCB-126 was found in all of the control columns with the exception of the HiTrap NHS Sepharose. PCB IA columns were then prepared by immobilizing a polyclonal rabbit anti-PCB antibody to two HiTrap Sepharose columns. Different sample loading and elution solvent systems were evaluated. Optimized loading and elution solvents were 20% methanol in phosphate buffered saline (PBS) with 0.1% Triton X-100, and 100% methanol with 0.01% Triton X-100, respectively.

**Results:** The IA columns showed reproducible coupling efficiency for the immobilization of the PCB antibody and consistent binding and releasing of PCB-126. The coupling efficiency (5 mg of antibody in 1 mL of resin bed) for the IA columns ranged from 96 to 98%. The maximum loading for the two IA columns were similar ranging from 200 ng to 250 ng of PCB-126 (~0.04 µg of PCB-126 per mg of antibody). The IA columns were challenged with real-world soil and sediment samples and effectively removed interferences from these matrices prior to enzyme-linked immunosorbent assay (ELISA) analysis. Quantitative recoveries (84–130%) of PCB-126 were obtained for all of the 17 pairs of spiked and non-spiked soil and sediment samples using IA column cleanup followed by ELISA. The percent difference (%D) values for two different extract dilutions of the same sample were less than 20% (7.3 to 17%).

**Conclusions:** These findings suggest that there was no matrix interference in the sample extracts after the IA column cleanup. Recoveries of the positive control standard solution of PCB-126 from the IA columns ranged from 82 to 107%. The IA columns could withstand 100% methanol with 0.01% Triton X-100 as the elution solvent and could be reused more than 20 times with no change in performance.

*Notice: The United States Environmental Protection Agency (EPA) through its Office of Research and Development funded and collaborated in the research described here under contract EP-D-04-068 to Battelle. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.*

#### ISEE-1094

##### Body Burdens of HpCDF Released from an Industrial Source in Southern Finland

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**Background:** Ca. 8000 kg, or 16 . . . 21 kg in WHO TEQ (tetrachlorodibenzodioxin equivalent) unit, of two dioxin-like chemicals, octachlorodibenzofuran (OCDF), and heptachlorodibenzofuran (HpCDF), were released from a wood preservative chemical manufacturing plant into the Kymijoki River in Southern Finland between years 1940 and 1984. The released chemicals have accumulated in the bottom sediments of the river and the Gulf of Finland, and they have bioaccumulated strongly in the fatty fish in the Baltic Sea. Consumption of Baltic fish has been the main pathway of the released chemicals, the longer half life HpCDF in particular, into human body burdens. In humans, HpCDF is stored in fatty tissues.

**Methods:** We used the measurements of human fat in four population samples, one representing the general population of Finland (aged 15 . . . 85 years), another one representing the subpopulation living along the contaminated river, the third representing lactating mothers (sampled in 1987, 93, and 96 onwards) and the fourth consisting of coastal fishermen. Body burdens were assessed from the fat HpCDF data by computing the total body fat mass from the computed body mass index (BMI) and body weight for each sampled individual.

**Results:** Analyses of the data revealed that (i) HpCDF accumulated in men by an order of magnitude from the age of 15 to 80 years, but it did not accumulate in women, probably due to HpCDF lost in breast feeding, (ii) in lactating women the HpCDF levels were reduced by an order of magnitude from 1987 to 1996, due to environmental decay of HpCDF after the end of the release, (iii) HpCDF body burden distributions for the population of the Kymijoki basin was not elevated in comparison to the rest of the population, highlighting the low contribution of local food and river water to the diet, (iv) HpCDF body burdens of the coastal fishermen were an order of magnitude higher than among the general population, pointing out the significance of the fish diet for the exposure.

**Acknowledgement:** Project has been funded by the European Chemical Industry Council (CEFIC) LRI contract B3.3-KTLE-0511.

#### ISEE-1096

##### Public Health Impacts of Residential Wildfires: Analysis of Ash and Debris from the 2007 Southern California Fires

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**Background:** The Southern California Fires of 2007 occurred throughout seven counties and burned more than 350,000 acres in inhabited and open space areas. The fires consumed more than 2200 residential and commercial structures, as well some 2000 vehicles. The destruction left in the wake of the fires had the potential to result in wide-spread public exposure to toxic materials. Experiences from fires of a similar nature indicate that many hazardous substances may be found in burned residential areas, including metals, pesticides and herbicides, polycyclic aromatic hydrocarbons (PAHs), asbestos, and polychlorinated biphenyls (PCBs). Because of the widespread destruction affecting multiple population centers, the California Environmental Protection Agency (CalEPA) made the determination that the burn ash and debris posed an immediate threat to public health and safety according to the Federal Environmental Management Agency (FEMA) Disaster Assistance Policy 9523.13. As part of that determination, Geosyntec Consultants, in conjunction with scientists from CalEPA and the US Environmental Protection Agency (US EPA), designed a comprehensive sampling and analysis plan to determine the nature and concentration of contaminants of concern in the ash and debris.

**Methods:** Using a statistically-based sampling plan, debris samples were collected from 70 different burn sites in two affected counties. The samples were analyzed for the presence of constituents which may pose a risk to human health, including California Title 22 metals and PAHs.

**Results:** Results indicated that the ash contained significant levels of heavy metals, including arsenic (mean range 7.31–14.0 mg/kg), cadmium (mean range 2.64–23.0 mg/kg), copper (mean range 3835–4383 mg/kg), and lead (mean range 404–1493 mg/kg), even after household hazardous waste was removed from the sampling area. Concentrations of these metals were significantly above California background levels and exceeded the health-based standards set forth in the US EPA Preliminary Remediation Guidelines (PRGs) and the California Human Health Screening Levels (CHHSLs).

**Discussion:** Based on the results of this study, CalEPA undertook a massive clean-up effort in the affected jurisdictions. This was the second time such an analysis has been undertaken in the aftermath of massive wildfires in California, and represents, to our knowledge, the first comprehensive characterization of the public health risk from fire ash and debris. The results of this study underscore the importance of emergency recovery efforts and may provide information on which to base decisions for future firestorm events.

#### ISEE-1097

##### Carbaryl and Naphthalene Exposures Among a Pregnant Latina Population Living in an Agricultural Area

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**Background:** Naphthalene, a respiratory carcinogen, is a component of vehicle exhaust, cigarette smoke and mothballs. Carbaryl, a potential

neurotoxicant, is commonly used in agriculture and for landscape maintenance. 1- and 2-hydroxynaphthalene (1- and 2-naphthol) are metabolites of naphthalene; 1-naphthol may also derive from carbaryl.

**Methods:** We measured 1- and 2-naphthol in urine samples collected in the first and third trimester from over 500 pregnant women living in the Salinas Valley, CA (1999–2001). The women were participants in a community-based cohort study (Center for the Health Assessment of Mothers and Children of Salinas-CHAMACOS) led by the University of California at Berkeley.

**Results:** The CHAMACOS detection frequencies for 1- and 2-naphthol ranged from 66% to 75%. Median concentrations for both compounds were similar to median concentrations among U.S. national reference data for 118 pregnant women (NHANES). Correlation analyses indicate moderate correlations between the two metabolites within each sampling time point ( $\rho = 0.42\text{--}0.56$ ,  $P < 0.001$ ), and between the two sampling time points for 2-naphthol ( $\rho = 0.56$ ,  $P < 0.001$ ). If exposure to only naphthalene was occurring, we would expect similar amounts of both metabolites. The average of the women's 13-week metabolite ratios of 1-naphthol to 2-naphthol was 5 to 1, suggesting that exposure to both carbaryl and naphthalene may be occurring in this cohort. By contrast, the average ratio of 1-naphthol to 2-naphthol among pregnant women participating in NHANES was 2 to 1. Among CHAMACOS women working in agriculture during their first trimester of pregnancy, median 1-naphthol levels were slightly higher (2.3  $\mu\text{g/L}$ ) compared to women not employed in agriculture (1.8  $\mu\text{g/L}$ ) (Kruskal-Wallis  $P$ -value = 0.05). Additional analyses of metabolite levels and potential risk factors of exposure such as number of farmworkers living in the home, distance of home to agricultural fields, smoking, etc., and diet will be presented. Finally, a comparison of the estimated maternal doses to U.S. EPA health-based reference values will provide a basis to interpret the health significance of these exposure levels.

#### ISEE-1098

##### Arsenic Methylation is Associated with Skin Lesions

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**Background:** Chronic arsenic exposure from ingesting contaminated drinking water is a global public health concern with the Ganges Delta region the most heavily impacted. Upon ingestion, inorganic arsenic (InAs) is methylated to monomethylarsenic acid (MMA) and dimethylarsenic acid (DMA). An individual's ability to methylate arsenic is considered a risk factor for arsenic-induced disease. This study quantifies the risk of arsenic-metabolism on skin lesions in a population chronically exposed to arsenic-contaminated drinking water in Pabna, Bangladesh.

**Methods:** First void urine samples were collected in sterile, single use containers and frozen until analysis. Urinary arsenic species [arsenite (As<sub>3</sub>), arsenate (As<sub>5</sub>), MMA, and DMA] were detected using High Performance Liquid Chromatography Hydride Generated Atomic Absorption Spectrometry (HPLC-HGAAS). Conditional logistic regression was used to investigate the effect of arsenic methylation, as measured by the percentage of each urinary arsenic metabolite (%InAs, %MMA, and %DMA), among 900 case-control pairs. Cases were defined based upon a clinical diagnosis of one or more of the following conditions: keratosis of the extremities, spotted melanosis, Bowen's disease, or squamous cell carcinoma. Controls were individuals without any visible skin lesions selected from the DCH catchment area and matched one-to-one on gender, age (within 3 years), and area of residence. Each metabolite was centered at its mean of 12.9%, 13.2%, and 73.9% for %InAs, %MMA, and %DMA, respectively.

**Results:** The %InAs was not significantly associated with the odds of skin lesions (OR 1.0, 95%CI 0.99–1.02). However, the %MMA was significantly associated with an increased odds of skin lesions (OR 1.03, 95%CI 1.01–1.04) and the %DDM was significantly associated with a

decreased odds of skin lesions (OR 0.98, 95%CI 0.98–0.99). Thus, for every 1% increase in MMA above the mean, the odds of skin lesions increased by approximately 2.8%. This finding contributes to the growing body of research that supports the theory that individuals with diminished methylation capacity who are chronically exposed to arsenic have an increased risk of disease.

**Conclusion:** While reducing exposure must remain the priority for addressing arsenic toxicity, improving nutrition, particularly folate intake which has been shown to improve arsenic methylation, may help lower the risk of negative health effects such as skin lesions amongst exposed individuals.

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#### ISEE-1099

##### Wipe Sampling for Nicotine as a Marker of Environmental Tobacco Smoke Contamination of Surfaces

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**Background:** Environmental tobacco smoke (ETS) is a carcinogenic mixture that contaminates air and also deposits on dust and surfaces. Nicotine is a widely used tracer for ETS, and is usually measured in air, although a few groups have reported contamination levels in dust and surfaces.

**Methods:** We have developed a method for evaluating ETS contamination of homes and cars through wipe sampling of nicotine, using cotton facial wipes wetted with 0.1% ascorbic acid. Wipes are then spiked with deuterated nicotine, made basic, extracted into methylene chloride, and measured for nicotine by liquid chromatography tandem mass spectrometry (LC-MS/MS).

**Results:** The limit of detection is approximately 0.1  $\mu\text{g}$  nicotine/m<sup>2</sup> (1 ng/wipe over blanks), and the median coefficient of variation for replicate measures of surface nicotine is 10.2%. In our studies of homes and cars contaminated with ETS, levels of air nicotine correlated well with levels of surface nicotine (values of  $\rho > 0.60$ ). Wipe sampling has the advantage for use in field studies that only a single instantaneous measurement need be taken, as compared to air sampling which requires hours or days. In addition, ETS residues on surfaces may pose a potential route of exposure through dermal uptake or ingestion, especially for children.

**Conclusion:** In summary, the wipe sampling method for nicotine presented here is a sensitive and specific method for assessing ETS contamination of surfaces.

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#### ISEE-1101

##### Comparison of Alternative Monitoring Methods for Activity/Location Data

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**Methods:** From April 2 to July 12, 2007, RTI International conducted a pilot test of four alternative methodologies for collecting time/activity/location/energy-expenditure (TALE) data: (1) a real-time pocket PC diary, (2) a real-time voice diary, (3) a real-time paper diary, and (4) a passive photo diary. Each of 40 participants was asked to record each change of activity or location for 7 consecutive days using one of the four modes of data collection. In addition, two passive location monitoring systems were utilized. RF beacons were placed in the rooms of the participant's home and in the participant's primary vehicle. The pocket PC, carried by the participant, recognized when the participant was in the vicinity of a beacon, and it stored the date and time that the participant was in that

location. In addition, the participant carried a "BodyPack" monitor with a GPS receiver that reported to the pocket PC the date, time, latitude, and longitude every 2 minutes whenever the participant was outdoors.

**Discussion:** This presentation will compare the four modes of data collection with regard to data completeness, data quality, and participant burden. In addition, the results of the active and passive data collection systems will be compared. Implications for the second generation data collection system, being tested in the summer of 2008, also will be discussed.

#### ISEE-1103

#### Estimating On-Road and Near-Road Exposures Due to Traffic Congestion

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**Background:** Traffic congestion increases on-road and near-road pollutant exposures due to increased time in traffic and increased pollutant levels in traffic-related microenvironments. Few studies have measured or modeled pollutant concentrations in traffic-impacted locations under both congestion and free flow conditions, which provides critical information for exposure assessment purposes. The purpose of this study is to estimate exposures to traffic-related air pollutants attributable to traffic congestion.

**Methods:** Pollutant concentrations are estimated by an integrated model that includes a micro-simulation traffic model (VISSIM), a comprehensive emissions model (CMEM), and an air quality dispersion model (CALINE4). This integrated model is used to predict on-road and near-road concentrations of carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides ( $\text{NO}_x$ ). A Java program is developed to link individual vehicle information (vehicle ID, vehicle type, speed, acceleration and position) with CMEM to obtain second-by-second emission for each vehicle. They are aggregated into average emission factors for a road segment, which in turn are used in CALINE4 to predict ambient pollutant levels with traffic volume and meteorological conditions (wind direction, wind speed, mixing height and atmospheric stability). The integrated model is evaluated by field data, which include measurements of pollutant concentrations along transects of several local roads under congestion and free-flowing conditions. We developed different indicators of vehicle emissions and exposures that are relevant to different purposes, e.g., total emissions on a road network for regional air quality, emissions at the road segment level for local hot spots, and integrated exposures over a commuting route. The latter is defined as the sum of the on-road pollutant levels in each segment multiplied by the travel time in each segment. Scenarios representing uncongested and congested conditions, including two traffic flows (334 and 1247 vehicles per hour per lane), are simulated. The simulation includes a 6 km length of freeway that includes a junction and merges from three lanes to two lanes.

**Results:** Emission factors for each pollutant strongly increase with traffic volume. At high traffic volume, the integrated model predicts significantly peak emissions for each pollutant as compared to Mobile 6.2, which is based on steady speed. Differences are minor at low traffic volume when congestion is not apparent. Exposures also increase significantly.

**Conclusion:** These results can be explained by congestion and acceleration/deceleration patterns caused by heavy traffic. The findings can be used in exposure estimation, health risk evaluation, and transportation planning.

#### ISEE-1104

#### Long-term Exposure to Air Pollution and Increased Mortality in Lupus

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**Background:** Accumulating toxicological, clinical, and epidemiologic data have shown that exposures to particulate air pollutants can induce proinflammatory cytokines, cause systemic inflammation, and alter the immune system. Although ambient air pollution has been recognized as a pervasive threat to cardiovascular health and lupus patients are vulnerable to developing cardiovascular diseases, scientific data on air pollution and clinical outcomes in lupus are scarce and limited.

**Objectives:** To examine the increased mortality in lupus, if any, associated with exposure to ambient  $\text{PM}_{10}$  (particulate matter with aerodynamic diameter  $\leq 10 \mu\text{m}$ ) and explore the potential organ damages in response to long-term exposure to ambient air pollution.

**Methods:** We conducted a prospective study among 265 (aged  $38.9 \pm 14.8$  years; 91% female) recently diagnosed patients with systemic lupus erythematosus recruited through university- and community-based rheumatologists in 60 counties in North Carolina and South Carolina to investigate the putative effect of  $\text{PM}_{10}$  on mortality. For patients who died between 1998 and 2005, we applied a validated spatiotemporal Bayesian Maximum Entropy modeling approach to estimating the 1-year exposure to ambient  $\text{PM}_{10}$ , matched to the index date of death, at each participant's residence. For those who were still alive by the end of follow-up, we used the same algorithm to estimate the 1-year exposure, matched to a randomly selected comparison date. We also related the clinical data on cumulative organ damages, as assessed by the Systemic Lupus International Collaborating Clinics Damage Index among 138 subjects in 2001, to the estimated annual average  $\text{PM}_{10}$  levels. Multiple logistic regression models were used to examine these associations, adjusted for potential confounders.

**Results:** Thirty-two patients died during the study period with an estimated annual average  $\text{PM}_{10}$  level of  $19.8 \pm 5.4 \mu\text{g}/\text{m}^3$  (inter-quartile range: 16.1–23.3). There was a graded increase in mortality risk across the quartile distribution of  $\text{PM}_{10}$  (Odds Ratio [OR] = 1.00, 1.18, 1.58, and 1.82). Assuming a linear association, we found that the mortality risk doubled for each  $10 \mu\text{g}/\text{m}^3$  (approximately across the 20<sup>th</sup>–80<sup>th</sup> percentile) increase in 1-year  $\text{PM}_{10}$  exposure (OR = 2.03; 95%CI: 1.02, 4.02). After adjusting for age, race/ethnicity, sex, smoking habits, socioeconomic status (education, health insurance status), and state of residence, we still observed an incremental exposure-response pattern for the  $\text{PM}_{10}$ -mortality association (adjusted OR = 1.00, 1.21, 1.35, and 1.49) and an increased mortality associated  $\text{PM}_{10}$  (adjusted OR = 1.68 [95%CI: 0.79, 3.60] for each  $10 \mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{10}$ ), although the effect sizes were diminished. We also found that more cardiac damages were associated with estimated long-term exposure to  $\text{PM}_{10}$ . As compared to lupus patients residing in areas with long-term average  $\text{PM}_{10}$  level below the median ( $\leq 22.5 \mu\text{g}/\text{m}^3$ ), those residing in more polluted areas were more likely to have cardiac damage (OR 2.69; 95%CI: 0.79, 9.21). This positive association became stronger (adjusted OR = 3.92; 95%CI: 1.03, 14.8) and statistically significant after adjustment for age, gender, race/ethnicity, socioeconomic status and smoking.

**Conclusions:** Our study provided the epidemiologic evidence supporting the novel hypothesis that particulate air pollutants increase mortality in lupus, likely through cumulative cardiac damages.

#### ISEE-1105

#### Epidemiologic Studies Generated During Litigation: Lessons from Three Plaintiff-Supported Studies

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**Background:** Epidemiologic investigations are sometimes sponsored by parties to litigation. Typically, these are done by defendants in toxic tort or product liability lawsuits, either by scientists employed by the defendant company or by consultants working for the company. Less frequently, plaintiffs' attorneys or Legal Aid organizations provide support for epidemiologic studies that may shed light on health risks borne by their clients. Litigation may raise scientific questions regarding disease causation connected with specific exposures that are not considered a priority by other research funding mechanisms. Yet the reliability of science generated through litigation is often dismissed due to potential biases as a result of advocacy in the legal process. We review current dilemmas surrounding norms of science in the context of the changing landscape of epidemiologic research and present three case-examples from our work.

**Methods:** The three examples demonstrate different methodologies and health outcomes that were investigated by the authors. The first is an investigation of adverse birth outcomes and birth defects in Camden, NJ residents exposed to trichloroethylene in their drinking water. This involved analysis of birth outcome data obtained from the New Jersey Department of Health for births to mothers who resided in the exposed community. The second example is an analysis of cancer incidence following exposure to dioxin and other incinerator emissions in the Wingate community in Fort Lauderdale, Florida. This analysis was contrasted with a previous report by the Florida Department of Health. The third example was an analysis of cancer in a cohort of graduates of Beverly Hills High School, in Los Angeles County, California. The incidence of three types of cancer in this cohort was compared with expected incidence calculated from the SEER program data for the same time period.

**Results:** In the Camden exposed population the odds of children being born with congenital heart defects were elevated compared to other large urban populations in New Jersey (OR = 2.74; 95%CI 2.74–4.14). Other adverse reproductive outcomes, low birthweight and the sex ratio at birth were examined and will be presented. In the Wingate community, the standardized incidence ratio for prostate cancer was elevated in the most exposed census tracts (SIR = 135; 95%CI 117–155) compared to the rest of Broward County, Florida. In Beverly Hills High School graduates, SIRs in the years 1990–2001 were elevated for Hodgkin's Disease (SIR = 337; 95%CI 208–515), thyroid cancer (SIR = 166; 95%CI 95–269) and testicular cancer (SIR = 205; 95%CI 117–331). Other sub-group analyses were done and will be presented.

**Conclusion:** Litigation-generated research can produce valid results if conducted with standard methods, transparent analyses and funding source disclosures. We have been able to produce useful epidemiologic information in three different settings where environmental exposures were at issue in lawsuits. The sources of support in litigation should be provided so that readers can evaluate the potential biases in the reported findings, as is required in other scientific settings.

#### ISEE-1106

#### Indoor Pesticide Exposures in Low Income Hispanic Children Living in Agricultural and Urban Communities

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**Background:** A key policy question about children's pesticide exposures is whether children residing in agricultural communities have higher exposures compared to children residing in urban communities and thus require additional protection. Limited studies suggest that indoor pesticide exposures in these areas may be substantially different; however, few studies have directly tested this hypothesis or quantified exposures to a mixture of agricultural and home-use pesticides. It is possible that factors such as socioeconomic status, historical pesticide use, and housing disrepair may affect the levels of pesticide exposures in different

populations. In earlier studies, we have found both home and agricultural-use pesticides in house dust from homes in agricultural areas (median levels of chlorpyrifos, diazinon, daethyl, and permethrin of 49, 21, 31, and 230 ng/g respectively, Bradman et al., 2007). In this study, we extend these evaluations to directly compare pesticide levels in the homes of 15 low-income Mexican-descent children living the Salinas Valley, CA (an agricultural area) and 13 homes from demographically similar children living in Oakland, CA (an urban area).

**Methods:** Two dust samples were analyzed for each home except for one home in each respective location for which we analyzed one sample ( $n = 54$  dust samples). Replicate samples were obtained 5–8 days apart. We measured 31 common agricultural and home-use pesticides including 12 organophosphates, 14 pyrethroids, 2 carbamates, 1 phthalate herbicide, 1 dicarboximide, and 1 synergist pesticide ingredient in household dust samples.

**Results:** Preliminary results indicate that fewer of the families in the agricultural community reported using pesticides indoors within the 3 months prior to collection of the dust sample compared to families in the urban community. The pesticides most frequently used and stored in households were pyrethroids. For the homes where we obtained 2 dust samples, we found that pesticide concentrations did not differ significantly within each home. The following pesticides were detected in at least 50% of participants' homes: Propoxur (median = 28.9 ng/g), Diazinon (median = 13.2 ng/g), Daethyl (median = 6.9 ng/g), Allethrin (median = 54.2 ng/g), Piperonyl Butoxide (median = 169.5 ng/g), cis-Permethrin (median = 493.3 ng/g), trans-Permethrin (median = 841.8 ng/g), and Cypermethrin (median = 365.6 ng/g). There were significantly different detection frequencies in agricultural versus urban homes for: Diazinon (79% vs. 52%,  $P = 0.03$ ), Daethyl (97% vs. 0%,  $P < 0.001$ ), and Bifenthrin (14% vs. 44%,  $P = 0.01$ ).

**Conclusion:** These findings suggest that current agricultural use pesticides are detected more frequently in homes located in agricultural areas, while some home-use pesticides are found more often in urban homes. This study provides direct exposure information important for the identification of potential vulnerable populations; and identifies frequently used pesticides which warrant further investigation on their potential long-term health impacts in these populations.

#### Reference:

Bradman A, et al. Pesticides and their Metabolites in the Homes and Urine of Farmworker Children Living in the Salinas Valley, CA. JESEE Jul 2007;17(4):331–49.

#### ISEE-1107

#### Daily Temperature at Residence vs Central Measurements in Eastern Massachusetts

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**Background:** Recent studies have reported increased mortality during heat waves worldwide in extreme temperature conditions. These studies used daily central site temperature as the exposure variable, often measured at the closest airport which is typically located outside the urban area. However, temperature is spatially variable within a city, and housing and landscape characteristics affect exposure. Heat islands may exhibit extreme exposures.

**Methods:** To help investigate the acute effects of temperature on mortality accounting for these variations, we developed a spatio-temporal model for temperature in Eastern Massachusetts.

We obtained Massachusetts daily temperature data for 1994 to 2006 from 397 different sites resulting in 30 to 210 daily measurements, from

four different data sources: NCDC, EPA, Weatherbug Professional, and Weatherunderground. Land use, elevation and census data were obtained from The National Land Cover Database 2001 provided by USGS (U.S. Geological Survey) and the Massachusetts Geographic Information System (MassGIS). The prediction model for daily temperature included smooth functions of space, distance to coastline, elevation and land use indicators, as well as wind direction, wind speed, temperature at Logan air-port, and several interactions of these temporally fixed and time varying terms. We focused on the warm months—April to September.

**Results:** Maximum daily temperature at Logan airport was on average 22°C and ranged between 2 and 34°C. Daily temperature at Logan airport only explained 50% of the variation of temperature at the other monitoring locations, indicating substantial spatial variability as well. Our model captures about 20% of the remaining variation, and shows that the spatial variability in temperature is time-varying. We will show typical patterns of spatial variability in ambient temperature and plan on comparing the results of our spatial model to results using Logan airport temperature in a case-crossover analysis of geocoded mortality data.

#### ISEE-1110

#### Health Effects in a Population Cohort Exposed to Cesium 137 in the Goiania Radiological Accident: Offspring Growth and Development During Childhood and Adolescence

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**Antecedents:** A vandalized radiotherapy unit carried out in the city of Goiania, Brazil, in 1987, caused an important radioactive accident in local population. Since then, a specific health program was organized to provide regular health assistance for the affected cohort, whose health conditions have been recorded since then. This paper presents an evaluation of the observed pattern of growth and development during childhood and adolescence in the offspring of individuals directly exposed to Cs 137 during the accident.

**Objectives:** To present the pattern of anthropometrical growth and development in the offspring of persons directly exposed to Cs 137 in the Goiania accident in 1987.

**Methods:** All children born after the accident, being one of their parents either included in group I or group II (directly exposed to Cs 137) were traced. Their respective health records were retrieved and analyzed aiming to characterize their growth and development patterns. Birth weight, height and weight measurements carried out during childhood, and menarche age were obtained.

**Results:** Forty four children have been born after the accident, five of them (three women and two men) with intrauterine exposure to Cs137. Spontaneous abortion and birth defects were not reported or diagnosed in any of all these forty four pregnancies. Anthropometrical measurements carried out during childhood reveal a growth pattern ranging into normality standards. Among those with intrauterine exposure, menarche and sexual secondary characteristics developed without abnormality. A spermogram carried out in one of the adolescents with intrauterine exposure to Cs 137 did not show abnormalities too.

**Discussion:** The observed growth pattern in the offspring of parents previously exposed to Cs 137 during the accident did not reveal abnormalities. These results also include children whose mothers were directly exposed in the accident during pregnancy, but such intrauterine exposure seems not to have affected the offspring growth. A psychiatric evaluation of these children has been in progress. Further monitoring on the fertility pattern of this group deserves to be carried out.

**Conclusions:** Parents exposure to Cs137 in the Goiania radioactive accident in 1987 seems not to have been associated to growth disturbances in the respective offspring.

#### ISEE-1111

#### Linear Regression of the Fuzzy Dependent Variable For Epidemiological Study

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**Background:** Dichotomization of the outcome by a single cut-off point is an important part of various epidemiological studies. It is so because in virtue of fundamentally nonlinear behavior of biomedical systems, merely quantitative differences in the system outcome  $Y$ , beyond a certain point, may pass into qualitative changes in the system state. For that reason, the linear regression of continuous dependent variable  $Y$  on the system parameter(s)  $X$  cannot reflect the leap between the system states. Instead, one can create the binary dependent variable  $\delta_Y$  and use it to consider how changes in  $X$  can affect the transition from the state  $\delta_Y = 0$  to the state  $\delta_Y = 1$ . Among the most popular techniques, employed to analyze the relationship of a dichotomized dependent variable with explanatory variables, are linear regression, probit regression and logistic regression. These techniques are well known and their procedures are well established. Troubles start when categories are becoming uncertain. Many clinical categories such as *high*, *low*, and the like, are linguistic ones, and therefore they do not suggest certain cut-off points, which divide the observations into two groups. Besides, in many real-life situations the boundary between categories can be identified only approximately, i.e. in some intervals. For that reason, when dichotomizing a continuous dependent variable, one can select any cut-off point within these intervals. This entails that in order to have any practical meaning the regression model must be robust to this uncertainty.

**Objectives:** In our work, we propose the use of the linear regression model with the fuzzy membership function as a dependent variable. This fuzzy membership function denotes to what degree the value of the underlying (continuous) outcome falls below or above the dichotomization cut-off point. In the work, we test the robustness of the linear regression model of such fuzzy dependent variable with the data obtained from the real study of iron deficiency anemia in 618 infants living in the Negev, Israel.

**Methods and Results:** The study dataset was collected in 2002–2005 years and it was comprised of questionnaire information and laboratory findings. The dependent continuous variable of the dataset is an infant's hemoglobin level (Hgb, measured in g/dl); its summary statistics (mean  $\pm$  SD) are  $10.88 \pm 0.96$  g/dl. The dataset independent (explanatory) variables along with their summary statistics are: infant's age (*months*)  $4.96 \pm 1.33$ ; ethnicity (*binary variable*) Jews = 212, Bedouins = 406; breastfeeding (*times a day*)  $3.12 \pm 3.08$ ; intake of infant formula (*times a day*)  $2.81 \pm 2.00$ ; intake of cow's milk (*times a day*)  $0.11 \pm 0.51$ ; infant's age when breastfeeding stopped (*months*)  $5.05 \pm 1.88$ .

**Conclusions:** We systematically tested the robustness of the linear regression model with the fuzzy dependent variable by changing the boundary for the category *Anemia* within the interval  $11.0 \pm 1.0$  g/dl with 0.2 g/dl step. We found that the behavior of the latter model persisted over the whole interval. This shows an applicability of the proposed method for more broad epidemiological studies.

#### ISEE-1116

#### Predicting Chronic Fine and Coarse Particulate Exposures Using Spatio-Temporal Models for the Northeastern and Midwestern U.S.

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**Background:** Chronic epidemiological studies of airborne particulate matter have been limited by their reliance on exposures estimated using city- or county-wide ambient concentrations, which ignore within-city spatial gradients and restrict studies to areas where nearby monitoring data are available. This restriction is particularly limiting for fine particles ( $PM_{2.5}$ ) given the small number of ambient monitoring sites before 1999

and for coarse ( $PM_{10-2.5}$ ) particles for which routine ambient monitoring only recently began.

**Methods:** To address this limitation, we developed spatio-temporal models that included location-specific covariates to predict monthly outdoor  $PM_{2.5}$  and  $PM_{10-2.5}$  concentrations over the northeastern and Midwestern US. For  $PM_{2.5}$ , monthly concentrations were estimated for two periods: 1988 through 1998 and 1999 through 2002. Models for both time periods included smooth spatial terms and smooth regression terms of GIS-derived and meteorological predictors. The spatio-temporal structure of the 1999–2002 model allowed the  $PM_{2.5}$  spatial surface to vary each month, while that for the 1988–1998 model included predicted  $PM_{10}$  levels and extinction coefficient estimates to compensate for the paucity of  $PM_{2.5}$  monitoring data during the earlier time period. We calculated monthly outdoor  $PM_{10-2.5}$  levels as the difference of these estimated  $PM_{2.5}$  concentrations and estimated  $PM_{10}$  concentrations from our previously developed model.

**Results and Discussion:** Our models were strong predictors of monthly  $PM_{2.5}$  concentrations (cross-validation  $R^2$  of 0.77 and 0.68 for pre- and post-1999, respectively), with little bias (0.2 and 0.3  $\mu g/m^3$ , respectively) and high precision (2.2 and 2.8  $\mu g/m^3$ , respectively). Models performed well in both rural and urban areas and in all seasons, although with better precision in spring and fall compared to summer and winter. Similarly, estimated monthly coarse PM agreed well with measured levels ( $R^2$  of 0.64). The strong performance of our models demonstrates their ability to estimate individual-specific chronic  $PM_{2.5}$  exposures for large populations accurately and precisely.

#### ISEE-1117

##### Case-Crossover Analysis of the Triggering of Preterm Birth by Ambient Air Pollutant Concentration in the Few Days Before Birth

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**Objectives:** A previous study in Pennsylvania (1997–2001; Sagiv et al. Environ Health Perspect 2005;113:602–606), using time-series methods, reported significantly increased risk of preterm birth associated with increases in the mean  $PM_{10}$  concentration 2 and 5 days before birth, and the mean  $SO_2$  concentration 3 days before birth. We evaluated the acute association between spontaneous preterm birth and ambient air pollutant concentrations in the previous few days using case-crossover methods.

**Materials and Methods:** Cases of preterm birth (<37 weeks gestational age) were identified from a linked birth certificate and maternal/newborn hospital discharge dataset (1999–2003) maintained by the New Jersey Department of Health and Senior Services. Mothers with known risk factors for preterm birth (i.e. gestational hypertension, pre-eclampsia, eclampsia, type I or II diabetes mellitus, placenta previa, and/or placental abruption) were excluded. Daily pollutant concentrations ( $PM_{2.5}$ ,  $SO_2$ ,  $NO_2$ , CO,  $O_3$ ) were measured by the New Jersey Department of Environmental Protection, with the closest monitor to each case's residence (within 5 km) providing air pollutant concentrations for analysis. We examined the risk of spontaneous preterm birth associated with moving average pollutant concentrations in the few days before birth (1–5 day moving averages), among n = 8035 cases of preterm birth, using conditional logistic regression models.

**Results:** In preliminary analyses, we found no clear evidence of increased risk of preterm birth associated with any moving average pollutant concentration, after adjusting for apparent temperature. However, each 0.3 ppm increase in the 3 day moving average CO concentration was associated with a significantly decreased risk of preterm birth (OR = 0.96; 95%CI = 0.92, 1.00). In contrast, each 10 ppb increase in the 5 day moving average  $O_3$  concentration was associated with a non-statistically

significant increased risk of preterm birth (OR = 1.06; 95%CI = 0.99, 1.14). There did not appear to be effect modification of these results by the newborn's gender or maternal race. However, each effect was observed only in the winter, not the summer.

**Conclusions:** These findings do not support an association between risk of spontaneous preterm birth and ambient air pollution concentrations in the previous few days. The protective CO effect and the adverse  $O_3$  effect are likely due to confounding by mothers' personal activities. Further analyses will evaluate the role of confounding by co-pollutants, and will apply time-series techniques to validate these findings. We will also repeat these analyses to evaluate associations between all preterm births including those with known risk factors.

#### ISEE-1120

##### Infectious Disease in a Warming World: How Weather Influenced West Nile Virus in the United States (2001–2005)

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**Background:** The effects of weather on mosquito populations in the United States have been widely reported. However, few studies have examined the overall impact of these meteorological conditions on the incidence of human West Nile Virus infection, which may be particularly important given the projected trends in North American weather patterns.

**Methods:** To identify meteorological conditions associated with human West Nile Virus cases, we conducted a case-crossover study of 16,298 human West Nile Virus cases reported to the Centers for Disease Control from 2001–2005 in 17 states across the United States. We obtained daily meteorological data from the National Weather Service and estimated cumulative temperature in degree-days with the single-sine method. To evaluate the impact of weather on human-mosquito interactions, we estimated the relative risk of disease occurrence over the following week associated with maximum daily temperature, dew point temperature, and daily precipitation using a time-stratified case-crossover distributed lag model. To assess the impact of weather on mosquito viral dynamics, we estimated the relative risk of disease occurrence over the following month associated with weekly cumulative temperature and precipitation using a bidirectional case-crossover distributed lag model.

**Results:** An increase in daily maximum temperature of 5°C was associated with a 23% (95%CI: 19, 27%) increase in West Nile Virus incidence over the next week. Higher weekly cumulative temperature was significantly associated with 52–130% higher incidence of reported West Nile Virus infection over the next month for each interquartile range increase. The presence of at least one day of heavy rainfall within a week was associated with a 29% (95%CI: 11, 50%) to 50% (95%CI: 30, 73%) higher incidence of reported West Nile Virus infection during the same week and over the subsequent two weeks. A 20 mm increase in cumulative weekly precipitation was associated with a 5% (95%CI: 3, 8%) increase in incidence of reported West Nile Virus infection over the subsequent two weeks.

**Conclusions:** Warmer temperatures and heavy precipitation increase the risk of human West Nile Virus infection in the United States. Warmer summers, shorter winters, increased total rainfall and increased frequency of extreme weather events are projected to occur in North America in the coming decades, and may enhance the transmission of West Nile Virus and other mosquito-borne infectious diseases. Public health planning efforts need to consider the impact of global climate change on vector-borne diseases.

**ISEE-1122****Comparison of Continuous Personal Ozone Measurements to Ambient Concentrations and Exposure Estimates from the APEX-Ozone Exposure Model**

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**Methods:** A personal monitoring study was conducted using a miniaturized UV absorption monitor (PEM) to measure ozone concentrations in a scripted series of microenvironments in the vicinity of the Millbrook fixed-site monitor in Raleigh, NC. One-minute ozone concentrations recorded by the PEM provided a continuous record of ozone concentrations in the scripted locations, which included indoor, in-vehicle, and outdoor microenvironments. The technician was also equipped with a GPS unit, an ActiHeart™ heart rate and activity monitor, and a digital video camera that continually recorded the immediate surroundings on DVD. The script scheduled five 10-minute events per hour over a 10-hour period, for a total of 50 sampling events, including two events set aside for collocation of the PEM and the ambient monitor. Window position was varied while in indoor and in-vehicle microenvironments. Measurements in outdoor near-road microenvironments were made both upwind and downwind of roadways. Ozone concentrations from the PEM were compared to ambient concentrations from the Millbrook monitor and exposure estimates from the U.S. Environmental Protection Agency's Air Pollution Exposure Model (APEX). Researchers ran APEX-Ozone for 200 iterations using an activity pattern that incorporated the 50 scripted exposure events.

**Results:** PEM concentrations were similar to ambient and modeled concentrations for outdoor microenvironments, with a median personal/ambient ratio of 0.92 (median personal/APEX ratio = 0.97). As expected, PEM concentrations indoors and inside vehicles were lower than ambient concentrations. Window position had a substantial effect on personal/ambient ratios in indoor and in-vehicle microenvironments. The median personal/ambient ratio for indoor microenvironments was 0.26 when windows were open and 0.03 when windows were closed; for in-vehicle microenvironments, the corresponding ratios were 0.43 for open windows and 0.05 for closed windows and vents (fan off). Analysis of the APEX model results found that PEM concentrations were higher than modeled concentrations in indoor and in-vehicle microenvironments when windows were open, and lower than modeled concentrations when windows were closed. The median ratio of indoor PEM concentrations to APEX concentrations was 1.87 for open windows and 0.13 for closed windows.

**Conclusion:** These results indicate that the PEM used in this study is suitable for measuring personal ozone exposures in a variety of microenvironments, and suggest that PEM studies in multiple locations could be useful for evaluating exposure model estimates.

**ISEE-1124****Organic Diets Associated with Lower Pesticide Urinary Metabolite Excretion in Children Living in Agricultural and Urban Areas**

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**Background:** Recent studies suggest that dietary ingestion of pesticides is a key route of pesticide exposure to young children. For example, Lu et al (2006) observed that urinary metabolites of several common organophosphorus (OP) pesticides significantly decreased in children eating organic diets. Additionally, there is considerable debate in scientific

and policy arenas as to whether child pesticide exposures are higher in agricultural versus urban areas.

**Methods:** In this study, we replicated the procedures followed by Lu et al. in a group of 40 children aged 3–6 years, 20 of whom resided in Salinas, CA with farmworker parents, and 20 of whom resided in east Oakland, CA, an urban area. All children were of Mexican descent and were demographically similar. The protocol involved daily urine sampling over 15 days while children were following prescribed diets. On days 1–4 participants consumed typical conventional diets, on days 5–11 participants consumed an organic diet, and on days 12–15 participants returned to their typical conventional diets. We then measured 6 dialkyl phosphate (DAP) metabolites of OP pesticides in the urine.

**Results:** All values presented are median concentrations. Excluding the organic week samples, overall DAP concentrations were higher in Salinas, CA compared to Oakland (170 nmol/L vs 105 nmol/L, respectively). For the organic week, we excluded the first three days of urine results to allow for washout of residual diet exposure. DAP concentrations during the organic week were also higher in Salinas, CA compared to Oakland children (94 nmol/L vs 77 nmol/L). For all children, concentrations were lower during the organic week (78 vs 127 and 119 nmol/L pre- and post-organic, respectively) than when they consumed their traditional diets. In Salinas, DAP concentrations decreased by 44% during the organic week compared to 26% in Oakland. In absolute terms, median concentrations also decreased more substantially during the organic week in Salinas vs Oakland (change = 76 vs 28 nmol/L, respectively). These results were driven by levels of dimethyl DAPS.

**Conclusion:** Overall, these findings indicated that exposures were higher in Salinas compared to Oakland, and that pesticide exposures and excretion were lower during the organic diet week. In this presentation we will examine these findings in more detail. We will also report on results for pesticide-specific metabolites.

**Reference**

Lu et al. *Environ Health Perspect* 114: 260–263 (2006).

**ISEE-1125****Dental Disorders Among Chinese Restaurant Cooks Cohort: Result from the National Health Insurance Data**

Yang Y,\* and Wu T,† \*Kaohsiung Medical University, Kaohsiung, Taiwan; and †China Medical University and Hospital, Taichung, Taiwan.

**Background:** When cooks cook, they need to taste food, however, the studies in the occupational disease of teeth were few. In Taiwan, there were approximately 341,620 Chinese restaurant cooks; therefore, the cooks' occupational dental disease is an issue of concern. We examined the incidence of dental disorders among Chinese restaurant cooks in Taiwan.

**Methods:** To investigate the incidence of dental disorders to which Chinese restaurant cooks are most at risk in Taiwan, National Health Insurance Data from 2001 to 2005 were used to identify dental disorders for study populations, including 58,849 certified cooks and 118,206 references matched for age and sex.

**Results:** The 5-year cumulative incidence of dental disorders was significantly higher in the cooks than in the references (83.1% vs. 76.4%,  $P < 0.001$ ). We investigated further the relation between the work years and sex in cooks. By logistic regression, in terms of dental caries, pulpitis and periodontosis, incidences in females or work year elder were significantly higher than in males or work year younger.

**Conclusion:** The occupational exposures may have an effect on Chinese restaurant cooks. These findings suggest the need to promote the occupational safety education for Chinese restaurant cooks.

**ISEE-1126****Heavy Metal Contamination of House Dust in Homes of Mothers that Smoke in Proximity to Their Infant**

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**Background:** Environmental tobacco smoke (ETS) and traffic have been identified as sources of hazardous metal dusts. Household dust may be a sink for the metal particulates in households with smokers. Metals such as cadmium, chromium, and arsenic have been identified in mainstream cigarette smoke. Infants and young children may be at higher risk of exposure to metals in household dust relative to adults through hand to mouth behaviors and proximity to re-suspended floor dust.

**Methods:** This was a cross-sectional study ( $n = 37$  households) comparing three existing types of households with infants less than 1 year 1) non-smokers; 2) mothers who are smokers that smoke away from their infant; and 3) mothers who are smokers that smoke around their infant. House dust samples were collected by cyclone vacuum (HVS3, Sandpoint, ID), sieved with a 150 um sieve, and processed by microwave-assisted extraction into acid. Trace elements were measured by inductively coupled plasma mass spectrometer (ICP-MS, Agilent Technologies, Inc., Santa Clara, CA).

**Results:** In household dust collected in the infant's bedroom, concentrations of the metals arsenic, vanadium, manganese and tin were elevated in homes where the mother reported smoking around the infant ( $P < 0.05$ ).

**Conclusion:** These results implicate house dust as a potential exposure pathway to a wide variety of trace metals with various toxicity levels, including potential carcinogens, associated with cigarette smoking in households with small children. No previous studies have assessed the contribution of smoking behaviors in mothers with young children with regards to metals in house dust.

**ISEE-1127****Development of Korean Exposure Factors Handbook**

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**Background:** In order to conduct an exposure assessment, information on exposure variables reflecting human behavioral characteristics is needed. When a researcher applies a randomly chosen factor or a factor used in foreign countries, it fails to reflect the characteristics of the exposure according to differences in race, environment, culture, and life habits, increasing the uncertainty of the results of exposure assessment. Therefore, this study produced a handbook of exposure factors which can be applied to Koreans.

**Methods:** 'Development and Application of Korean Exposure Factors Project (Jang et al., 2007)' was carried out for three years beginning in 2005. The project examined, analyzed, and assessed domestic research materials for exposure factors. Based on the results of the project, Korean Exposure Factors Handbook was produced. Included Exposure factors were as follows: General Factors-lifetime, body weight, surface area, inhalation rates, drinking water intake, and soil ingestion; Food Ingestion Factors-intake of grain and grain products, intake of meat and meat products, intake of fish and shellfish, intake of seaweeds, intake of vegetables, intake of fruits, intake of nut and seed products, intake of dairy products, intake of eggs, intake of oils and fats, intake of seasonings, and intake of sugars and sweeteners; Activity Factors-time spent in activities, time spent in locations, time spent inside vehicles, hand washing, face washing, showering, bathing, swimming, population mobility, and occupational mobility.

**Results:** The handbook was composed of process to calculate recommended value, comparison with foreign results, reliability, and limitation for each exposure variable. As for recommended value, not only mean value but also distribution value was presented. In addition, the values of a variable by gender, age, district, income level, and education level were also presented. The Exposure Factors Handbook can be downloaded from a website Korean ([www.keh.or.kr](http://www.keh.or.kr)). The Koreans average lifetime was 78.6 years, and average body weight was 62.8 kg and average body surface area 17,084 cm<sup>2</sup>. As for drinking water intake, they drank 1,502 ml of water daily except for water intake through food. As for soil ingestion, children were estimated to ingest an average of 118 mg of soil daily. The average daily food intake was also estimated. The results were as follows: grain-14 g/kg, meat-1.62 g/kg, fish-1.53 g/kg, vegetables-6.47 g/kg, oils and fats-2.73 g/kg, and eggs-0.47 g/kg. The Koreans spent an average of 1,282 minutes indoors, 76 minutes outdoors, and 83 minutes inside vehicles. Average time in each vehicle was as follows: automobile-44.8 minutes, bus-19.9 minutes, subway-13.0 minutes, taxi-2.2 minutes, train-0.4 minutes and so on. The Korean spent 16.8 minutes daily taking a shower, 23.2 minutes weekly bathing, and 20.7 minutes monthly swimming. Their population mobility was an average of 8.8 years and occupational mobility an average of 5.8 years.

**Discussion:** Even when compared with Exposure Factors Handbooks of foreign countries, this study is not losing its competitiveness in terms of the recentness, representativeness, and reliability of its materials. Therefore, it is expected that the handbook will be used in risk assessment and various studies.

**ISEE-1129****Urinary 1-Nitropyrene Metabolites in Taxi Drivers in Shenyang, China**

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**Background:** 1-Nitropyrene (1-NP) is one of the most abundant nitrated polycyclic aromatic hydrocarbons (NPAHs) in diesel exhaust particulate matter (DEP) and is a main contributor of direct-acting mutagenicity in DEP. Therefore, the metabolites of 1-NP are expected to be a biomarker for assessment of exposure to DEP. In this study, we examined the levels of urinary 1-NP metabolites in 10 non-smoking taxi drivers working in Shenyang, China. It was presumed that these subjects would be exposed to high levels of urban traffic exhaust. We simultaneously assessed the exposure to airborne fine particulate matter (PM<sub>2.5</sub>) and 1-NP from the working environment.

**Methods:** Samples were collected for 5 days in summer and winter seasons (September and December, 2005). To monitor the exposure to PM<sub>2.5</sub> and 1-NP, personal samplers (holder: ATPS-20H, Shibata, Tokyo, Japan) were placed inside and outside cars ( $n = 5$ ), and PM<sub>2.5</sub> was collected on quartz filters during the subjects' workshift. The pumps were operated at a flow rate of 1.5 L/min. Quantitative analysis of 1-NP was performed by HPLC with fluorescence detection. Post-shift urine samples were collected and hydroxy-1-nitropyrenes (3-, 6-, and 8-OHNP) in the urine samples were analyzed by liquid chromatography with tandem mass spectrometry (LC-MS/MS, API 4000 Q-Trap, Applied Biosystems, CA)<sup>1)</sup>.

**Results:** The ambient PM<sub>2.5</sub> concentrations in summer were higher than those in winter (summer:  $140 \pm 39$ , winter:  $84.4 \pm 53 \mu\text{g}/\text{m}^3$  (mean  $\pm$  SD)), whereas 1-NP concentrations were similar in both seasons (summer:  $485 \pm 310$ , winter:  $492 \pm 420 \text{ fmol}/\text{m}^3$  (mean  $\pm$  SD)). These data clearly showed that the subjects were occupationally exposed to high levels of traffic exhaust. 6-OHNP and 8-OHNP were found in urine samples from all of the subjects, while 3-OHNP was hardly detected in the urine

samples. The concentrations of the sum of 6-OHNP and 8-OHNP in summer and winter were  $10.3 \pm 6.9$  and  $11.6 \pm 10$  nmol/mol creatinine (mean  $\pm$  SD), respectively.

**Conclusion:** This study suggested that urinary 1-NP metabolites increased with increasing 1-NP concentrations in ambient air, and should be useful for the surveillance of exposure to NPAHs and DEP.

#### Reference

- 1) A. Toriba et al., *Chem. Res. Toxicol.*, **20**, 999–1007 (2007).

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#### ISEE-1131

##### In Vitro Study of Transdermal Permeation of Insect Repellent and Sunscreen

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**Background:** It has been reported that concurrent use of insect repellent and sunscreen results in higher dermal absorption of both than lone use of either. The report was confirmed for insect repellents containing DEET (*N,N*-diethyl toluamide) and sunscreen containing oxybenzone, but was uncertain for insect repellents and sunscreen containing other ingredients. To understand whether the reported fact can be extended to products containing other ingredients, we conducted a series of pigskin diffusion experiments using insect repellent ingredients of DEET and citral (lemongrass oil), and sunscreen ingredients of oxybenzone and 2-ethylhexyl-*P*-methoxycinnamate (EHMC).

**Methods:** The experiments were conducted on Franz diffusion cells, each of which consists of a donor and a receptor compartments, and the tested pigskin was placed in between. There were eight combinations of repellent and sunscreen ingredients ([no repellent, DEET, citral]  $\times$  [no sunscreen, oxybenzone, EHMC]–[no-no]); each of them was placed in the donor compartment, and the buffer solution in the receptor compartment was taken out for analysis of high performance liquid chromatography at various times within an 8-hour period. Each combination was repeatedly tested for 6 times.

**Results:** The preliminary results show that all diffusion tests followed the Higuchi equation, in which permeated concentrations were proportional to the square root of time, indicating a steady release of the diffusion. The DEET-oxybenzone combination had a significantly higher concentration of DEET in the buffer solution than the lone DEET test ( $P < 0.05$ ), indicating that more DEET penetrated the skin with the presence of oxybenzone. Similar to the DEET-oxybenzone combination, the mixture of DEET and EHMC also resulted in more DEET under the tested skin. However, either oxybenzone or EHMC did not have the extra transdermal penetration while being used with DEET simultaneously. In contrast, citral, when used with oxybenzone or EHMC, did not appear to have the enhancement of transdermal permeation.

**Conclusion:** In summary, sunscreen helps enhance dermal absorption of DEET, and people have to be of caution when using a DEET-containing insect repellent and sunscreen at the same time.

#### ISEE-1132

##### Association Between GIS-Based Exposure to Traffic-Related Air Pollution During Pregnancy and Birth Weight in Sabadell, Spain

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**Objective:** INMA (Environment and Childhood) Study is a Spanish research network of several birth cohorts to study the impact of environmental pollutants and diet on children's development and health. Here we aim to assess the relationship between prenatal exposure to traffic-related air pollution and birth weight in the cohort of Sabadell ( $n = 558$ ), a city in the metropolitan area of Barcelona.

**Material and Methods:**  $\text{NO}_2$  and BTEX (benzene, toluene, ethylbenzene, *m,p*-xylene and *o*-xylene) were measured at 57 sampling sites with passive samplers between April 2005 and March 2006. Land Use Regression (LUR) models were developed for each pollutant using geographic data as predictor variables and then applied to predict outdoor air pollution levels at the cohort addresses. LUR estimates were temporally-adjusted using daily levels of  $\text{NO}_2$  measured at a fixed monitor. For each pregnant woman we obtained 9-month average exposures as well as trimester specific exposures to  $\text{NO}_2$  and BTEX. The relationship between prenatal air pollution exposure and birth weight was assessed with linear regression models. Models were adjusted for child's sex, gestational age, parity, maternal age, maternal smoking during pregnancy, maternal height and weight, paternal height, season of conception, and copollutant. We treated birth weight as a continuous outcome and pollutants as both continuous and categorical variables. Finally, we repeated the analyses excluding women who had moved during pregnancy or had worked outside their homes during the whole pregnancy period ( $n = 324$ ) to investigate potential exposure misclassification of this subgroup.

**Results:** Birth weight was inversely associated with exposure to  $\text{NO}_2$  only in the second trimester of pregnancy. Newborns of mothers with exposure to  $\text{NO}_2$  above the median ( $31.2 \mu\text{g}/\text{m}^3$ ) showed lower birth weight ( $\beta = -64.7$ ,  $P = 0.07$ ), although the association became negligible after adjusting for control variables ( $\beta = -41.0$ ,  $P = 0.21$ ). When restricting the analysis to women who had not moved or worked outside their homes during the whole pregnancy, the strength of the association increased. In this group, the crude difference in mean birth weight for newborns with an  $\text{NO}_2$  exposure above the median was  $-137.1 \text{ g}$  (95%CI:  $-229.3$  to  $-44.9$ ) and the adjusted difference was  $-110.1 \text{ g}$  (95%CI:  $-193.0$  to  $-27.1$ ). Coefficients did not change substantially after adjusting for BTEX exposure in the second trimester of pregnancy. We did not find any significant association between birth weight and 9-month or trimester-specific exposure to BTEX.

**Conclusion:** We found an effect of exposure to  $\text{NO}_2$  in the second trimester of pregnancy on birth weight and the association was stronger for women who had not moved or worked during the whole pregnancy. Results suggest that time-activity patterns have to be considered to avoid exposure misclassification.

#### ISEE-1134

##### Space-Time Clustering Analyses of Type 1 Diabetes in Children from Northern England

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**Background:** The aetiology of type 1 diabetes in children is uncertain. A number of recent studies have suggested an infectious aetiology. It has been postulated that the Ljungan virus is involved. Support for this hypothesis may be provided by a finding of space-time clustering.

**Objective:** The aims of this study were: (i) to determine whether there was space-time clustering in cases of childhood diabetes from Northern England; (ii) to test for differences due to age at diagnosis; and (iii) to test for differences between the sexes.

**Methods:** We studied the incidence of type 1 diabetes diagnosed in children aged 0–14 years and diagnosed during the period 1990–2007. All cases were resident in a defined geographical region of Northern England. We applied a second-order procedure based on  $K$ -functions to test for global clustering. Fixed thresholds of closeness in space (0.5,

1.0,...,7.5 km) and closeness in time (0.1,...,1.5 years) were used. Locations were the residential addresses at time of diagnosis. Tests were repeated using nearest neighbour thresholds to allow for variable population density, providing the primary result for each analysis. The following sub-groups were analysed separately: cases aged 0–4 years, 5–9 years, 10–14 years, males and females.

**Results:** We analysed 458 cases of type 1 diabetes. Overall, there was little or no evidence of global space-time clustering ( $P = 0.07$ ). There was also no evidence of clustering in any sub-group (ages 0–4:  $P = 0.48$ ; ages 5–9:  $P = 0.19$ ; ages 10–14:  $P = 0.48$ ; males:  $P = 0.83$ ; females:  $P = 0.11$ ).

**Conclusions:** The results have not found any evidence of global space-time clustering for cases of type 1 diabetes diagnosed in North East England. However, this does not preclude the possible involvement of a ubiquitous infection or one that has a heterogeneous latent period. Further research will examine geographical heterogeneity in incidence.

#### ISEE-1135

##### Association Between Pollution and Public Perception of Air Quality-SEQAP, a Risk Perception Study in France

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**Background and Objectives:** Many studies have been published in environmental perception field, including atmospheric air pollution. However, most of them only used opinion questions to quantify public perception of air quality. On the other hand, few studies linked perception of air quality and objective measurement of air pollution. The SEQAP project aims to construct and validate a scale to measure air quality perception (QAP) in order to study the relation between perception and pollution concentrations, and the representations and risk perception associated to pollution, using epidemiological and sociological approaches.

**Methods:** The QAP scale (including sensory perceptions, symptoms and risk perception) was built and validated using psychometric methods. About 2 500 inhabitants were interviewed by telephone from May 2006 to June 2007 in 8 French towns. The questionnaire asked on socioeconomic characteristics, health status, quality of life, opinion about air quality and the QAP scale questions. For each town, concentrations of the key atmospheric pollutants (including particles  $PM_{10}$ , nitrogen dioxides  $NO_2$ , Ozone  $O_3$ , and sulfur dioxide  $SO_2$ ) were obtained from the French air pollution Monitoring Network. The mean of the 7-days preceding the telephonic interview were used as a proxy of individual exposure estimation. Relations between QAP and exposure estimates after adjustment for confounders were investigated by multiple linear regression models.

**Results:** After adjustment for the determinants of the QAP score (sex, morbidity, quality of life, vehicle, town, meteorology), a significantly association with  $PM_{10}$  ( $P = 0.003$ ) was observed: the QAP score increased with the particles level. The QAP score was higher parting a subgroup of the population, those susceptible to air pollution effects (respiratory and/or allergic diseases group and depressive group). However, the association between  $PM_{10}$  and QAP score remained significant after exclusion of these susceptible groups. A significantly association between QAP and ozone was also found ( $P = 0.001$ ), but only in the summer season. There were no statistical association between the opinion questions on air pollution and pollutant concentrations after adjustment for confounders.

**Conclusion:** To our knowledge, this epidemiological study is one of the first to show a relation between air quality perception and pollutants level in France, and more particularly for particles, and ozone in summer. The QAP score appeared to act very differently than the opinion question about air quality often used by authors to link perception of pollution and air quality.

#### ISEE-1136

##### Wind Turbines and Noise: Is There a Minimal Siting Distance?

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**Background:** The share of renewable energy sources is in constant increase in France and worldwide. This orientation notably results from the need to diversify energy sources and reduce dependency on fossil energies. It also takes places in a global context of greenhouse gas emissions reduction. In France the wind turbine production was of about 0.75 GW in 2005 and is now more than 2.7 GW. In spite of the growing interest for renewable energy sources, their potential environmental and health impact is a source of concern. This is the case for wind turbines for which residents put forward the noise generated by the future wind parks to contest their construction. These concerns led the French National Academy of Medicine to temporarily recommend a minimal distance of 1500 metres between wind turbines (>2.5 MW) and habitations. Following this, the French ministries in charge of health and environment commissioned AFSSET to further investigate the acoustic impacts of wind turbines and produce detailed recommendations.

**Methods:** To perform the study, a work group constituted of experts in acoustic, metrology and health effects was set up. AFSSET's expertise was conducted in close cooperation with the Agency for environment and energy management (ADEME). The experts reviewed the available data regarding wind power developments and perspectives, health effects of noise, regulations applicable to wind turbines and wind parks in various countries as well as noise levels measured in residential areas. Regional authorities were also interviewed through a questionnaire (97 regional authorities investigated, return rate 42%) to understand the current management practices and siting distances. Numerical simulations were performed to assess noise levels induced by wind parks in various topographic and meteorological conditions. There are basically two regulation strategies in noise management: acceptance levels based on absolute noise (including ambient background and other sources) and acceptance levels based on emergence (the contribution of a specific source to the ambient level). Absolute levels are used in some countries (e.g. Germany, Denmark, Greece and Sweden), while a combination of absolute and relative levels are used in other countries (e.g. England, Australia, New Zealand and France). The French regulation, which is amongst the most restrictive, relies on an emergence limit of 3 dB(A) at night.

**Results and Discussion:** The numerical simulations carried out indicated that the noise emergence induced at 1500 m remains weak and generally below 3 dB(A). Nevertheless, higher noise emergences may occasionally be found for particularly penalizing conditions. Questionnaire results indicated that the mean current siting distance is of 650 m ( $n = 180$ ). Complaints from residents were reported for about 10% of wind parks. Considering this, and the lack of direct health effects, the setting of a precautionary distance of 1500 m does not seem relevant. Besides, the advantage provided by such a straightforward approach must be put in balance with its consequences on wind park development. Finally, the workgroup concludes that the existing simulation capabilities are sufficient to support the implementation emergence regulation and should be further developed within the existing impact studies framework.

**ISEE-1137****Respiratory Health: Frequency of Asthma, Wheezing and Allergies in Inuit Children in Relation to Indoor Air Quality**

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**Methods:** A respiratory health survey on a representative sample (1023) of 0 to 14 years old Inuit children was undertaken in 2004 for the first time in Nunavik. The data on respiratory symptoms and asthma were obtained from a household respondent, usually a parent, by means of the standardized ISAAC questionnaire. Other questions were also asked about various home and environment variables.

**Results:** Results indicate that the prevalence of wheezing, persistent wheezing and severe wheezing is three to four times higher in the 0–4 age group compared to the 5–14 age group (14.5% vs. 3.4%). In comparison with southern Quebec and many countries, the prevalence of wheezing in younger Inuit children is relatively high, while it is relatively low among older children. The prevalence of wheezing among 5–14 years old Inuit is about half of the prevalence of wheezing found in children of southern Quebec aged between 9 and 13, and is similar to countries at the low extremity of the worldwide distribution of asthma prevalence. On the other hand, the prevalence of lifetime or current asthma among Inuit children aged 5–14 is almost double that of the 0–4 age group. Only 5.6% of children have allergy, which is associated with a higher risk of current asthma, and persistent or severe wheezing. About 50% of children with wheezing took asthma medication in the two days prior to the survey. The prevalence of the use of asthma medication is 5.2% in the general Inuit population (adults and children combined). Smoking restrictions are present in 84.1% of Inuit homes. No significant association was found between asthma or wheezing and passive smoking. The prevalence of asthma or wheezing was not statistically associated with the number of children aged 0–14 in the household.

**Discussion:** From a public health perspective, these results are quite encouraging. Indeed, we found low frequency of allergy and asthma symptoms in 5–14 years old children, high level of smoking restriction in the Inuit homes and absence of documented negative effect of overcrowding in Inuit population of children. However, the results concerning the relatively high frequency of wheezing in the 0–4 age group, the proportion of children with persistent and severe wheezing, and the frequent use of asthma medication could suggest difficulty in controlling respiratory symptoms. Lower respiratory tract infections may play a major role. More research is needed to evaluate the clinical aspects of wheezing episodes and to estimate the adequacy of asthma control in this population.

**ISEE-1139****Exposure Assessment for Trace Contaminants in Consumer Products**

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**Background:** Evaluating the safety of consumer products involves the assessment of the ingredients directly added to the product and any potential contaminants. There are instances where low levels of materials of concern are found as unavoidable trace contaminants in the ingredients used to make consumer products. These contaminants can be a naturally occurring constituent in the raw material, are unreacted precursors or side reaction products as a result of synthesizing the ingredients, or reaction by-products. Although the amounts of these trace contaminants are controlled to as low a level as practical, some will unavoidably occur in the finished consumer product. Furthermore, in some cases the same ingredient may be used in multiple consumer products. When such uses occur, aggregate exposure to the trace contaminant may need to be assessed.

**Discussion:** Benzene is one trace contaminant found in many raw materials since it is used as a solvent for organic synthesis and it is naturally present in many petroleum derived solvents or raw materials. Benzene is an IARC Group 1 carcinogen and is listed as carcinogen on a variety of regional and local inventories. Some types of acrylic acid cross-linked polymers (AACP) are synthesized using benzene as a solvent. Since AACP are commonly used emulsion stabilizer's products using AACP may contain trace levels of benzene (<0.5 ppm). In such instances it is important to assess exposure to benzene from use of products containing acrylic acid copolymers. Typically for benzene the most relevant route of exposure would be inhalation. Since a cosmetic oil/water emulsion type product applied to the skin offers the highest potential for dermal exposure for a consumer product, the potential for volatilization of benzene from this type of product is minimal. A conservative approach is to assume that all of the benzene in this type of product is available for penetration through the skin. In all cases the resulting projected exposures are several orders of magnitude lower than regulatory values that have been derived for different geographical regions of the world. The approaches for conducting exposure assessments to individual products and to aggregate exposure to multiple products will be discussed and contrasted for benzene and other trace contaminants.

**ISEE-1140****Interpretation of Benzene Urinary Biomarker Data for Risk Assessment: A Case Study**

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**Background:** The Biomonitoring Technical Committee of the International Life Sciences Institute (ILSI) Health and Environmental Sciences Institute (HESI) is developing a benzene case study of the relationship of human biomarker data to risk. This poster presents an evaluation of published measurements of benzene metabolites that defines the lower limits of environmental air benzene concentrations that can be reliably characterized using its urinary metabolites [S-phenylmercapturic acid (SPMA), t,t-muconic acid (MA), phenol, catechol, and hydroquinone], and urinary benzene.

**Methods and Results:** The study analyzed data from 52 reported "reference" populations who were not exposed to benzene containing products or industrial sources, but who had exposures to ambient air levels, dietary sources, and tobacco products. The overall range of central tendency (mean, geometric mean, or median) for the aforementioned metabolites in urine were 0.5–18 µg/L (SPMA), 33–414 µg/L (MA), 2.8–16 mg/L (phenol), 1.3–18 mg/L (catechol), and 0.3 to 7.5 mg/L (hydroquinone). For this comparison, creatinine corrected data were converted to µg/L using the U.S. population mean creatinine value of 1.38 g/L for ages 30–39. For thirteen of the reference populations, urinary or airborne benzene levels were used to determine the upper bound urinary concentration of benzene metabolites that could occur as a result of benzene exposure; therefore, permitting a determination of the levels of each metabolite from the background sources (e.g., smoking, diet, pharmaceuticals, etc.). Measured metabolite concentrations were 4.5 (SPMA), 11 (MA), 57 (phenol), 405 (catechol), and 310 (hydroquinone) times greater than the maximum theoretical amount predicted from the benzene exposure concentration. This calculation assumes an average conversion of inhaled benzene of 0.11%, 4.5%, 45%, 6%, and 3% for each urinary metabolite, respectively. The reported conversion of inhaled benzene to the urinary metabolites varies across studies and individuals. For SPMA, assuming a percent conversion of 0.3% (a reported upper range for the formation of this metabolite) decreased the above ratio from 4.5 to 1.6. A ratio of 1 would be consistent with the current understanding that there are no other known sources of SPMA.

**Conclusions:** These data suggest that background sources of these benzene urinary metabolites will mask benzene exposure-derived levels

below approximately 0.08 ppm benzene for MA, 0.5 ppm for phenol, 2.3 ppm for catechol, and 2.7 ppm for hydroquinone (the benzene concentrations corresponding to 2 times the background concentration). Our next step is to request the full data sets for these reference populations and repeat the analysis on an individual basis with the goal of defining the concentration of each urinary metabolite that may be used to quantify benzene exposure.

#### ISEE-1141

#### Risk of Birth Defects in a Population Living Near a Municipal Solid Waste Incinerator During Different Operating Periods

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**Background:** Municipal waste incineration induces environmental contamination with toxic substances such as dioxins, furans and heavy metals, which have a teratogenic potential, but little epidemiologic evidence is available on this topic. We examined the risk of congenital anomalies associated with maternal exposure to emissions of a modern municipal solid waste incinerator in a northern Italy community (Reggio Emilia, population about 150,000) during the period 1998–2006, through a population-based case-control study.

**Methods:** In the analysis we included the livebirths and stillbirths as well as the induced abortions with diagnosis of congenital anomalies, and a corresponding series of control births, using maternal age as an additional matching variable and limiting the analysis to women residing in the municipality. Sources of data were the Hospital Discharge Registry and the population-based Registry of Birth Defects “IMER” of the Emilia-Romagna Region, yielding an overall number of 352 congenital anomalies diagnoses and 352 control births during the study period. We calculated the risk of prevalence of birth defects in the offspring associated with maternal residence near the incinerator by using a conditional logistic regression model.

**Results:** In the two periods (1998–2002 and 2006) of normal operation of the incinerator, among women residing <1 km and 1–2 km from the plant the prevalence of birth defects in the offspring was not higher than that observed in the remaining municipal population. Furthermore, there was no reduction in the risk of congenital anomalies in the offspring of women residing up to 2 km from the incinerator in the shut-down period, from 2003 to 2005. Further adjustment for educational attainment level did not appreciably change these results.

**Conclusion:** Findings of the study do not appear to support the hypothesis that the environmental contamination occurring around an incineration plant as examined in this study induces teratogenic effects in the exposed population.

#### ISEE-1143

#### Characterisation of Particulate Exposure During Fireworks Displays

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**Background:** Fireworks generate aerosols which disperse according to wind direction and speed. Little is known about the level and content of

exposure to fine particles ( $PM_{2.5}$ ) among people attending or living in proximity to firework launch sites. To document levels of  $PM_{2.5}$  and their elemental content in proximity to fireworks, a pilot project was carried out during the nine fireworks launches of the 2007 Montreal International Competition.

**Methods:** For each event, the Lagrangian model of the Canadian Meteorological Centre (CMC) was used to predict the location of the firework plume. Then within the predicted plume location (“predicted sites”),  $PM_{2.5}$  was continuously measured with a photometer (Sidepak, TSI) and, integrated samples were collected for about 50 minutes using portable personal samplers (at breathing zone height). Each “predicted” sampling location was situated within 500 to 2000 m of the launch site. To collect a greater amount of  $PM_{2.5}$  mass for more detailed chemical characterization, an additional sampler was located on a roof (“fixed site”, collection at 50 lpm for one hour) in relatively close proximity to the launch site (1100 m). The elemental composition of the collected  $PM_{2.5}$  samples from “predicted sites” was determined using both a non-destructive energy dispersive XRF method and an ICP-MS method with a near-total microwave-assisted acid digestion. The elemental composition of the “fixed site” samples was determined by ICP-MS.

**Results:** Given wind variation and the challenge of accurate forecasts, both the “fixed” and the “predicted sites” turned out to be in the plume for only four of the nine launches. The highest  $PM_{2.5}$  levels, measured at the closest location to the launch site, reached nearly  $10\,000\,\mu g/m^3$ , 500 times background. Elements such as sulphur, chlorine, barium, magnesium, antimony, strontium, titanium and copper were higher in plume-exposed filters.

**Conclusions:** This project showed that 1) the CMC Lagrangian model accurately predicted the location of the plume four times out of nine, notwithstanding the near misses, 2) persons in the plume and in close proximity to the launch site may be exposed to extremely high levels of  $PM_{2.5}$  for about 30 minutes and, 3) the plume contains specific elements for which little is known of their acute cardio-respiratory toxicity. Further consideration is needed to accurately assess the risk of exposure to fireworks plumes and what if any public health measures should be implemented.

#### ISEE-1144

#### Space-Time Clustering of Cancer in Young People from Northern England

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**Background:** Previous studies have found space-time clustering amongst certain diagnostic groups of cancer in children aged 0–14 years. However, there are marked differences in the diagnostic groups involved for cases aged 15–24 years.

**Objective:** The aim of this study was to determine whether there was evidence of space-time clustering in young people aged 0–24 years and also separately to analyse childhood (aged 0–14 years) and adolescent/young adult cases (aged 15–24 years).

**Material and methods:** Cases diagnosed during the period 1968–2005 were abstracted from the Northern Region Young Persons’ Malignant Disease Registry. This registry is population-based and covers a geographically defined region of Northern England. Data were analysed using the K-function method. Clustering at birth and diagnosis was studied.

**Results:** 5973 cases of cancer in young people were analysed. There was statistically significant evidence of space-time clustering amongst cases of Wilms tumour in children ( $P = 0.03$ ), carcinoma in adolescents/young adults ( $P = 0.03$ ) and lymphoid leukaemia in adolescents/young adults ( $P = 0.04$ ). These results were based on time and place of birth only. The result for carcinoma was driven by cases of melanoma in adolescents/young adults ( $P = 0.08$ ).

**Conclusions:** The findings for Wilms tumours, carcinoma (especially melanoma) and lymphoid leukaemia suggest the involvement of spatio-temporally varying environmental components in aetiology. Furthermore, the findings suggest that the relevant aetiological exposures occurred at similar ages or in-utero. Interpreting the results together with other epidemiological evidence suggests a possible infectious aetiology for cases of lymphoid leukaemia in adolescents/young adults. However, other environmental factors are likely to be involved for Wilms tumours and melanoma.

#### ISEE-1145

#### Survey Measures of Indoor Air Quality: A Birth Outcomes Study

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**Background:** Indoor air is an important source of air pollution exposure affecting birth outcomes, since pregnant women in the United States spend a large majority of their time indoors. We evaluated associations between indoor air pollution and a woman's risk of having a term low birth weight (LBW) baby. The UCLA Environment and Pregnancy Outcomes Study (EPOS) is a case-control survey of 2,543 Los Angeles (LA) County mothers who gave birth in 2003, including preterm and/or LBW infants as cases, and full-term normal weight infants as controls.

**Methods:** The survey collected data on indoor sources of air pollution and allergens including potential allergen sources (pets), indoor combustion sources (smoking, gas appliances, and cooking methods) and housing characteristics that may affect indoor air exposures (ventilation and carpeting). To isolate the effects of environmental tobacco smoke, we restricted these analyses to women who reported never having smoked ( $n = 1,761$  never smokers).

**Results:** Of these non-smoking women, 14.4% ( $n = 252$ ) reported living with one or more smokers during pregnancy, with mothers of Black, Asian, or other races being more likely to live with a smoker than non-Hispanic white or Hispanic mothers. Our data suggested that children born to non-smoking mothers who lived with a smoker during pregnancy might have a small increase in odds of term LBW (OR = 1.35, 95%CI = 0.84, 2.17), adjusting for maternal age, race/ethnicity, marital status, education, payment source for prenatal care (a proxy measure for socioeconomic status), and infant birth season. However, mothers living with a smoker, but who reported keeping their windows open frequently (all day or night, or all the time) appeared to have no increased odds of term LBW in both crude (OR = 1.00, 95%CI = 0.50, 1.97) and adjusted models (OR = 0.88, 95%CI = 0.44, 1.76), compared to women living in non-smoking households who also kept their windows open frequently. In contrast, mothers who kept their windows closed most of the time had increased odds of term LBW, where the odds of term LBW were much higher for those who also lived with a smoker (OR = 3.36, 95%CI = 1.71, 6.59) than those living in non-smoking households (OR = 1.51, 95%CI = 1.02, 2.23). We plan to investigate other contributors to indoor air pollution, including gas appliances with and without pilot lights, cooking methods and ventilation, and pet allergens. Measures of ambient air pollution exposure are available for all women in this cohort, and we will investigate the relative effects of indoor and outdoor air pollution on adverse birth outcomes.

#### ISEE-1149

#### Evaluation and Calibration of Continuous Real-Time Particle Monitors for Fine Particle Exposure Analysis

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**Background:** Fine particles with aerodynamic diameter less than 2.5 micrometers ( $PM_{2.5}$ ) are of great concern due to their persistence in the

environment and their impacts on human health. Previous studies have demonstrated a relationship between urban  $PM_{2.5}$  pollution levels and mortality and morbidity. Acute exposure to  $PM_{2.5}$  is associated with diseases such as cardiovascular malfunction. The EPA-approved method of quantifying  $PM_{2.5}$  concentrations utilizes gravimetric measurement of filter samples—this requires a minimum sampling time of several hours. However, the concentrations of airborne particulate matter (PM) can vary substantially, both with time and from one microenvironment to another. Thus, portable real-time monitoring devices are an effective way of assessing human exposure to fine particles. PM monitors are available that can be set to continuously record concentrations over time scales as short as one second—having time-resolved measurements allows identification of what activities or locations are the major contributors to this exposure. Most real-time PM monitors measure light scattering to quantify particle concentrations. However, the light scattering properties of particles vary substantially with size and with composition. The SidePak real-time PM samplers used in our experiments were calibrated by the manufacturer to the respirable size fraction of Arizona road dust. This calibration factor may not be reliable for quantifying other sources of PM. Therefore, comparison of real-time monitors with the EPA-approved gravimetric method using the source of PM to be measured is crucial. In addition, when using multiple real-time monitors, collocated intercomparison measurements are necessary.

**Methods:** We used eleven TSI SidePak real-time PM samplers and two gravimetric samplers to monitor indoor  $PM_{2.5}$ . Using the gravimetric sampler as the reference standard, we conducted both lab and field experiments to evaluate and calibrate the SidePak samplers. The effects of humidity and different sources of  $PM_{2.5}$  were explored under controlled experimental conditions.

**Results:** Over a concentration range of approximately 60 to 500 micrograms per cubic meter, there is strong linear relationship between the SidePak and the gravimetric measurements ( $r^2$  value = 0.997). For example, for environmental tobacco smoke, we found that SidePak monitors consistently reported PM concentrations that were 3.4 times as high as gravimetric samples. To correct for this, the internal calibration factor for the SidePak would need to be adjusted to 0.29 instead of being left at the default value of 1. All eleven SidePaks correlated with each other very well, with calibration factors ranging from 0.98 to 1.18, and  $r^2$  values ranging from 0.986 to 0.999.

#### ISEE-1150

#### Potential Occupational Exposures of Hairdressers to Vinyl Chloride in Hairspray (1962–1973)

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**Background:** Vinyl chloride was used as a propellant in a small percentage of aerosol hairspray products from approximately 1962 to 1973. Since that time, questions have arisen regarding whether occupational exposures of hairdressers to vinyl chloride in hair salons would be sufficient to increase the risk of developing angiosarcoma of the liver (ASL), which has been linked definitively with vinyl chloride exposures among industrial workers with chronically high exposures.

**Methods:** To estimate the airborne concentration of vinyl chloride for both individual hairdressers spraying hairspray and background concentrations of vinyl chloride in hair salons over time, modeling was conducted using actual hairspray use characteristics in the literature taken from the time period during which vinyl chloride was present in the products. Both near field (personal breathing zone) and far field (background) concentrations of vinyl chloride were modeled over time for representative small and large salons. Ventilation and air movement characteristics, air exchange rates, salon size, the number of hairdressers,

and the number of customers were also taken into account using Monte Carlo techniques.

**Results:** The results of our work indicate that the lifetime cumulative doses via inhalation for beauticians for the 11-year time period in which it was used in some products are as much as 10 to 100 fold lower than those found among workers who developed ASL.

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#### ISEE-1151

#### Maternal Prenatal Urinary Concentrations of Di-(2-Ethylhexyl) Phthalate in Relation to the Timing of Labor: Results from a Birth Cohort Study of Inner-city Mothers and Newborns

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**Background:** Di-(2-ethylhexyl) phthalate (DEHP) is a peroxisome proliferator activated receptor subtype  $\gamma$  (PPAR $\gamma$ ) agonist. During pregnancy, placental PPAR $\gamma$  activation plays a role in uterine quiescence and down regulation at parturition allows for stimulation of uterine contractions. It has thus been hypothesized that prenatal exposure to DEHP could reduce risk of prematurity. On the other hand, it has also been hypothesized that prenatal DEHP exposure may play a role in inducing or potentiating intrauterine inflammation, a known risk factor for prematurity. Several prior studies have assessed the relationship between prenatal DEHP exposure and gestational age, with inconsistent findings. The current study evaluates relationships between DEHP metabolite concentration in maternal urine during pregnancy and gestational age among a cohort of 213 African American and Dominican mothers and newborns from New York City.

**Methods:** Mono-2-ethylhexyl phthalate (MEHP), mono-2-ethyl-5-oxohexyl phthalate (MEOHP) and mono-2-ethyl-5-hydroxyhexyl phthalate (MEHHP) were measured in 3<sup>rd</sup> trimester spot urine samples collected from the mothers. Specific gravity was used to adjust for urinary dilution. Analyses excluded planned C-sections. Gestational age was extracted from newborn medical records ( $n = 166$ ) or calculated from the expected date of confinement ( $n = 47$ ). Multivariate models controlled for race/ethnicity, parity, maternal asthma, active and passive smoking during pregnancy, pre-pregnancy weight, education, newborn gender and premature rupture of the membrane. Additional variables evaluated but not controlled as they did not change parameter estimates were maternal age, marital status, BMI, weight gain during pregnancy, season and year of delivery, emergency C-section, other SES measures and health conditions.

**Results:** The phthalate metabolites were detected in 84% to 100% of maternal urine samples during pregnancy with a wide range in concentrations (0.5–1750 ng/ml). Mean gestational age was  $39.4 \pm 1.3$  weeks and was shorter by 1.4–1.6 days for each log-unit increase in the DEHP metabolite concentrations (95%CI 0.2, 2.9 days,  $P$ -value  $\leq 0.02$ ). For MEHP, gestational age averaged 4.9 (95%CI 1.2, 8.5) days less for subjects with the highest compared to the lowest quartile concentrations ( $P = 0.01$ ). Results were similar for the other metabolites. Results were also similar prior to adjusting for specific gravity or when analyses were restricted to full-term infants ( $\geq 37$  weeks gestation).

**Conclusion:** Results suggest that prenatal exposure to DEHP may shorten gestation. However, given inconsistencies between these and prior research findings, additional analyses are warranted to elucidate mechanisms and evaluate whether differences in study design, exposure levels or underlying characteristics of the populations are contributing to the disparate results.

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#### ISEE-1152

#### From Exposure Science to Policy Change: A 32-Country Comparison of Tobacco Smoke Derived Particle Concentrations in Public Places

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**Background:** The Framework Convention on Tobacco Control (FCTC) is an historic international public health treaty intended to reduce the devastating health and economic impact of the global tobacco epidemic. It requires all ratifying nations, of which there are over 150, to implement strong secondhand smoke or tobacco smoke pollution (TSP) protection policies (among many other provisions). Studies that use quantitative means for assessing levels of TSP exposure have generally been conducted in selected cities, primarily in wealthier Western nations. Little data exists in non-Western nations to document levels of exposure. Such localized information can be more salient to policymakers.

**Methods:** This study provided novel scientific equipment and methods to researchers around the world to determine TSP exposures in a wide range of geographically and economically disparate countries. The TSI Sidepak AM510 Aerosol Monitor was calibrated for TSP and used to measure the concentration of particles less than 2.5 microns ( $PM_{2.5}$ ) in hospitality venues, such as bars and restaurants, transportation venues, and other public places. The amount of smoking, number of people, and dimensions of each place sampled were determined. In all, 2,531 places were sampled with over 1,700 outside of the U.S. Countries in this study are from all regions of the world including the Americas, Europe, Eastern Mediterranean, South-East Asia and Western Pacific, and Africa.

**Results:** Overall, places with no observed smoking had a geometric mean  $PM_{2.5}$  level of 23 (micrograms per cubic meter), while  $PM_{2.5}$  in places with observed smoking were 8.3 (95%CI 7.1–9.1) times higher at 182. The active smoking density (average number of burning cigarettes per volume) was significantly and positively correlated with  $PM_{2.5}$  ( $\rho = 0.69$ ,  $P < 0.001$ ). The large increase in  $PM_{2.5}$  when smoking was observed was consistent across countries, although the difference between smoking and smoke-free places was smaller in countries with higher background  $PM_{2.5}$  levels.

**Conclusion:** Levels of indoor fine particle air pollution in places with observed smoking are typically greater what than what the World Health Organization and US Environmental Protection Agency have concluded is harmful to human health. This is true in countries all over the world. Comprehensive smoke-free regulations are the most effective strategy to reduce tobacco smoke pollution exposure.

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#### ISEE-1153

#### Airborne and Urinary Exposure to Polycyclic Aromatic Hydrocarbons in a Population of Pregnant Women: A Pilot Study in Hamilton, Canada

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**Background:** Recent studies have linked maternal personal exposure to airborne polycyclic aromatic hydrocarbons (PAHs), measured by a 48-hour air sample in the 3<sup>rd</sup> trimester, with adverse birth outcomes, such as lower birth weight and decreased neurodevelopment in the early years of life. For the purposes of larger epidemiologic studies, the use of PAH biomarkers such as urine metabolites to assess exposure to airborne PAHs would be beneficial. However, there is little data, to date, on these biomarkers in pregnant women. The goal of this pilot study was to compare measured airborne PAH levels with urinary PAH metabolites for a small cohort ( $n = 20$ ) of pregnant women living in Hamilton, Canada.

**Methods:** To maximize the power of the study, the selection criteria targeted 10 women living in an area pre-determined to have "high"

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ambient air pollution (i.e. areas impacted by ambient air pollution, traffic and industry) and 10 living in "low" areas. The women participated in 48-hour personal and indoor air monitoring for PAHs in the third trimester and provided a urine sample in each trimester. PAH vapour phase and particle phase  $\leq 2.5$  microns were collected on a quartz microfiber filter and polyurethane foam (PUF) cartridge and extracted together from both media. Concentrations in air for 8 lighter PAH compounds were highly intercorrelated (Spearman's rho = 0.40 to 0.89) as were the heavier compounds (rho = 0.44 to 0.87) so results were collapsed to 2 composite PAH variables: the sum of each of the groups of compounds (Total PAH<sub>1-8</sub> and Total PAH<sub>9-16</sub>). Outdoor air sampling was completed at a central monitoring site on the days of the personal sampling.

**Results:** Preliminary results indicate that personal concentrations of both Total PAH<sub>1-8</sub> ( $GM_{LOW} = 60.1 \text{ ng/m}^3$ ;  $GM_{HIGH} = 83.4 \text{ ng/m}^3$ ; Kruskal-Wallis  $P = 0.05$ ) and Total PAH<sub>9-16</sub> ( $GM_{LOW} = 1.2 \text{ ng/m}^3$ ;  $GM_{HIGH} = 2.0 \text{ ng/m}^3$ ;  $k-w P = 0.08$ ) were significantly different for those living in the pre-determined "high" or "low" exposure areas. For the Total PAH<sub>1-8</sub>, personal measurements were correlated with indoor ( $\rho = 0.76$ ) and outdoor concentrations ( $\rho = 0.55$ ). Stronger relationships were observed for Total PAH<sub>9-16</sub>, where personal measurements were correlated with indoor ( $\rho = 0.91$ ) and outdoor concentrations ( $\rho = 0.89$ ). Regression models for Total PAH<sub>1-8</sub> and Total PAH<sub>9-16</sub> that included living in a high area and outdoor PAH concentrations predicted 44% and 71% of the variability in personal measurements. Preliminary results for the biomarkers showed no difference in the creatinine-unadjusted urinary PAH metabolites between women living in "high" and "low" areas; further analyses will consider food intake and changes in the PAH metabolites across each trimester of pregnancy.

**Conclusions:** These results show increased personal samples of PAHs for women living in "high" air pollution areas of Hamilton. Personal measurements of the heavier PAHs, were strongly associated with outdoor PAH measures taken at a central site and regression models that included central site and a high/low indicator predicted a high proportion of the variability. This implies that personal exposure to these compounds was strongly affected by outdoor ambient PAHs and that central site monitoring could be an effective way to predict personal exposure especially in combination with a geographic indicator.

#### ISEE-1154

#### The Global Burden of Anthropogenic Ozone and Particulate Matter Air Pollution on Premature Human Mortality

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**Background:** Tropospheric concentrations of ozone and particulate matter (PM) have increased significantly since preindustrial times. These pollutants have been demonstrated to cause negative health impacts, including cardiovascular and respiratory mortality. Previous estimates of the global burden of air pollution on premature human mortality have been based on compilations of global air quality measurements. Here we use results from a global atmospheric chemistry and transport model (MOZART-2) simulation of ozone and PM concentrations in 1860, the preindustrial base case, and 2000, the present day case, to drive human mortality estimates. This model-based method allows estimation of mortality in regions for which ground-level concentration measurements are unavailable and omitted from estimates based on direct air quality measurements. In addition, by simulating the preindustrial base case, we are able to isolate the mortality due to anthropogenic pollution and avoid making assumptions for background ozone and PM concentrations.

**Methods:** Global excess mortality is calculated using short-term ozone and long-term PM concentration-response functions (CRF) from the

epidemiologic literature, with global population data for the present from LandScan™ and regional baseline mortality rates from the World Health Organization.

**Results:** Assuming no upper or lower concentration threshold for health effects, preliminary results show that anthropogenic air pollution causes 2–3 million premature deaths due to cardiovascular and respiratory disease and 150,000 to 250,000 premature deaths due to lung cancer each year. The globally distributed results show that the highest concentrations of mortalities occur in regions with the greatest population. Finally, we consider the sensitivity of these results to varying concentration response functions and health effect thresholds.

#### ISEE-1155

#### Using Computer Simulation to Communicate Exposure Levels and Risks: A Pilot Intervention Study for Secondhand Smoke in Automobiles

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**Background:** Exposure scientists struggle with ways to communicate environmental exposures and health risks to policy makers and lay persons. Exposure science generally involves analyzing chemical and physical properties of matter and/or mathematical and statistical modeling, which are not accessible to many people. However, accurate and understandable knowledge of threats to health is vital in developing protective legislation and general education, and informing the media and the public. Effective approaches are needed to bridge the gap between scientific findings in exposure and the need for society to respond and adapt to these data. To address the need for better exposure and risk communication, we have developed and begun testing a role-playing, computer simulation platform that delivers real-time feedback on environmental contamination and the impact of specific, exposure-related behaviors. The system incorporates psychological theory, which posits that people who are likely to modify their behavior are those who see the immediate impact of their actions on the health of themselves or others around them, e.g., their family, co-workers, or community members. We hypothesize that the system, when used by policy makers, or placed in public locations, at health provider offices, or on websites, will result in better understanding of complex microenvironments and will promote actions or attitudes, including new family, local or state policies, that lead to reduction or elimination of dangerous exposures.

**Methods:** To study the merit and feasibility of using computer simulation to instill knowledge and intentions to change exposure-related behavior, we evaluated a pilot intervention that presents simulated real-time levels of secondhand smoke (SHS) exposure in automobiles. It uses a mathematical model to simulate SHS levels resulting from different ventilation scenarios. Because many children around the world are exposed to SHS, proven intervention approaches are needed. Our aim is to evaluate changes in knowledge, attitude or behavior in families that serve to reduce SHS exposure or result in smoke-free family policies. The key learning points of the interactive intervention, as delivered by a talking animated character, include the potential for dangerous particle levels in cars under a variety of ventilation conditions, the existence of surface contamination from SHS, and the potential for specific health risks from exposure (e.g., asthma, respiratory infection).

**Results:** From the results of focus groups, we have found that the system engaged participants' interest and they indicated that it would be likely to impact their smoking behavior. For the main portion of the pilot study we selected 80 subjects from low-income, female caregivers at a Women, Infant, and Children (WIC) clinic in San Joaquin County, California. Subjects were randomly assigned to an "intervention group" or an educational control group. The "intervention group" received the full "simulator" experience, whereas the control group was presented with simple text and static images that communicate the same essential

learning points as the full intervention. Both groups gave 2-month follow-up interviews.

**Conclusion:** The simulation was found to trigger better retention of specific SHS exposure messages in subjects and it led to better intentions to change SHS-related behavior.

#### ISEE-1156

#### ISEA 2008: State-of-the-Science Probabilistic Aggregate and Cumulative Residential Exposure Models and Recent Residential Exposure Measurement Studies: How the Data and Models Compare

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**Background and Discussion:** Predictive algorithms and associated chemical- and scenario-specific input variables underlie residential exposure assessment methods (e.g., U.S. Environmental Protection Agency's Residential Exposure Assessment Standard Operating Procedures). Predictive models (e.g., Calendex™, CARES®, ConsExpo, LifeLine™, and SHEDS) have been developed and used as the basis for deterministic, screening-level and higher "tier" (probabilistic) quantitative human health risk analyses for pesticide-containing products that are proposed for use in and around homes. Residential exposure monitoring studies (e.g., environmental measurements such as surface deposition and transferable residues) and human and residential exposure factor data have been used to inform the algorithms and input variable values. This presentation will provide an overview of comparative modeling results for selected exposure scenarios. Specifically, the comparison will highlight similarities and differences between the models in how they accommodate input data, and highlight common issues and areas of uncertainty. Posters for specific modeling efforts will be acknowledged.

#### ISEE-1157

#### Measuring and Modeling the Residential Proximity Effect: Investigating Localized Dispersion of Indoor Air Pollutants

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**Background:** Human exposure scientists seek to quantify levels of airborne pollutants that occur in breathing zones of subjects. It is well known that indoor sources that emit pollutants in the same room as a receptor person are likely to result in much higher exposures than emissions occurring elsewhere in a home. As one moves closer to the active source, one's exposure will increase. This phenomenon, termed the "proximity effect", occurs because of the finite time required for emitted pollutants to mix in an interior space. The traditional approach of modeling indoor levels as well-mixed can break down when the source is active and the receptor is within several meters. Prior investigators have studied rates of indoor air pollutant mixing and dispersion in laboratory settings or occupational settings. However, the proximity effect has yet to be well characterized for the residential environment. CFD and other frameworks have been used to study air flow in homes, but have significant input uncertainty and their complexity can be prohibitive for many exposure scientists. Therefore, we sought to empirically study the residential proximity effect and to develop simple modeling approaches that accurately encapsulate the effect without relying on complex or uncertain input parameters.

**Methods:** We used an analytical turbulent diffusion model (Keil 2000; Drivas et al. 1996) to model the indoor proximity effect. The steady-state form of the model is a simple inverse function ( $1/r$ ) of the source-receptor distance,  $r$ . To parameterize and evaluate the diffusion model, and also to provide stand-alone data on the proximity effect, we performed 20

experiments where we precisely controlled mass emissions of carbon monoxide (CO) at the center of a 36-sensor array (real-time sensors by Langan Products). We also performed 10 experiments in which we machine-smoked a series of six 10-minute cigarettes (60-minute total smoking time) at the center of an array of 14 real-time particle sensors (TSI SidePak AM510). The sensors sampled every 10 second and were positioned at standing or sitting breathing zone heights at distances of 0.25 to 6 meters from the source. For each 1-hour experiment we emitted CO or particles continuously in 1 room of a 3-bedroom house and systematically changed household ventilation conditions to produce a range of realistic turbulent mixing such as might occur for a typical residential environment. We measured the air change rate of the room using SF-6 tracer decay. The factors for household ventilation conditions were: (1) Window Closed/Open; (2) HVAC Fan On/Off; (3) No Movement/Person Walking, (4) Oscillating Room Fan Off/On; (5) Centralized Heat On/Off.

**Results:** We found that the time-averaged empirical data were reasonably well fit by the model. Fitted values of the model parameter D, ranged from values under 0.01 to over 50 m<sup>2</sup>/min. Since real-time concentrations had a strong random character, it was more difficult to fit the transient concentrations with either the dynamic or steady-state model.

**Conclusion:** The empirical data revealed a strong indoor proximity effect. The quiescent effect extended out to 4 meters from the source, but half that distance or less for faster mixing conditions.

#### ISEE-1160

#### Effect Modification of Air Pollution Effects on Arrhythmias ER visits: Gender and Age

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**Background:** Air pollution has affected, mainly, both respiratory and cardiovascular diseases. Different indicators and analytic methods have been used to investigate this relationship. Emergency room visit is a very sensible indicator of air pollution effects. In this study we adopted a case-crossover design to investigate the effect of daily variations in air pollutants on daily arrhythmia emergency room visits.

**Methods:** Data on arrhythmia (ICD 10<sup>th</sup> Revision: I45–I49) emergency room visits were provided by the Institute of Heart, of the University of São Paulo Faculty of Medical Sciences for the period January 1<sup>st</sup> 1998 to December 31<sup>st</sup> 2005 and stratified in supra-ventricular arrhythmias (I45.6, I47.1, I47.9, I48, I49, I49.1, I49.5) and ventricular arrhythmias (I47, I47.0, I47.2, I49.0). Air pollution data (PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, and CO) were provided by the São Paulo State Environmental Agency. Weather data were provided by the University of São Paulo Institute of Astronomy, Geophysics, and Atmospheric Sciences. We used a case-crossover design with referent exposure days chosen using the time-stratified approach such that exposures on the case day were compared to exposures occurring every third day of the same month and year as the case day. In the model we controlled for day of the week, relative humidity, and temperature.

**Results:** Effects of air pollutants on arrhythmias emergency room visits were acute (at lag 0) and only for those patients with supra-ventricular type. Interquartile range increases in PM<sub>10</sub> (24.6 µg/m<sup>3</sup>), O<sub>3</sub> (31.4 µg/m<sup>3</sup>), CO (1.4 ppm), NO<sub>2</sub> (57.8 µg/m<sup>3</sup>), and SO<sub>2</sub> (8.2 µg/m<sup>3</sup>) were associated with increases in supra-ventricular arrhythmias emergency room visits of 5.9% (95%CI: 2.9–9.1), 2.0% (95%CI: 0.4–3.6), 4.3 (95%CI: 1.6–7.0), 6.0 (95%CI: 2.8–9.3), and 6.5 (95%CI: 3.3–9.7), respectively. Effect modification by gender and age groups (0–20 years, 21–50 years, 51–60 years, 61–70 years, and older than 70) showed that effects were most frequent among people aged from 51 to 71 years of age and effects among women were, in general, twice the effect observed for men.

**Conclusions:** Among the two main types of arrhythmia, supra-ventricular ones seem to be more affected by daily changes in air pollutants. Also, age and gender impose effect modification in the association between air pollutants and arrhythmia emergency room visits being women the most susceptible group.

#### ISEE-1161

##### 1-Nitropyrene Exposures in Air and Biomarker Levels in Urine Amongst Workers Exposed to Traffic-Related Air Pollution in Trujillo, Peru

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**Background:** 1-nitropyrene (1-NP) is enriched in diesel exhaust particulate matter (DPM) relative to other sources of PM and it is considered to be a marker for DPM. It has also been proposed that metabolites of 1-NP could be used as biomarkers of exposure to DPM.

**Methods:** In the current study we measured 1-NP exposures in air and 1-NP biomarker levels in urine amongst a group of 17 workers (3 traffic policemen, 9 bus drivers, 5 minivan drivers) exposed to traffic-related air pollution in Trujillo, Peru. Biomarker levels, but not air exposures, were also measured in a group of four non-occupationally exposed office workers from Trujillo. Each subject wore sampling equipment throughout their entire work shift in order to measure their full work shift exposure to PM<sub>2.5</sub>. 1-NP concentrations were measured in extracts from the PM<sub>2.5</sub> filters by using 2-dimensional high performance liquid chromatography tandem mass spectrometry (2D-HPLC-MS/MS) method. In addition urine samples were collected pre-and post workshift from each of the participants. 1-NP metabolites were isolated from the urine by using blue rayon and alumina solid phase extraction, and were analyzed by using HPLC-MS/MS.

**Results:** The PM<sub>2.5</sub> exposures for these subjects during their workshifts were as follows: bus drivers 98 ± 33 µg/m<sup>3</sup>; minivan drivers 99 ± 29 µg/m<sup>3</sup> and traffic policemen 90 ± 33 µg/m<sup>3</sup>. However the typical workshift duration was shorter for traffic policemen (482 ± 34 minutes) compared to bus drivers (876 ± 32 minutes) and minivan drivers (884 ± 47 minutes). Workshift 1-NP exposures were as follows: bus drivers 81 ± 22 pg/m<sup>3</sup> and minivan drivers 164 ± 70 pg/m<sup>3</sup>. Workshift 1-NP exposures for two of the traffic policemen were 77 pg/m<sup>3</sup>, 34 pg/m<sup>3</sup>—which was similar to the 1-NP exposures observed for the bus drivers. However, the workshift 1-NP exposure for the third traffic policeman was unusually high—3870 pg/m<sup>3</sup>. There was no obvious explanation for this unusually high 1-NP exposure. 1-NP metabolites were detected in urine from all workers. 6-hydroxy-1-nitropyrene (6-OHNP, mean = 42 fmol/mg creatinine) and 8-hydroxy-1-nitropyrene (8-OHNP mean = 20 fmol/mg creatinine) were the most abundant isomers detected. 1-NP metabolite levels (sum of 6-OHNP and 8-OHNP) were as follows: bus drivers 36 ± 22 fmol/mg creatinine; minivan drivers 17 ± 13 fmol/mg creatinine, traffic policemen 14 ± 5 fmol/mg creatinine and office workers 13 ± 9 fmol/mg creatinine. When comparing urine samples collected prior to the workshift to urine samples collected at the end of the workshift, no consistent cross-shift increase in urinary biomarker levels was observed.

#### ISEE-1162

##### PM<sub>10</sub> Cardiovascular Mortality in Age Groups in São Paulo

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**Background:** Air pollution in São Paulo dropped almost 40% between mid 1990 and the beginning of the 21<sup>st</sup> century. However, it is still

surpassing air quality standards and affecting health of city inhabitants. This study was developed to assess the effects of inhalable particles, generated mainly from automotive exhausts, on cardiovascular mortality among adults and elderly people.

**Methods:** Mortality data was provided by the municipal mortality information improvement program (PROAIM) for the period from January 1<sup>st</sup> 2000 to December 31<sup>st</sup> 2006. Daily records of PM<sub>10</sub> measured in fourteen monitoring stations spread all over the city were provided by the São Paulo State Environmental Agency. Temperature and humidity information were obtained from the University of São Paulo Institute of Astronomy, Geophysics, and Atmospheric Sciences. We used generalized linear Poisson regression models to assess the effects of inhalable particles on daily total cardiovascular deaths, controlling for both long and short term trends and weather variables.

**Results:** Particles effect was acute, remaining positive and statistically significant at lags 0 and 1. An interquartile range increase in the 2-day moving average of PM<sub>10</sub> (25.8 µg/m<sup>3</sup>) was associated with a 1.6% (95%CI: 0.6–2.7) increase in total cardiovascular daily deaths. Effect modification by age showed that the elderly group (65 years of age and older) was more affected than adults (45–64 years of age). Interquartile range increases in the 2-day moving average of PM<sub>10</sub> increased daily cardiovascular deaths in 1.2% (95%CI: −0.7–3.2) for adults and 2.4% (95%CI: 1.2–3.7) for elderly.

**Conclusions:** Despite the decrease in PM<sub>10</sub> daily levels in São Paulo in the last decade, the magnitude of its effects on cardiovascular mortality are similar to those observed in studies carried out in the 1990s. Besides concentrations of air pollutants, their toxicity and individual susceptibility may play relevant roles in terms of air pollutants adverse health effects.

#### ISEE-1163

##### Blood Manganese Level and Attention Deficit/Hyperactivity Disorder in Early School Age Children

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**Background and Objectives:** Excessive exposure to manganese, in spite of its essentiality, in earlier life can affect neurodevelopment, and could possibly be associated with development of neurodegenerative disorders. Recent reports on exposed children suggest its association with development of attention deficit/hyperactivity disorder (ADHD). However, it is not clear whether this relationship is evident in child population without definite source of exposure. This study was conducted to evaluate the relationship between blood manganese level and ADHD in metropolitan area.

**Subjects and Methods:** We have recruited 531 children (279 males and 252 females) between six and eight years old (mean 6.9 ± 2.9 years), from four elementary schools in two metropolitan areas of Korea. Questionnaire survey on the general characteristics, developmental history, disease history, current behavioral features, environmental exposure, and diet were done on the parents of the children. ADHD was evaluated with DuPaul Parent and Teacher Rating Scale. Scales of social skill made of 38 items and scales of personal behavior made of 17 items were also measured. Blood manganese level was analyzed by atomic absorption spectrometry.

**Results:** Mean blood manganese level was 14.6 ± 4.2 µg/L (range 6.4 µg/L–52.0 µg/L). More than 50% (276) children had blood manganese concentration higher than the reference level. Blood manganese level was positively correlated with a history of developmental delay in infancy and

peer relationships. Blood manganese level was not associated with total DuPaul score. DuPaul score was not significantly related with categorized blood manganese level after adjusting for age, gender, and area. Blood manganese level was not significantly related to the social skill scales nor personal behavior scales.

**Discussions and Conclusions:** In this study, blood manganese level was not associated with ADHD scale. Relatively narrow range of blood manganese levels in children without prominent environmental sources of manganese source might have been a factor for this negative relationship.

#### ISEE-1164

#### The Short-Term Impact of Fine Particulate Air Pollution and the Hospital Admission for Respiratory Diseases in Alta Floresta—Amazon Forest

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**Background:** The rapid processes of land-use changes in the Brazilian Amazon have already deforested around 14% of its original native forest area in the last three decades. The Amazon Basin is the largest area of tropical forests on Earth, covering more than 5 million km<sup>2</sup>, and is home to about 1/3 of the global biodiversity. This deforestation process is the result of several factors such as road construction, urban growth, expansion of extensive cattle ranching, increasing timber extraction, and the intensive rise of monocultures. These human activities are responsible for the long range atmospheric transport of the pollutants and its impacts on the ecosystem and human health effects.

**Objectives:** To assess the association between particulate matter with an aerodynamic profile  $\leq 2.5 \mu\text{m}$  from forest fire and the health impact measured by daily number of hospital admission for respiratory disease in children under 5 and elderly in the region of Alta Floresta in Amazon region.

**Material and Methods:** The study was carried out in a region at the border of deforestation in the Amazon region including six municipalities with about three hundred thousand habitants. Daily hospital admissions due to respiratory conditions in children and elderly were obtained from Brazilian Ministry of Health Database and daily levels of PM<sub>2.5</sub> were obtained from the CATT-BRAMS Model for the period of 2004–2005. Generalized additive Poisson regression models were adopted using control variables.

**Results:** The high concentration of aerosol particles  $\leq 2.5 \mu\text{m}$  observed in the Amazon region atmosphere during the dry season is associated with intense anthropogenic biomass burning activity reaching levels of 326.5  $\mu\text{g}/\text{m}^3$ . The increase of 10  $\mu\text{g}/\text{m}^3$  in PM<sub>2.5</sub> in the current day was associated with an increase of 4% (95%CI: 1.01;1.06) in the hospital admission for elderly people. All the moving averages showed significance, with increases of 3% [2 days moving average (95%CI: 1.01;1.06), 3 days moving average (95%CI: 1.01;1.06), 4 days moving average (95%CI: 1.01;1.06), 5 days moving average (95%CI: 1.01;1.06)], and 4% [6 days moving average (95%CI: 1.01;1.07), 7 days moving average (95%CI: 1.01;1.07)] in the hospital admission for elderly people. These results show that the exposure to PM<sub>2.5</sub> generated by the biomass burning can lead to health problems in the sensitive age groups.

#### ISEE-1168

#### Determination of In-Vehicle Exposures of Particulate Matter and Black Carbon

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**Background:** The relationship between exposure to fine particles and adverse health effects such as inflammatory symptoms, respiratory diseases and cardiovascular diseases has been suggested by epidemiologic evidence. Particulate matter (PM) and black carbon (BC) can be generated by automobile exhaust. Concentrations in the vehicle are frequently high, due to proximity to relatively undiluted emissions from other vehicles and high air exchange rate inside vehicles. American population spends 6.6% (95 min day<sup>-1</sup>) of their daily life in the transportation microenvironments. The in-vehicle portion of exposure can be a significant part of personal total exposure to ambient particulates. The purpose of this study was to identify determinants of in-vehicle PM and BC levels.

**Methods:** This study measured in-vehicle particle number concentrations from 0.25  $\mu\text{m}$  to 10  $\mu\text{m}$  by an aerosol spectrometer (Model 1.109, Grimm Technologies, Inc.). BC concentration was measured by an aethalometer (Model AE-42, Magee Scientific, Co.). The measurement was repeated 3 times a day (morning, midday and evening) for 13 consecutive days in May 2007 while a vehicle was driven on the 1-hour pre-determined route in Lexington, Kentucky. Fan of the vehicle was operated in the lowest setting without operation of air conditioning or heating. Windows were closed to prevent air from entering the vehicle. Vehicles in front of the testing car were recorded by video tape. A global positioning system device was placed in the car.

**Results:** The average speed of all run was 37 km/h. The mean PM<sub>1.0</sub> number concentration was 286  $\mu\text{g}/\text{cm}^3$  (morning: 302  $\mu\text{g}/\text{cm}^3$ , midday: 270  $\mu\text{g}/\text{cm}^3$ , evening: 287  $\mu\text{g}/\text{cm}^3$ ). The mean PM<sub>1.0–10</sub> number concentration was 0.1  $\mu\text{g}/\text{cm}^3$  in the three different times of day. The mean BC concentration was 1.9  $\mu\text{g}/\text{m}^3$  (morning: 2.5  $\mu\text{g}/\text{m}^3$ , midday: 1.6  $\mu\text{g}/\text{m}^3$ , evening: 1.5  $\mu\text{g}/\text{m}^3$ ). Weather was mostly sunny during the experimental period. When there was a brief shower in one evening, PM<sub>1.0</sub> concentration was the lowest. The average PM number and BC concentrations showed clear trend of increasing from Monday to Friday and decreasing during weekends. The PM number and BC concentrations were the highest in the morning. The PM<sub>1.0</sub> number concentration was 16% higher in the morning than other times of day. The mean BC concentration in the morning was 61% and 75% higher than in the midday and the evening, respectively. When the vehicle speed was higher than the average speed (37 km/h), PM<sub>1.0</sub> number concentration was slightly decreased. Particle size distribution of PM<sub>1.0</sub> was similar by the time of day, while that of PM<sub>1.0–10</sub> was higher in the evening and lower in the morning. Based on visual information analysis using video tape, high PM<sub>1.0</sub> number concentrations were observed when approaching busy cross-roads. Additional statistical analysis of the extensive database may be necessary to identify more determinants of the in-vehicle exposures to PM and BC.

#### ISEE-1171

#### Using a Mobile Monitoring Platform to Characterize Pollution Concentrations On and Near Heavily-Traveled Roadways in Communities Adjacent to the Ports of Los Angeles and Long Beach

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**Background:** The communities adjacent to the Ports of Los Angeles (POLA) and Long Beach (POLB) are heavily impacted by containerized goods movement, particularly heavy-duty diesel truck (HDDT) traffic. The POLA and POLB combined handle 43% of the container traffic entering the United States and container volumes at these ports are expected to triple in the next decade. Thus, existing and future poor air quality in the area and the resulting adverse health impacts are of great concern. HDDTs traveling through these communities create localized high pollution

concentrations missed by conventional fixed-site monitoring, and these concentrations are critical for accurate exposure assessment.

**Methods:** To quantify these impacts, a mobile monitoring platform equipped with real-time instrumentation was driven along fixed routes in these communities to collect spatially- and temporally-resolved data including black carbon, nitrogen oxide, particle bound-polycyclic aromatic hydrocarbons, and ultrafine particle (UFP) number concentration.

**Results:** Concentrations of these pollutants were frequently found to be several times higher in 150 meter buffer zones immediately downwind of roadways compared with upwind buffer and "non-buffer" zones. Impacts were usually higher during morning times of stagnant wind conditions. High concentrations were also observed when driving on roads heavily trafficked by HDDT, or when driving behind high-emitting or hard-accelerating gasoline vehicles, e.g., UFP number concentrations exceeding one million particles per cubic centimeter.

**Conclusion:** Overall, near-roadway exposures were significantly elevated for persons living, working or attending school in locations close to heavily diesel trafficked roadways in these port communities.

#### ISEE-1173

#### Effect of Regulative European Policies to the Level of DBP Exposure from Normal Use of Consumer Products

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**Background:** Dibutyl phthalate (DBP) is widely used in cosmetics, toys, household cleaning products, textiles and in paints, laquers and varnishes. DBP is classified as CMR substance (substance classified as carcinogen, mutagen or toxic to reproduction) by EU and for this reason European Union has implemented two directives limiting the use of DBP in consumer products. The first Commission Directive 2004/93/EC prohibits its use in cosmetics and the second Commission Directive 2005/84/EC restricts the use of DBP (as substances or as constituent of preparations) at concentrations greater than 0.1% by mass of the plasticized material in toys and childcare articles.

**Objective:** The purpose of this study was to investigate how the implementation of these directives may affect the level of aggregate exposure to DBP from normal use of consumer products.

**Methods:** Levels of exposure were evaluated in three European countries (France, Finland and UK) with two alternative scenarios: business-as-usual (BAU) and implementation of the regulative Commission directives. Exposures were calculated with ConsExpo which is a tool that provides descriptive models to estimate and assess the exposure to substances from consumer products and the uptake of these by humans. ConsExpo enables calculations for multipathway exposure and not only with point values but also calculations with distributions. Exposure factors, such as use of household products and time spent in different activities/microenvironments, have been obtained from the European Exposure Factors (ExpoFacts) database and from national databases. Information of concentrations of DBP in consumer products was obtained from earlier studies and some national registers. Exposure evaluations were conducted for adults and children separately, because children constitute a high-exposed group due to use of DBP in toys.

**Results and Discussion:** Ingestion is the main intake route for the DBP exposure for both adults and children. For adults food is the main intake medium, but it's difficult to evaluate how much of the intake through food can be indirectly related to the use of DBP in consumer products. Based on the previous risk assessments conducted for DBP the main sources of consumer product exposure for adults are use of do-it-yourself (DIY) products and use of cosmetics. This naturally means that levels of

exposure have clearly decreased after the implementation of the ban to use DBP in cosmetics. For children an important part of the total intake results from non-dietary ingestion, in other words through hand-to-mouth and object-to-mouth activities. For this reason the concentration limit of DBP in toys has a clear decreasing effect on the levels of DBP exposure of children. The most important health endpoint of repeated exposure to DBP is developmental and reproductive toxicity for which a tolerable daily intake of 100 µg/kg body weight per day is established by European Food Safety Authority (EFSA) based on the LOAEL values obtained from the animal studies.

**Conclusion:** Preliminary calculations of the levels of average exposure resulting from normal use of consumer products do not appear to exceed this level in any of the participating countries after the policy measures have been implemented.

#### ISEE-1174

#### Polymorphisms of Cytochrome P450 1A1 (CYP1A1) Gene, Cigarette Smoking and Risk of Coronary Artery Disease

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**Background:** The relationship between cigarette smoking and coronary artery disease (CAD) has been previously demonstrated with strong epidemiological evidence. Cytochrome P450 1A1 (CYP1A1) is one of the key enzymes that metabolize cigarette smoking derived toxin and may be relevant to smoking-induced atherogenesis. However, studies of the association between polymorphism of CYP1A1 gene and CAD risk are limited. This hospital-based case-control study was designed to examine whether two single nucleotide polymorphisms (SNPs) of this gene, CYP1A1\*2A (T6235C) and CYP 1A1\*2C (A4889G), play a role in susceptibility to smoking-related coronary artery disease.

**Materials and Methods:** Participants ( $n = 1262$ ) who had undergone coronary angiography were recruited from a hospital in North Taiwan between Nov. 2001 and Jun. 2004. Subjects having any coronary arteries with 50% or more luminal obstructions were defined as cases, others as controls. Information about sociodemographic factors and smoking status were obtained by a self-administered questionnaire. Genotypes of CYP1A1\*2A and CYP 1A1\*2C polymorphisms were determined by PCR-RFLP and allelic specific PCR methods among 670 subjects (457 cases and 213 controls). Logistic regression was used to calculate the odds ratios (ORs) and 95% confidence intervals (CIs).

**Results:** The frequencies of the CYP1A1\*2A and CYP 1A1\*2C genotypes among controls were in Hardy-Weinberg equilibrium with C allele 0.28 and G allele 0.35, respectively. No significant differences were observed in CYP1A1 genotype frequencies between cases and controls ( $P > 0.11$ ). After adjusting for potential confounders, the CYP1A1\*2C G/G genotype compared to the A/A+A/G genotype was significantly associated with a decreased risk of CAD (OR = 0.35, 95%CI = 0.16–0.76). This protective effect was pronounced among never cigarette smokers but the interaction between genotype and smoking status was not statistically significant ( $P = 0.68$ ). Among never cigarette smokers, individuals carrying the CYP1A1\*2C G/G genotype have 71% decreased risk of CAD than those carrying the A/A+A/G genotype (OR = 0.29, 95%CI = 0.09–0.87). However, there was no significant association between CYP1A1\*2A polymorphism and CAD risk.

**Conclusion:** Our finding suggest that the CYP1A1\*2C polymorphism may reduce the risk of CAD in the Taiwanese population, especially among never smokers.

**ISEE-1175****Elemental Composition and Oxidative Properties of PM<sub>2.5</sub> in Relation of Origin of Air Masses in ECRHS II City Tartu**

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**Objective:** Air quality is affected by regional and local factors. In northern part of Europe transboundary air pollution plays important role in the pollution levels, since local air is relatively clean. Russia and Eastern European countries e.g. Byelorussia, Ukraine, Poland etc. have still a great amount of industry with obsolete or absent emission purification systems. Formed pollution is transported with air masses into neighboring countries. The aim of the study was to determine the extent to which the elemental composition and oxidative properties of PM<sub>2.5</sub> are affected by the origin of air masses.

**Material and Methods:** Fine particulate matter (PM<sub>2.5</sub>) was sampled in Tartu, Estonia in urban background area over one year during the European Community Respiratory Health Survey II (ECRHS II). Elemental composition of 71 PM<sub>2.5</sub> samples was analyzed for different chemical elements using dispersive X-ray fluorescence spectrometry (ED-XRF). The oxidative activity of these particles from 36 samples was assessed afterwards by measuring their ability to generate hydroxyl radical in the presence of hydrogen peroxide. The origin of air masses was determined by computing 96 hour back-trajectories of air masses with HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model, developed by NOAA Air Resources Laboratory. The trajectories of air masses were divided into 5 groups (50% of points in a sector) according to geographical pattern (1- Russia; 2-Eastern Europe; 3-Western Europe; 4-Scandinavia; 5-No prevailing sector). The associations were analysed with Statistica 7.

**Results:** During study-time air masses were coming predominantly (ca 30%) dominantly from Scandinavian direction; the other 3 directions had almost similar shares (18–22%) and only 8% of trajectories belong into group 5. Higher levels on total PM were found from air masses originated from sectors 1 and 2 ( $18.51 \pm 7.33$  and  $19.96 \pm 9.23 \mu\text{g}/\text{m}^3$ ). In spring, summer and winter, these sectors gave the highest value. In autumn, the abundances were highest in sector 3. For black smoke, the trend was similar as well; however, sector 4 played a more important role in here. From these elements, high levels of Pb, Ti and Br could be seen among air masses from Russia. The oxidative properties were related to direction of air masses as well; showing about 1.5 times higher values when air masses come from Eastern Europe or Russia. Similar relations were observed for Al and Si showing about 1.5 times higher values for all statistics when air masses come from the directions of Russia or Eastern Europe.

**Conclusions:** The elemental composition and oxidative properties of PM<sub>2.5</sub> in urban background is depended on the origin of air masses. The most dangerous particulate matter comes to Estonia with eastern and southern air-masses (Russia and Eastern Europe). The less risky air was observable when air-masses originated from North (Scandinavia). Thus, higher potential to damage the health was observed for particulates coming from areas using less developed technologies and lower environmental standards.

**ISEE-1176****Health Impact Assessment of Locally Emitted Particulate Matter in Tallinn Using Clustering and Modeling Techniques**

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**Objective:** Health impact assessment (HIA) uses the information on exposure, baseline mortality/morbidity and exposure-response functions from relevant epidemiological studies to quantify the negative health impacts. The aim of the current study was to improve HIA methods using GIS, dispersion modeling and clustering approaches.

**Material and Methods:** The almost 390 000 registered residents in Tallinn, were according to neighborhoods divided into 84 clusters to describe better the exposure to air pollution and identify the areas with largest risks. Actual baseline rates for total mortality (ICD-10 classification, A00-Y98) and hospitalization with cardiovascular (I00-I99), and respiratory diagnosis (J00-J99) were calculated. The exposure to fine particles (PM<sub>2.5</sub>) was calculated by clusters, using the modelled annual PM<sub>2.5</sub> levels ( $200 \times 200 \text{ m}$  grids) in Tallinn. For the model validation and the morbidity impact assessment, the daily average concentrations of PM<sub>10</sub> at 3 monitoring stations in 2005 were used. To describe the effects on mortality, we broadly employed the RR found in the US ACS cohort, 1.06 per  $10 \mu\text{g}/\text{m}^3$  increase of PM<sub>2.5</sub> for inhabitants in age 28+ as exposure-response assumption. For the assessment of respiratory and cardiovascular hospitalizations a RR of 1.0114 and a RR of 1.0073 per  $10 \mu\text{g}/\text{m}^3$  increase of PM<sub>10</sub> were used, respectively. The direct costs related to morbidity were calculated based on data from the Estonian Health Insurance Fund on expenses of treatment in hospitals in 2005. To express the cost of premature deaths the concept of Value of Life Year (VoLY) was used.

**Results:** The population-weighted modeled annual exposure to PM<sub>2.5</sub> in Tallinn was  $11.5 \mu\text{g}/\text{m}^3$  (excluding the regional background). The monitored concentration of particulate matter (PM<sub>10</sub>) was generally highest in city center and lowest in a residential area. In spring, high pollution episodes (daily average up to  $140 \mu\text{g}/\text{m}^3$ ) driven by coarse particles (PM<sub>2.5–10</sub>) are common. Our analysis shows that outdoor air pollution could lead to 296 (95%CI = 76–528) premature deaths in Tallinn per year that causes 3859 (1023–6636) Years of Life Lost (YLL) in a year. Using “life-tables,” the decrease in life-expectancy was estimated to 0.64 (0.17–1.10) years. The decline is bigger in the polluted city center, where it may reach up to 1.17 years. However, in the least polluted neighborhoods, it remains between 0.1–0.3 years. Dividing the YLL with number of the incidences indicated that life expectancy declines among the close to 13 years. As for the morbidity, the short-term effect of air pollution will result in 71 (43–104) respiratory and 204 (131–260) cardiovascular hospitalizations per year in Tallinn. The biggest external costs related to exposure to outdoor air pollution comes from the premature deaths: on average 23 (5–105) million EUR in a year. In comparison, the cost of air-pollution driven hospitalizations adds 0.3 (0.2–0.4) million EUR.

**Conclusion:** Clustering the city for analysis and using GIS implementations helped to improve the accuracy of air pollution health impact estimations, especially with the poor air pollution monitoring data. The main reason for the high levels of air pollution in the city center is traffic and local heating.

**ISEE-1177****Characterization of Different Fractions of Particulate Matter at Various Locations with Contrast in Local Source Emissions: First Phase of the RAPTES Study**

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**Background:** In recent years numerous epidemiological studies have demonstrated that adverse health effects can be related to daily changes in

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the concentration of ambient particulate matter (PM). Toxicology is supporting the plausibility of these effects at high exposure levels. It is not clear, however, which specific components or sources of emissions of PM are responsible for the observed effects. The aim of the hybrid toxicological-epidemiological RAPTES study is to characterize the physical, chemical and oxidative properties of inhaled PM and to establish which of these characteristics determine or predict the adverse cardiovascular and respiratory effects seen after PM exposures in cell culture systems, experimental animals and volunteers. In a first phase of the study, a characterization of particulate matter at various locations was made.

**Methods:** PM samples were collected on 8 different sites in the Netherlands: continuous traffic, stop-and-go traffic, primarily truck traffic, underground train station, harbor, pig farm, steelworks, and urban background sites. Those locations have been selected based on predicted high contrast and low correlation between major PM components and contributing sources. Levels of air pollution at each site were quantified during a 6-hour sampling period. PM samples collected using a Versatile Aerosol Concentration Enrichment System (VACES) equipped with SKC-Biosamplers (coarse, fine + ultrafine, and ultrafine fractions of PM), and a Micro-Orifice cascade Impactor (MOI) were chemically analyzed including an assessment of their ability to generate reactive oxygen species. PM samples for elemental composition were collected using a High Volume Sampler (PM<sub>10</sub> and PM<sub>2.5</sub>). PM was also physically characterized on site using a Nanoparticle Surface Area Monitor (NSAM), a Condensation Particle Counter (CPC), and the Harvard Impactors (HI). HI filters were analyzed for absorption coefficients as indicator of carbonaceous PM.

**Results:** All sites were visited at least three times (30 sampling days) between June 2007 and February 2008. The average number concentrations of particles ranged from 13,000 particles/cm<sup>3</sup> at the farm site to 80,000 particles/cm<sup>3</sup> at the primarily truck traffic site. Significant temporal variability was found at every site, e.g. the 1<sup>st</sup> percentile at the primarily truck traffic site was 16,000 particles/cm<sup>3</sup> whereas the 99<sup>th</sup> percentile was 213,000 particles/cm<sup>3</sup>. Variability was related to motorized vehicles passing by, e.g. ships at the harbor site, or trucks at the traffic sites. PM<sub>10</sub> concentrations ranged from 20 µg/m<sup>3</sup> at the harbor site to 390 µg/m<sup>3</sup> at the underground train station, while PM<sub>2.5</sub> ranged from 9 µg/m<sup>3</sup> at the farm site to 120 µg/m<sup>3</sup> at the underground train station. The site-specific average absorption coefficients ranged from 1.3 × 10<sup>-5</sup>/m at the farm site to 13 × 10<sup>-5</sup>/m at the underground train station.

**Discussion:** Consistently high PM<sub>10</sub> and PM<sub>2.5</sub> concentrations as well as the amount of carbonaceous material were measured at the underground. PM number concentrations (40,000 particles/cm<sup>3</sup>) were relatively high as well, in contrast to previous studies in undergrounds. The high temporal variability raises the question of how to characterize the exposure, i.e. either using an average number of particles or a frequency/magnitude of peaks.

#### ISEE-1178

#### Size-Dependent Characteristics of Metals in Particulate Matter Exposures from Traffic-related Emissions

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**Background:** Many epidemiological studies have demonstrated that exposure to particulate matter (PM) may cause adverse health effects. However, most of these studies rely on environmental concentration data collected at central monitoring sites. For studies having personal exposure data, most of them focused on either the PM<sub>10</sub> or PM<sub>2.5</sub>, and gave little information regarding the metal compositions.

**Objective:** In this study, we aim to quantify size-dependent concentrations of elements in samples collected on human subjects.

**Methods:** Five-stage personal cascade impactor samplers (PCIS; stage A: >2.5 µm, B: 1.0–2.5 µm, C: 0.50–1.0 µm, D: 0.25–0.50 µm, and E: < 0.25 µm) were used to conduct the PM sampling in an urban area. Eighteen mail carriers were recruited in this panel study. Each subject wore the personal cascade impactors for a week during the hours when they were delivering mail outdoors. A cascade impactor also was located at a central monitoring site. Particle filters were digested in a microwave digestion system and the elemental concentrations were determined using the inductively-coupled plasma mass spectrometry (ICP-MS) technique.

**Results:** For personal samples, the most abundant elements in the PM<sub>1.0–2.5</sub> mode were Ca (830.6 ng/m<sup>3</sup>), Al (453.8 ng/m<sup>3</sup>), Fe (422.7 ng/m<sup>3</sup>), and Na (293.6 ng/m<sup>3</sup>), followed by Sn, Mg, and K (all between 100 and 200 ng/m<sup>3</sup>). In the PM<sub>0.50–1.0</sub> mode, Ca (482.2 ng/m<sup>3</sup>), Al (274.4 ng/m<sup>3</sup>), Sn (266.3 ng/m<sup>3</sup>), and Fe (238.2 ng/m<sup>3</sup>) were the most abundant. In the PM<sub>0.25–0.50</sub> mode, the most abundant elements were Ca (356.8 ng/m<sup>3</sup>), Fe (205.0 ng/m<sup>3</sup>), Al (202.7 ng/m<sup>3</sup>), and K (201.7 ng/m<sup>3</sup>), followed by Sn (both between 100 and 200 ng/m<sup>3</sup>). In the PM<sub>0.25</sub> mode, Fe (196.2 ng/m<sup>3</sup>), K (181.6 ng/m<sup>3</sup>), and Ca (122.6 ng/m<sup>3</sup>) were the most abundant. In general, the elemental concentrations at the central site presented similar profiles in all size modes, but the personal samples showed significantly higher concentrations than the central site samples for all elements. High longitudinal correlations between personal and central site samples were observed for Na, Mn, Al, and Sr in Stage B ( $r = 0.55 \sim 0.90$ ). In Stage E, elements having high longitudinal correlations were Sb, Pb, Co, Cd, and Cu ( $r = 0.60 \sim 0.85$ ) which represented tracers from the traffic-related emission sources. We are currently conducting source apportionment analysis on both personal and central site samples to further determine the major emission sources of personal PM exposures and quantify their contributions.

#### ISEE-1179

#### Effects on Lung Function from Long-Term Exposure to Various Sources of PM in a Large Swiss Cohort (SAPALDIA)

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**Background:** Exposure to particulate matter impairs respiratory health. Although few epidemiological studies investigated associations between mortality or hospital admissions and exposure to various PM sources, no study has examined reductions in lung function due to long-term exposure to various sources of PM. The Swiss cohort study on air pollution and lung diseases in adults (SAPALDIA) is a prospective study of 9651 adults (18–60 years) randomly selected from population registries from 8 Swiss areas in 1991 (S1) with 8047 participants reassessed in 2002 (S2). Lung function measurements in S1 and S2 included FVC, FEV<sub>1</sub>, FEV<sub>1</sub>/FVC and FEF<sub>25–75</sub>. We had previously reported cross-sectional associations between PM<sub>10</sub> levels and decrements in lung function. More recently, we reported attenuations in age-related lung function decline among those who had experienced larger decreases in ambient residential PM<sub>10</sub>-levels during the 11 years of follow-up. This paper investigated for the first time, the association between lung function declines and exposure to source-specific PM<sub>10</sub>, including long-range transported PM<sub>10</sub> and traffic originated PM<sub>10</sub>.

**Methods:** Individual exposure to source-specific PM<sub>10</sub> was assigned to each subject according to the 11-year residential history using the spatially resolved PM<sub>10</sub> concentrations from a validated dispersion model. Complete data was available for 8568 participants in S1 and 5923 participants in S2. Effects of annual means of PM<sub>10</sub> at S1 and S2, changes

in PM<sub>10</sub> between S1 and S2, and cumulative exposure to PM<sub>10</sub> between S1 and S2 on lung function parameters were assessed using mixed linear models with random area effects. Analyses were done separately for never-smokers, never-smokers living at least 20 m from main streets, all subjects and all subjects living at least 20 m from main streets controlling for gender, age, height, body mass index, occupational exposure, nationality, atopy, parental smoking, and environmental tobacco smoke. Cross-sectionally in SAPALDIA 1, significant reductions in FVC were found for total PM<sub>10</sub>, while exposure to traffic PM<sub>10</sub> was found to significantly reduce FEV<sub>1</sub> across all subject groups. No cross-sectional associations were found for SAPALDIA 2. Observed reductions in all sources of PM<sub>10</sub> between S1 and S2 were significantly associated with an attenuated decline in FEV<sub>1</sub> and in FEF<sub>25–75</sub>; however, the beneficial effects were stronger for traffic and secondary PM<sub>10</sub> than for other sources. Our findings suggest source-specific effects of PM<sub>10</sub> on lung function.

#### ISEE-1180

#### **Respiratory Health Impact of Diesel Exhaust from Truck Traffic Among Adults and Asthmatic Children in Trans-Alpine Highway Valleys in Switzerland**

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**Background:** Trans-Alpine highway traffic exhaust is the major source of air pollution along the highway valleys of the Alpine regions. However, no studies have examined health impacts from such exposure due to the limited population and pollution measurements. We examine the impact of residential exposure to highway traffic on respiratory symptoms in adults and children residing in the Swiss alpine highway corridor.

**Methods:** This study includes longitudinal exposure and health measurements in a pediatric asthma panel, as well as cross-sectional questionnaire survey data from adults and children. Residents were recruited from alpine highway communities. Between 2005 and 2007, 1840 adults (ages 15–70) and 1300 children (ages 7–13) answered a questionnaire on respiratory health (asthmatic and bronchitic symptoms), respective risk factors and potential confounders. In addition, a subset of 13 children with asthma participate in monthly monitoring between 2007 and 2009 for the collection of outdoor exposure measurements of NO<sub>2</sub> and various PM components, and personal respiratory health indicators including exhaled NO and oxidative stress markers in exhaled breath condensate. Our first health effect assessment involved cross-sectional logistic regression modeling with highway exposure represented by a binary variable and a Gaussian function simulating the relationship for pollutant concentrations and distance to the highway source. Our second health assessment involves source-apportioned outdoor exposure estimates for individual subjects based on particle number and PM speciation data. Our third assessment using data from the asthma panel involves regression analysis of longitudinal respiratory effects from outdoor exposure to diesel truck related pollutants.

**Results:** For adults, positive associations were found between exposure to highway traffic and wheezing without cold (OR = 3.1, 95%CI: 1.3–7.6) and chronic cough (OR = 2.9, 95%CI: 1.2–7.1). The health model using a Gaussian exposure function indicated effects leveling off at ~400 m. The association with chronic cough was driven by a subgroup reporting hay fever or allergic rhinitis. Analysis of respiratory effects among children is currently underway.

**Conclusion:** Our results so far demonstrate that air pollution from highway traffic along the trans-alpine highway valleys negatively affects the respiratory health of adults, with a potential susceptible group as those having hay fever or allergic rhinitis.

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#### ISEE-1181

#### **Hypertension at Exposure to Road Traffic and Railway Noise**

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**Background:** The association between noise exposure and hypertension is relatively well established for occupational noise exposure and aircraft noise. Few studies have examined the possible risk of hypertension due to road traffic and railway noise.

**Methods:** A detailed description of the study area and methods for calculation of noise levels has been given elsewhere (Ohrstrom E et al., J Acoust Soc Am 2007;122:2642–2652). The study was performed east of Gothenburg, Sweden where a major part of the population live along two major traffic routes and are exposed both to noise from road traffic from a highway (about 20 000 vehicles/24 h) and noise from a major railway (about 200 trains/24 h). The area is approximately 20\*6 kilometres with detached, terraced and apartment houses. A GIS-based mapping of noise levels from road traffic, railway and aircraft noise and certain stationary noise sources (grid distance 15 m) was performed at the most exposed side of each residential building, using a validated model. In the present study we used the 24-hour average, L<sub>Aeq,24h</sub>. Sound levels were linked to the population register. We selected part of the population between 18 and 75 years who had resided at least 6 months in dwellings with outdoor sound levels of L<sub>Aeq,24h</sub> 45 dB or more. In total 1953 persons (71%) responded to a postal questionnaire evaluating symptoms and effects of traffic noise. Questions were included on various background factors (type of dwelling, year of moving into it, smoking, weight, height, and education), occupational noise, and heredity for hypertension. Questions were: Do you have hypertension diagnosed by a physician? If so, in which year? Do you take any hypertensive drugs? Prevalence of hypertension and use of antihypertensives were calculated for different noise categories. Possible trends over noise strata were evaluated using the Mantel Haenzel Chi<sup>2</sup> statistics. Prevalence odds ratios were calculated using logistic regression.

**Results and Discussion:** When age, heredity, BMI, education, and self-reported occupational noise, were included in logistic regression models together with road traffic noise, the odds ratio for hypertension was increased in the highest road traffic noise category (61–70 dB) in men (17 cases, OR 2.2, 95%CI 1.01–4.8). For those diagnosed with hypertension more than 10 years after moving into their present dwelling the OR was 11 (95%CI 3.0–39), although based on few (8) cases. There were no similar associations in women. The fact that odds ratios increased with years spent in the dwelling strengthens the case for a causal association. Major possible confounders were taken into account. Selection bias, some people moving away from areas affected by road traffic noise would result in underestimation of the potential impact of noise. Information bias should be small; exposure classification was objective; the primary outcomes, physician-diagnosed hypertension and antihypertensive medication are relatively distinct, and there was a high agreement between the two of them.

**Conclusion:** The study shows a positive association between calculated road traffic noise at the residence and risk of hypertension among men.

#### ISEE-1183

#### **Improving Human and Ecological Exposure Assessments: A Bayesian Network Modeling Approach**

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**Background:** Human and ecological exposure assessment strategies frequently utilize deterministic (i.e. point estimate) model endpoints with a

poorly-defined relationship to human health and the potential risk of human disease outbreaks. We demonstrate how Bayesian network models address these shortcomings and improve human and ecological risk assessments by propagating causal agent uncertainty through multiple potential fate and transport pathways into both existing and proposed measures of human health and disease risk. Our application focuses on three key features of Bayesian networks which distinguish it from other modeling approaches. First, the Bayesian network provides a clear graphical representation of system components and assumed causal relationships between them. This graphical modeling framework, which we demonstrate in an analysis of fecal contamination in coastal shellfish harvesting waters, indicates how current management practices often focus on water quality measures which may not relate directly to human health, and where future monitoring efforts should be focused to improve quantification of human health risks. Second, Bayesian networks combine several nested sub-models which can be individually assessed and calibrated at different spatial and temporal scales. Variability in climatic conditions, land use change patterns, and other model inputs can therefore be propagated through the network and reflected by an appropriate degree of uncertainty in model endpoints. Third, the Bayesian network model allows decision makers to identify acceptable levels of risk to human and ecological health and, through an exposure reconstruction approach, generate scenarios under which those management criteria are met. This work represents continuation of an ongoing effort to identify, evaluate, and apply more effective model-based strategies for protecting human and ecosystem health.

**Results:** The Bayesian network approach to modeling human and ecosystem health facilitates probabilistic representation of model endpoints, thereby allowing clearer interpretation of uncertainty and identification of future monitoring needs. We find, as an example, that uncertainty in the probabilistic interpretation of fecal contamination indicator organisms is one of several uncertainties in the interpretation of water quality data to protect human health. Other uncertainties, which are explicitly expressed in a Bayesian network, include the relationship between indicator organisms in the water column and pathogen concentrations in shellfish, and the relationship between shellfish pathogen concentrations and human health. These findings suggest that Bayesian networks are, and will likely continue to be, robust modeling tools which decision makers can utilize to improve human and ecological health assessments. These preliminary results will provide a platform to discuss opportunities and challenges of applying Bayesian tools to predict the success of various environmental decisions in reducing exposures to pollutants.

*Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1184

##### Mapping Community Determinants of Heat Vulnerability

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**Background:** Many recent studies have shown that not all people are equally vulnerable to heat; specific demographic subgroups of the population are more at risk. Physical environment characteristics such as proximity to green space and access to air conditioning in one's home can modify heat exposure. The study objective is to map vulnerability to heat throughout the continental United States to identify areas that may be at increased risk of a public health emergency in a future heat wave.

**Methods:** We used U.S. Census data from 2000 to capture social vulnerability as defined by population characteristics. The variables % non-white, % below the poverty line, % aged over 65 and % not

graduated from high school were mapped at the county level nationally, as well as at the census tract level for a sub-metropolitan area analysis for New York City (NYC). Principal component analysis was used to reduce the number of correlated variables used in the analysis. At each level of spatial resolution, an index of social vulnerability was created from the independent composite factors determined by the principal component analysis. We analyzed spatial autocorrelation of vulnerability indices to characterize their spatial structure.

**Results:** Preliminary data show variation in social vulnerability to heat nationwide. There was statistical evidence of clustering of social vulnerability nationally (Moran's I Statistic  $P < 0.01$ ), with particularly socially vulnerable locations along the Texas/Mexico border, along the Mississippi River, and in the northern plains. Clustering of social vulnerability exists by census tract (Moran's I Statistic  $P < 0.01$ ) with focused points of high social vulnerability in the northern section of Brooklyn, Harlem, and the southern end of the Bronx. The census tract in NYC at the 95<sup>th</sup> percentile of our social vulnerability index was three times more vulnerable than the 5<sup>th</sup> percentile census tract.

**Conclusion:** Understanding the patterning of potential vulnerability to heat can guide local interventions to protect the most vulnerable. Future analyses will include additional variables of social vulnerability, examine other U.S. cities, and include housing characteristics and satellite images of land cover to capture features of the physical and built environment that can affect heat exposure and opportunities for relief from heat. Illustrating within-city variability with finer resolution data highlights the possibility for targeted interventions to the populations most at risk from heat.

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#### ISEE-1185

##### Serum Concentrations of Polyfluoroalkyl Compounds in Pre-Adolescent Children Pooled Samples

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**Background:** Polyfluoroalkyl compounds (PFCs) are used in multiple commercial applications including surfactants, lubricants, paints, polishes, food packaging and fire-retardant foams. Although several PFCs are known to be toxic, this occurs at serum concentrations that are orders of magnitude higher than those observed in the general population. The National Health and Nutrition Examination Survey (NHANES) includes exposure assessment of the United States general population at various life stages to PFCs and other selected environmental chemicals.

**Methods:** With the exception of cotinine, exposure data in NHANES for children less than 12 years of age were lacking for PFCs since insufficient serum was available to assess exposure to PFCs in individual NHANES samples from pre-adolescent children. However, enough serum remained from the measurements of cotinine in children 3–11 years old to prepare 24 pools, 2 per each demographic group, each representing a combination of race/ethnicity, gender, and age. To ensure that no individual sample overly influenced the results, samples included in any one pool were of equal volume. Most pools included 42 (3–5 year old) or 115 (6–11 year old) individual samples randomly selected. The concentrations of 9 PFCs in children 3–11 years of age from NHANES 2001–2002 were estimated by using on-line solid-phase extraction coupled to isotope dilution-high performance liquid chromatography-tandem mass spectrometry.

**Results:** Perfluorooctane sulfonate (PFOS), perfluorooctanoate, perfluorohexane sulfonate (PFHxS), perfluorononanoic acid, 2-(N-ethyl-perfluorooctane sulfonamido)acetate, and 2-(N-methyl-perfluorooctane sulfonamido)acetate (Me-PFOSA-AcOH) were detected in all 24 pools. The unweighted mean concentrations of PFOS were higher than the other PFCs. Higher mean concentrations of PFHxS and Me-PFOSA-AcOH, two compounds associated with carpet treatment applications, may be related to higher contact with

carpeted floors among young children. The concentrations of some PFCs differed on the basis of race/ethnicity.

**Conclusions:** The measurements of PFCs in these samples will complement the measurements previously conducted on the 2001–2002 NHANES participants aged 12 years and older. They will also be useful for children's environmental health studies, including the National Children's Study.

#### ISEE-1188

#### The Health Effect of Chromium Containing Cement Dust Assessed by Combined Methods of Epidemiologic and Toxicologic Approach

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**Background and Objectives:** Cement dust could be the cause of diverse health effects, because it includes many heavy metals, such as hexavalent chromium. The airs and soils around cement industries have been more polluted than before, since cement industries have used diverse wastes as fuels and side-raw materials in cement production. Epidemiologic study is needed to investigate what is the cause of the health problems. So, the aim of this study is to assess the health effects of particles around cement industries on residents.

**Material and Methods:** We assessed cancer incidence ratio with data of cancer registry. We conducted health survey in 100 residents around cement industries and 99 control groups. We also assessed internal exposure of heavy metals. And we performed cytotoxic test to assess the toxicities for particles captured around cement industries. and microarray with bloods in the residents to detect characteristics of gene expression after exposure to particles around cement industries.

**Results:** Standardized incidence ratio of laryngeal cancer (Seo Myeon) around cement industries was more increased to 3.48 with borderline significance than standardized incidence ratio of laryngeal cancer in over all Korean areas. The prevalence of chronic coughs and sputums more than 3 months a year were significantly higher around cement industries than control areas. Most heavy metals concentrations were within normal level for general population, WHO environmental health criteria. Chromium concentrations ( $0.0289 \mu\text{g}/\text{m}^3$ ) in particulate matter around cement industries were higher than other areas in Korea. Blood chromium levels in study population were  $3.16 \sim 3.60 \mu\text{g}/\text{L}$ , which are increased value compared to exposure levels of general population. Urine chromium showed positive correlation of borderline significance with urine MDA, and negative correlation with FVC and FEV<sub>1</sub>. By microarray data, cell exposed to dust around cement industries showed increased immune response and inflammation compared to control. Gene expression of MAP3K1 and MAP3K8 above MAPK signaling cascade associated with occurrence of respiratory diseases and cancer were increased at the blood of residents

**Conclusions:** Micro-array data suggested the mechanism which cause damage to residents exposed to dust around cement industries. Without appropriate biomarker explaining exposure and biological effect, microarray approach could be helpful in epidemiologic investigation to explore the mechanism.

#### ISEE-1190

#### Quantitation of the Tobacco-Specific Nitrosamine 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) in Urine by LC Tandem Mass Spectrometry

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**Background:** The tobacco-specific nitrosamine (TSNA) 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNK) is a powerful pulmonary carcinogen in

rodents, and it is believed to be a potent carcinogen in humans as well. The metabolite of NNK, 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), is present in the urine of tobacco users and, at lower concentrations, in the urine of nonsmokers exposed to secondhand smoke (SHS), and consequently it can be a valuable biomarker of human exposure to TSNA in tobacco and tobacco smoke. Accordingly, we have developed and validated a sensitive and accurate method to quantitate NNAL in urine from both smokers and nonsmokers.

**Methods:** Urinary NNAL was measured as free (i.e. non-conjugated) NNAL, and also as total NNAL after hydrolysis of NNAL-glucuronide. The concentration of NNAL-glucuronide can be estimated as the difference between the total and free measurements. Total NNAL was measured following an overnight incubation with  $\beta$ -glucuronidase. For the analysis of NNAL, 5 mL urine samples were extracted by liquid-liquid extraction on ChemElute columns, which were eluted with methylene chloride. The extracts were back-extracted into HCl, neutralized and buffered, and then processed on custom designed molecularly imprinted polymer columns (MIP Technologies). Analysis and quantification of NNAL is conducted by using an API 5000 mass spectrometer and an Xterra RP18 column (5  $\mu\text{m}$ , 3.0  $\times$  150 mm). The system is calibrated with a 10-point standard curve ranging from 0 to 2 ng of NNAL/5 mL. This method has been validated by examining precision, accuracy, recovery, linearity, pool stability, and ruggedness.

**Results:** The day-to-day precision (CV) was 24.9, 14.1 and 3.9%, respectively, for a concentration of 5, 50, and 200 pg/mL. Accuracy determinations at a concentration of 10 pg/mL indicated at bias of 3.6%. Recoveries were greater than 10% overall. Accelerated stability testing of this method indicated that NNAL was stable in pooled urine for at least 2 years at  $-70^\circ\text{C}$ , and ruggedness testing confirmed that the method parameters remained stable within expected limits. We have applied this procedure to the measurement of urinary NNAL in a number of studies involving both smokers and nonsmokers, with an emphasis on the latter. Although the concentrations among nonsmokers are typically quite low, we have found significant increases in NNAL among nonsmokers following exposure. For example, in a defined exposure study the total urinary concentration of 40 nonsmokers increased from 7.422(95%CI, 5.352–10.29) pg/mL to 20.09 (95%CI, 17.00–23.75) pg/mL ( $P < 0.0001$ ) following 4 hours of exposure to secondhand smoke in an environmental chamber. Additional studies of nonsmokers exposed to SHS have also indicated detectable increases in total NNAL.

**Conclusions:** Overall, our results indicate that this combination of liquid-liquid and MIP column extraction followed by sensitive LC/MS/MS assays provides an analytical method suitable for application to epidemiologic investigations of health risks associated with the exposure to tobacco smoke or SHS in both smokers and nonsmokers, and has sufficient sensitivity to measure increases in NNAL following relatively limited exposures to SHS.

#### ISEE-1194

#### Ambient Concentrations of Aldehyde Compounds and Their Potential Sources in the Urban Communities of Paterson, New Jersey

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**Background:** Aldehydes are known as toxics because of their adverse effects on public health, and therefore it is important to understand concentrations and source characteristics of aldehydes in urban communities. In this paper, concentrations of formaldehyde, acetaldehyde, propionaldehyde and acrolein were measured in an urban community in New Jersey from November 2005 through December 2006.

**Methods:** Three sites in the city of Paterson, which were dominated by industrial, commercial and mobile sources, were chosen as monitoring locations. For industrial and mobile sites, sampling systems were placed

on school building roofs. Measurements were simultaneously conducted in the background site located in Chester, NJ, which is located about 36 miles west/southwest of Paterson, NJ. The Passive Aldehydes and Ketones Sampler Method (PAKS) was used for the aldehyde measurement.

**Results:** Formaldehyde and acetaldehyde were found to be the most abundant ambient aldehydes at all sites. Nonparametric Bonferroni adjusted Wilcoxon tests showed no significant differences in aldehyde levels between sites ( $P > 0.1$ ). There was also no significant seasonal variation at each site ( $P > 0.1$ ). These results suggest that vehicle emissions were to be the dominant sources in the study areas. This was confirmed by a significant correlation of formaldehyde, acetaldehyde, and propionaldehyde among different sites. The concentration ratios of formaldehyde/acetaldehyde and acetaldehyde/propionaldehyde were calculated for each season within each site and then compared to literature values to investigate potential emission sources of aldehydes. The ratios for formaldehyde and acetaldehyde were between 1.15–5.71 and the ratio for acetaldehyde/propionaldehyde were between 1.42–9.23, suggesting there might be different sources in different seasons and sites. However, as the ratios were within the range reported in other urban areas (1.2–8.38), it indicated that the aldehyde compounds measured in this study were derived mainly from anthropogenic sources. Further analysis will be conducted to identify the contributions from secondary emissions to aldehyde pollution in the study areas.

#### ISEE-1195

##### Secondhand Smoke And Erectile Dysfunction Among Non-Smoking Men, NHANES 2001–2002

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**Background:** Erectile dysfunction (ED) predominately results from endothelial cell dysfunction and frequently co-occurs with diseases in other vascular beds including coronary artery disease and peripheral vascular disease. The prevalence of ED among men aged 20 years and older in the US has been estimated at 18.4. Cigarette smoking is a known determinant of ED; current smokers have a 50% increased risk and former smokers have a 20% increased risk of developing ED, compared to non-smokers. Little information on the prevalence of ED among non-smokers exposed to secondhand smoke is available. This study investigated the association between secondhand smoke and ED among non-smoking men using the 2001–2002 National Health and Nutrition Examination Survey (NHANES).

**Methods:** NHANES is a cross-sectional survey designed to monitor the health and nutritional status of the US population. During NHANES 2001–2002, information on ED, self-reported secondhand smoke exposure, and a biomarker of secondhand smoke exposure (cotinine) was obtained for 1318 non-smoking men aged 20 years and above. Self-reported secondhand smoke exposure was dichotomized as exposed to secondhand smoke at home or work, or not exposed at home or work. Cotinine levels were log transformed and analyzed as a categorical variable and as a restricted cubic regression spline. Logistic regression was performed to examine the likelihood of having ED among different secondhand smoke exposure groups, adjusted for confounding factors. Effect modification was evaluated for age and former/never smoking status. In addition, a piecewise logistic regression model was fit to allow the slope of the regression line to change at a defined cutpoint.

**Results:** The age adjusted prevalence of ED among non-smoking men was 12.0 (SE: 0.86). Among men that self-reported secondhand smoke exposure, 14.3% (SE: 3.57%) reported ED. There appeared to be a dose response trend in the age adjusted prevalence of ED with increasing log cotinine levels. The prevalence started at 10.4 (SE: 0.925) at a dose of <0.03 ng/mL where it stayed approximately constant until a dose of 0.60 ng/mL where the prevalence increased to 15.1 (SE: 4.07). The prevalence continued to increase to 22.9 (SE: 10.3) for doses greater than 1.6 ng/mL.

After adjusting for demographic and cardiovascular risk factors, men with cotinine levels > 0.60 ng/mL had 1.29 (95%CI: 0.52–3.22) times the odds of having ED compared to men with cotinine levels = 0.60 ng/mL. This effect appeared to be greatest for men aged 60–69 and never smokers. Results from the piecewise regression indicated that the slope for men with cotinine levels greater than 0.60 ng/mL was 1.41 (95%CI: 0.54–3.65) times the slope of men with cotinine levels less than or equal to 0.60 ng/mL.

**Conclusions:** These results suggest an increased prevalence of ED among non-smokers with higher cotinine levels (>0.6 ng/mL), although they were not statistically significant. The approximately 29% increase in odds of ED among nonsmokers is comparable to the 20% increased risk found for former smokers. These results provide additional evidence to support prevention of exposure to secondhand smoke.

#### ISEE-1196

##### Hearing Impairment in 12-Year-Old Children Environmentally Exposed to PCBs

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**Background:** In line with findings from experimental studies, we recently demonstrated the potential ototoxic effects of polychlorinated biphenyls (PCBs) in a group of 8–9 year-old Slovak children environmentally exposed to PCBs. To further investigate this association, we conducted a follow-up examination of the same group of children at age 12 years.

**Methods:** The cohort consisted of 575 children from two different regions of Slovakia: Michalovce, a highly PCB-polluted region in Eastern Slovakia (n = 353); and the Bratislava region, a less-polluted urban area of Slovakia (n = 222). The follow-up examination included otoscopy, tympanometry, pure tone audiometry, assessment of transient evoked otoacoustic emissions (TEOAE), and distortion product otoacoustic emissions (DPOAE). A total of 15 individual PCB congeners were analyzed in serum, measured concurrently at 12 years of age. Additional data on environmental risk factors were also collected at the time of the examination. Children with middle ear pathology were excluded from the analysis.

**Results:** As expected, total PCB concentrations were lower in the Bratislava region as compared with the Michalovce region (200.6 ng/g lipid vs. 396.1 ng/g lipid, respectively). Overall, amplitudes of DPOAE (for all frequencies examined) as well as amplitudes for TEOAE response (grouped into half octave bands for 1000 and 1500 Hz) were lower in children from the Michalovce district compared to children from the Bratislava region. In terms of the hearing assessment, we observed correlations between left- and right-ear measures for both TEOAE and DPOAE, and strong associations between TEOAE and DPOAE performance, with no differences across sex. In addition, no association between hearing thresholds and TEOAE and DPOAE measures was noted, and decreases in the amplitude were more pronounced in the left ear. Regarding the association between PCB concentrations at 12 years and audiometric measures, higher hearing thresholds were observed among children in the highest quartile of PCB concentration compared with children in lower quartiles, especially for results gathered from the left ear and for the low frequencies (Mann-Whitney's test). In addition, TEOAE responses (grouped into half octave bands) were lower for 1000 and 1500 Hz frequencies in children in the upper PCB quartile compared to lower quartiles (Mann-Whitney's test). Results for amplitudes of DPOAE for 1000 and 2000 Hz were similar (Mann-Whitney's test). For some endpoints, we calculated the benchmark doses (BMDs) and the BMDLs, defined as the lower bound of the 95% confidence interval for the BMD. The BMD is defined as the level of exposure that will increase the risk of

performance below the designated cutoff score (defined as  $p_0$ ) by a prespecified amount. This increase is referred to as the benchmark response (BMR). Setting  $p_0$  at 0.1 and the BMR at 0.05 for the left ear, the TEOAE at 1000 and 1500 Hz, and the DPOAE at 1000 and 2000 Hz, the following BMD and BMDL pairs were obtained: 2034, 859; 2212, 813; 2028, 1069; and 3310, 1034 PCBs ng/g lipid, respectively.

**Conclusion:** These data indicate that a total PCB serum level <800 ng/g lipids may not confer an additional risk with regard to sensorineural hearing damage.

#### ISEE-1198

#### Predicting Personal Exposures to NO<sub>2</sub>, O<sub>3</sub>, EC and PM<sub>2.5</sub>: A Comparison of Healthy Adults and Asthmatic Children Residing in Windsor, Ontario

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**Background:** Recent evidence has suggested that susceptible subpopulations such as asthmatic children may have higher personal exposures to particulate matter when compared to healthy individuals (Liu, 2003). However, it is not yet known if this trend holds true for other airborne pollutants. During the eight week winter and summer sampling sessions, five repeated personal, indoor, and outdoor 24-hr measurements were obtained for each participant. In 2005, data were obtained for 48 non-smoking adults from Windsor Ontario, in order to assess their exposure to a variety of air pollutants based on their daily routines, and characteristics of their homes. In 2006, this sample design was repeated however, in this instance, asthmatic children were defined as the target study population.

**Methods and Results:** Through the use of generalized linear mixed models, the sources of exposure to NO<sub>2</sub>, O<sub>3</sub>, EC and PM<sub>2.5</sub> for healthy adults and asthmatic children will be elucidated. It is expected that sources, such as presence of a gas range, will emerge as major predictors of exposure to NO<sub>2</sub> for both populations, given that housing stock is consistent among these two groups (i.e. 24.5% of household had a gas range in both 2005 and 2006). As well, demographics and locations were similar for this study will allow for direct inter-comparisons of sources of exposure between a susceptible and a healthy population. Preliminary analysis has indicated that although asthmatic children have lower mean personal concentrations of NO<sub>2</sub> in summer (6.56 ppb, CI: 5.84–7.39 ppb) when compared with their healthy adult counterparts (10.04 ppb, CI: 8.45–11.94 ppb), their winter concentrations are higher (11.68 ppb, CI: 10.54–12.96 ppb vs. 8.033, CI: 6.88–9.37 ppb). However, it is currently unknown as to why these differences exist. Initial regression analyses have revealed that predictive models can estimate between 48.7%–60.8% of the variability in adult personal NO<sub>2</sub> levels, with indoor levels showing much higher correlations with personal levels than outdoor concentrations. Time Activity Data (TAD) has also revealed that asthmatic children spend the majority of their time indoors, although when compared with adults, they spend more time outdoors in both winter and summer (10.5% vs. 6.1% in summer, 5.9% vs. 1.4% in winter). Combining this information together with data collected from baseline questionnaires investigating housing characteristics, along with daily questionnaire results on cooking and cleaning activities, land use regression variables, and air exchange data, these analyses will determine whether these two groups should be treated differently in future epidemiological studies where direct measures of exposure are not available.

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#### ISEE-1199

#### A Spatio-Temporal Study Design to Assess the Relationship Between Traffic-Related Air Pollution and Emergency Hospitalizations: An Application to London Around the Introduction of the Congestion Charge Scheme

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**Background:** There is increasing interest in estimating the effect of long-term changes in air pollution on changes in health outcomes across areas. Such study designs are less vulnerable to confounding than those evaluating only spatial contrasts in exposure. We developed a study design to estimate the association between changes in traffic-related air pollution and emergency hospitalizations over time across small areas within Greater London. This design was applied to data from a two-year period surrounding the introduction of the London Congestion Charge Scheme (CCS).

**Methods:** Annual average NO<sub>x</sub> concentration was estimated for the year before (2002) and after (2003) the introduction of the CCS using an emission-dispersion model. Emergency hospitalizations for ischemic heart disease were aggregated at the ward level. Change in NO<sub>x</sub> was defined as the difference in ward average NO<sub>x</sub> for the post-pre CCS period. We used a binomial distribution to model the number of hospitalizations occurring in the post-CCS period out of total hospitalizations during the study years in each ward.

**Results:** Across London, annual average NO<sub>x</sub> was 32 ppb in 2002 and 36 ppb in 2003. Differences in NO<sub>x</sub> (2003–2002) varied by an IQR of 1.8 ppb across wards. The IQR of the percentage of hospitalizations in 2003 was 11%. Deprivation, an important confounder in spatial studies, was predictive of change in NO<sub>x</sub> ( $P = 0.003$ ), but not of ward level changes in hospitalizations ( $P = 0.24$ ). On average, an increase in NO<sub>x</sub> was associated with a decrease in hospitalizations across wards: OR 0.93 95%CI (0.91, 0.95) per IQR difference in NO<sub>x</sub>.

**Discussion:** This design is unlikely to be confounded by factors that vary only across areas (e.g. deprivation) or time (e.g. weather). However, it may be confounded by differential trends in ward level socio-demographics. The design is being applied to longer time periods as well as additional cardio-respiratory diagnostic categories.

#### ISEE-1202

#### Characterization of Chromium Species Distribution as a Function of Particle Size in Chromium Waste Laden Soils

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**Background:** Fill laden with Chromium Ore Processing Residue (COPR) was deposited in Hudson County over a course of nearly a century and as a result, the various sites of deposition contain chromium at various concentrations with valence states of trivalent ( $\text{Cr}^{+3}$ ) and hexavalent chromium ( $\text{Cr}^{+6}$ ). Chromium in the form of  $\text{Cr}^{+3}$  is an essential element for life and has a low toxicity, while  $\text{Cr}^{+6}$  has a range of toxic effects including carcinogenicity. Given the fact that the mobility and variability of chromium species can be quite large and the ratio of the chromium species could depend on particle size, it is thus very important to understand concentrations and size distributions of chromium species in Hudson country to determine whether any generalizations can be drawn that bear on risk assessment and risk management activities. In this paper, concentrations of chromium species and total chromium were measured in different particle size fractions for the contaminated soils collected from 10 sites in Hudson country.

**Methods:** Soil samples were sized down to 7 different fractions (2.5  $\mu\text{m}$  to 250  $\mu\text{m}$  and above). After microwave digestion with strong alkaline

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(for chromium species) or acid (for total chromium), the samples were analyzed by quadrupole inductively coupled plasma mass spectrometry.

**Results:** The maximum concentration of Cr<sup>+6</sup> species was determined as 11,100 µg/g, which is about 31% of total Cr found in the soil samples. The lowest concentration of Cr<sup>+6</sup> species in soil was determined as 0.76 µg/g, which is about 0.5% of total Cr measured. It was observed that the mass of Cr<sup>+6</sup> tended to distribute toward smaller particle sizes. A significant negative correlation between Cr<sup>+6</sup> and particle size was observed at 6 sites and a marginal negative correlation was found at 2 sites, indicating that there is potential risk for significant inhalation and deposition if the soil is resuspended by traffic and wind. Only 2 sites showed no significant correlation between Cr<sup>+6</sup> and particle size.

#### ISEE-1203

##### Quantifying Mortality Effects in Health Impact Assessments—Quantifying Attributable Deaths and/or Life Years and Their Value

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**Background and Discussion:** Health Impact Assessment involves predicting future changes in population health following interventions, e.g. the reduction of air pollution. In practice, to do this for mortality outcomes presents particular technical problems, since a change in mortality rates affects the size and shape of subsequent populations at risk. The solution is to use life-table methodology, which provides a framework for a consistent treatment of mortality impacts. We have developed IOMLIFET, a system of spreadsheets that allows maximum flexibility in both the input assumptions and the summary outputs. Impacts on mortality hazard rates may differ across both age and (future) calendar time; outputs, expressed either as numbers of deaths or life-years experienced, can also be summarised in any subsets or combinations of these two time axes. We've applied our method to a variety of HIA topics. We'll show some example predictions and demonstrate why we prefer life-years as an output over attributable deaths, and how some commonly-used simplifications may mislead as longer-term projections. We'll discuss common approaches to weighting predicted gains in life years, either by applying monetary values, or by making adjustments for depleted quality of life due to illness or disability in the years before death. We'll also discuss the problems of communicating results of predictions, including placing them in context with other better-known risks.

#### ISEE-1204

##### Outdoor Exposure Assessments of Multi-Pollutant in Sarnia, Ontario, Canada

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**Background:** As part of a community health study, an air quality investigation was carried out in Sarnia, Ontario, Canada. Sarnia has one of the largest concentrations of chemical industries in Canada, known as the 'Chemical Valley'. In order to investigate intra-urban variability in ambient concentrations, passive samplers were deployed for a two-week integrated period in October 2005 at 39 sites across the city of Sarnia. Methods: Nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), and volatile organic compounds (VOCs) were monitored. Exposure to NO<sub>2</sub> has been linked to respiratory problems and elevated risks of lung cancer. Sulphur dioxide is suggested to be related to a high incidence of hospital admissions for respiratory diseases, an increase in lung cancer cases, and cardiopulmonary mortality. VOCs are also of a significant health concern and are emitted primarily by the chemical industries which are abundant

in the area. The Ogawa samplers (Ogawa Inc., Japan) were used for NO<sub>2</sub>, SO<sub>2</sub>, and ozone monitoring, whilst 3 M #3500 passive monitoring badges (Guillevan, Montreal, Canada) were used for VOCs. The pollutant measurements from a total of 37 monitoring sites were included in the analysis.

**Results and Discussion:** The concentrations of NO<sub>2</sub> ranged from 5.7 to 16.7 parts per billion (ppb), SO<sub>2</sub> from 0.8 to 13.0 ppb, ozone from 13.4 to 21.3 ppb, and total VOCs from 2.4 to 21.8 µg/m<sup>3</sup>. The spatial variability was investigated using ranking and mapping techniques to identify spatial patterns of those air pollutants across the Sarnia area. It was found that spatial variability was large for NO<sub>2</sub>, SO<sub>2</sub>, and VOCs, but small for ozone. For each of the four pollutants studied, a rank was assigned to each site based on the concentration values, with the highest value receiving a rank of one. The Spearman rank correlations were low between SO<sub>2</sub> and ozone. The correlation was moderate to high among VOCs, NO<sub>2</sub> and SO<sub>2</sub>, suggesting common sources in Sarnia. The VOC concentrations were positively correlated with ozone concentrations, indicating some local production of ozone. On the other hand, NO<sub>2</sub> was negatively correlated with ozone, suggesting consumption of NO<sub>2</sub> by photochemical reactions. The 37 sites were then classified into three categories of high, moderate, or low exposure levels based on the concentration ranking of NO<sub>2</sub>, SO<sub>2</sub>, and VOCs, respectively: with the top 1/3 of the sites classified as high and the bottom 1/3 of the sites classified as low. The areas classified as 'high' exposure to NO<sub>2</sub>, SO<sub>2</sub>, and VOCs are grouped closely around the industrial facilities, indicating that the industrial and chemical facilities strongly influence the air quality in Sarnia. Also, the further one moves away from these major sources, the higher the density of 'low' exposure areas. North Sarnia and the shoreline of Lake Huron in particular, have relatively low outdoor exposure levels. The results of this study will be used for the community health study.

#### ISEE-1205

##### Serum Dioxin, Furan, and PCB Concentrations and Half-Life Study Among the U.S. General Population

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**Background and Objective:** The goal of this study is to quantify the population-based background concentrations of the 29 congeners of dioxins, furans, and PCBs for which World Health Organization (WHO) Toxic Equivalency Factors exist in serum using two datasets: the reference population (Jackson/Calhoun counties) data from the University of Michigan Dioxin Exposure Study (UMDES) 2004–2005, and the non-Hispanic white sub-population data in the National Health and Nutrition Examination Survey (NHANES) 2003–2004. The Jackson/Calhoun data has the advantage of lower limits of detection (LOD), while it is limited by having few participants older than 75 years. However, NHANES has more participants older than 75 years, but it has much higher LOD because of smaller blood samples.

**Methods and Results:** Multiple imputation was employed to impute the serum concentrations below the LODs. Correlation coefficient matrix was used to examine the associations of serum concentrations among the 29 congeners. The background mean, median, 75th percentile, and 90th percentile serum concentrations were estimated by age and gender using linear and quantile regressions for complex survey data. By concatenating the UMDES data with the NHANES data, we improved the imputation for the values below the LOD in the NHANES data by incorporating the observed serum dioxin, furan, and PCB measures in the Jackson/Calhoun data. At the same time, inclusion of the NHANES data enhanced the

estimates of the upper percentiles of serum dioxin, furan, and PCB concentrations among older people in the Jackson/Calhoun population. Using the regression results, the mean, median, 75th percentile, and 90th percentile serum concentrations of the WHO 29 congeners and their total toxic equivalent (TEQ) value can be estimated for females and males between ages 20–85. In addition, the relative half-lives of these congeners compared to 2,3,7,8-TCDD were estimated, based on the magnitudes of regression coefficients associated with age.

#### ISEE-1206

#### Latency Patterns of Kidney Cancer Mortality in Arsenic-Exposed Region II of Chile from 1950 to 2000

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**Background:** Kidney cancer mortality has been found to be increased with exposure to arsenic in previous studies, but the evidence was insufficient for the International Agency for Research on Cancer (IARC) to classify kidney cancer among the cancers resulting from arsenic in drinking water. Region II of Chile experienced a rapid onset of very high arsenic exposure beginning in 1958, followed by sharp declines when water treatment plants started to be installed in 1971. This situation has not been seen before, will probably never recur, and offers a unique opportunity to study time trends in health impacts of arsenic. We recently published lung cancer, bladder cancer and acute myocardial infarction mortality rates in Region II from 1950 to 2000. Here we present our findings on kidney cancer mortality.

**Methods:** We investigated kidney cancer mortality from 1950 to 2000 in the arsenic-exposed Region II of Chile in comparison with the unexposed Region V. For the years 1950–1970, mortality data were obtained from death certificates for the two regions and for the years 1971–1979 and the years 1980–2000, computerized mortality data were obtained from the Chile National Institute of Statistics and the Ministry of Health, respectively. We calculated and plotted 5-year Poisson regression mortality rate ratios for the entire study period, 1950–2000, comparing Region II with Region V for men and women separately and age adjusted in 10-year age strata from 30 to greater than 80 years.

**Results:** Kidney cancer risks for Region II compared with Region V started to increase about 10 years after high arsenic exposures started in 1958, with a mortality rate ratio (RR) of 2.51 among men for the 5-year period centered in 1967 (95% confidence interval (CI): 1.13, 5.55), and an RR of 3.23 for women in 1970 (95%CI: 1.57, 6.63). The peak kidney cancer mortality rate ratio was 4.23 (95%CI: 2.88, 6.21) for men in 1980, with subsequent declines to 1.61 for the 5-year period centered in 1998 (95%CI: 1.29, 2.21). Mortality RRs among women reached 3.99 (95%CI: 1.68, 9.49) in 1981 but remained high longer than for men with an RR of 4.37 in 1993 (95%CI: 3.48, 5.50), and then gradually began to decline reaching a mortality rate ratio of 2.32 in 1998 (95%CI: 1.97, 2.73).

**Conclusions:** This 50-year mortality study has showed a clear latency pattern of increase in deaths from kidney cancer. Long latency was apparent with increased kidney cancer mortality continuing for at least 25 years after the high exposures started to be reduced. The latency patterns are consistent with a causal interpretation and this study, which is by far the largest on arsenic and kidney cancer, strengthens the epidemiological evidence that arsenic in water causes increased rates of kidney cancer mortality.

#### ISEE-1207

#### Maternal Residence near Municipal Waste Incinerators and Risk of Urinary Tract Birth Defects

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**Background:** Municipal solid waste incinerators (MSWI) have been particularly developed in France as an alternative to storage and for energy production: in 2004, more than 11 millions of tons of municipal solid wastes were incinerated in France. Despite a number of recent technological improvements, the main drawback of incineration remains the release in the atmosphere of a mixture of persistent toxic chemicals such as heavy metals, dioxins and furans, polychlorobiphenyls, polycyclic aromatic hydrocarbons, various COV, particulates... In a previous ecological study conducted in the southeast of France, we found an association between living in the vicinity of MSWI and the risk of urinary tract birth defects. We decided to deepen this finding by conducting a case-control study specially designed to test this hypothesis.

**Methods:** From various medical sources in the Rhône-Alpes area, we attempted to identify all children diagnosed at birth or before birth with a renal birth defect or obstructive uropathy, between 2001 and 2003. Three hundred and four (304) cases were identified and compared to 319 controls of similar age, sex and district of birth. Exposure to MSWI emissions during the first trimester of pregnancy was estimated at the place of residence of the mother. We used dioxins as a marker of the mixture, for all incinerators in activity at the time of the study, using a second generation Gaussian modelling (ADMS3 software), taking into account dioxins emissions at the plant, chimney heights, physical characteristics of the pollutants, meteorological parameters, topography and ground occupation. Presence of other industries contributing to emissions of dioxins, population density and a deprivation index of the neighbourhood were also measured. All control families and 61% of the cases families could be interviewed to collect a number of individual sociodemographic and medical variables and lifestyle factors.

**Results:** Two indices of exposure have been analyzed: gaseous and particulate dioxins. After adjustment for child's sex, age and place of birth, and population density, an increase in the risk of urinary birth defects was observed among children exposed above background level. This risk is statistically increased when mothers have been exposed to gaseous dioxins above median level of exposure (OR = 1.98 95%CI[1.02; 3.84]).

**Conclusion:** Our study suggests a doubling in the risk of urinary birth defects among children of women exposed to dioxins above average. Although many characteristics of the study families have been considered, it is still possible that this association might be random or explained by a risk factor other than vicinity of an incinerator, notably the exposure to traffic pollution. The interpretation of these results is especially delicate since estimated additional exposure levels attributable to MSWI emissions appear low compared to atmospheric concentrations reported in some urban areas. In addition, dioxins should be considered as a marker of a whole mixture and these results must be interpreted accordingly.

#### ISEE-1208

#### Air Pollution Exposure and Reproductive Outcomes Study in Barcelona

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**Background:** Recent epidemiological studies have explored relationships between pregnant women's exposures and reproductive outcomes, finding inconsistent results but possibly small adverse effects (specifically CO, SO<sub>2</sub> and PM on fetal growth and pre-term delivery). The potential for small causal effects is important to investigate because of substantial health impacts it can generate at the population level. A major weakness of most studies to date has been crude exposure assessments, using mostly nearest-monitor approaches. The effect of exposure misclassification

which may occur in these ecological assessments is typically to bias results towards the null. We have designed a study in Barcelona, Spain, that aims at improving exposure assessments in this urban context and estimating measurement errors, which will then be accounted for in exposure-response models of air pollution and birthweight.

**Methods:** Personal monitoring or use of biomarkers could be considered “gold standards” in exposure assessment. However, in large studies such methods are not feasible for all participants due to high costs and time limitations. Two major sources of errors are 1) inadequate estimates of ambient concentrations, and 2) lack of consideration of activity patterns of study subjects. We have planned to tackle both these sources. First, in an urban setting such as Barcelona, much of the variability in pollution concentrations are due to traffic. This variability is best and most efficiently captured by models such as land-use regression (LUR) which account for local-area characteristics (traffic, population, etc.) while still relying on measured pollution. Furthermore, model diagnosis provides prediction error estimates to be integrated in exposure-response analyses. Secondly, we aimed at understanding factors influencing personal exposures. By collecting detailed information on a sub-sample of pregnant women inferences can be made at the population level. The precise data thus acquired serves to simulate exposures in all subjects to improve estimates and to evaluate measurement errors associated with ecological assessments. The study makes use of a Barcelona hospital registry with ongoing entries containing personal and foetal characteristics including home-addresses and birthweight (approximately 20,000 births, 12.3% with birthweight <2500 g). To model pollutants, NO<sub>x</sub> (Ogawa samplers) will be monitored in 40 sites (traffic, urban and regional background) and PM<sub>2.5</sub> (Harvard impactors) in half of them for fourteen days in 2 or 3 campaigns. LUR methodology will be applied to sampled concentrations combined with local geographic data to predict ambient exposures at home-addresses. Personal sampling will be undertaken on 60 pregnant women recruited at the hospital, 20 in each of three predicted exposure tertiles. They will be asked to keep 7-day diaries of activities related to air pollution exposures, including mobility data. Throughout that time they will wear a NO<sub>x</sub> sampling tube, and for 48 hours a small backpack for monitoring PM<sub>2.5</sub> (BG1400, GK2.05). PM filters will be weighed, and light absorbance determined as a measure of elemental carbon. Further analyses are planned for PAHs, VOCs and elemental composition. The modeled and personal exposure information will be incorporated in a Bayesian Hierarchical framework to estimate and adjust for measurement error information in health effects models.

#### ISEE-1209

#### Phthalates, Polycyclic Aromatic Hydrocarbons and Perchlorate Associations with Thyroid Hormones During Pregnancy: Results from a Pilot Study

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**Background:** Current evidence suggests thyroid function may be altered by exposure to chemical contaminants. Few studies, however, have assessed the impact of low level exposures in pregnant women. We conducted a pilot study to evaluate the association between non-persistent pollutants and thyroid function in 45 pregnant women ≤22 weeks gestation (mean: 11.7 weeks; range: 4–22) in Central Oklahoma.

**Methods:** Urine samples from the first prenatal visit were analyzed for 9 phthalate metabolites, 20 hydroxylated polycyclic aromatic hydrocarbons (OH-PAHs), and perchlorate. Serum total thyroxine (T4), total triiodothyronine (T3), free T4, and thyroid stimulating hormone (TSH) were measured in blood collected at the same visit. Measurements below the limit of detection were imputed by dividing detection limits by √2. Analyses were restricted to analytes detected in >60% of samples. Specifically, we evaluated all 9 phthalates, 10 OH-PAHs summed by

parent compound to create 4 groupings (phenanthrene, fluorene, naphthalene, pyrene) and the molar and potency adjusted ratio of perchlorate to iodide. Linear regression models compared mean thyroid hormone levels between women with concentrations categorized as > or ≤ 75<sup>th</sup> percentile for each compound.

**Results:** After applying a Bonferroni correction for multiple comparisons, higher concentrations of mono-3-carboxypropyl phthalate were associated with a TSH increase of 0.9 mIU/mL ( $P = 0.002$ ), adjusted for age, body mass index, gestational age and urinary creatinine. Adjustment for race/ethnicity and smoking status had little or no impact on point estimates and these factors were not retained in final models. Positive associations with TSH were also suggested for perchlorate ( $\beta = 0.8$ , SE = 0.28,  $P = 0.008$ ) and the fluorene OH-PAH group (2-hydroxyfluorene + 3-hydroxyfluorene + 9-hydroxyfluorene) ( $\beta = 0.6$ , SE = 0.29  $P = 0.06$ ), but did not meet the corrected criterion for statistical significance ( $P < 0.0035$ ). Similarly, increased concentrations of 1-hydroxypyrene were marginally associated with increased T3 ( $\beta = 35.6$ , SE = 15.4,  $P = 0.02$ ) and T4 levels ( $\beta = 2.0$ , SE = 0.89,  $P = 0.03$ ). No associations were observed with free T4.

**Discussion:** Previous studies have shown high doses of perchlorate competitively inhibit iodide uptake in the thyroid gland; however, the biological mechanism by which certain PAHs or phthalates may affect the thyroid is unknown. Factors altering maternal thyroid hormones may lead to cognitive and sensory deficits in offspring. This pilot study suggests that further investigation of thyrotoxicants is warranted.

#### ISEE-1210

#### Current Estimates of Population Serum PCDD, PCDF, and Dioxin-like PCB Levels in the United States

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**Background:** Environmental emissions of polychlorinated dibenz-p-dioxins (PCDDs), dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs) have been decreasing over the past three decades. However, population serum concentrations of these compounds continue to be monitored due to their environmental persistence and bioaccumulation. Three recent studies of adults in the United States were compared to identify current population concentrations of PCDDs, PCDFs, and PCBs.

**Methods:** Data are taken from the 2004–2005 University of Michigan Dioxin Exposure Study (UMDES) which analyzed serum from 946 Michigan subjects including 251 control subjects; the Agency for Toxic Substances and Disease Registry's (ATSDR) 2001 study of 415 subjects from two parishes in Louisiana; and the 2001–2002 National Health and Nutrition Examination Survey (NHANES) of the United States which included serum concentrations from 1081 adults from multiple states.

**Results and Discussion:** Adult concentrations of total PCDDs, PCDFs and dioxin-like PCBs calculated using the World Health Organization's 1998 toxic equivalency system range from 5–238 parts per trillion (ppt) for the UMDES sample (29 congeners), from 3–166 ppt for the ATSDR sample (23 congeners), and from 8–208 ppt for the NHANES sample (26 congeners). Analyses suggest that age-stratified median and 95th percentile levels of total serum PCDDs, PCDFs and PCBs are also similar across the nation, regardless of the location of the population sampled. The concentrations of total serum dioxins, furans and PCBs have decreased in comparison to historical levels from the United States. Additional serum concentration data from the three studies and references will be provided.

**ISEE-1211****The University of Michigan Dioxin Exposure Study: A Follow-Up Investigation of Cases with High Serum Concentrations of 2,3,4,7,8-PENTACDF**

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**Background:** The 29 congeners of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans and dioxin-like polychlorinated biphenyls that have consensus toxic equivalency factors were measured in serum of 946 subjects who were a representative sample of the general population in five Michigan counties. The study was motivated because of concerns about human exposure to dioxin-contaminated sediments in the Tittabawassee River (TR). Over 80% of the total toxic equivalency (TEQ) in TR sediments is due to two furan congeners, 2,3,7,8-TCDF and 2,3,4,7,8-PentaCDF; only the latter congener has a prolonged serum half life in humans and can serve as a biomarker of exposure to contaminated sediment. The individual with the highest adjusted serum level of 2,3,4,7,8-PentaCDF in the UMDES (42.5 parts per trillion, or 4.18 studentized residuals above the log-normalized mean after adjustment for age, age<sup>2</sup>, and body mass index) reported a unique history. From 1984–1996 he raised beef cattle in the flood plain of the TR (4–6 cows at a time). He never sold the meat commercially. He and his family ate the meat, and he also gave it to friends and family.

**Methods:** Interviews and serum samples were obtained from 15 friends and family members who ate the beef.

**Results:** The mean, median, and 95th percentile for serum 2,3,4,7,8-PentaCDF in the study control population were 6.0 ppt, 5.4 ppt, and 13.0 ppt, respectively. The mean, median, and 95th percentile for serum 2,3,4,7,8-PentaCDF for the beef consumers were 9.9 ppt, 8.4 ppt, and 20.5 ppt, respectively. When corrected for age, age<sup>2</sup> and BMI, the mean serum 2,3,4,7,8-PentaCDF level in friends and family members was 0.67 studentized residuals above the mean (range: -0.6 to 3.0 studentized residuals above the mean).

**Conclusion:** It appears that heavy consumption of beef raised on dioxin-contaminated soil can be an important pathway of exposure for persons who consume the beef.

**ISEE-1212****Mercury Effect on Blood Pressure through hs-CRP in Children**

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**Background:** Health effects of mercury on cardiovascular system are under debate. We investigated mercury effect on blood pressure (BP) through a inflammatory marker, high-sensitivity C-reactive protein (hs-CRP), in Korean children.

**Methods:** Data was obtained from 5,446 children ranging from 6 to 14 years of age from metropolitan, industrial complex and rural areas. Total mercury was measured by CETAC M-6000A Automated Mercury Analyzer using cold vapor generation technique in whole blood. Systolic and diastolic blood pressure checked two times and mean systolic and diastolic BP were calculated. hs-CRP was measured to investigate the intermediate role between blood mercury and BP.

**Results:** We finally analyzed 2,211 children and the majority of the participants were 7 years old (75.2%). Means of systolic and diastolic BP were  $106.9 \pm 11.8$  mmHg and  $66.2 \pm 10.4$  mmHg, respectively. Geometric mean of blood mercury was  $1.79 \pm 2.08$  (range; 0.01 ~ 17.77)  $\mu\text{g/L}$ . The percentage of hs-CRP over 3 mg/L was 9.91%. Mean systolic blood pressure was significantly elevated with blood mercury level ( $\beta = 0.808$ ,  $P = 0.013$ ) after controlling gender, BMI, area, and omega-3 fatty acid intake. Mercury effect on systolic BP in 7 years old in metropolitan area, which is the highest blood mercury, is much stronger ( $\beta = 2.892$ ,  $P \leq 0.0001$ ). The level of hs-CRP was significantly positively correlated with blood mercury and diastolic BP.

**Conclusion:** This study suggests that mercury elevate systolic blood pressure in urban children by inducing inflammation.

**ISEE-1213****Prenatal Ambient Air Pollution Exposure and Respiratory Health in Early Life: Findings from the UCLA EPOS Cohort**

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**Background:** A growing body of evidence suggests fetal and lung development can be adversely affected by pre- and postnatal exposure to airborne pollutants. In 2003 we surveyed 2,543 women in Los Angeles County, California four to six months post-delivery as part of a study examining the impact of prenatal air pollution exposures on preterm and low weight birth (the UCLA Environment and Pregnancy Outcomes Study, EPOS). The EPOS survey ascertained prenatal tobacco and alcohol consumption, marital status, income, occupation, stress and indoor air pollution exposures during pregnancy. In 2006–2008, we attempted to re-contact 2,470 mothers who agreed to be followed during the first interview.

**Methods:** Surveys were completed with 1,215 women (49% follow-up) and collected information on the child's respiratory health using a modified ISAAC questionnaire, residential history since birth, and potentially important covariates. The average age at follow-up was 3.5 years. Each woman's reported residential zip code at birth was linked to a government air monitoring station and hourly measurements for CO, NO<sub>2</sub> and O<sub>3</sub> and 24-hour measurements for PM<sub>10</sub> and PM<sub>2.5</sub> were averaged for the entire pregnancy and each trimester based on the gestational age and birth date reported on the birth certificate. Responders to the second survey were more likely to be US born, non-Hispanic Whites, older, married, more educated, and higher income and less likely to have had a preterm or low weight infant than non-responders. However, the distributions of pregnancy air pollution averages were similar for both groups. We used logistic regression to examine associations between prenatal air pollution averages and respiratory endpoints, adjusting for maternal race/ethnicity, education and prenatal care payment source (all models) and for parental asthma, reports of cockroaches, water damage, or mold in the home in the past 12 months, furry pets in the home before one year of age, day care attendance before two years of age, and exclusive breastfeeding for at least 3 months (depending on outcome).

**Results:** We estimated a 30–40% increase in odds of wheezing in the past 12 months per  $10 \mu\text{g}/\text{m}^3$  increase in average third trimester particle exposure (OR = 1.34, 95%CI = 1.07–1.67 and OR = 1.42, 95%CI =

1.01–1.99 for PM<sub>10</sub> and PM<sub>2.5</sub>, respectively). Odds of doctor-diagnosed asthma increased 38% (OR = 1.38, 95%CI = 1.01–1.88) and odds of doctor-diagnosed ear infections increased 32% (OR = 1.32, 95%CI = 1.09–1.61) per 10 µg/m<sup>3</sup> increase in average first trimester PM<sub>10</sub>. We also estimated a 49% increase in odds of ear infections per 1 ppm increase in entire pregnancy average CO (OR = 1.49, 95%CI = 0.97–2.27). Children with higher estimated pregnancy exposures to O<sub>3</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> were also more likely reported as suffering from sneezing, runny or stuffed noses apart from colds in the past 12 months than those with lower exposures to these pollutants (OR = 1.42, 95%CI = 1.01–1.99 per 1 ppbm entire pregnancy average O<sub>3</sub>; OR = 2.20, 95%CI = 1.41–3.42 per 10 µg/m<sup>3</sup> PM<sub>10</sub>; OR = 1.80, 95%CI = 0.82–3.93 per 10 µg/m<sup>3</sup> PM<sub>2.5</sub>). In future work we plan to evaluate how these estimates change when considering postnatal air pollution exposures, residential mobility (both during and after pregnancy), and multiple pollutants in the same model.

#### ISEE-1214

#### Development of Prediction Models for Bone Lead Levels in a Community-Based Population

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**Background:** Lead levels in bone serve as a dosimeter for cumulative exposure to lead. However, the technologies for measuring lead levels in tibia (cortical) and patella (trabecular) bones are expensive and require specialized expertise and may not be available in many existing cohorts. Measuring lead levels in blood is relatively easier. This study attempts to build a prediction equation model for bone lead using measured blood lead levels, and other standard covariates routinely recorded in an epidemiologic study.

**Methods:** Data was analyzed on complete observations for 825 participants in the Normative Aging Study. Subjects having one measure of tibia and patella lead levels as measured by a K-x-ray fluorescence instrument from year 1991–1999 along with measurements of blood lead and 36 other potential covariates were included in the model selection process. Age, education, and daily intakes of calcium, vitamin D and total calories were always included in the model regardless of significance because these variables are known as significant determinants of bone lead levels, whereas the remaining 31 variables were subject to statistical variable selection. We first split the data into a training set and test set to obtain a 3:1 ratio in sample sizes. The important predictors of tibia and patella lead levels in the training set were selected by the least absolute shrinkage and selection operator (LASSO) and then assessed by several model selection criteria (AIC, BIC, etc.). We then predicted the bone lead measurements in the test set, based on the model fitted in the training set. We also conducted a second validation to predict the bone lead levels recorded at a future time point for the subjects included in the initial test set.

**Results:** For tibia lead, the selected model consisted of 20 predictors, including: age, education, daily intakes of calcium, vitamin D, zinc, iron and total calories, blood lead, smoking status, pack-years of smoking, body mass index, systolic and diastolic blood pressure, serum levels of total cholesterol, creatinine and phosphorus, hematocrit, and current diagnosis of diabetes, with R<sup>2</sup> = 0.289 when fitted on the training set. The prediction model of patella lead levels includes the above predictors and daily vitamin E intake and physical activity, with R<sup>2</sup> = 0.305 when fitted on the training set. The correlation coefficients of the observed and predicted values in the first test set were 0.531 (tibia) and 0.596 (patella), and in the second test set were 0.450 (tibia) and 0.566 (patella). The median and interquartile ranges of the absolute error in prediction (|observed-Predicted|) were (6.62, 7.14) for tibia lead and (11.22, 12.38)

for patella lead in test set 1 and (5.78, 7.95) for tibia lead and (10.27, 12.87) for patella lead in test set 2 respectively, illustrating that a reasonable prediction is attained by the proposed equations.

**Conclusions:** This study suggests that one is able to predict bone lead levels in test datasets with reasonable accuracy. If replicated in other populations, such an algorithm may be useful for predicting bone lead levels in members of other cohorts which are similar in nature.

#### ISEE-1216

#### Traffic-Related Air Pollution and Circulating Levels of Total and Allergen-Specific IgE Among Children in Detroit, Michigan

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**Introduction:** There is a growing body of literature suggesting a relationship between traffic-related air pollution and allergic health outcomes. Animal studies have demonstrated that air pollution, particularly diesel exhaust particles, may stimulate or enhance atopic responses. Epidemiologic studies have also suggested that traffic-related air pollution may have an adjuvant effect on allergic response. This study examined relationships between traffic pollution and clinical markers of atopy among asthmatic and non-asthmatic children (aged 9–12 years) in Detroit, Michigan.

**Methods:** Total and allergen-specific IgE levels were assessed in serum from 194 children participating in Mechanistic Indicators of Childhood Asthma (MICA) and the Detroit Children's Health Study (DCHS). Traffic variables included distance to major roadways with 50,000 or more vehicles per day (vpd) and traffic intensity (vpd/km) within a 1500 meter buffer area around the home.

**Results:** Increased exposure to traffic-related air pollution was associated with increased total- and allergen-specific IgE levels. Traffic intensity within 1500 meters (ranging from 14,745 to 169,607 vpd/km) was positively associated with total- and allergen-specific serum IgE. In multivariate models adjusting for age sex, parental education and ethnicity, log total serum IgE and log allergen-specific IgE increased by 0.078 (P-value = 0.024) and 0.11 (P-value = 0.024) per 10,000 vpd/km within a 1500 meter buffer area. Distance to major roadways (ranging from 5–5700 meters) was inversely associated with total serum IgE and allergen-specific IgE in multivariate models. Log total serum IgE and log allergen-specific IgE decreased by 0.21 (P-value = 0.039) and 0.26 (P-value = 0.063) per 1000 meters, respectively. Models restricted to African-American children (N = 167) were similar, with P values < 0.05. Effect estimates for traffic variables and atopy were similar among asthmatics (N = 89) and non-asthmatics (N = 105). Associations between traffic and serum IgE were not improved by considering tighter buffer areas.

**Conclusions:** These results were consistent with previous studies suggesting that increased exposure to traffic-related air pollution may impact allergic responses in children.

*Although this work was reviewed by EPA and approved for publication, it may not reflect official Agency policy.*

#### ISEE-1217

#### Extrapolation of Traffic Volumes on Local Road Networks to Support Assessment of Traffic-Related Exposure to Pollutants

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**Background and Discussion:** Recent health studies have identified traffic proximity as an important factor in relating environmental

exposures to a number of health outcomes, but credible traffic data is typically not available for most roads other than busy freeways and major arterials. From the health perspective, improved estimates of on-road traffic density may be important for improving exposure assignments. This project utilized a novel approach to estimate traffic density on local road networks using Long Beach as a case study. Our strategy used Geographically Weighted Regression to generate prediction parameters at sampled locations based on a combination of neighborhood land use, and network related attributes. The performance accuracy of different models was validated based on the standard statistical measures of error between observed and predicted values. The model with the greatest predictive power was utilized to predict traffic volumes at non-sampled locations across the road network. The resulting measurements of traffic volume will be used in current and future studies relating traffic density patterns to human health effects.

#### ISEE-1218

##### Evaluation of Land-Use Regression Models in Detroit, Michigan

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**Introduction:** Land use regression (LUR) models have emerged as a cost-effective tool for characterizing exposure in epidemiologic health studies. However, little critical attention has been focused on validation of these models as a step toward temporal and spatial extension of land-use regression model prediction for application in multiple study populations. This presentation evaluated LUR models developed for Detroit Children's Health Study (DCHS) using outdoor residential measurements from several Detroit-area studies.

**Methods:** LUR estimated outdoor concentrations of benzene, toluene, ethylbenzene, m/p and o-xylenes (BTEX) and nitrogen dioxide ( $\text{NO}_2$ ) were compared with outdoor residential  $\text{NO}_2$  and BTEX measurements collected under Detroit Exposure Aerosol Research Study (DEARS) and Mechanistic Indicators of Childhood Asthma-Air Monitoring (MICA-Air). LUR models were developed under DCHS based on outdoor air monitoring conducted at neighborhood schools during summer 2005. Monitoring data were used in conjunction with representative traffic, point sources, and other variables to develop LUR models. The DEARS study collected winter and summer outdoor measurements for Detroit homes from 2005–2007. MICA-Air collected outdoor residential measurements in fall 2006. Model predictions were evaluated through qualitative comparisons and linear regression analyses.

**Results:** Qualitative comparison of estimated concentrations and measurements showed good agreement between low, low-medium, medium-high, and high outdoor residential concentrations for  $\text{NO}_2$  and BTEX species. Preliminary analysis showed good agreement between estimated and measured  $\text{NO}_2$  for outdoor residential concentrations within the range of measurements used to develop the LUR model. Estimated and measured BTEX species showed less agreement.

**Conclusions:** Preliminary results suggest that land-use regression models were better able to characterize outdoor residential  $\text{NO}_2$  compared with BTEX species for the Detroit area models. Factors influencing the predictive power of these models including seasonality, pollutant species, sampling timeframes, and geographic area will be discussed further. These analyses provide insights on the strengths and limitations of applying LUR models in temporal and spatially heterogeneous study populations.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

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#### ISEE-1219

##### The Effects of Calcium Supplement in Reducing School Children Blood Lead Levels in Bandung

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**Background:** The population's exposure to lead is mostly related to vehicle exhaust in area where leaded-gasoline is still being used (about 80%), glazed ceramics used for food preparation and storage, paint and canned food. It is well documented that excess exposure to lead causes severe health problem in children, resulting among others in adverse neurobehavioral effect damage. Several studies suggest that an inverse relationship exists between blood lead levels and cognitive function along with learning ability in children.

**Objective:** The objective of this study was to examine the effect of daily calcium-supplement intake on reducing blood-lead levels (BLLs) among elementary school children in Bandung.

**Methods:** Forty elementary schools were randomly selected comprised of 400 children. Schools were then divided into three groups of calcium-supplement intervention groups (250 mg/day and 500 mg/day) and one control group. Blood samples from finger tip were determined for lead levels before and after three months calcium-supplementation. Paired-t test, ANOVA and multivariate risk factors modeling of *Generalized Estimating Equations (GEE)* were performed in the analyses.

**Results:** The average reduction in BLL for school children aged 9 to 11 years old were about 43% and 44% among the children with 250 mg/day and 500 mg/day of calcium supplement, respectively. A statistically significant ( $P < 0.05$ ) inverse relationship was found between blood lead levels and daily calcium-supplement intake. The analyses of GEE revealed that the reduction in BLL was associated with calcium supplement intervention, nutritional status, and time of trip to school.

**Conclusion:** The findings suggest that calcium supplement provided a protective effect against lead accumulation in the body among children.

#### ISEE-1220

##### Indoor Airborne VOC Exposure and Symptoms of Allergy and Asthma in Children

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**Objectives:** To examine the risk of indoor chemical exposure on the occurrence of asthma and allergy symptoms among Swedish children.

**Methods:** In the Swedish Dampness in Buildings and Health study a nested case-control study of 198 cases and 202 control children between the ages 3 to 8 were conducted between October 2001 and April 2002. Cases were randomly selected from a pool of questionnaire respondents who reported at least two symptoms of wheezing, rhinitis and eczema without a cold during last 12 months. Controls were chosen from those who reported absence of symptoms.

**Results:** Compared to the controls, geometric mean concentrations of glycol ethers in the homes of cases, asthma cases, rhinitis, and eczema cases, respectively, were significantly higher and a dose response relationship was indicated. 1,2-propanediol was the most commonly found glycol ether. Compared to the unsensitized cases, level were higher among the sensitized cases, respectively, for glycol ethers (0.98 vs. 0.84  $\mu\text{g}/\text{m}^3$ ,  $P = 0.08$ ) and Texanol B (0.75 vs. 0.35  $\mu\text{g}/\text{m}^3$ ,  $P < 0.01$ ). Controlling for the male gender, wet cleaning frequency, butyl benzyl phthalate (BBzP), and di(2-ethylhexyl)phthalate (DEHP), one natural-log unit increase in glycol ether exposure was associated with 53% increase in risk of being a case (95%CI, 1.13–2.06), 65% increase in risk of being an asthma case

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(95%CI, 1.15–2.37), 122% increase in risk of being a rhinitis case (95%CI, 1.41–3.53), and 63% (95%CI, 1.14–2.34) increase in risk of being an eczema case.

**Conclusions:** Glycol ethers are widely used as food, pharmaceutical, cosmetic, cleaning, as well as water-based paint additives. Indoor exposure to glycol ether in the children aged 3–8 is associated with a dose-dependent increasing risk of being an asthma, rhinitis and eczema cases, respectively.

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#### ISEE-1221

##### Effects of the Social Environment on Incident Asthma in Childhood: Associations with School Title I Funding and Crime in the Community

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**Background:** Higher prevalence rates of childhood asthma are often reported in areas of low socioeconomic status (SES). The social environment may plausibly affect risk for asthma through pathways involving psychosocial stress, behavioral risk factors (e.g. maternal smoking in utero), access to medical care, or exposure to hazards of the physical environment (e.g. air pollution or indoor allergens). We examined the effects of the neighborhood, school and community social environments on incident asthma in a prospective cohort of Southern California school children.

**Methods:** The study population included 2456 subjects with no wheeze or asthma at baseline enrollment (2002–2003) of the Children's Health Study cohort. Doctor-diagnosis of new onset asthma was reported annually over 3 years of follow-up. Subjects resided in 274 neighborhoods and attended kindergarten or first grade in one of 45 schools distributed in 13 communities. Neighborhood and community environment were characterized by data from the U.S. 2000 Census, including measures of deprivation, income inequality and racial segregation. Communities were also characterized by 2004 crime rates reported to the Federal Bureau of Investigation. Finally, school environment was characterized by data reported to the California Department of Education for the 2002–2003 academic year, including whether or not a school received Title I funding, which aims to reduce academic underachievement in disadvantaged populations. Covariates included modeled estimates of exposure to traffic-related pollution at the home and a wide range of individual and household risk factors for asthma that were assessed at baseline. A multilevel Cox proportional hazards model with random effects at both the community and school level was used to measure associations between the social environment and incident asthma, and then test confounding by individual-level risk factors.

**Results:** Increased risk for incident asthma was observed in subjects attending schools receiving Title I funds compared to those from schools without funding (HR 1.71, 95%CI 1.14–2.58), and residing in communities with higher rates of larceny crime (HR 2.41, 95%CI 1.29–4.51 across the full range of 1827 incidents per 100,000 population). These effects were not explained by individual-level risk factors for asthma, although the effect of the larceny crime rate was partially positively confounded by adjustment for exposure to traffic-related pollution.

**Conclusions:** These results suggest that social disparities in asthma are related to higher risk for onset of asthma in areas of low SES. In particular, elevated risk for asthma in schools receiving Title I funding and communities with high rates of larceny crime may occur due to risk factors related to areas of high deprivation that were not measured in this analysis, such as indoor allergens in older, poorer schools. Alternatively, these effects may indicate stressful environments for children. Further investigation of the social environment could both elucidate the role of risk factors such as stress in mediating contextual effects and identify new avenues for disease prevention.

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#### ISEE-1222

##### Air Manganese and PM<sub>2.5</sub> Concentrations in Two Rural Communities of Hidalgo, Mexico

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**Introduction:** As part of the study of the ecosystem health risks due to anthropogenic activities in a Manganese (Mn) mining area of the state of Hidalgo, PM<sub>2.5</sub> measurements were performed at different sampling points in two rural communities, one near by Mn sources and one control, in the period from March to June 2007.

**Objective:** To describe and compare the concentrations of PM<sub>2.5</sub> and Mn between the exposed and control community.

**Methods:** The control community was divided into 9 sampling points and the exposure community into 10. At each sampling point daily (24 hours average) indoors and outdoors measurements of PM<sub>2.5</sub> were conducted and repeated during one week. The monitors used were low-volume equipment (Mini Vol); the filters were analyzed to obtain the concentrations of Mn by Particle induced x-ray emission technique.

**Results:** The exposed community had higher average indoor and outdoor PM<sub>2.5</sub> levels than the control community (51.6 Vs 31.8 indoors; 43.6 Vs 18.1  $\mu\text{g}/\text{m}^3$  outdoors, respectively). Also the exposed community had the higher indoor and outdoor levels of Mn (0.09 Vs 0.02 indoors; 0.11 Vs 0.04  $\mu\text{g}/\text{m}^3$  outdoors). The Mn outdoor levels were higher than indoor levels in both communities. The results indicate that there is a significant difference in both PM<sub>2.5</sub> and Mn concentrations between the two communities.

**Conclusions:** The concentrations of PM<sub>2.5</sub> found in the exposed community are similar to those reported in different parts of Mexico City metropolitan area. The average Mn concentration in the exposed community is twice that recommended by the guidelines of the World Health Organization. Besides, 70% of the measurements were above this limit.

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#### ISEE-1223

##### Influence of Traffic on Local Air Quality in Boston, MA: A Community-University Partnership

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**Background:** Many urban communities are concerned about nearby traffic and the effect it has on local air quality and community health. However, there have been few opportunities for these communities to participate in the design and implementation of studies aimed at addressing these concerns. The Boston neighborhood of Mission Hill is a community faced with increasing congestion given close proximity to major hospitals and research institutions, and also exhibits elevated rates of multiple diseases influenced by traffic-related air pollution. To address concerns voiced by the community, the Mission Hill Health Movement (MHM) and Harvard School of Public Health jointly planned a study to investigate the relationship between different traffic parameters and air quality, with the aim of understanding the primary contributors to spatial and temporal patterns of multiple air pollutants.

**Methods:** The MHM office served as a fixed monitoring site and a base for a mobile monitoring campaign, and Boston-area high school students were recruited and trained to be the mobile monitoring team. At the fixed site, we monitored ultrafine particulate matter, fine particulate matter (PM<sub>2.5</sub>), black carbon (BC), polycyclic aromatic hydrocarbons (PAHs), and nitric oxide (NO), and also collected data on wind speed and direction, temperature, and relative humidity. One traffic monitor was installed on the major roadway immediately outside the MHM office to

collect traffic data classified by axle width (a proxy for fuel class), speed, and gap time. Another traffic monitor counted vehicles on the other major roadway within the community, in a lane traveling toward the intersection of the two major roads. Mobile monitoring included fine and ultrafine particulate matter and PAHs, and was conducted during weekdays, with measurements collected in two two-hour shifts each day. For each shift, the high school students walked for one hour on scripted routes throughout the neighborhood, and stood for one hour at one of twelve locations on either of the major roads counting traffic, measuring traffic flow, and counting the frequency of traffic backups.

**Results:** All pollutants but PM<sub>2.5</sub> displayed clear diurnal patterns with peaks at morning rush hour, although with some variability in patterns corresponding to different traffic sources. PAH and BC concentrations displayed a sharper peak around 8–9 AM with a gradual decline throughout the day, while ultrafine particles peaked earlier and remained elevated throughout the morning. In regression analyses of fixed site data, most traffic parameters were significantly ( $P < 0.05$ ) associated with ultrafine particle counts, with stronger associations for low-speed and diesel traffic. Similar associations were seen for BC, while PM<sub>2.5</sub> had weaker associations with traffic. Mobile monitoring demonstrated the most significant spatial gradients for ultrafine particle counts, with elevated concentrations on the major roads and levels that decreased rapidly with distance into the neighborhood. Beyond findings linking traffic and local air quality, our study demonstrated that having community members play a role in monitoring can heighten the community's awareness about air quality issues, result in the collection of quality data, and spur a dialogue between university researchers and community groups that is useful to both.

#### ISEE-1224

#### Lung Function Growth and Small Airways Structure and Function Assessed by HRCT

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**Background:** Lung function growth is frequently quantified using spirometry in environmental epidemiologic studies of air pollution; however, most studies have focused on the effects of acute exposures on short-term changes in airway function. Findings from the Children's Health Study (CHS), a 15-year study of the chronic effects of air pollution among 11,000 children residing in 13 Southern California communities, indicate that current levels of air pollutants are associated with reduced lung function growth and lower maximum attained measures of airway flows. It is critically important to establish whether the deficits in flows occur as a result of irreversible anatomic changes in the airway structure, size or wall thickness that indicate elevated long-term risk for adverse health outcomes, or whether the deficits arise from potentially reversible physiologic changes that may not influence long-term risk. Developments in lung imaging using High-Resolution Computed Tomography (HRCT) make it feasible to investigate the anatomic relationship between air pollution-associated deficits in spirometric measures of airway flow and permanent changes in the structure and function of the airways.

**Methods:** Previous participants from the CHS were contacted who were old enough to have achieved maximum lung function, had lung function measured by the CHS on at least 2 occasions, and were current residents of communities within 200 miles of Los Angeles. Participants were selected based on the community of residence at the time of participation the Children's Health Study, of which approximately half were from communities with poor air quality. Participants had completed pulmonary function testing within one-year prior to the CT scan. A low dose of radiation (80 mAs) was used that minimized the risk to patients, while maintaining an acceptable image quality. HRCT scans were obtained from

29 previous CHS participants (mean age at scan, 25.0 years; females = 16).

**Results:** Height at HRCT scan was significantly negatively associated with wall area (as a percentage of total area measured) ( $r = -0.37, P < 0.05$ ). The association of sex with wall area percentage approached significance ( $P = 0.06$ ) with females having larger wall area percentage. Wall area percentage was significantly associated with lower FEV<sub>1</sub> ( $P < 0.05$ ). The relationship showed a similar pattern for FVC ( $P = 0.12$ ). We failed to find significant differences in mean wall area percentage between subjects who had resided in more or less polluted communities during their participation in the CHS. We also failed to detect significant associations of average lifetime pollution levels (NO<sub>2</sub>, PM<sub>10</sub>, ozone) with mean wall area percentage.

**Conclusion:** These results suggest that it is possible to assess spirometric deficits in airway flows using HRCT imaging. Further research is needed to investigate whether pollution-associated deficits can be quantified using HRCT.

#### ISEE-1225

#### Nitrogen Dioxide Exposure Inside and Outside of Primary Schools

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**Background:** Spatial studies of air pollution and health often assume personal pollution exposure is based on estimated pollution values at the home address. However increasingly we are aware that in many cases people are exposed to very high levels of pollution in places where they may spend less time than at home, but which may actually contribute a greater proportion of an individual's total daily air pollution dose. For children, a location where they spend a significant proportion of time and which is therefore a potential source of pollution exposure is the school. Schools are of interest as sources of pollution exposure for a number of reasons. Firstly, they are often located near or on busy main roads; secondly, children often spend large periods of their school day time outside (away from any pollution protection buildings could possibly provide); and finally, it could be argued that the compulsory requirement to attend school comes with a social responsibility to provide a 'safe' (non-polluted) environment. It should be noted that in New Zealand there is currently a great deal of public and government debate over the levels of pollution in/or near schools and pre-schools, following a recent decision by the Chief Medical Officer to not allow a daycare centre to open because of poor air quality. This debate is now focusing on how to assess the 'safety' of schools and pre-schools in relation to air quality.

**Methods:** This paper will present the findings of a study into nitrogen dioxide levels in and around ten schools in Christchurch, New Zealand. Sampling, using Palmes diffusion tubes, was carried out during two two-week periods in September and October 2007, one in school term time and the other in the school vacation (to see whether there was a reduction in nitrogen dioxide concentrations in during school vacation periods where traffic numbers would be reduced as a result of no 'school run' travel). Tubes were located in classrooms, in the school grounds and on roads at the schools' perimeter. In addition to the nitrogen dioxide levels other data included ambient real-time measurements collected at a fixed site by the local authority, meteorological data (temperature, rainfall, wind speed and direction), traffic volume, and distance of monitors from main roads. This information was used to determine variations in nitrogen dioxide concentrations using regression and correlation analysis.

**Results and Discussion:** Positive associations were found between nitrogen dioxide concentrations in the school grounds and; the percentage of time that the school was downwind of a main road, the traffic volume on the main road, and the distance from a main road. Indoor levels were generally lower than those recorded outdoors, although at two schools where the classroom was very close to the school car park indoor levels were higher. These findings are useful in assessing school based exposure

and in establishing the effectiveness of indirect measurements as a surrogate for personal exposure in school environments and applying this in areas of similar meteorology.

#### ISEE-1227

##### Comparison of Methods to Assess Dietary Exposure to Polycyclic Aromatic Hydrocarbons and Heterocyclic Amines

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**Background:** Epidemiological studies of dietary exposure to polycyclic aromatic hydrocarbons (PAH) and heterocyclic amines (HCA), carcinogens found in cooked meats, have observed an increased risk of cancer, but results have been inconsistent. The standard practice is to estimate dietary intake of these chemicals from food frequency questionnaires (FFQ) coupled with dietary carcinogen databases. Little is known about how exposure estimates from this method compare with estimates from other available methods, particularly biological markers.

**Methods:** We compared exposure estimates for the PAHs benzo[a]pyrene (BaP) and pyrene and the HCA 2-amino-1-methyl-6-phenylimidazo[4,5b]pyridine (PhIP) derived from the three accepted methods: 1) a meat-specific FFQ administered at two time points one year apart combined with a dietary carcinogen database; 2) diet diaries longitudinally collected at three time points over one year combined with the same carcinogen database; and 3) urinary 1-hydroxypyrene-glucuronide (1-OHPG) as a biomarker for PAH and urinary PhIP measured in overnight urine samples longitudinally collected at three time points concurrent with the diaries. This study was conducted in 54 non-smoking control participants from an ongoing case-control study of colorectal adenoma in Baltimore, MD.

**Results:** For PAHs, the between-method correlation was strongest for BaP intake estimated from the diary-database and urinary 1-OHPG, after excluding participants with evidence of tobacco smoke exposure (elevated urinary cotinine) (Spearman  $r = 0.65$ ,  $P < 0.05$ ). Dietary BaP exposure estimated from the FFQ-database was also statistically significantly correlated with urinary 1-OHPG (Spearman  $r = 0.39$ ,  $P < 0.05$ ). Meat intake alone, as determined by both the FFQ and diaries, was correlated with urinary 1-OHPG (FFQ: Spearman  $r = 0.31$ ,  $P = 0.04$ ; diaries: Spearman  $r = 0.33$ ,  $P = 0.03$ ). Among the three approaches for assessing dietary HCA exposure, a correlation was only observed between the diary-database and urinary PhIP, when the analysis was restricted to values above zero or the detection limit (Spearman  $r = 0.81$ ,  $P < 0.001$ ). The three different approaches for estimating dietary exposure to PAH were moderately correlated, providing confidence in the methods. However, statistically significant correlations were observed between meat intake and urinary 1-OHPG concentration, without incorporating the carcinogen database to estimate BaP exposure. In contrast, PhIP exposure estimates from the three methods were generally not correlated. This may be due to the small number of sampling days, the overall low intake and variability in intake of meat cooked in ways that produce PhIP, or assumptions or deficiencies in the carcinogen database. Further examination of discrepancies between the different methods may provide insight into ways to improve the dietary exposure assessment of PAH and HCA.

#### ISEE-1228

##### Associations Between PBDE Body Burden and Thyroid Hormone Levels in Pregnant Women Participating in the CHAMACOS Study

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**Background:** Polybrominated diphenylethers (PBDEs) are synthetic chemicals used as fire retardants in a number of consumer products including textiles, furniture and electronics. These chemicals, which are persistent, lipophilic, accumulate in biological organisms and biomagnify through the food chain have been measured in human populations in the United States, Canada, Europe and Japan. Animal studies suggest that exposure to PBDEs may result in decreased serum free and total thyroxine (T4), and in some cases in increased thyroid-stimulating hormone (TSH) levels. Only one small study ( $n = 9$ ) has investigated the question in pregnant women and reported no associations. Disruption of thyroid function is of particular significance during pregnancy as thyroid hormone of maternal origin has been shown to reach the fetus in biologically significant amounts throughout pregnancy and since thyroid hormone is essential for normal brain development. Our aim was therefore to determine whether PBDE body burden was negatively associated with free and total T4, and positively associated with TSH levels during pregnancy.

**Methods:** Women enrolled in the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) with enough stored serum for PBDE and thyroid hormone analysis were included in the present study. Women who were  $\geq 18$  years of age,  $< 20$  weeks gestation, English or Spanish speaking, Medi-Cal eligible (state-sponsored health care) and planning to deliver at Natividad Medical Center, the county hospital, were eligible for inclusion in the CHAMACOS study. We measured the concentration of 7 PBDE congeners (IUPAC Nos 47, 85, 99, 100, 153, 154 and 183) using high resolution gas chromatography/high resolution mass spectrometry with isotope dilution quantification (HRGC/HRMS) in serum samples collected at 26 weeks gestation from 288 women. We concomitantly measured total T4 and TSH using immunochemiluminometric assays and free T4 using direct equilibrium dialysis followed by ultrasensitive radioimmunoassays. While free T4 measurements obtained with commonly used immunoassays may be affected by the increased T4-bound protein levels observed during pregnancy, equilibrium dialysis, which physically separates the free from the bound T4 portion, has been shown to yield valid results in these circumstances. We analyzed data using multiple linear regression models to evaluate associations and control for potential confounders.

**Results:** Mean (SD) serum concentrations for free and total T4 were 0.8 (0.2) ng/dL and 10.7 (1.6)  $\mu$ g/dL, respectively. TSH geometric mean (GSD) was 1.2 (1.7) mIU/L. Free and total T4 levels were low in 7 and 10 participants, respectively, while TSH concentrations were high in 15 women. Analysis of pilot data on 24 women suggest that the sum of measured PBDE congeners (median = 20.6 ng/g lipids) in this population was lower than reported by previous U.S. studies but higher than levels observed in Europe and Japan. These data also suggest negative associations between all PBDE congeners but BDE-153 and 183, and free T4 ( $n = 19$ ). Except for BDE-183, results further suggest negative associations between PBDE congeners and total T4. Associations with TSH were inconsistent. We will expand on these results by including data from the full sample.

#### ISEE-1229

##### Spatiotemporal Exposure Assessment of Atmospheric Hydrogen Sulfide Produced by Industrial Hog Operations

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**Background:** Malodor is a common problem near industrial hog operations, which release air pollutants from confinement buildings, fecal waste pits, and fields where wastes are applied as fertilizers. Hydrogen sulfide ( $H_2S$ ), which has a rotten egg smell, is a significant gas released by these facilities. We implemented a method for assessing space/time atmospheric concentrations of  $H_2S$  near hog operations.

**Methods:** We placed active samplers that recorded 15 minute measurements of H<sub>2</sub>S and passive samplers that were exposed for 2 weeks in communities near hog operations. The active samplers allowed us to capture the high temporal variability of H<sub>2</sub>S which is characterized by long periods of low values, interrupted by spikes in concentration. The passive samplers provided a cost effective way to obtain more spatial points. These two data sources were integrated using the Bayesian Maximum Entropy method of non-linear spatiotemporal geostatistics to produce space/time maps of H<sub>2</sub>S.

**Results and Discussion:** We estimated a space/time separable additive mean trend. The spatial component was modeled as the sum of exponential plumes centered at each hog operation with a range of approximately 1.5 km. For the daily temporal component, a sinusoidal curve that peaked at 3:00 am fit the data well. Although chronic H<sub>2</sub>S levels were typically below 2 ppb for any given area, acute spikes in H<sub>2</sub>S concentrations lasting 1–6 hours could reach 50 ppb. Results to date include initial maps that illustrate these fluctuations in H<sub>2</sub>S exposure for residents living in the study area. Spatiotemporal estimates of H<sub>2</sub>S concentration could be used to investigate correlations between air pollutants and symptoms reported by neighbors of hog operations. However, modeling concentrations in the study region is difficult due to the high density of hog production facilities. Because of a lack of measurements at the same locations throughout the year we were unable to uniquely decompose seasonal trends. Even with these limitations, this work should help improve assessment of atmospheric H<sub>2</sub>S near industrial hog operations and provide a foundation for a more comprehensive study regarding the space/time variations in atmospheric H<sub>2</sub>S.

#### ISEE-1230

#### Spatial and Temporal Variation in Polycyclic Aromatic Hydrocarbon Concentrations, Based on Personal, Indoor, and Outdoor Monitoring Among Non-Occupationally Exposed Pregnant Cohort

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**Objectives:** In a cohort of pregnant women in Krakow, we (1) examined the contribution of behavior patterns, housing characteristics, meteorological conditions, and non-stationary sources to the indoor/outdoor ratio for the nine PAHs; (2) identified markers associated with the ambient and non-ambient sources; and (3) identified predictors of the outdoor PAHs.

**Methods:** Pregnant women (n = 341) were monitored for their personal exposure to airborne benz(a)anthracene, chrysene/isochrysene, benzo(b)-fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene and pyrene for 48 hours during the late 2<sup>nd</sup> trimester. In a subset of women, residential indoor (n = 76) and outdoor monitoring (n = 70) were conducted simultaneously using an identical device.

**Results:** The mean indoor/outdoor (I/O) ratios of all PAHs were lower than 1 even among homes reporting PAH sources other than environmental tobacco smoke (ETS). The mean I/O ratios were markedly below 1 during the winter even for those who reported 5+ hours of daily ETS, suggesting that the outdoor generated PAHs overwhelmed the indoor sources. For the households located near an industrial plant, the outdoor benz(a) anthracene, benzo(b) fluoranthene, benzo(k) fluoranthene and chrysene levels were markedly higher than the indoor levels (mean I/O ratio = 0.36–0.57), compared to those who do not live near the industrial plant. Use of coal/wood furnace for home heating, living near bus depot or the cross-roads, time spent outdoor, or transit, respectively, and not using the exhaust fan use during cooking were not associated with significant reductions in mean I/O ratio for benz(a)anthracene, benzo(b)fluoranthene,

benzo(k)fluoranthene and chrysene. Within the homes with ≥5 hours/day ETS exposure during non-heating months, benzo(g,h,i)perylene, benzo(a)pyrene and indeno(1,2,3-c,d)pyrene show highest median ratios during the non-heating season, although all eight carcinogenic PAHs, except dibenz(a,h)anthracene have median I/O ratios >1. During the heating months, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene and chrysene demonstrate highest [outdoor–indoor] concentration difference (ng/m<sup>3</sup>) with larger interquartile range and higher median among those near the industrial plant, compared to those not near the plant. Thus, benzo(g,h,i)perylene, benzo(a)pyrene and indeno(1,2,3-c,d)pyrene are proposed as non-exclusive markers of ETS, while benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene and chrysene are proposed as markers of the outdoor sources. The estimated infiltration efficiencies of the eight carcinogenic PAHs are high, ranging between 77–92%. Temperature and wind speed are associated with a significant increase in the outdoor concentration of the nine PAHs and summed eight carcinogenic PAHs ( $\Sigma$ 8 c-PAHs). A one degree Celsius decrease is associated with a 15% (95%CI, 12–17%) increase in the outdoor  $\Sigma$ 8 c-PAHs concentration. A one meter/second decrease in wind speed is associated with a 58% increase in  $\Sigma$ 8 c-PAHs concentration.

**Conclusion:** These results highlight the important contribution of ambient PAHs to both personal and indoor exposure to PAHs. Since PAHs from coal and other fossil fuel burning are ubiquitous world-wide, the findings support the reduction of ambient PAH levels to protect the developing fetus and child as a susceptible population.

#### ISEE-1231

#### Determinants of Exposure in Households Cooking with Biomass in Ghana

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**Objective:** Globally, approximately 3 billion people cook with biomass and solid fuels, which accounts for about 1 million deaths in children under five (WHO 2006). We have been gathering information about exposures to smoke from cooking with biomass fuels in rural Ghana in support of a research project to investigate whether maternal exposures during pregnancy renders the developing infant more predisposed to early respiratory morbidity and mortality. Here we report on determinants of personal exposure to air pollution through detailed exposure assessments including air monitoring and surveys on cooking practices and behaviors.

**Material and Methods:** Data were gathered in the Kintampo region of central Ghana between July and December 2007 as follows: 1) a brief cooking survey on fuels, stove, and kitchen-type was administered to 12,418 households participating in the Kintampo Demographic Surveillance System (KDSS) from July through November 2007; 2) researchers recruited random subset of 440 KDSS households and conducted extended surveys aimed at gathering information on cooking practices as well as the cook's baseline respiratory status (using the validated ATS Adult Questionnaire, 1978); 3) in a sub-sample of 36 non-smoking households, researchers collected one 24-hour integrated particulate matter (PM<sub>2.5</sub>) kitchen sample, as well as one integrated and one real-time personal sample. Gravimetric filters were pre- and post-weighed for PM<sub>2.5</sub>, as well as analyzed for black carbon. Predictors of real-time personal and integrated kitchen air samples were analyzed, including cooking behavior, fuel, stove and kitchen ventilation characteristics (indoor, semi-enclosed, outdoor).

**Results and Conclusions:** Results from the KDSS module showed that wood is the primary cooking fuel (77.8% of households), followed by charcoal (19.1%). Virtually all of the households cooking with wood did so using a traditional, open three-stone or mud stove. With respect to kitchen types, a majority (56.7%) of households reported their main

cooking area to be located outdoors, 24% reported a semi-enclosed cooking area, and 17% reported a fully enclosed area. The 24-hour mean  $PM_{2.5}$  concentrations in the kitchen areas was  $421 \mu\text{g}/\text{m}^3$  (SD 367) while the 24-hour integrated personal exposure mean was  $125.8 \mu\text{g}/\text{m}^3$  (SD 76.7). Preliminary results show that personal exposure to biomass smoke (as measured by  $PM_{2.5}$ ) exhibits considerable between-subject variability. Our expectation that kitchen type would have a measurable impact on exposures, however, was not supported by the data. Rather the data suggest that ethnicity and fuel type are the main drivers of exposure. If indeed exposure to biomass smoke is largely predicted by behavioral patterns, this would constitute a critical factor in the design and implementation of interventions and educational campaigns to alleviate exposures in developing countries around the globe.

#### ISEE-1235

#### The Effects of Maternal Exposure to Disinfection By-Products in Drinking Water on Small for Gestational Age Births

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**Background:** Public health initiatives to disinfect drinking water throughout the past century have drastically reduced waterborne diseases. However, epidemiological studies have found associations between disinfection by-products (including trihalomethanes) in drinking water and small for gestational age (SGA) births, although the strength and magnitude of this relationship is not yet clear.

**Methods:** We obtained births data from the NSW Health Department's Midwives Data Collection. Drinking water quality data was obtained from one water authority supplying water to residents of regional NSW. Monthly data on total and each of four trihalomethanes in drinking water was available in each of the discrete water distribution zones serviced by the water authority. We selected only those births whose mother's geocoded usual residential address was within one of the drinking water distribution zones and calculated trimester and entire pregnancy average trihalomethane exposures using the monthly water distribution zone concentrations. We used ordinary logistic regression models to control for maternal, infant and area level factors and trends (including maternal smoking, maternal country of birth, parity, pre-eclampsia, gestational diabetes, maternal age, antenatal care, maternal aboriginality, socio-economic status, season of birth) associated with SGA births (defined as below the third percentile of birth weight for gestation and gender). We assessed the effects of total and the four trihalomethanes in separate multivariate models.

**Results:** The 40,511 consecutive, singleton births in the study region between 1998 and 2004 included 977 (2.41%) SGA births. Multivariate analysis found an interquartile range (IQR) increase of  $13 \mu\text{g}/\text{L}$  in bromodichloromethane over the entire pregnancy was associated with a 15% increase in the risk of SGA births (adjusted odds ratio 1.15 [95%CI: 1.02, 1.30]) with similar results for the first and third trimester. An IQR increase of  $38 \mu\text{g}/\text{L}$  in total THM in the entire pregnancy was associated with a 20% increase in the risk of SGA births (adjusted odds ratio 1.20 [95%CI: 1.03, 1.38]) with a similar result in the first trimester. Dibromochloromethane and chloroform showed similar positive associations with SGA births but we found no association with bromoform.

**Conclusion:** Maternal exposure to trihalomethanes in drinking water during pregnancy is associated with an increased risk of small for gestational age births.

#### ISEE-1236

#### Accuracy Assessment of Long-Term Exposure Estimation Using Modern Geostatistics

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**Background and Discussion:** In recent years, long-term exposure to ambient pollutants has been shown to be a critical etiological factor for many chronic diseases. For health administration purposes, it is essential to address the long-term air pollution exposure level of the general population in a space-time context. Geostatistics has been widely applied in the spatial estimation of short- and long-term exposure studies. However, the commonly used upscaling technique that derives long-term exposure estimates from the average of short-term ambient pollution observations (daily or hourly data) may over-smooth the actual heterogeneity of the exposure pattern at the smaller time-scale. This simplification can seriously question the accuracy of the generated long-term exposure estimates across space-time. To our knowledge, there exists no systematic geostatistical analysis of the accuracy assessment of long-term exposure estimates. In this study, we use the Bayesian Maximum Entropy (BME) method of modern geostatistics to estimate the spatial and spatiotemporal distribution of monthly and annual  $PM_{10}$  exposures from daily and hourly data in North Carolina state (USA) and in Taipei city (Taiwan). BME estimation is performed in two distinct environments: relatively rural and high degree of urbanized areas. Valuable insight was gained by assessing and comparing the long-term exposure estimation accuracy under different real-world scenarios.

#### ISEE-1238

#### Biohazard Evaluation for Hospital Workers

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**Objective:** This study attempted to evaluate biohazards for workers in hospitals in Taiwan.

**Material and Method:** A questionnaire was administered to 3305 clinical staff and 1919 administrative staff in 12 hospitals reporting their health condition and biohazard diseases. The clinical staff included physicians, dentists, nurses, and technicians, while the administrative staff included office workers, accountants and cashiers. The effective questionnaire recovery rate was 63.8% for the 8188 workers in the 12 hospitals. Student  $t$  and  $\chi^2$  statistics were used to compare personal covariates between clinical and administrative staff. Logistic regression was employed to identify correlations between biohazard risk and job title. The level of statistical significance was set to  $\alpha = 0.05$  for all tests. Data analyses were performed using the SAS 9.1 statistical package.

**Results:** The prevalence rates of bronchitis, faecitis, pneumonia, allergic rhinitis varicella, urticaria and hepatitis B among clinical staff were significantly higher than for administrative staff, respectively. The clinical staff had a 2.66-fold higher risk of suffering tuberculosis than administrative staff (odds ratio = 2.66, 95%CI = 1.08–6.57). Moreover, the clinical staff had a 2.45-fold higher risk of suffering pneumonia than administrative staff (odds ratio = 2.45, 95%CI = 1.55–3.89). Additionally, the clinical staff had a 1.51-fold higher risk of suffering from hepatitis B than administrative staff (odds ratio = 1.51, 95%CI = 1.08–1.93). The clinical staff had a 1.43-fold higher risk of suffering from faecitis than the administrative staff (odds ratio = 1.43, 95%CI = 1.13–1.18).

**Conclusion:** The biohazard disease risk in clinical staff exceeded that in administrative staff. Biohazard prevention thus should be strengthened in hospitals in Taiwan.

**ISEE-1239****Mercury Exposure Assessment in Informal Gold Miners**

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**Background:** In Mongolia, the Government has implemented the Gold -I. II programmes since 2000, encouraging domestic and foreign investment in gold mining. As a result, the number of gold mines reached 153 and annual gold production has doubled, reaching 11.6 tonnes by the year of 2006. Moreover, the Mongol Bank started to purchase gold from individuals due to the rapid increase of informal gold mining in this sector since 2002. There are 30000 informal gold miners nationwide.

**Objective:** The main objective of the survey is to determine total mercury concentration in urine and hair; to study work exposure of informal gold miners.

**Methods:** A total of 44 informal gold miners (exposed) and 160 (core) women aged 15–35 were covered in the survey. The core group was selected randomly for comparing the general distribution of mercury exposure among women population aged 15–35 from 4 villages (Khongor, Khushaat, Bornuur, Jargalant). The mercury concentration was measured in urine by Lumex-machine, and AAS was used for determination in hair samples at Minamata Disease National Research Center, Japan. Mean concentration of mercury, descriptive statistics, and hypothesis tests were conducted on the observational data using SPSS 12. Data were tested for normality and one-sample t-test with mercury content variances in bio-samples differed significantly between core and exposed group.

**Results:** The mean concentration of mercury was estimated at 0.06 µg/g in root (hair taken from scalp 3 sm) and 0.055 µg/g in tip among women of Khongor sum. In the reference group, sum mercury was measured at 0.111 µg/g in root, 0.080 µg/g in tip. The mean Hg was determined to be 0.156 µg/g in urine for the core group of Khongor sum, and 0.1551 µg/g in urine for the reference sum by AAS. Mercury concentration in hair and urine sample is within recommended levels, and there was no statistical difference ( $t = 1.2$ , CI-95.0) between Khongor and Hushaat sum. The content of total mercury was measured in urine by Lumex-machine on site: the mean was 3.36 µg/g in the core group, 10.58 µg/g in the exposed group of Bornuur sum, and 2.975 µg/g core and 8.606 µg/g exposed in Jargalant sum.

**Conclusion:** 1) Informal gold miners of Bornuur and Jargalant sum were exposed to metal mercury. 2) The total mercury concentration was within WHO recommended levels at the core group of Khongor and Khushaat sums, but higher in the core group in Bornuur and Jargalant sums. 3) There is a need to prohibit the usage of mercury in gold mining and to treat exposed informal gold miners and affected residents.

**ISEE-1240****Chronic Arsenic Exposure and Dermatological Lesions, Hypertension and Chromosomal Abnormalities: An Epidemiological Study**

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**Background:** Chronic exposure to arsenic compounds is a major concern to public health issues in developing and developed countries. The aim of this study was to investigate the effect of chronic exposure to arsenic on dermatological lesions, hypertension and chromosomal abnormalities in a region in the northwest of Iran.

**Methods:** We investigated the occurrence of dermatological lesions, hypertension and chromosomal abnormalities in two groups: 101

subjects with chronic exposure to arsenic in drinking water, and 107 subjects with no exposure. Daily/yearly absorbed amount of arsenic were calculated for all subjects. Cumulative arsenic index for each individual was then estimated on the basis of age, water consumption and residence status.

**Results:** Mean systolic blood pressure in exposed group (137, 95%CI: 132–142) was significantly different from non-exposed group (107, 95%CI: 99.9–114). The same difference was observed for diastolic blood pressures (exposed: 82, 95%CI = 79–85; non-exposed: 71, 95%CI = 66–75). The incidence of hyperkeratosis was 34 times higher among exposed group compared to control group (OR = 34,  $P < 0.001$ ). A significant difference was also observed in the occurrence of skin pigmentation between two groups (OR = 2.4,  $P < 0.007$ ) as well as location and severity of those pigmentations. Twenty five percent of exposed group showed chromosomal abnormalities ( $P = 0.05$ ).

**Conclusions:** Arsenic exposure was found to be a serious health problem demanding an attention and specific health care including safe drinking water. Educational programs are recommended for local general practitioners and exposed communities about the nature, diagnosis and treatment of the lesions and disorders. Geo-coding of contaminated areas and monitoring the contamination rate of soil and agricultural products in arsenic contaminated areas may also help to prevent further problems in the region.

**ISEE-1241****Association Between Maternal Serum Concentration of Folic Acid and Infant Birth Weight: Hokkaido Birth Cohort Study on Environment and Child Health in Japan**

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**Objective:** A number of reports have found insufficiency in maternal serum folic acid causes infant abnormalities such as neural tube defects and congenital heart disease. Recent studies have also addressed the lack of serum concentration of folic acid in pregnant woman as a potential risk factor of under-nourished embryos. Undernourishment in prenatal period is likely to reduce infant body size as well as result in cardiovascular disease and diabetes during adolescence and young adulthood, as a number of researchers have recently shown. Thus, decreased levels of maternal serum folic acid are an important public health issue. To determine associations between maternal serum concentration of folic acid and infant birth weight among mothers with and without folic acid supplementation, we conducted the present sub-study within the Hokkaido study on environment and child health, which is the largest-scale prospective birth cohort study in Japan.

**Method:** The cohort has so far recruited more than fourteen thousand pregnant women during their first visit for prenatal healthcare at forty obstetric establishments ranging from university hospitals to community-based clinics around the region of Hokkaido. Among all the participants, the data on 5,346 pregnant women regarding maternal serum folic acid and lifestyle such as smoking habits during pregnancy through self-administered questionnaires were made available for the study. Excluding cases with diabetes, pregnancy-induced hypertension, thyroid disorders and persistent intake of drugs for epilepsy, ulcerative colitis, and Crohn's disease that were likely to reduce infant birth weight, 3361 mothers and infants were selected for analysis. In the analysis of the association between maternal serum folic acid level and infant birth weight, concentrations of folic acid were divided into quartiles, with cutoff points of 5.8, 7.1, and 8.8 ng/ml. Statistical analysis was performed using the Kruskal-Wallis and Mann-Whitney tests with Bonferroni's adjustment as

well as multiple linear and logistic regression, using the SPSS 13.0 statistical package.

**Results:** There was a significant association ( $P < 0.001$ ) between maternal serum folic acid level and smoking during pregnancy as well as level of schooling and annual income. In the logistic regression analysis, smoking during pregnancy increased the risk of the occurrence of infant birth weight less than 2500 g (OR:1.91; 95%CI;1.37–2.66). Mothers with the folic acid and/or vitamin supplementation had a significantly higher ( $P < 0.001$ ) concentration of serum folic acid in comparison with mothers who had taken no supplement. When analyzing with the multiple linear regression model adjusted for maternal and infant variables, maternal serum concentration of folic acid in the lowest quartile (less than 5.8 ng/ml) had a significantly negative relationship with infant birth weight, as seen not among mothers with folic acid supplement, but among mothers without the supplement.

**Conclusion:** Supplementation including folic acid may increase maternal serum folic acid levels, while smoking during pregnancy is likely to decrease serum folic acid and result in reducing infant birth weight. Folic acid supplementation should be recommended for all mothers before and after delivery as well as for infants so as to prevent low birth weight that can cause adverse perinatal and adult health outcomes.

#### ISEE-1242

#### Reported Ill Effects and Perceptions of the Dangers of Passive Smoking Among Indoor and Outdoor Workers in Bars in Ibadan, Nigeria

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**Background:** Exposure to passive tobacco smoke can occur at home, work and in public places and has been linked to a variety of health outcomes. Workplace exposure as occurs in indoor bars and restaurants in Nigeria are the major areas where workers get exposed to such.

**Objective:** This survey was conducted to compare the immediate reported health problems between a selected group of indoor bar workers and outdoor bar workers and evaluate their perceptions of about the dangers of passive tobacco smoke. The study included a self-reported component of general health feeling, common ailments and the number of sick days off work.

**Methods:** Interviewer-administered questionnaires were used for the study. The questionnaires had sections on knowledge about health effects of passive tobacco smoke and health problems of respondents as well as their attitude towards passive smoking.

**Results:** The median duration of exposure to passive smoking was 2.5 months (range 1–13 months) in the indoor group. Seventy-nine respondents in the indoor group (83%) reported a poor health feeling as against 15 (15%) in the outdoor group. Cough and nasal irritation were reported in 10 (11%) of the workers in the indoor areas as against 8 (8%) in the outdoor areas ( $P = 0.042$ ). Skin irritation were reported in 7 (6.2%) of those in the indoor areas as against 7 (7.0%) in the outdoor areas ( $P = 0.11$ ), while acute eye irritation and watery discharges were reported in 14 (15%) of workers in the indoor areas as against 7 (7%) in the outdoor areas ( $P = 0.015$ ), and nausea in 8 (9%) and 2 (2%) in indoor workers and outdoor workers respectively ( $P = 0.03$ ).

**Conclusion:** The reported health feeling and common ailments among this group of workers point to the fact that indoor exposure to passive smoking may have impacted on the health of the workers. More elaborate measurement of suspended particulate matter and respiratory function may be of help in future studies.

#### ISEE-1243

#### Summer 2007 Heat Waves in Rome: Results of the Prevention Programme Based on General Practitioner Surveillance

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**Background and Objective:** Since 2006, within the national network for prevention of the heat-health effects, a programme of active surveillance of high risk patients by their General Practitioners (GPs) was implemented in Rome. The objective of this study is to evaluate the impact of GPs prevention programme during summer 2007 by comparing summer mortality between patients included and not included in the surveillance programme.

**Material and Methods:** Elderly patients with different risk levels were identified on the basis of demographic and health information (1–2) retrieved from population registries and health information systems. The participation of GPs to the programme was on voluntary basis. GPs contributed to the definition of the high risk population by reviewing the lists of patients selected through local information systems; during the summer, GPs actively monitored patients through specific interventions: changes in pharmacological treatment, phone calls and home visits, home-based treatments, facilitated access to nursing and residential homes. The Relative Risk (RR) of death during heat wave versus non-heat wave days was computed stratifying for patients included/not included in the surveillance programme.

**Results:** Out of 2550 GPs working in Rome 489 (19.2%) participated in the surveillance programme. Among the 565743 residents in Rome aged 65 years and over, 28229 (5.0%) subjects were identified to be at high risk on the basis of health information systems. GPs received the list of their own patients and reviewed the list including patients considered at risk but not identified by the procedure. Patients included in the surveillance programme ( $N = 12939$ ) were mainly aged  $\geq 75$  years, not self-sufficient people, and with mental and/or physical disorders. During heat wave days ( $N = 38$ ), 138 and 1703 deaths occurred among patients included and not included in the programme, respectively. An excess mortality of 7% in patients included in the programme and 13% in those not included was observed when comparing heat-wave days with other days; the greater increase in mortality was observed among individuals classified at high risk but not included in the surveillance programme (+32%).

**Conclusion:** An innovative intervention for prevention of the heat-health effects based on GP's surveillance activity was introduced in Rome although the involvement of GPs was low. These preliminary results suggest that the GPs' surveillance programme might reduce the impact of heat waves on health of high risk population. Further studies are necessary to evaluate the impact of prevention programmes to reduce mortality during heat waves.

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#### ISEE-1244

#### Assessment of Active and Passive Smoking in Different Stage of Pregnancy—Results of Prospective Study in Lodz Region

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**Background:** Active smoking and exposure to environmental tobacco smoke is still a significant public health problem. Based on the data from epidemiological studies, we can assume that about 20–30% of women actively smoke during pregnancy. Such exposure is associated with poor pregnancy outcome including increased risk of spontaneous abortion,

placenta previa, abruptio placenta, preterm premature rupture of membranes, stillbirth, low birth weight, preterm delivery and sudden infant death syndrome. The recently conducted studies also indicate that prenatal exposure to tobacco smoke is a risk factor for respiratory infections, asthma, allergy, childhood cancer, and it has neurobehavioral consequences regarding children's health. The risk for most of these conditions has been found to increase with the number of cigarettes smoked. On the other hand women who stopped smoking early in pregnancy are at the lower risk for most of those pathologies. The assessment of exposure to tobacco smoke in different periods of pregnancy is important as it is the first step in the evaluation of influence of such exposure on pregnancy outcome.

**Objective:** The objective of the study was to analyze the active and passive smoking by pregnant women in different weeks of pregnancy and assess the reliability of smoking status and exposure to ETS based solely on interview.

**Methods:** Study population consisted of 204 women enrolled before 22 weeks of pregnancy. Mean age of women was 26.6 years (range 17–42 years), educational status was as follows: primary or vocational –32%, college –40%, university –28%. The women were interviewed three times during pregnancy. From all women included into the study the saliva sample was collected three times to verify smoking status in pregnancy. Cotinine level in saliva was analyzed using Liquid Chromatography with Tandem Mass Spectrometry. Statistical analysis was based on finite mixture regression model which allowed us to identify distributions of cotinine concentration for groups of women with different smoking status. AIC criteria were used for identification of number of groups. We compared information on tobacco smoke exposure from interview with cotinine levels as gold standard to assess its reliability.

**Results:** Based on regression model for cotinine level in saliva the 3 groups of women were identified. Sixty seven percent of women were in the non-smoking category with the mean cotinine level 2.4 ng/ml (95%CI 0.6–9.6), 10% in the category of ETS exposed or irregularly smoking women with mean cotinine level 50.2 ng/ml (95%CI 13.5–187.1) and 23% were classified as regularly smoking women, with the mean cotinine concentration 171.8 ng/ml (95%CI 63.9–461.9). In the end of pregnancy the percentage of nonsmoking women was 3% higher comparing to the status noticed at enrollment which indicate that about 10% of women quit smoking within pregnancy. Specificity of interview as measurement of exposure to tobacco smoke was 100% but sensitivity was only 60%.

**Conclusions:** We estimated that 33% of pregnant women were exposed to tobacco smoke. Only about 10% of women quit smoking during pregnancy. Sensitivity of interview as measurement of exposure to tobacco smoke was 60%.

#### ISEE-1245

##### Predicting Vulnerability to Heat: Summer 2007 and 2008 in Rome

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**Background and Objective:** Heat is now widely recognized to be associated to short term increases in daily deaths, and many European countries are developing programs to prevent its negative effects. In order to target prevention strategies towards sub-groups at higher risk, a criterion for the classification of subjects according to their level of vulnerability to heat was developed. Objective of this study is to present the analysis of mortality during the summer 2007 in Rome, by level of vulnerability, to underline limits and pitfalls of this method of classification, and to propose some major changes for summer 2008.

**Methods:** On the basis of the results of a case-crossover study and the analysis of summer 2003 mortality in four Italian cities, variables composing the vulnerability indicator are: gender, age, marital/family status, previous two years hospital admission for a selection of heat-

related causes, and the socio-economic level of the area of residence. An overall score is computed, and each person is allocated in one of the four risk categories (low, medium, high and very high). Summer mortality was analysed by level of vulnerability, age and gender. For each level of vulnerability the exposure-response curve of the relationship between maximum apparent temperature and daily mortality was described. Relative risks of dying during heat-wave days vs non-heat wave days were computed by level of vulnerability and gender. The relative risk of dying among the higher risk subjects compared to the low risk group was analyzed only during heat wave days.

**Results:** Among the 565743 residents in Rome aged 65 years and over, 28229 (5.0%) subjects were identified to be at high risk on the basis of information from local health information systems. The levels of the indicator are unbalanced by gender, with more female in the higher risk levels. Exposure-response curves show a higher impact of temperature on mortality for the medium-high and high levels groups, suggesting that the indicator appropriately discriminates subjects more vulnerable to temperature changes. An increasing trend in mortality by level of risk is more evident among males than females (Males: RR = 1.19,  $P = 0.9$  in medium-high vs low level; 1.95,  $P = 0.8$  among high risk vs low level. Females: RR = 1.03,  $P = 0.9$  in medium-high vs low level; 1.42,  $P = 0.6$  among high risk level vs low level). During heat wave days, the risk of dying is about six-times higher among those at medium-high risk, (RR = 5.71;  $P < 0.001$ ) and eight-times higher for those at high risk (RR = 8.03;  $P < 0.001$ ) compared to those at low risk.

**Discussion:** The indicator has shown to clearly discriminate subjects according to their level of vulnerability to extreme temperatures. However our results have suggested some refinements in the definition of the score to be used for the next summer: specifically the score attributed to be a woman and to different pathologies will be reviewed. Furthermore, the recent availability of current data on pharmacological treatments will allow us to include this information in the total score. The new score results for summer 2008 will be presented.

#### ISEE-1246

##### Dermal Exposure to Pesticides Among Women Working in Polish Greenhouses After the Restricted-Entry Intervals Expired

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**Background:** The widespread use of synthetic chemicals after Second World War has revolutionized agricultural practice. Pesticides are a broad group of heterogeneous chemicals, which are used to kill insects, weed, fungi and rodents. Despite the fact that before introduction on the market the potential human toxicity of new every compound is carefully assessed, they are suspected of being related to various health problems. Pesticides may enter to the body by dermal absorption, inhalation or oral absorption. A measurement of exposure level and exposure scenario is especially important among people who are not directly involved in the process of spraying.

**Objectives:** The objective of the study was to assess the exposure to selected pesticides of workers tending and harvesting greenhouse cultivations and biological protection workers after the restricted-entry intervals expired.

**Methods:** Exposure assessments were conducted among women tending and harvesting vegetables and biological protection workers at vegetable production greenhouse in Poland. A total of twenty two women were recruited to participate in the study. The exposure assessment methods were used to estimate workers' exposures to selected pesticides after the restricted-entry intervals expired. From the list of the most frequent used pesticides three were selected for the analysis: hexythiazoks, azoksyrobin, imazalil. Cotton gloves and patches on chest and arms were used during whole shift of work in greenhouse. Pesticide exposure evaluation included deposition on clothing patches and gloves as a

surrogate for skin deposition. Measurements of pesticide concentrations in gloves and patches were performed with liquid chromatography and mass spectrometry technique (LC-MS/MS). The linear regression model with random effect was used to assess differences between pesticide concentration in women tending and harvesting vegetables and biological protection workers. Results are adjusted for between batch variability of measurement error.

**Results:** All pesticides (hexythiazoks, azoksyrobin, imazalil) were found on cotton patches and gloves. No differences in the concentrations of hexythiazox or azoxystrobin spraying were observed. The lower concentration of active ingredients used on patches and gloves was after exposure to imazalil spraying ( $<0.001$ ). The concentrations of active ingredients on patches and gloves between sprayings were proportional to the concentration of active ingredients used during sprayings. There were no differences in pesticides concentration on patches between women tending, harvesting vegetables and biological protection workers. On other hand statistically significant differences were found on cotton gloves ( $P = 0.003$ ). The biological protection workers had lower level of active ingredients on patches and gloves than women tending and harvesting vegetables.

**Conclusion:** Dermal exposure of women to pesticides during work in a greenhouse takes place even when employees are not engaged in the process of spraying.

#### ISEE-1247

#### Estimating Indoor Radon Exposure and Excess Risk of Lung Cancer

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**Objective:** We consider the assessment of the lung cancer risk from indoor radon in a population on a national level. The lung cancer risk is assumed to be linearly associated to the radon level, and the arithmetic mean (AM) reflects the lung cancer risk rather than the geometric mean (GM). In an epidemiological study in Sweden, the radon exposure was measured and the over-risk of lung cancer from radon indoors was estimated, using a weighted mean to adjust for the fact that the sample is not proportional to the population in different parts of Sweden (that has different background exposure of radon).

**Material and Methods:** We used data from a large Swedish case-control study (Pershagen et al. 1994), including 1360 men and women (aged 35 to 74, with lung cancer diagnose). Two control groups ( $n = 1424 + 1423$ ) were randomly selected from the same municipalities. Radon levels were measured in dwellings occupied by the study subjects for at least two years. The measurements were made around 1990. A logarithmic transformation is applied to the radon data and a population weighted GM is estimated, using weighted least square regression. The weighted GM cannot directly be transformed to a population weighted AM. Therefore we used a numeric integration in the risk assessment.

**Results:** The unweighted AM is  $106 \text{ Bq/m}^3$ . Using previous results on risk estimation, we assume that an increase of the radon level by  $100 \text{ Bq/m}^3$  results in an increase of the risk of lung cancer by 15% (Lagarde et al. (1997), Darby et al. (2005)). From this we estimate that, out of 3000 cases of lung cancer, 410 can be attributed to indoor radon. If we instead perform a numeric integration of the lognormal distribution ( $\text{GM} = 60 \text{ Bq/m}^3$ ), the result indicate that 400 cases are resulting from indoor radon. After taking the population density into account, a weighted GM is  $54 \text{ Bq/m}^3$ . The numerical integration estimates that 365 cases of lung cancer are attributed to indoor radon.

**Conclusions and Discussion:** When estimating exposure on a national level, the total risk factor must take into account the population density. This can be done easily by weighting. However, it is not straight forward to transform the weighted GM to a weighted AM. A numerical integration is a feasible way to get a risk estimate without losing the weighting. After accounting for population density, the number of lung cancer cases

attributed to indoor radon is lower. One explanation is that, by weighting, we assign high weights to areas with high population density. In several of these areas the indoor radon exposure is relatively low.

Darby, S. et al (2005). *British Medical Journal* 330(7485): 223. Lagarde, F. et al (1997). *Health Phys* 72: 269–276. Pershagen, G. et al (1994). *New England Journal of Medicine* 330: 159–164.

#### ISEE-1248

#### Health Effect Estimates from Kriged Exposures Depend on Spatial Structure

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**Background:** Recently many observational studies have incorporated heterogeneity of air pollution over space by predicting ambient concentration using kriging. More research is needed to better understand how kriging predictions affect health effect estimates. The underlying true exposure distributions (as defined by geographical predictors and spatial correlation structure) have an important role to play in this understanding. This simulation study investigated performance of health effect estimates from kriging prediction as a function of spatial structure.

**Methods:** True annual individual  $\text{PM}_{2.5}$  exposure and associated time to cardiovascular event were simulated for ten thousand hypothetically-sampled subjects in the LA urbanized area. To examine different spatial structures of the underlying  $\text{PM}_{2.5}$  distribution, we specified forty-two true exposure models. These models were decomposed into a mean and a covariance model. Parameters initially obtained from data analysis and previous studies were expanded in order to examine a variety of spatial structures. We assessed two different mean models and twenty-one covariance models. Half the true exposure models included spatially dependent mean structure, represented as linear and quadratic terms of longitude and latitude. The other half had constant mean. Under an assumed spherical covariance model, we evaluated combinations of range and partial sill parameters to capture small vs. large spatial correlation (range varied from 10 km to 500 km) and small to large variability (partial sill varied from 0.1 to 90). We assumed no residual local scale variability (nugget). To assess the impact of exposure distribution on inference in a health model, we predicted individual  $\text{PM}_{2.5}$  exposure by kriging simulated realizations of  $\text{PM}_{2.5}$  at monitoring sites. We compared health effect estimates (relative risk of cardiovascular effect) conditional on true vs. kriged individual  $\text{PM}_{2.5}$  across spatial structures.

**Results:** Exposure distributions with more spatial structure produced better predictions of  $\text{PM}_{2.5}$ . Specifically, means of mean square prediction errors and variances for kriged  $\text{PM}_{2.5}$  were smaller for increasing spatial correlation and/or addition of geographical predictors. Likewise, health effect estimates conditional on predicted exposures had better properties for exposure distributions with more spatial structure. Estimated relative risks given kriged  $\text{PM}_{2.5}$  gave coverage probability closer to 95 percent and smaller mean square error as spatial dependence increased. Spatial structure improved the results whether it was in the mean model, in the covariance model (with higher spatial correlation), or both. In particular, mean square error decreased dramatically with the addition of a second order mean model. We observed interesting relationships between summary properties of the exposure predictions and the health effect estimates across the underlying exposure distributions. Mean square prediction error of kriged  $\text{PM}_{2.5}$  relative to variance of true  $\text{PM}_{2.5}$  was negatively correlated with coverage probability and positively associated with mean square error of estimated relative risk.

**Conclusion:** More spatial structure in air pollution produced better kriging predictions of exposure as well as better health effect estimates. This result held regardless of whether the structure was captured in the mean or the covariance model.

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**ISEE-1249****Incorporation of the Infant Breast Milk Exposure Pathway into an Exposure and Risk Assessment Model**

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**Background:** The Clean Air Act requires the U.S. EPA to assess the residual risk from the continued emissions of hazardous air pollutants (HAPs), including dioxins and mercury, from source categories regulated under section 112(d) of the CAA. To this end, ICF and EPA have developed a comprehensive exposure and risk modeling framework to evaluate inhalation and ingestion exposures and risks. The residual risk modeling framework uses EPA's TRIM.FaTE model to estimate media concentrations of HAPs. Algorithms from EPA's *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* are used to estimate non-breast milk ingestion exposures. Exposure levels in media and foodstuffs are used to calculate lifetime cancer risk or chronic non-cancer hazard quotients.

**Objective:** Recent biomonitoring data confirms the presence of hazardous chemicals such as dioxins and mercury in human breast milk. However, the breast milk exposure pathway often is not included in exposure and risk assessment models that are used for regulatory purposes. The goal of this project is to incorporate the breast milk exposure pathway into EPA's residual risk modeling framework.

**Methods:** A literature review was conducted to identify existing infant breast milk exposure algorithms. Comparative analyses were conducted to determine which equation provides the most reasonable basis to estimate contaminant concentrations in breast milk. The infant average daily dose equation added to the residual risk modeling framework is a linear kinetic model that uses three categories of data to estimate dose including chemical specific data, person specific data (for the mother and infant), and media specific data (for the contaminated breast milk and other contaminated foods consumed by the mother prior to nursing). As different compounds partition to either the breast milk fat (e.g., dioxins) or to the aqueous phase of breast milk (e.g., heavy metals such as mercury), the infant dose equation includes variables for the concentration in breast milk fat as well as the concentration in the aqueous phase of breast milk.

**Results:** The enhanced residual risk modeling framework estimates an infant's average daily dose of one or more HAPs and an adult's lifetime daily dose of one or more HAPs, taking into account exposure to HAP-contaminated breast milk during the first year of life. The relative contribution to mercury and dioxin exposure from the breast milk pathway, in comparison to other pathways, is demonstrated. Provisional results from dioxins and mercury show the utility of a breast milk exposure model in light of its contributions to exposure and risk assessments for HAPs.

**ISEE-1250****Interpreting Biomonitoring Data for Monobutyl Phthalate in Urine Using a Physiologically Based Pharmacokinetic Model: Estimation of In Utero Exposure**

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**Background:** Phthalate esters have been widely used as plasticizers and in cosmetics. At high doses in rodents, several phthalate isomers, including di-n-butyl phthalate, have been shown to disrupt normal male reproductive development. Epidemiological studies attest to phthalate exposure in humans based on serum and urine measurements from samplings representative of US population. Physiologically based pharmacokinetic (PBPK) modeling can be

employed to increase our comprehension of the correlation between this biomonitoring data and environmental exposure.

**Methods and Results:** Extrapolation of an existing rodent PBPK model for n-dibutyl phthalate (DBP) and the primary metabolite (n-monobutyl phthalate, MBP) to humans was carried out in order to estimate the intake concentrations of DBP based on measured urinary excretion data for MBP. The predictive ability of the model was tested against published data for a single dose of labeled DBP followed by collection of a 24 h urine sample. The percent free MBP vs. conjugated MBP in urine was compared to a sub-sample of urine data collected as part of the NHANES study (U.S. Centers for Disease Control). The model adequately described both the amount of MBP excreted in a 24 h urine sample after a single exposure to DBP and the percent free MBP in urine. Parameter sensitivity and Monte Carlo analyses was performed to investigate sources of variability in model output. The model was applied to reconstruct daily dose for DBP based on the variability in concentrations of MBP measured in human urine from biomonitoring studies conducted by the U.S. Centers for Disease Control. Extrapolation of the rodent pregnancy model to humans allowed for further assessment of the variability in human fetal exposure to MBP.

**ISEE-1251****Blood Cadmium, Blood Lead and Chronic Kidney Disease in U.S. Adults**

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**Background:** Cadmium and lead are well established nephrotoxicants at high levels of exposure. At lower, chronic levels that are relevant for many general populations, their nephrotoxicity is not well established. Moreover, while exposure to multiple environmental nephrotoxicants is common, data on renal risk from joint exposure to cadmium and lead are scarce.

**Objective:** To investigate the associations of blood cadmium and lead with albuminuria and reduced estimated glomerular filtration rate (GFR) in a representative sample of US adults who participated in the 1999–2004 National Health and Nutrition Examination Survey (NHANES).

**Methods:** The study population included adults  $\geq 20$  years old with determinations of blood cadmium and lead ( $N = 10,872$ ). Blood cadmium and lead were measured by atomic absorption spectrometry in 1999–2002 and by inductively coupled plasma-mass spectrometry in 2003–2004. Urine albumin was measured by solid phase fluorescence immunoassay. Serum creatinine was measured by a kinetic rate Jaffé method, aligned to the assay employed in the development of the Modification of Diet in Renal Disease Study formula, and used to estimate GFR. Statistical analyses accounted for NHANES complex sampling design and weights. Multivariable models on the association of blood cadmium or blood lead with markers of kidney disease were adjusted for sociodemographic factors, for kidney disease risk factors and for the other metal.

**Results:** The weighted prevalences of albuminuria  $\geq 30$  mg/g creatinine and of reduced GFR (estimated GFR  $< 60$  mL/min/1.73 m $^2$ ) in the study sample were 9.0% and 5.6%, respectively. The geometric mean blood cadmium and lead were 0.40  $\mu\text{g/L}$  and 1.60  $\mu\text{g/dL}$ , respectively. The multivariable adjusted odds ratios (95% confidence interval) for albuminuria  $\geq 30$  mg/g and for reduced GFR comparing participants in the highest versus lowest blood cadmium quartile were 1.97 (1.44, 2.69) and 1.40 (1.00, 1.97), respectively. The corresponding odds ratios comparing participants in the highest versus lowest blood lead quartile were 1.30 (1.02, 1.66) and 1.45 (1.04, 2.03), respectively. The associations were progressive and consistent across sub-groups defined by age, sex and smoking status. The odds ratio for albuminuria  $\geq 30$  mg/g and for reduced GFR comparing the 75<sup>th</sup> to the 25<sup>th</sup> percentile of blood cadmium levels were 1.23 (0.80, 1.86) and 1.05 (0.47, 2.31), respectively, for participants

in the lowest lead quartile; and 1.93 (1.45, 2.57) and 1.96 (1.35, 2.87), respectively, for participants in the highest lead quartile. The corresponding odds ratios comparing the 75<sup>th</sup> to the 25<sup>th</sup> percentile of blood lead levels were 1.08 (0.86, 1.36) and 1.04 (0.72, 1.49), respectively, for participants in the lowest cadmium quartile; and 1.29 (1.07, 1.56) and 1.08 (0.86, 1.36), respectively, for participants in the highest cadmium quartile.

**Conclusions:** In this large representative sample of US adults, higher blood cadmium and blood lead levels were associated with increased rates of albuminuria and reduced GFR. There was also suggestion of an interaction for kidney disease between the two metals. Our findings add to the concern of nephrotoxicity at chronic low levels of cadmium and lead exposure in the general population and indicate increased kidney disease risk from exposure to both cadmium and lead.

#### ISEE-1252

#### Relationship Between PM<sub>10</sub> Concentrations and Asthma Patients in Metropolitan Areas in Korea Using Spatial and Time-Trend Analysis

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**Background:** The environment, not to say of air quality has not been much appreciated during the rapid industrial growth in the last millennium in Korea. Higher expectation for quality of life, however, increased the level of concerns about pollution, and it was not easy to ameliorate the air pollution despite of the growing demand for clean and safe air. When compared to the OECD countries, air pollution in Seoul of Korea is up to 2.8 times more serious than the New York City and two times than London and Tokyo. Literature in epidemiology accumulated the evidence of the strong association between particle concentrations and their adverse health effect. Korean Government recently enacted a special law of the "Capital Region Atmospheric Environment Improvement in 2003" to enhance the air quality and has introduced many measures to meet the pollution reduction target. Characteristics of air pollution should be identified to improve the air quality, specifically to reduce the PM<sub>10</sub> concentrations in the capital region of Korea.

**Objective:** This study aims to understand the characteristic trends of PM<sub>10</sub> concentrations in several metropolitan cities in Korea. Transport-in of pollutants among factors affecting PM<sub>10</sub> concentrations is the focus of our interest and we used air pollutant level at background site in Korea by many different standards. We investigated the spatial distribution and trends of PM<sub>10</sub> concentration, and characteristics of patients with asthma contingent on this distribution to identify the effects of long-range transport and local emission.

**Data and Method:** We used hourly average PM<sub>10</sub> concentration from 56 monitoring sites in Seoul, Incheon, Kyeong-gi in 2004~2006, provided by the Ministry of Environment. We also obtained hourly average information on temperature, humidity, air pressure and wind direction from the Korea Meteorological Administration. We separated the PM<sub>10</sub> concentration of "air pollutant level at background site" in Korea by long-range transport (LRT) and local emission (LE). For hierarchical clustering analyses, we used the weekly average of each site by LRT and LE, respectively. We estimated the spatial correlation model to see the differences in the spatial trends in PM<sub>10</sub> concentration by changing the clusters. We controlled for the time trend (e.g. year, month and weekday), temperature, relative humidity, air pressure and wind speed in the spatial correlation analysis. The number of asthma patients per 10 days and per 100,000 people was used to see if there was correlation between this number and the PM<sub>10</sub> concentrations by the cluster.

**Results:** Analysis using local emission resulted in 11 clusters with the regional characteristics and analysis with long-range transport resulted in 4 clusters where no regional characteristics remained. The number of patients with asthma for 10 days standardized by the population size

within clusters had the dose-response relationship with the PM<sub>10</sub> concentration in clusters.

**Conclusion:** Results from this study suggests that control of transport-in pollutants is as important as the local emission control in order to reduce the level of PM<sub>10</sub> concentrations.

#### ISEE-1253

#### Correlational Relationships of Multi-Elements In-Between Human Perinatal Media

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**Background:** The German Environmental Specimen Bank for Human Tissues as part of the German Environmental Specimen Bank routinely samples and analyzes human matrices from university students for exposure to environmental noxae. All samples are stored under stable deep freezing conditions (-150°C) for later retrospective analyses. Currently, a pilot study which started November 2005 provides a basis for monitoring chemical exposures of newborns.

**Methods:** Standard operation procedures are being prepared for sampling, preparation, first exposure analyses and cryo-conservation of human placenta, umbilical cord blood (UCB), umbilical cord, amniotic fluid, amnion, newborn urine, maternal blood (MB) and maternal urine. Until March 2008, perinatal samples are collected of 99 mother-newborn-pairs. Multi-element analyses are performed with high resolution ICP-MS for 66 elements. Preliminary statistical analysis of UCB (n = 23), MB (n = 37), placenta (n = 37) and amnion (n = 37) are used for comparing medians and geometric means of element concentrations as well as inter-correlational relationships. Therefore, each of the 66 elements is analyzed concerning a monotone relationship between all possible pair-wise combinations of the four perinatal media.

**Results:** Results of relational analysis of element concentrations in all media investigated show that all significant correlations (Spearman's rank correlation coefficient;  $P < 0.05$ ) observed are positive and that there are clear differences between media pairs. Ranking media pairs according to the number of significant correlations found between the same elements delivers following results: placenta-amnion (37 of 66 elements: Ag, As, Ba, Bi, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Gd, Ge, Hf, Ho, Ir, K, La, Li, Mg, Na, Nd, Pr, Rb, Rh, Ru, Sc, Sn, Sr, Tb, Tl, Tm, V, Y, Yb, Zr) > UCB-MB (30 of 66 elements: Ag, Al, As, B, Bi, Br, Cd, Co, Cs, Cu, Ga, Ge, Mn, Na, Nb, Ni, P, Pb, Rb, Re, Rh, Ru, Sm, Sr, Te, Th, Tl, Tm, Zn, Zr) > placenta-MB (28 of 66 elements: Al, As, Au, Co, Cr, Cu, Fe, Ga, Gd, Ge, Ir, K, Li, Lu, Mn, Na, P, Pt, Re, Ru, Sm, Sn, Ta, Th, Tl, Tm, Yb, Zn) > amnion-MB (10 of 66 elements: As, Cd, Ge, K, Li, Lu, Na, Ru, Se, Sn) > placenta-UCB (9 of 66 elements: As, Ge, Mg, Na, P, Re, Sm, Th, Zn) > amnion-UCB (4 of 66 elements: Ga, Ge, Ru, Ti). Element correlations are analyzed in detail to decide how measurements of UCB-concentrations can be replaced by measurements in other perinatal media. Because stem cell-conservation is becoming a therapy option, UCB are expected to be less often available in future. An alternative approach is analyzing groups of chemical elements, as well as principal-component analysis after preprocessing data for parametric statistical methods.

#### ISEE-1254

#### Timing of Fetal Lead Exposure, Length of Gestation, and Risk of Prematurity

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**Objective:** Premature births worldwide constitute a significant public health problem. Research on the role of environmental toxicants, including lead exposure, in the complex etiology of this disease remains inconsistent. We assessed the effect of prenatal lead exposure on gestational age and risk of premature delivery using trimester-specific maternal blood and plasma lead levels as biomarkers of fetal exposure to lead.

**Materials and Methods:** We measured trimester-specific maternal blood and plasma lead levels in 273 pregnant women recruited in Mexico City from 1997–1999. Samples of whole blood and plasma were collected using strict procedures to prevent contamination and hemolysis of the samples and were analyzed for lead content by ICP-MS. Data were analyzed using generalized linear models (normal and binomial distributions) adjusting for maternal age, maternal education, history of adverse birth outcome, maternal cigarette smoking during pregnancy, infant gender, and pre-parity, in order to examine the associations of trimester specific lead exposure (log transformed), gestational age (days) and risk of premature delivery (< 37 weeks gestation).

**Results:** Of the 273 eligible participants, 173 women had complete information available on gestational age, every trimester-specific blood and plasma lead measurement, and covariates of interest. We had a total of 24 premature deliveries (11.4% of our eligible study population). In the 1st, 2nd, and 3rd trimesters, mean levels of lead in plasma were: 0.19 µg/dL, 0.15 µg/dL, 0.17 µg/dL; and in whole blood were: 6.8 µg/dL, 6.2 µg/dL, 6.8 µg/dL. As expected, maternal blood and plasma lead levels were moderately correlated ( $\rho$ : 0.41–0.77, all  $p < 0.05$ ) between trimesters. In single-trimester models gestational age was most strongly associated with plasma lead during the 1st (standardized coefficient, -1.74; 95% CI -3.17, -0.32) and 2nd (standardized coefficient, -1.56; 95% CI -2.89, -0.23) trimesters. Blood lead showed a marginal association with gestational age in the 1st (standardized coefficient, -1.14; 95% CI -2.68, 0.41) and 2nd (standardized coefficient, -1.35; 95% CI -2.74, 0.04) trimesters. In multi-trimester models a one-standard deviation increase in 2nd trimester blood lead predicted a 2.5 day decrease in gestational age ( $p = 0.09$ ) while the plasma multi-trimester model indicated the strongest effect on gestational age in trimester one, but failed to reach statistical significance at a  $p = 0.05$  level. In adjusted logistic regression models a one-standard deviation increase in plasma lead during the 2nd trimester increased the odds of premature delivery by 1.6 (95% CI 1.1, 2.4).

**Conclusion:** Fetal lead exposure in early pregnancy has a negative association with length of gestation. Circulating maternal plasma lead levels predict this adverse effect on gestational age better than maternal blood lead levels and second trimester plasma lead was significantly related with an increased risk of premature delivery. Our study supports the growing body of literature indicating that gestational length and risk of prematurity are adversely impacted by fetal lead exposure and that lead's mechanism of action may occur early in pregnancy.

#### ISEE-1255

#### The German Environmental Survey for Children (GerES IV): Socio-Economic Status and Exposure to Pollutants

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**Background:** The German Environmental Surveys (GerESs) are nationwide cross-sectional studies to determine the human exposure to environmental pollutants, to explore exposure pathways and to discover groups with higher exposure. As the discussion on environmental justice has recently gained momentum in Germany, the data of the latest GerES have been analysed systematically for the relationship between socio-economic status (SES) and environmental exposure.

**Methods:** From 2003 to 2006 the German Environmental Survey for Children (GerES IV) was carried out. A representative sample of 1,790 children aged 3 to 14 years was examined. Various pollutants were analysed in blood, urine and indoor air samples, in addition questionnaires on exposure-relevant habits and living conditions were administered. GerES IV was performed in conjunction with the German Health and Examination Survey for Children and Adolescents (KiGGS) conducted by the Robert Koch Institute. The GerES sample was a random subsample of KiGGS. Therefore, for all GerES participants KiGGS data are available as well, such as a SES index (parents' income, education, occupational status).

**Results:** Selected findings on the relation between SES and exposure to pollutants are presented. Exposure to persistent organochlorine compounds (DDT or PCB) is highest for high SES children. This is due to breastfeeding habits in different SES groups. Exposure to environmental tobacco smoke is highest for children from low SES families: This finding from questionnaire data was confirmed by nicotine and cotinine analysed in urine as well as benzene measured in indoor air. Formaldehyde and terpenes are volatile organic compounds, which outgas from furniture made of particle board or wood respectively. No consistent social gradient could be observed for formaldehyde, whereas the concentrations of terpenes in the air are considerably higher in the homes of high SES families. Social gradients could also be found for the use of several household products with questionable benefit and potential health risks: Detergents such as fabric softeners and disinfectants are more often used by low SES families whereas pesticides are mainly used in the homes of high SES families.

**Conclusion:** These results show that environmental pollution is not always a problem of disadvantaged children. There are several pollutants which affect children from high SES families more. Therefore, measures to reduce or prevent children's exposure have to be tailored to the specific SES groups.

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#### ISEE-1257

#### Urinary Mono-Ethyl Phthalate Concentrations and Reported Use of Personal Care Products Among Pregnant Women

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**Background:** Previous research has shown extensive use of diethyl phthalate (DEP) in personal care products, in particular as a solvent for fragrances. However, the contribution of personal care product use to DEP exposure in pregnant women remains uncharacterized.

**Methods:** Questionnaire data on personal care product use over 48 hours were gathered during the 3<sup>rd</sup> trimester of pregnancy from 184 African American and Dominican women from New York City. A spot urine sample was also collected and the monoester metabolite of DEP, mono-ethyl phthalate (MEP), was analyzed at the Centers for Disease Control and Prevention. Concentrations were adjusted for specific gravity prior to statistical analysis.

**Results:** MEP was detected in 100% of urine samples with widely varying concentrations (geometric mean 262.3 ng/mL, range 6.4 to 26,600 ng/mL unadjusted for specific gravity). Forty-three percent of participants reported using perfume over the 48 hours. Other personal care product types considered were hair spray, hair gel, nail polish or nail polish remover, liquid soap/body wash, and lotion/mist for hands or body.

Women reported using an average of 1.6 of these additional product types over the 48 hours. Neither perfume use nor the sum of the other 5 products varied significantly by ethnicity, maternal age, education, or pre-pregnancy BMI. Log transformed MEP concentrations (adjusted for specific gravity) were significantly associated with perfume use ( $\beta = 0.817$ ,  $P < 0.001$  controlling for the covariates). Women reporting use of perfume had on average 2.26 times the MEP concentration of non-perfume users (95% confidence interval 1.51 to 3.32). The model with perfume and the covariates explained 12.9% of the variance in urinary MEP concentration. No association was seen between the urinary MEP concentration and use of the other product types.

**Comments:** In this urban population of pregnant African American and Dominican women, perfume use over the previous 48 hours was associated with increased concentrations of urinary MEP. However, the low overall explanatory ability of the model suggests that there are other sources contributing to variation in urinary concentration perhaps including exposures not considered here as well as differences in uptake, timing of urine sample relative to perfume use, and metabolism. However, these results provide an opportunity for intervention since perfume use during pregnancy was common and is potentially modifiable.

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#### ISEE-1259

##### Stability of Socio-Economic Deprivation Index with Respect to Time from the Last Census and Spatial Scale of Its Use

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**Background:** In the last year the census socio-economic deprivation index (SESDI) was created in the Czech Republic (CR). Within the original study the correlation was found between the increased total and selected specific mortality rate (SMR) and the highest levels of deprivation on the district level.

**Objective:** The objective of the presented study was: A/ to explore a stability of the relationships in time away from census; and B/ to verify found relationships between SMR and SESDI on smaller spatial units.

**Material and Methods:** A/ SESDI was based on census 2001 and was constructed on the level of 77 Czech districts. Relationship between SMR and SESDI was explored using correlation analysis for specific years 2002–2006. B/ SESDI was re-elaborated for the smaller geographical units—ORP (in total 205 in the CR). Comparison was done using 22 ORP data in the Moravian Region with total population of 1,253,000 inhabitants. The total and specific SMR was calculated for the years 2003–2006 to avoid a bias caused by a lot of missing data in age categories in specific years. Correlation analysis was used for testing of relationships between mortality and SESDI.

**Results:** A/ The results confirmed the relationships between SMR and SESDI in the years following after census. Both in men and women positive association was found between the level of deprivation and total mortality (men 2001  $r = 0.60$ ; 2002–6 from  $r = 0.41$  to  $r = 0.56$ ; women  $0.53$ ;  $0.35$ – $0.51$ ), cancer mortality (men  $0.47$ ;  $0.19$ – $0.48$ ; women  $0.44$ ;  $0.38$ – $0.53$ ), mortality for gastrointestinal diseases (men  $0.53$ ;  $0.39$ – $0.51$ ; women  $0.41$ ;  $0.35$ – $0.50$ ) and mortality for lung cancer in men ( $0.55$ ;  $0.22$ – $0.50$ ). The relationships between SMR and SESDI varied between years, not in a systematic way, but more based on between years variability in SMR. These associations were stronger in men than in women. Further results of detail analysis also showed that the investigated total and specific mortality in men and women was more strongly correlated with factors of social deprivation than material deprivation. B/ The analysis of relationship between SMR and SESDI on the ORP level did not confirm the results on a district level—the only significant relationship was found between SESDI and total SMR and SMR for lung cancer in both sexes, respiratory diseases in men and all cancer mortality

in women. The analysis showed that the district level is the smallest unit applicable for analysis of relationship between SMR and SESDI. More detail spatial scale is not acceptable for analysis of specific SMR due to small frequency of mortality in age groups.

**Conclusion:** The relationships between socio-economic deprivation index and total and specific SMR remained stable in the years following after census. Slight variability between years was based more on variability in SMR but not in a systematic way. The smallest unit applicable for analysis of relationship between SMR and SESDI was confirmed to be district level due to small frequency of mortality in age groups in smaller units.

*Acknowledgement: This study was realized within the program EUREKA (E!3751 ISTAHIS).*

#### ISEE-1261

##### The Role of Socioeconomic Status as a Component of Susceptibility in Acute PM<sub>2.5</sub> Exposure and Childhood Mortality

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**Background and Objective:** The disproportionate exposure of low income populations to air pollution is compounded by the fact that low socioeconomic status (SES) may also modify the relationship between air pollution and mortality. Our objective was to evaluate the acute effect of fine particulate matter (PM<sub>2.5</sub>) on non-accidental and respiratory-related mortality with special focus on high and low SES regions in six counties of California from 2001–2005 in children 1–10 years old.

**Methods:** Mortality data were obtained from the California Department of Health Services and categorized by ICD-10 code into daily counts of non-accidental causes of death and respiratory-related deaths per county. Air pollution and meteorological data for Fresno, Kern, Stanislaus, Los Angeles, Riverside and Sacramento counties were obtained from the California Air Resources Board. Factor analysis was performed on 16 socioeconomic indicators, drawn from the U.S. Census 2000. The resulting distribution of SES index was dichotomized above and below the median. Poisson regression was performed to investigate the association between the acute effect of PM<sub>2.5</sub> and daily mortality counts per county.

**Results:** The risk for daily non-accidental mortality in Kern county was 7% (95%CI = 1.01, 1.14), Sacramento county was 26% (95%CI = 1.16, 1.34) and Yolo county was 25% (95%CI = 1.09, 1.44) per  $10 \mu\text{g}/\text{m}^3$  increase of prior 3 day PM<sub>2.5</sub> exposure. In Fresno, Kern and Sacramento counties, the risk of daily childhood respiratory-related mortality were 56% (95%CI = 1.48, 1.64), 30% (95%CI = 1.24, 1.36) and 18% (95%CI = 1.06, 1.32) per  $10 \mu\text{g}/\text{m}^3$  increase of prior 3 day PM<sub>2.5</sub> exposure, respectively. When stratified on SES index, the estimated relative rate (RR) for daily non-accidental mortality was more pronounced in regions with low SES index, in Kern (RR = 1.09; 95%CI = 1.03, 1.15) and Sacramento (RR = 1.29; 95%CI = 1.19, 1.38) counties per  $10 \mu\text{g}/\text{m}^3$  increase of prior 3 day PM<sub>2.5</sub> exposure. In Sacramento county, the RR for daily non-accidental mortality was 1.19 (95%CI = 1.09, 1.30) in regions with high SES index with each increment of  $10 \mu\text{g}/\text{m}^3$  prior 3 day PM<sub>2.5</sub>. The effects remained the same after adjusting for one-day lag of average temperature. No significant differences were observed in daily non-accidental and respiratory-related mortality and PM<sub>2.5</sub> exposures in other counties as well as the stratified models. Data will be analyzed adjusting for confounders such as time trends (day of the weeks), seasonal effects, calendar effects (short-term systematic effects) and unsystematic effects (temperatures and/or relative humidity).

**Conclusion:** Our results provide evidence of a childhood respiratory-related mortality effect of PM<sub>2.5</sub> exposure and suggest a stronger effect of PM<sub>2.5</sub> in regions with low SES. These findings may indicate that one potential mechanism by which SES affects health is by increasing susceptibility to air pollution.

**ISEE-1262****Environmental Burden of Disease Assessment for the Republic of Ireland**

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**Methods:** The World Health Organisation (WHO) Environmental Burden of Disease (EBD) methodology was applied to estimate the burden of disease from exposure to lead, outdoor air pollution, and unsafe water in Ireland. The assessments for exposure to lead and outdoor air pollution were exposure-based, using dose-response relationships derived from the literature. The assessment for exposure to unsafe water was scenario-based. Due to the uncertainties associated with the Relative Risks assigned to each drinking water scenario, estimates were calculated assuming two different exposure scenarios and compared with outcome-based estimates calculated using incidence rates from a recently conducted community-based study.

**Results:** For exposure to lead, the attributable incidence of mild mental retardation was estimated as 2.91 Disability Adjusted Life Years (DALYs) per 10,000 children aged 0–4 years. The attributable mortality from exposure to lead, from Ischaemic Heart Disease (IHD) and cerebrovascular disease in adults was 76 cases, 1.11% of the national mortality from IHD and cerebrovascular disease in 2002. The attributable morbidity from cerebrovascular disease and hypertensive diseases was 167 cases, which equated to 0.7% of the total morbidity from cerebrovascular disease and hypertensive diseases in 2002. At the national level, compared to a theoretic counterfactual exposure of  $PM_{10} = 10 \mu\text{g}/\text{m}^3$ , estimated attributable all-cause mortality in all ages from short-term exposure to  $PM_{10}$  was 103 cases. When only the urban populations were considered, a counterfactual of  $PM_{10} = 10 \mu\text{g}/\text{m}^3$  was associated with 50 attributable deaths, a plausible counterfactual of  $PM_{10} = 20 \mu\text{g}/\text{m}^3$  was associated with 11 attributable deaths. The estimated attributable cardiopulmonary mortality from long-term exposure to the equivalent theoretical counterfactual exposure of  $PM_{2.5} = 5.4 \mu\text{g}/\text{m}^3$  was 505 deaths. City-specific attributable mortality estimates were 197 deaths for a counterfactual  $PM_{2.5}$  of  $5.4 \mu\text{g}/\text{m}^3$ , and 31 deaths for a counterfactual  $PM_{2.5}$  of  $10.8 \mu\text{g}/\text{m}^3$ . Nationally, the attributable mortality from lung cancer from long-term exposure to a counterfactual  $PM_{2.5}$  of  $5.4 \mu\text{g}/\text{m}^3$  was estimated as 102 deaths. The city-specific attributable mortality estimates were 38 deaths for a counterfactual  $PM_{2.5}$  of  $5.4 \mu\text{g}/\text{m}^3$  and 31 deaths (low = 3, high = 10) for a counterfactual  $PM_{2.5}$  of  $10.8 \mu\text{g}/\text{m}^3$ . Applying the scenario-based approach, waterborne infection in Ireland was estimated to be responsible for between 799,000 and 860,000 DALYs in 2002, with an estimated attributable incidence of infectious diarrhoea between 518,215 and 557,945. Applying an outcome-based approach, the number of episodes of Acute Gastrointestinal Illness (AGI) was estimated to be between 220,930 and 644,380. Despite concerns regarding the suitability of the WHO methodology for a country with relatively low environmental exposures, sensitivity analyses indicated that the methodology was robust.

**Conclusions:** The results indicate that the state of the environment in Ireland is good; EBD estimates were generally below those reported for other European countries; however, concerns were raised regarding the health effects of urban air pollution and contamination of drinking water. The assessment was useful in quantifying the health burden from a number of risk factors in a comparable and consistent way, providing support for policy-makers, and facilitating the development of Environmental Health Indicators for Ireland.

**ISEE-1263****The Potential Impact of Residential Wood Burning Regulations in a California Region: Concurrent Wintertime Reductions in Ambient Pollution and Cardiovascular Mortality**

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**S252**

**Background:** Concern over the health effects from residential wood burning has been rising over the past several years. Hemmed in by mountains and lacking prevailing winds to disperse pollutants, the San Joaquin Valley of California has historically had some of the worst air quality in the United States. In order to address poor wintertime ambient air quality, in 2003, the San Joaquin Valley Unified Air Pollution Control District implemented a regulation that requires mandatory curtailment of residential wood burning when air quality is forecast to be poor, as well as: voluntary curtailment, restrictions to the type of fuel burned, a complaint process, prohibition of new or used uncertified devices, and a limit on the density of residential burning devices. This rule is in place during the "burn season", November through February. This rule represents the first implementation of burn regulations that apply uniformly across an entire air basin. The San Joaquin Valley is home to approximately 3.5 million people, about ten percent of California's population.

**Methods:** An ecological study examined cardiovascular and other non-injury wintertime deaths in residents 35 years and older living in the San Joaquin Valley from 2001–2005. Mortality data were obtained from the California Department of Health Services and categorized into ischemic heart disease deaths, cerebrovascular deaths, and all other non-injury deaths. We calculated age-standardized mortality rate ratios (RR) and 95% confidence intervals (CI) for each of the outcomes during the two burn seasons before and two burn seasons after the regulations took effect. Daily pollution data were obtained from (CARB) and dichotomised into pre- and post regulation categories. Univariate linear equations were used to investigate the association between the regulation implementation and changes in pollutant concentrations. Pollutants of interest were those associated with wood combustion and included maximum one hour concentrations of carbon monoxide (CO) and nitrogen dioxide ( $NO_2$ ), average daily fine particulate matter ( $PM_{2.5}$ ), and benzo(a)pyrene, butadiene, benzene, and toluene.

**Results:** Risk of age-standardized mortality due to ischemic heart disease and cerebrovascular disease decreased 4.8% (95% CI: 1.00, 1.09) and 5.4% (95% CI: 0.97, 1.14), respectively, after regulation implementation while there were no meaningful differences in rates detected in other non-injury deaths. Burn season average concentrations of CO,  $NO_2$ , and  $PM_{2.5}$  decreased 20%, 13%, and 25% after regulation implementation, respectively ( $P < 0.05$ ). Burn season average concentrations of benzo(a)pyrene, butadiene, benzene, and toluene decreased 32%, 44%, 29%, and 34% after regulation implementation, respectively ( $P < 0.05$ ). Data will be adjusting for confounders such as time trends, seasonal and calendar effects, and unsystematic effects (temperatures, pressure, and/or relative humidity).

**Conclusion:** The results indicate that the reduction in deaths due to ischemic heart disease and cerebrovascular disease may be associated with implementation of residential burn restrictions in San Joaquin Valley. The concurrent reduction in pollution following the implementation of the regulations is further evidence for the potential of these regulations to impact public health, particularly as residential wood burning is one of the largest contributors to ambient wintertime  $PM_{2.5}$  levels.

**ISEE-1264****Occupation and Risk of Renal Cell Cancer in Central and Eastern Europe**

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**Background:** Central and Eastern Europe is a region with a high incidence of renal cell cancer. Few studies have been conducted in these areas on the possible role of occupational exposures in this cancer. The purpose of this study was to examine the association of renal cell cancer with occupations.

**Methods:** From 1999–2003, we conducted a hospital-based case-control study in seven areas of the Czech Republic, Poland, Romania and Russia. A detailed occupational history was collected from cases and controls, together with information on potential confounders (tobacco smoking, body mass index, and hypertension). Odds ratios (OR) of renal cell cancer were calculated by comparing ever- vs. never-employment in selected jobs and industries, with follow-up analyses examining duration of employment.

**Results:** A total of 876 cancer cases and 1,469 controls were included in the analysis. An increased risk of renal cell cancer was observed for workers in agricultural labor and animal husbandry (OR = 1.57, 95% CI 1.00, 2.48), with greater risks seen with longer employment (> 10 years). Elevated estimates, based on a small number of cases, were also seen for employment in firefighting, petroleum refining, and work as a launderer or dry cleaner. Increases were also seen with employment as an electrical engineer (OR = 2.01, 95% CI 1.24, 3.28), although no pattern by duration of employment was seen.

**Conclusions:** This study suggests that occupation does not play a major role in renal cell carcinogenesis in Central and Eastern Europe. The excess risk among electrical engineers is possibly due to chance or bias.

#### ISEE-1265

##### Contributions of Diesel Truck Emissions to Indoor Elemental Carbon Concentrations in Homes Proximate to Ambassador Bridge

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**Background:** Residents of border communities in close proximity to major U.S. border crossings are potentially exposed to increased commercial traffic pollution, and are believed to experience a higher prevalence of adverse respiratory outcomes. The Ambassador Bridge, connecting Detroit, Michigan and Windsor, Ontario, is the busiest international commercial vehicle crossing in North America. It has an average daily traffic count of 36,000 vehicles with a large percentage of these being heavy duty diesel trucks. Previous studies have observed proximity to Ambassador Bridge to be a significant predictor of outdoor levels of traffic-related pollutants. However, because adults typically spend 70% or more of each day indoors, it is important to demonstrate the impact of traffic-related pollution in the home environment.

**Objectives:** The objective of this analysis is to examine the contribution of truck traffic across Ambassador Bridge to indoor exposure patterns of elemental carbon (EC), a common surrogate for diesel exhaust particles. We also aim to understand the relative importance of home ventilation characteristics and wind speed.

**Methods:** Simultaneous residential indoor and outdoor EC measurements were collected over five consecutive 24 hour periods in both the summer and winter. Ambient concentrations and meteorological data were collected at the U.S. EPA's central site monitor in Allen Park, MI, and home air exchange rates were estimated using a perfluorocarbon tracer. All measurements were collected as part of the Detroit Exposure and Aerosol Research Study (DEARS), a three year (2004–2007) field monitoring study designed to better understand relationships between air pollutants measured at a central-site monitor to those measured at residential indoor

and outdoor sites and personal exposures. The median indoor/ambient EC ratio across all seasons was less than one, suggesting that indoor EC concentrations are driven mainly by outdoor sources. Indoor concentrations were regressed on three predictor variables: ambient concentrations, distance from Ambassador Bridge, and percentage of time downwind. We incorporated separately wind speed and home ventilation status as effect modifiers.

**Results:** Our regression models indicate that ambient concentrations explained 49% of the variability in daily residential indoor EC concentrations. The percentage of time a home was downwind from the Ambassador Bridge was a significant ( $P < 0.05$ ) contributor to indoor levels, whereas there was no association with a home's distance from the bridge. In addition, the effect of ambient concentrations was greater in homes experiencing calm winds and the effect of the bridge was greater in homes with higher air exchange rates. More accurate predictions of indoor exposures will improve our exposure assessment for epidemiological studies.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1266

##### Prenatal Lead Exposure and Growth Trajectory of 0 to 5 Year-Old Children in Mexico City

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**Objective:** Maternal bone lead burden has been associated with smaller size of offspring at birth and at 1 month of age. These effects are thought to be caused by the mobilization of lead from bones to plasma, which then crosses the placenta. Fetal lead exposure may exert its effects on growth through disruption of thyroid signaling or by acting on fetal osteocytes. This study investigated children's weight change from 0 to 5 years of age in relation to prenatal lead exposure, as measured by maternal bone lead, in a cohort of 615 mother-infant pairs born between 1994 and 2005 in Mexico City. We hypothesized that prenatal exposure to lead would lead to decreases in overall weight gain.

**Materials and Methods:** Maternal patella lead was measured at 1-month postpartum using *in vivo* K-x ray fluorescence. Maternal socio-demographic information was obtained by trained interviewers at birth, 1, 3, and 6 months postpartum and every 6 months thereafter until child age of 60 months. Children were weighed at each interview by trained staff using standard protocols. Random effects models were fitted for patella lead to describe weight trajectories of children. Time since birth was modeled using splines to capture the non linear growth trajectories. Weight at birth, infant sex, breastfeeding practice and duration, maternal height and calf circumference, parity, mother's age at delivery, maternal education level, maternal smoking status during pregnancy, percentage of life lived in Mexico, and history of prior adverse birth outcomes were included in the models as potential confounders. The analysis excluded low birth weight babies (< 2500 g; N = 76) and premature babies (< 37 weeks gestation; N = 91) to minimize bias in the results due to rapid catch-up characteristic of these infants. Out of the 1216 mother-infant pairs, 615 had complete information on all the confounders listed above as well as gestational age, head circumference at birth, length at birth, and maternal patella and tibia lead.

**Results:** Mean patella lead at 1-month postpartum was 11.1 µg Pb/g (SD = 12.8). Mean blood lead levels among children was 3.9 µg Pb/g (SD = 3.05). After controlling for potential confounders, patella lead was

significantly and inversely associated with children's growth trajectories throughout early childhood. A 10  $\mu\text{g/g}$  increase in patella lead was associated with a 71.3g decrease in weight ( $\text{SE} = 34.3, P < 0.05$ ). These effects persisted after controlling for children's concurrent blood lead levels: a 10  $\mu\text{g/g}$  increase in patella lead was associated with a 91.0 g decrease in weight ( $\text{SE} = 38.2, P < 0.05$ ) indicating that the prenatal effect of patella lead is independent of any post-natal lead exposure effect in our study population.

**Conclusions:** Prenatal lead exposure reflected in maternal patella lead is associated with a lower weight among 0 to 5 year old children. These results indicate that impact of fetal lead exposure on growth can persist for years even after adjusting for postnatal lead exposure.

#### ISEE-1267

#### Are Data from Air Quality Monitoring Networks Relevant to Estimate Exposure in Epidemiological Studies? A Comparison with an Exposure Model Based on a Fine-Scale Measurement Campaign

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**Objective:** The estimation of exposure to air pollution in epidemiological studies is often achieved by assigning to each individual the values measured by the nearest permanent monitoring station. Although easy to implement, this approach assumes that air pollution levels are homogeneous within a buffer of several kilometres around each monitoring station, which may not hold, in particular in urban areas. Our aims were to implement an exposure model relying on a measurement campaign by diffusive samplers with a fine spatial resolution, and to compare the exposure estimates of the participants of a cohort study to those obtained by the more classical approach relying only on air quality monitoring stations.

**Material and Methods:** This study was conducted in the context of the EDEN mother-child cohort, during which 2002 pregnant women from two middle-sized cities (Nancy and Poitiers) have been recruited between 2003 and 2006. We restricted the study to 923 women (482 in Nancy and 441 in Poitiers) who lived within two areas of 165 km<sup>2</sup> around Nancy and 315 km<sup>2</sup> around Poitiers. Diffusive samplers NO<sub>2</sub> measures (9 two-week measurement campaigns in Poitiers and 12 in Nancy) have been conducted in 61 and 130 locations in each of these areas. A geostatistical model was built by combining these measures (spatial component of the model) to measures from permanent monitoring stations (temporal component of the model). The exposure window corresponded to the whole pregnancy, as the aim of the epidemiological study is to study the influence of NO<sub>2</sub> levels during pregnancy on birth outcomes. The degree of agreement between the geostatistical model and the estimate provided by the nearest permanent monitoring station was assessed with the kappa statistic.

**Results:** With our geostatistical model, the median exposure of the cohort during the whole pregnancy was 29  $\mu\text{g/m}^3$  and 14  $\mu\text{g/m}^3$  in Nancy and Poitiers, respectively, compared to 35  $\mu\text{g/m}^3$  and 18  $\mu\text{g/m}^3$  with the approach relying on the nearest monitoring station (Wilcoxon median comparison test,  $P < 10^{-4}$  in each area). In Nancy, among subjects in the highest exposure tertile, as estimated from the approach relying on the nearest monitoring station, 71% of the subjects were classified as being in the highest tertile of exposure by our geostatistical model, 28% as being in the intermediary tertile and 1% in the lowest exposure tertile (Cohen's Kappa = 0.29). In Poitiers, these proportions were 48%, 25% and 27%, respectively (Cohen's Kappa = 0.16). When the study population was restricted to the 277 women in Nancy and 211 in Poitiers living <2 km away from a monitoring station, Kappa's statistic remained below 0.4 (Kappa = 0.31 in Nancy and 0.28 in Poitiers).

**Conclusions:** Our comparison shows significant differences between the exposure estimates from a geostatistical model and the approach relying on the closest monitoring station, the latter tending to overestimate exposure. These differences might be due to strong within-city spatial contrasts in background NO<sub>2</sub> levels not captured by the air quality monitoring network.

#### ISEE-1269

#### Salivary Cholinesterase Activity in Children with Organic and Conventional Diets

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**Objective:** Previous efforts to determine the health effects of pesticides have focused on quantifying acetylcholinesterase activity in blood. Saliva biomonitoring, however, has recently been explored as a feasible, non-invasive alternative. In animal studies, organophosphate pesticides have been shown to produce a concentration-related inhibition of salivary cholinesterase activity, which mirrors the decline in blood cholinesterase activity. Human saliva also contains low levels of cholinesterase activity, though little is known about activity in children. This pilot study examined the feasibility of collecting saliva from young children, and assessed whether cholinesterase activity is measurable in children's saliva. We also explored whether differences in pesticide exposure from organic and conventional diets can be detected in salivary cholinesterase (ChE) activity.

**Materials and Methods:** We collected two saliva samples, one week apart, from 40 children between 2 and 5 years old. Unstimulated whole saliva was collected either by (1) having the child spit into a plastic cup, or (2) manually pipetting saliva from the child's mouth with a polyethylene Pasteur pipette. Total salivary ChE activity was measured using a modified radiometric assay and normalized for protein content. Daily food diaries were maintained for the week between sampling to verify that children were consuming either mostly conventional or mostly organic diets. Total volume of food consumed was determined and used to calculate percent of diet that was organic.

**Results:** Both saliva collection methods were successful in collecting 1 to 2 ml saliva. Older children (mean age 4.3 yrs) preferred spitting into a cup, while younger children (mean age 3.1 yrs) preferred the pipette method ( $P < 0.01$ ). Total ChE activity was measurable in all samples, with a 2.5% average difference between duplicate saliva samples. Median ChE activity among all children was 27.4 (range 2.9–157.8) nmol hydrolyzed/hr/mg protein. No difference was found in ChE activity between first and second saliva samples (repeated measures, log-transformed ChE,  $P = 0.27$ ). However, there was substantial intra-individual variability (mean coefficient of variation 40%, range 1–84%). Thirteen children were identified by parents as consuming at least 75% organic food. After adjusting for age, ChE activity in these children was similar to activity in children who were identified as mainly conventional consumers ( $P = 0.64$ ). Data from food diaries, however, suggest that most subjects overestimated the percentage of organic food consumed. After reclassifying children based on food diary data, age-adjusted ChE activity was unexpectedly lower among organic consumers compared to conventional consumers (log-transformed ChE,  $n = 28$ , beta = -1.2, SE = 0.52,  $P = 0.03$ ). Further adjustment for gender, home pesticide use, pets, and para-occupational pesticide exposure did not change results.

**Conclusions:** Saliva collection is feasible in young children, though efficiency of the collection method depends on the child's saliva production and cooperation. Cholinesterase activity is measurable in children's saliva with good repeatability between duplicate samples. However, the large amount of within-subject variability in the general

population may preclude its use as a reliable and sensitive biomarker for low-level pesticide exposure.

*This abstract is of a proposed presentation and does not necessarily reflect EPA policy.*

#### ISEE-1270

##### Environmental Chemical Hazards and Their Impact on Senior Citizens

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**Background:** As the proportion of older people in the general population increases, so does the need to include this group in matters of environmental medicine. This study on environmental chemical burden factors and their importance for senior citizens aims at determining correlations between exposure to hazardous substances, the internal body burden and adverse health effects in older people.

**Methods:** By means of analysis of blood and 24-hour urine samples of 55–65 year-old individuals ( $N = 242$ ) from the Münster area as well as a questionnaire survey, the Environmental Specimen Bank for Human Tissues has gathered the first set of data on the environment-related chemical body burden of this particular subgroup of the general population. These data are compared with a student group from the Münster area, which comprised 235 students aged 20–29 years. The hazardous substance burden was determined as part of human biomonitoring (HBM), particularly by testing whole blood, blood plasma and 24-hour urine. Following extraction with hexane and acetone (4 + 1, pH 2.0) and derivatization with diazomethane ( $\text{CH}_2\text{N}_2$ ), the plasma concentrations of pentachlorophenol (PCP), hexachlorobenzene (HCB) and the three polychlorinated biphenyl congeners PCB-138, PCB-153 and PCB-180 were determined using gas chromatography and mass spectrometry. Element analysis was done individually for each element and range of concentrations using high-resolution inductively coupled plasma mass spectrometry (HR-ICP-MS), cold vapour atomic absorption spectrometry (CV-AAS), atomic absorption spectrometry (AAS) or inductively coupled plasma atomic emission spectrometry (ICP-AES). Personal data (sex, age, place of birth, etc.), medical history data (current health status and eventual medication, body size and weight) and information on possible sources of burden (living near heavily traffic-loaded roads, industrial plants, etc.) as well as dietary habits were determined using a self-reported questionnaire. Hazardous substance burden in senior citizens are compared to body burden of students to determine age-dependent exposure differences. Multivariate risk factor analyses are done for arsenic, cadmium, copper, lead, mercury, selenium, silver, uranium, zinc, PCP, HCB, PCB-138, PCB-153, and PCB-180. Stepwise regression analysis is performed to identify statistically significant predictors and quantify explained variances.

**Results:** These statistical analyses are explorative since little data is available yet on hazardous substance burdens in older people. Overall, senior citizens show significantly higher levels of cadmium, lead, silver, uranium, HCB, PCB-138, PCB-153, and PCB-180 indicating bioaccumulation or age-depending physiological processes. Results of regression analyses show that internal hazardous substance burden is mainly influenced by physiological parameters, smoking, amalgam and dietary habits. An influence of illness/disease and medication on the hazardous substance burden cannot be observed. This must be investigated in greater and more specific collectives of senior citizens.

#### ISEE-1271

##### Adverse Effects of DDE on Human Sperm Parameters are Modified by Polymorphisms in PON1, GSTT1, and CYP1A1 and by Gene-Gene Interactions

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**Background:** Although use of 1,1,1-trichloro-2,2bis(p-chlorophenyl) ethane (DDT) was discontinued in the USA in the early 1970's, its persistence and bioaccumulation has led to measurable levels of its major metabolite, of *p,p'*-dichlorodiphenyl-dichloroethylene (*p,p'*-DDE), in serum samples from a representative sample of the USA population. Studies on populations with high exposure levels have found significant adverse effects of DDE/DDT on human sperm parameters. Studies involving subjects with ambient levels of exposure, however, have found little or no effect.

**Methods:** In the current study, we determined the effect of exposure to ambient DDE/DDT levels (mean DDE level 290 ng/g lipid) on sperm motility, morphology and concentration in men with and without genetic polymorphisms reported to be involved in contaminant and sex steroid metabolism. Importantly, we also controlled for the sum of other chlorinated pesticides and for the sum of polychlorinated biphenyl congeners. We analyzed the GSTT1, GSTM1, CYP1A1 m2, PON1 Q192R, and PON1 L55M polymorphisms.

**Results:** Comparison of means of DDT/DDE level and sum of PCB levels showed the L isoform of allele 1 and allele 2 for PON1 55 had non-significantly higher levels of contaminants. PON1 192 Q isoform of allele 1 also showed higher levels of contaminants, but the Q isoform of allele 2 showed lower levels. Multiple logistic regressions modeled low sperm motility (<50% motile), poor sperm morphology (<4% normal forms), and low semen concentration (<20 million sperm/mL) according to World Health Organization guidelines. After adjusting for race and serum lipid concentration, low sperm motility was associated with the highest quartile of DDT/DDE (odds ratio (OR) = 2.7, 95% CI = 1.2–6.2). Compared to those with 55MM and 55ML genotypes and GSTT1 carriers as the reference, 55MM/ML genotypes without the GSTT1 gene had an OR = 1.9 (95% CI = 0.6–6.1). The 55LL genotype in GSTT1 carriers had an OR = 2.2 (95% CI = 1.1–4.4) and the 55LL genotype in those without the GSTT1 gene had an OR = 4.9 (95% CI = 1.5–15.4) for low motility. After adjusting for serum lipid concentration and study site, low sperm morphology was associated with the highest quartile of DDE/DDT (OR = 2.7; 95% CI = 1.3–5.6) and the 192R isoform of allele 1 in combination with Cyp Ile/Val and Val/Val genotypes had a significant inverse association (OR = 0.2, 95% CI = 0.1–0.7) when compared to 192Q in combination with Cyp Ile/Ile as the reference (OR = 1.0). The 192Q isoform with Cyp Ile/Val and Val/Val genotypes had an association close to null (OR = 0.95, 95% CI = 0.5–1.8), while 192R with Cyp Ile/Ile suggested an inverse association, but did not reach statistical significance (OR = 0.8, 95% CI = 0.3–1.8). No interactions were observed for low semen concentration.

**Conclusion:** Our results show possible interactions among genes involved in metabolism and detoxification of environmental contaminants, which may alter sperm susceptibility to pesticide toxicity.

#### ISEE-1272

##### Mexico City Traffic-Related Air Pollution Exposures and Changes in Heart Rate Variability in a Young Population

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Boston, MA, USA; and †Emory University School of Medicine, Atlanta, GA, USA.

**Objective:** While air pollution exposures have been linked to cardiovascular outcomes, the contribution from traffic-related pollutants remains unclear. Using a panel study design with repeated measures, we sought to examine the associations between personal exposures to traffic-related air pollutants in Mexico City and changes in heart rate variability (HRV), a measure of cardiovascular autonomic control, in a young population of researchers.

**Methods:** We conducted a repeated measures panel study among 16 researchers with mean age of 35 years (range 22–56) who were monitored by ambulatory electrocardiogram. Researchers were monitored on average over 9.5 hours for 3 days while operating a mobile laboratory van designed to characterize traffic pollutants while driving in Mexico City traffic and “chasing” diesel buses. We examined the association between HRV [standard deviation of normal-to-normal intervals (SDNN), power in high frequency (HF) and low frequency (LF)] and 5, 30, 60, and 90-min moving averages of air pollution ( $PM_{10}$ ,  $PM_{2.5}$ ,  $O_3$ , CO,  $CO_2$ ,  $NO_2$ ,  $NO_x$ , and formaldehyde) using single-pollutant linear mixed effects models controlling for age, gender, origin, smoking status, time of day, and study day.

**Results:** HRV was negatively associated with  $O_3$ , CO,  $CO_2$ ,  $NO_2$ ,  $NO_x$ , and formaldehyde exposures. Positive associations were observed for HRV and  $PM_{10}$  and  $PM_{2.5}$  exposures. For ozone and formaldehyde, associations increased in magnitude and significance with increasing averaging periods. The largest effects were observed for HF, where an 18% (95% CI: 9.4 to 27) decline was observed per interquartile range (IQR) mean 90-min ozone (65 ppb) and a 13% (95% CI: 3.1 to 23) decline per IQR 90-min formaldehyde (34 ppb).  $PM_{10}$  and  $PM_{2.5}$ , which were highly correlated, had similar associations with HRV. The largest increase was observed for HF over the 90-min averaging period; a 7.4% (95% CI: 2.3 to 12.5) increase in HF was observed per IQR 90-min  $PM_{2.5}$  (8.35  $\mu g/m^3$ ). The associations for CO,  $CO_2$ ,  $NO_2$  and  $NO_x$ , which were all correlated, were similar with statistically significant associations observed for SDNN, but not HF or LF. The influence of averaging period differed for each pollutant and we observed the largest declines in SDNN for each pollutant as follows: 4.3% (95% CI: 1.8 to 6.8) per IQR 30-min CO (10 ppm), 4.1% (95% CI: 1.4 to 6.8) per IQR 90-min  $CO_2$  (105 ppm), 4.0% (95% CI: 1.7 to 6.3) per IQR 60-min  $NO_2$  (155 ppb), and 4.5% (95% CI: 2.2 to 6.8) per IQR 30-min  $NO_x$  (240 ppb).

**Conclusions:** We observed changes in HRV following exposure to high levels of Mexico City traffic pollutants in a young population. Results suggest heterogeneity in the effects of the different pollutants; with declines in HRV, especially HF, with ozone and formaldehyde exposures and increases in HRV with particle exposures.

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#### ISEE-1273

#### Ambient Concentrations of Polycyclic Aromatic Hydrocarbons and Phenolic Compounds Measured Before and During a Woodstove Change-Out Program in Libby, Montana

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**Objective:** Prior to the revised  $PM_{2.5}$  National Ambient Air Quality Standards in 2007, Libby (Montana) was the only  $PM_{2.5}$  nonattainment area west of the Mississippi, and outside of southern California. In an effort to reduce ambient  $PM_{2.5}$  concentrations, a large-scale woodstove changeout program was carried out, replacing nearly 1200 old polluting woodstoves with new, EPA-certified woodstoves. Since the winter of 2004/2005, The University of Montana, Center for Environmental Health Sciences (UM-CEHS) has conducted an ambient Polycyclic Aromatic Hydrocarbons (PAH) sampling program in Libby to measure the trends in

ambient PAH concentrations during the winter months throughout the duration of this large-scale woodstove changeout.

**Materials and Methods:** During the 3-year program, concentrations of PAHs and phenolic compounds were measured every three days throughout the winter months (November through February) using a high volume (Hi-vol) polyurethane foam (PUF) sampler. Following EPA Compendium Method TO-13A, samples were analyzed by Gas Chromatography/Mass Spectrometry. PAH and phenolic concentrations measured in Year 1 (winter 2004/2005) of the program serve as a baseline prior to the start of the woodstove changeout program. Results from Year 2 (2005/2006) and Year 3 (2006/2007) reflect winter periods prior to which 10%, and 60%, respectively, of wood stoves had been changed out. **Results:** The results of the PAH and phenolics sampling program showed that some of the organic species with the highest measured concentrations are also signature chemical markers for wood combustion. These include phenolic compounds such as phenol, 2-methylphenol (*o*-cresol), 4-methylphenol (*p*-cresol), and 2,4-dimethylphenol. Average ambient  $PM_{2.5}$  mass concentrations measured during the winter of 2006/2007 ( $21.8 \pm 8.5 \mu g/m^3$ ) were lower than those measured during the previous winters, down 19% when compared to the average winter concentrations of 2004/2005 ( $27.0 \pm 12.5$ ). In comparing the 2006/2007 measured PAH and phenolic compounds with the 2004/2005 values, PAHs and phenolics had an average of a 71% reduction.

**Conclusions:** The results of the 2006/2007 sampling program suggest that the air quality in Libby has dramatically improved as a result of the woodstove changeout program, and that the stove changeout was successful in lowering the ambient concentrations of PAHs and  $PM_{2.5}$  measured during the winter months.

**Acknowledgement:** Hearth, Patio, and Barbecue Association and NCRR (COBRE P20RR017670).

#### ISEE-1274

#### A Review of Historical Ambient Airborne Asbestos Concentrations in Cities and Buildings: 1950s to the Present Day

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**Background:** Historically, airborne asbestos fibers have been measured in both rural and urban environments in the United States and elsewhere. The data clearly indicate that in nearly all urban environments and many rural settings there is some background intake of inhaled asbestos by the general population. In some locations, the airborne concentrations are due to the presence of asbestos in soil and exposed rock which is released due to weathering and/or erosion. Noteworthy, especially during the 1950–1980 time period, are the multitude of anthropogenic sources that often contributed to the ambient asbestos concentrations including the mining and milling of asbestos materials, the manufacture and cutting of pipe, manufacture and cutting of wallboard, as well as the manufacturing and use of asbestos-containing commercial products including amosite asbestos spray insulation for fireproofing, acoustic or decorative purposes (which was predominantly applied in urban high rise buildings from the late 1950s until the mid 1970s). Although these sources contributed to ambient asbestos levels, based on epidemiological studies, there has been no apparent increased risk of developing asbestos related diseases in the general population due to these concentrations. Despite the extensive historical literature that reports ambient asbestos concentrations, our research indicates that there have been no known attempts to present a comprehensive review of this data.

**Discussion:** This paper presents the data from nearly 50 published and unpublished papers on the historical and present day ambient asbestos concentrations in rural and urban U.S. and foreign outdoor environments, as well as indoor air measurements taken inside buildings including,

schools, residences, and public and commercial buildings. Some of the data collected within the buildings may have had either intact or damaged asbestos-containing materials (ACMs). Our analyses of these data indicate that the airborne concentrations were not appreciably different than the concentrations of asbestos experienced by many workers and residents who interacted with various products that contained so-called encapsulated asbestos.

#### ISEE-1277

#### **Soil Solubility o Chemical Contaminants: Concept, Determination and Effects on Dermal Absorption**

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**Background:** The complex interactions between soil organic matter and soil contaminants partly determine the extent to which a contaminant can associate with a given soil. The maximum amount of contaminant that can combine with a soil without meeting the thermodynamic characteristics of a separate phase can be called the *soil solubility* ( $S_{soil}$ ). Given a soil and a particular compound, if the soil concentration ( $C_{soil}$ ) is defined as the mass of chemical per mass of clean soil, then  $S_{soil}$  represents the value of  $C_{soil}$  above which neat chemical is present in the soil. Significant to the discussion here, the driving force for dermal absorption (i.e., the thermodynamic activity) of a given compound is the same for all soils with  $C_{soil} > S_{soil}$ . Thus, the rate of dermal absorption should be the same for any  $C_{soil} \geq S_{soil}$ . Despite this, the solubility of a chemical contaminant in soil is almost never considered in dermal permeation studies from soils. Furthermore, soils are commonly contaminated by distributing a solution of the chemical in a volatile solvent, which evaporates. Often, the soil concentration is relatively high and it is difficult to know whether or not it is larger than  $S_{soil}$ .

**Methods:** Solubility values of a test chemical, methyl paraben (MP), were determined in the 38–63 µm sieve fraction of two different soils by two methods: differential scanning calorimetry (DSC) and equilibrium uptake into silicone rubber membranes (SRM) (90-µm thick with an area of ~1 cm<sup>2</sup>). The organic carbon content of the 38–63 µm sieve fraction of the two soils, identified as CSU and ISU, was 1.5 and 3.8%, respectively. Furthermore, the permeation of MP and/or <sup>14</sup>C-MP through split-thickness (~300–400 µm thick) human cadaver skin was measured from contaminated soils with  $C_{soil}$  of  $3 \times 10^{-4}$  to 300 mg MP/g soil, using vertical flow-through diffusion cells at 32°C and 50% relative humidity.

**Results:** Surprisingly, MP solubility was larger in the CSU soil than in the ISU soil, (86 mg MP/g CSU versus 35 mg MP/g ISU) even though the ISU soil had the larger organic carbon content. Permeation of MP through skin was proportional to  $C_{soil}$  for  $C_{soil} \leq S_{soil}$  and it reached essentially the same maximum value for both soils when  $C_{soil} > S_{soil}$ . For the same  $C_{soil} \leq S_{soil}$ , the permeation was larger from the ISU soil than from the CSU soil. This was expected since permeation should be proportional to  $C_{soil}/S_{soil}$  and  $S_{soil}$  was smaller for the ISU soil than for the CSU soil.

**Conclusions:** These observations are consistent with the expectation that the thermodynamic activity of a chemical is at its maximum value for soils containing neat chemical, as would occur when  $C_{soil} > S_{soil}$ . Increases in  $C_{soil}$  above  $S_{soil}$  will increase the amount of neat chemical in the system without increasing the driving force for permeation through skin.

#### ISEE-1278

#### **Maternal Exposure to Air Pollution and Congenital Heart Disease: A Register-Based Study**

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**Objective:** To test the hypothesis that maternal exposure to air pollution is a risk factor for congenital heart disease (CHD).

**Methods:** *Study Design and setting:* A case-control study of all cases of CHD within the population of the Northeast of England between 1st January 1993 and 31st December 2003. *Cases and Controls:* Data on cases and controls were extracted from the Northern Congenital Abnormality Survey (NorCAS) and Regional Maternity Survey Office. Cases were classified according to ICD-10 codes. Controls were matched to cases by year of birth with a control/case ratio of four to one. *Exposure:* Data for PM<sub>10</sub>, SO<sub>2</sub>, NO, NO<sub>2</sub>, O<sub>3</sub> and CO were obtained for seven automatic monitoring stations. Each case and control was assigned the weekly average of measured pollutant levels by the closest working monitor for each week of the pregnancy period. *Statistical Analysis:* Single and multiple pollutant logistic regression models were used to quantify the unadjusted and adjusted odds ratios (OR) of exposure to air pollution and occurrence of each ICD-10 class of CHD and for the five most frequently occurring individual CHDs. Analysis was performed separately for the first, second, and third months and trimesters of pregnancy and for the window period of week 3–8 of pregnancy. We adjusted for socioeconomic status, sex, season of birth, degree of urbanity and distance to monitor. Quartiles of exposure were extracted and treated as a categorical variable in the models to investigate the dose-response relationship. Separately, semivariograms were developed for SO<sub>2</sub> levels, measured by 56 non-automatic monitors active in the study region for the study period. The resulting distance range (16 km) was used as an inclusion criterion for study participants. The modelling approach was repeated for this subset.

**Results:** A total of 2728 CHDs were notified to NorCAS for the period of study across the study region. There was an increased risk of congenital malformations of cardiac septa (CS) in association with exposure to CO (OR = 2.28, 95% confidence interval (CI): 1.71,3.05) and NO (OR = 1.01, 95% CI: 1.01,1.02). Ventricular septal defect (VSD) was associated with exposure to CO (OR = 2.59, 95% CI = 1.83, 3.66) and NO (OR = 1.01, 95% CI = 1.01, 1.02). Tetralogy of Fallot (ToF) was associated with NO (OR = 1.02, 95% CI = 1.01, 1.04) and congenital pulmonary valve stenosis (PS) was associated with CO (OR = 2.50, 95% CI = 1.19, 5.23). For these associations, ORs were statistically significant (*P*-value < 0.05) for all quintiles of exposure and there was an increasing trend in ORs from the first to the fourth quintiles. These results remained consistent after restricting case inclusion to those living within 16km of a monitor.

**Conclusion:** No consistent association was found between maternal exposure to PM<sub>10</sub> and O<sub>3</sub> and CHD in the offspring. CO was found to be associated with VSD, PS and CS which is consistent with the findings for VSD reported in the United States. Consistent associations across quartiles of exposure were found for NO and VSD, ToF and CS. NO was not included in previous studies.

#### ISEE-1279

#### **Deficit in Lung Function Growth and Exposure to Air Pollutants in Adolescents Residing in Mexico City**

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**Objective:** To evaluate the association between lung function growth and long-term exposure to ozone (O<sub>3</sub>), particulate matter <10 (PM<sub>10</sub>) and nitrogen dioxide (NO<sub>2</sub>) in Mexico City adolescents.

**Methods:** A cohort of 829 healthy middle school children residing in Mexico City, aged 12 to 15 years, was evaluated every six months, from January 2000 to June 2002. Spirometric tests, following American Thoracic Society (ATS) standards, a risk factor questionnaire were applied

at each evaluation. The associations between lung function and exposure to air pollutants ( $O_3$ ,  $PM_{10}$ , and  $NO_2$ ) measured in the six months prior to the spirometry were evaluated using general linear mixed models.

**Results:** After adjusting for acute exposure and other potential confounding factors, deficits in FVC,  $FEV_1$  and  $FEF_{25-75\%}$  growth over the two and a half year follow-up period were significantly associated with exposure to  $PM_{10}$  and  $NO_2$ . In multi-pollutant models, an interquartile range (IQR = 23.1 ppb) increase in mean  $PM_{10}$  concentration was associated with an annual deficit: in FVC of 14.5 cl in girls and 16.6 cl in boys, in  $FEV_1$  of 15.6 cl in girls and 20 cl in boys, and in  $FEF_{25-75\%}$  of 25.2 cl in girls and 32.6 cl in boys, and an interquartile range (IQR = 10.9 ppb) increase in  $NO_2$  with an annual deficit in  $FEV_1$  of 8.1 cl in boys.

**Conclusion:** We conclude that long-term exposure to  $PM_{10}$  and  $NO_2$  is associated with a deficit in FVC,  $FEV_1$  and  $FEF_{25-75\%}$  growth among adolescents living in Mexico City.

#### ISEE-1281

#### Air Pollution Characterization Based on Air Masses: Implications for Human Exposures

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**Background:** Associations between air pollutants and meteorological variables are usually studied using a single meteorological variable such as temperature. However, additional information is gained by examining these associations using combinations of meteorological variables. Sheridan (2002) developed the spatial synoptic classification (SSC) system to associate each day with one of eight different air masses or a transition between two air masses. Air masses are characterized according to their origin (e.g., polar, moderate or tropical) and to their moisture content (e.g., moist or dry). Thus, the air mass concept provides information about the history of the air affecting a given location on a given day, and also potentially provides information about pollution sources, and meteorological conditions affecting the mixture of ambient pollutants.

**Methods:** The SCC is used to characterize air masses affecting Charlotte, North Carolina, over a ten year period (1996–2005). It is then used in conjunction with air pollutant data to examine relationships with daily 24 h average concentrations of  $PM_{2.5}$  and  $PM_{10}$ ,  $NO_2$ , and CO, and 8-h maximum  $O_3$  obtained from the U.S. EPA's Air Quality System. Relationships with  $PM_{2.5}$  composition examined for the latter half of this period (2001–2005) using data for aerosol components from the speciation trends network. Relationships between criteria pollutants and air mass is examined in terms of 1) concentration ranges of the pollutants in each air mass; and 2) spatial variations in pollutant concentrations in each air mass. For example, the median concentration of  $O_3$  is 60 ppb within the moist tropical air mass and 25 ppb within the moist polar air mass. Under the dry tropical pattern, the 90<sup>th</sup> percentile of the differences of  $O_3$  concentrations between different sites could be as large as ~30 ppb, while under the moist polar pattern, the difference reduces to ~10 ppb. Potential sources of air pollutants and source regions affecting the Charlotte area are examined using the aerosol speciation database. These results will help us better understand the interactions between meteorology conditions/climate change, and personal exposures to ambient pollutants, and therefore better quantify the effect of climate change on human health effects.

#### ISEE-1282

#### Updated Meta-Analysis of Mobile Phone Use and Brain Tumors

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**Objectives:** Two recent meta-analyses of studies published through early 2007 have evaluated the use of mobile phones and risk of brain tumors. However, these meta-analyses used different exposure classifications: one of latency, the other of "regular use" and duration of use and arrived at different conclusions (Hardell L, et al. Occup Environ Med 2007; 64:626–632 and Kan P, et al. J Neurooncol 2008; 86:71–78, respectively). Also, these two meta-analyses did not include the same set of studies. Four additional case-control studies not included in either meta-analysis were published in 2007 and 2008, and three case-control studies of acoustic neuroma published between 2002 and 2006 were not included in the meta-analysis of regular use (Kan et al.). We have included these studies in an updated meta-analysis of mobile phone use and brain tumor risk, considering exposure assessments defined as regular use, and duration of use, latency, and other categories.

**Methods:** Using MEDLINE we exploded the search terms of *brain tumor*, *acoustic neuroma*, *meningioma*, *glioma*, and *cellular telephone* to locate any additional studies through 2008 that reported information on mobile phone and brain cancer risks. Meta relative risks (RRs) and 95% confidence intervals (CI) were calculated using a random-effects model (stratified by specific tumor types) for regular phone use, duration of use, and latency. Sensitivity and influence analyses were also conducted.

**Results:** Of 35 initially identified publications, 17 case-control studies containing 8,272 cases of brain tumors and 17,398 controls were included. Studies excluded overlapped with included studies or did not report data for regular or duration of use. Eight studies reported results for regular mobile phone use and risk of acoustic neuroma, ten for risk of glioma, and eight for risk of meningioma. The meta RR for regular use and risk of acoustic neuroma was 0.86 (95% CI: 0.74–1.01). For glioma the meta RR was 0.87 (95% CI: 0.77–0.99) and for meningioma was 0.78 (95% CI: 0.68–0.91). Four studies reported information on duration of use greater than 10 years by tumor type. The meta RR for all types brain tumors combined was 1.07 (95% CI: 0.83–1.37). Our meta RR value for regular use remains similar to Kan et al. values despite the addition of new studies. For duration of use, our meta RR was lower than the value reported by Kan et al., which could be explained by differences in the estimates used in analysis.

**Conclusions:** We observed no increased risk by specific type of brain tumor with regular use of mobile phones. We also did not observe a risk with duration of use greater than 10 years. Our results are counter to results obtained by the Hardell et al. meta-analysis, which analyzed latency and not duration of use, and did not calculate summary relative risks for "regular use". Future IARC publications that will pool all of the data across INTERPHONE studies and assess a variety of exposure metrics should help to resolve these discrepancies.

#### ISEE-1283

#### Exposures of a Panel of Senior Citizens with COPD to Multiple Air Pollutants in Los Angeles

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**Background:** Air Quality Criteria Documents produced by the US EPA (and now Integrated Science Assessments) have consistently reported causal or likely causal links between ambient criteria pollutants and adverse human health effects based on the review of numerous human clinical, animal toxicological and epidemiologic studies. However, due to the inter-correlations between these criteria pollutants at ambient air, it is difficult to accurately quantify the health effects caused by a single criteria pollutant in epidemiologic studies. A multi-pollutant human exposure study could quantify the association between personal exposures and ambient concentrations for multiple pollutants and their sources, and the associations among personal exposures to different pollutants, and therefore, could help refine epidemiologic findings.

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**Methods:** A multi-pollutant exposure study was conducted in Los Angeles, CA, in 2000 (Lau et al., 2001). Twenty-two senior citizens with chronic obstructive pulmonary disease (COPD) participated in the study. Many of the homes of the study participants were located near major highways or other major roads many were affected by activities in the Port of Long Beach. The study was conducted in two seasons (summer and winter), with 15 participants in each season (8 of the 22 people participated in both seasons). During each studied season, 5 groups of 3 participants were monitored. Each group of 3 was monitored simultaneously for seven consecutive days. Twenty-four hour average residential outdoor, indoor and personal exposure concentrations were measured for PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO as well as PM species. PM<sub>2.5</sub> and PM<sub>10</sub> samples were also collected at a central monitoring site. The air exchange rate for each home and personal activity information were measured as well.

**Results:** Mean 24-hr indoor, outdoor and personal PM<sub>2.5</sub> concentrations were 16.9, 13.5 and 19.6  $\mu\text{g}/\text{m}^3$ , respectively during the winter, and 18.1, 19.3, and 25.1  $\mu\text{g}/\text{m}^3$ , respectively during the summer. For NO<sub>2</sub>, the mean 24-hr indoor, outdoor and personal concentrations were 11.4, 13.5 and 11.2 ppb, respectively during the winter, and 6.8, 10.0, and 6.9 ppb, respectively during the summer. The pooled (across study participants and sampling days) correlation coefficients among indoor, outdoor and personal PM<sub>2.5</sub> (24-h average) ranged from 0.16 to 0.48. The correlations among personal exposure and indoor, outdoor, and central site concentrations become much stronger, ranging from 0.24 to 0.80, when 7-day averaged exposures and concentrations were examined. Source contributions to personal exposure are estimated with tracer species and the distance from each residence to the source examined. Errors associated with using ambient concentrations as surrogates for personal exposure will also be presented.

#### ISEE-1285

##### A Land Use Regression Model for Predicting PM<sub>2.5</sub> in Mexico City

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**Introduction:** Epidemiologic studies in the world have evaluated the PM<sub>2.5</sub> exposure using "Land Use Regression" (LUR) models, but in Mexico this model has not been implemented. Objective: To evaluate the particles PM<sub>2.5</sub> exposure generating a spatial model called "Land Use Regression" in the Mexico City and Metropolitan Area.

**Material and Methods:** The concentrations of PM<sub>2.5</sub> were measured in 36 schools from June to October 2003 (rainy season). We constructed a GIS in the study zone and for each sample location circle buffers were made considering different radii. These buffers included physical, geographical and demographic characteristics, density, type and vehicular traffic flow, distance of places of interest to each school. Linear regression analysis was used to assess the association between PM<sub>2.5</sub> concentrations and land use variables.

**Results:** Concentrations ranged from 16.1 to 23.4  $\mu\text{g}/\text{m}^3$  (average 19.8  $\mu\text{g}/\text{m}^3$ ). The final model included 5 spatial variables (main avenues inside buffer from 0 to 250 meters, schools located in 500 meters radii of some industrial zone, coordinated position (UTM) in the X axis, relative humidity and wind speed) and explained 60 % of the variability of the PM<sub>2.5</sub> concentration in the study zone.

**Conclusions:** The results of this study are in agreement with that realized in other countries and can be used as an effective tool to evaluate the air pollution exposure in epidemiologic studies.

#### ISEE-1286

##### Effects of Particulate Matter on Genomic DNA Methylation Content and iNOS Promoter Methylation

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**Background:** Exposure to Particulate Matter (PM) from ambient and occupational sources has been associated with adverse health outcomes, including cardiovascular and respiratory disease, but the mechanisms linking PM inhalation to adverse health outcomes have not been completely clarified. Inhaled PM has been shown to produce systemic changes in gene expression, which can be detected in peripheral blood of exposed individuals. DNA methylation is a primary epigenetic mechanism regulating the expression of human genes, and initial observations in *in vitro* and animal models have shown that air particles, or air particle components such as toxic metals, can induce changes in DNA methylation. Whether DNA methylation changes occur in human subjects exposed to PM has never been determined.

**Objectives:** To identify short- and long-term effects on blood DNA methylation in foundry workers with well-characterized exposure to PM with aerodynamic diameters < 10  $\mu\text{m}$  (PM<sub>10</sub>), we measured promoter DNA methylation of inducible nitric oxide synthase iNOS, a gene activated by PM exposure, and global genomic methylation content, estimated in Alu and LINE-1 repeated elements. Lower DNA iNOS promoter methylation is known to be associated with increased iNOS expression. Reduced genomic methylation content in blood DNA has been observed in subjects with cardiovascular disease, as well in cancer subjects, and can be produced *in vitro* by reactive oxygen species.

**Methods:** High-precision quantitative DNA methylation analysis was performed through PCR-Pyrosequencing of bisulfite-treated blood DNA from 63 male foundry workers (mean age = 44 years, SD = 7.6) who were examined before (baseline) and after (post-exposure) three days of work. Individual PM<sub>10</sub> exposure during the three days of work was estimated based on PM<sub>10</sub> area measurements and time spent by the study subjects in each area. Individual PM<sub>10</sub> level was between 73.4–1220  $\mu\text{g}/\text{m}^3$ . PM<sub>10</sub> within each work area showed very high correlations ( $R > 0.90$ ) in measurements taken over one year. Because all study subjects reported to have performed their standard work routines during the three days of the study, PM<sub>10</sub> level represented both the exposure during the week of the study, as well as the usual exposure at work of the study subjects.

**Results:** iNOS promoter DNA methylation exhibited a significant decrease in post-exposure blood samples compared to the baseline (difference = -0.61 %5 mC;  $P = 0.02$ ). PM<sub>10</sub> level showed a non-linear effect on iNOS promoter methylation measured on post-exposure samples, with the strongest decrease in the second tertile of PM<sub>10</sub> exposure (difference = -2.93 %5 mC;  $P = 0.005$ , compared to the first PM<sub>10</sub> tertile). Global methylation content estimated in Alu and LINE-1 repeated elements did not show changes in post-exposure measures compared to the baseline. PM<sub>10</sub> exposure levels were significantly associated with decreased global methylation content, regardless of whether DNA methylation was measured in baseline or post-exposure blood samples.

When baseline and post-exposure samples were included in the same statistical models, PM<sub>10</sub> levels were negatively correlated with decreased methylation in both Alu (Beta = -0.19; P = 0.04) and LINE-1 (Beta = -0.34; P = 0.04), likely reflecting long-term effects of PM<sub>10</sub> on DNA methylation.

**Conclusions:** Our findings indicate DNA methylation as a novel molecular mechanism which may mediate PM effects on human health.

#### ISEE-1287

#### Longitudinal Evaluation of Spatial Exposure Models for El Paso, TX, USA

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**Background:** Evaluating spatial models and covariates to updated conditions, extended regions and multiple points in time represents a step beyond the ambient exposure estimation methods used in environmental epidemiology. We compare NO<sub>2</sub> exposure predictions from a spatial model developed for a school district in El Paso, TX (Smith et al., *Atmos. Environ.* 40: 3773–3787) with recent measurements and estimates predicted from an updated model. The recent measurements and updated model will be used to assess children's exposure to ambient pollutants (NO<sub>2</sub>, VOCs and O<sub>3</sub>) in an ongoing asthma study in El Paso County.

**Methods and Results:** Starting with the covariates used in the original study, we expand spatial coverage from the city to the county level, temporal coverage to two years, and use updated traffic and population density data and multiple VOC sources rather than oil facilities alone. The initial study was school-based versus the current usage of water facilities selected to optimize covariate variability. The current study uses multiple linear regression to estimate the pollutant surface, whereas the original study used semi-parametric general additive model regression. Updated covariates from the original study (elevation, traffic intensity, population density, and distances to point sources and border crossings) explained NO<sub>2</sub> concentrations for the current study period (P < 0.001, adjusted R<sup>2</sup> = 0.83). A model using distance to freeways instead of traffic intensity explains NO<sub>2</sub> surfaces slightly better than the original model (P < 0.001, adjusted R<sup>2</sup> = 0.85). Slopes for the land use regression covariates in the current study did not vary significantly among measurement periods. Additional comparisons of old and new predicted estimates with recent, county-wide longitudinal NO<sub>2</sub> measurements will be presented. Evaluations such as these will inform the direction of exposure assessments in spatial-based environmental epidemiology studies for El Paso.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1288

#### Lung Cancer Mortality and Exposure to Biocide in the Auto Industry

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**Objective:** Exposure assessment studies suggest that airborne endotoxin is highly correlated with mass particulate of synthetic metalworking fluids. Biocide is added to waterbased fluids to limit microbial growth, but may only reduce airborne endotoxin in the short term. Limited occupational epidemiologic evidence also indicates endotoxin is protective against lung cancer. Using biocide as a surrogate measure of endotoxin, we investigated whether lung cancer mortality was inversely associated with biocide exposure in an updated follow-up of autoworkers exposed to metalworking fluids.

**Methods:** We performed a nested case-control analysis from a retrospective cohort study of 46,399 hourly workers employed in three auto manufacturing plants. Each case was matched by age with 20 controls. Using Cox regression, we estimated mortality rate ratios for lung cancer as smoothed functions of years exposed to biocide and cumulative exposure to synthetic fluids (mg/m<sup>3</sup>-years) using penalized splines in separate models.

**Results:** There were 1,137 lung cancer deaths at end of follow-up. A non-linear exposure response was observed for synthetic fluids; with a HR that decreased to a minimum of 0.54 at the 97.4% percentile (6.0 mg/m<sup>3</sup>-years) of exposure before rising (with wide confidence bands). For biocide, the HR decreased in a linear fashion (with narrow confidence bands) down to 0.58 at the 99th percentile of exposure (11.3 years of exposure).

**Conclusion:** We have found evidence of inverse risk for lung cancer mortality in association with years exposed to biocide. The less consistent findings for synthetic fluids suggest that exposure to biocide may be a better surrogate for endotoxin exposure in this study.

#### ISEE-1290

#### Seasonality of Birth in Atlanta and Implications for Temporal Studies of Preterm Birth

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**Background:** It is well known that birth rates exhibit seasonal variation, and there is some evidence to suggest that such seasonal variation in birth rates can differ among socio-demographic subgroups. We examined these seasonal birth patterns and whether they could confound time-series investigations of preterm birth and seasonally varying exposures such as air pollution, water quality, allergen levels, pesticide application and meteorological factors.

**Methods:** The study cohort consisted of all births in 20-county metropolitan Atlanta delivered between January 1, 1994, and December 31, 2004 (n = 715,875). We identified months with higher and lower than expected number of births for the overall birth cohort and in subgroups stratified by socio-demographic factors. Within the context of a time-series analysis, we then explored whether the seasonal patterns of birth could lead to artifactual seasonal differences in observed rates of preterm birth.

**Results:** The overall seasonality of birth exhibited a peak in births in August-September and a trough in April-May. The most meaningful differences in seasonal pattern of birth were observed across levels of maternal education, race/ethnicity and marital status. Maternal age groups and primiparity status showed less divergent patterns of birth seasonality. These seasonal patterns of birth led to seasonal differences in the gestational age distribution and socio-demographic composition of the pregnancies at risk for preterm birth. As a result, there were small differences in the expected rate of preterm birth across calendar months.

**Conclusions:** In metropolitan Atlanta between 1994 and 2004, we observed seasonal patterns of birth which differed among socio-demographic subgroups. These patterns lead to seasonal heterogeneity in the pregnancies at risk for preterm birth and thus warrant consideration in temporal studies of seasonally varying exposures and adverse pregnancy outcomes.

#### ISEE-1291

#### Spatial and Temporal Analysis of Disinfection By-Product Concentration

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**Background:** Previous epidemiological studies suggest that elevated exposure to drinking water disinfection by-products (DBPs) may be associated with bladder cancer and adverse reproductive outcomes. Most of these studies rely on total trihalomethane (TTHM) and haloacetic acid (HAA) concentrations as surrogate measures for exposure to DBPs. These surrogate measures are often based on town-average (i.e., group-level) concentrations to estimate individual-level exposure to DBPs. In addition to ignoring inter-individual variability, these limited data may inadequately capture spatial and temporal trends in DBP formation in drinking water. This has important implications for exposure assessment in epidemiological studies especially for health outcomes with very narrow critical periods of exposures.

**Methods:** We assessed temporal and spatial variability in routinely-collected DBP monitoring data for 16 large water distribution systems in Massachusetts. Preliminary data for ten years (1995–2004) suggest that TTHM concentrations have begun to decrease over time. For example, when restricted to the 11 towns with complete quarterly data, the mean TTHM value decreased from 49.8 µg/L in 1995 to 38.2 µg/L in 2004. The change in TTHM concentration between towns is likely an indicator of changes in treatment processes for several water systems in anticipation of the DBP Stage 1 rule (effective in 2004). We also detected seasonal variability across the distribution systems, with average TTHM concentrations 30–40% higher in the summer compared to the winter. The seasonal variability that was observed reinforces the need for collection of multiple samples per year to adequately capture temporal variability for exposure assessment purposes. Alternatively, regression modeling techniques can be used to estimate missing time periods or to examine specific windows of exposure. We also examined towns with high spatial variability to determine the validity of using town average concentrations to estimate individual level DBP exposures.

**Results:** Five of the distribution systems showed high spatial variability amongst the quarterly sampling locations. Roughly half of the sample locations in these towns had TTHM concentrations differing by more than 60%. This spatial variability was fairly consistent (30–50%) across the quarterly sampling periods, although most towns demonstrated less spatial variability in the winter quarter. In systems with considerable spatial variability, the average town-level concentrations may not adequately characterize exposures to most individuals in these water systems.

**Conclusion:** These preliminary data on 16 of 200 Massachusetts towns demonstrate the need to examine the impact of measurement error due to temporal and spatial variability in assigning individual level DBP values in epidemiological studies.

#### ISEE-1292

#### The Impact of the Introduction of an Improved Stove (PATSARI) on Urinary Polycyclic Aromatic Hydrocarbons (PAHs) Biomarkers of Exposure

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**Background:** Cooking and heating with biomass fuels on open fires or traditional stoves results in high levels of health-damaging pollutants including carcinogenic polycyclic aromatic hydrocarbons (PAHs), product of the incomplete combustion of biomass present mainly in the particulate phase of smoke. One approach to decrease the high levels of pollutants related to biomass fuel has been the implementation of improved wood-burning chimney stoves. The aim of this study is to compare the urinary PAHs biomarkers of exposure before and after the introduction of an improved chimney stove (PATSARI).

**Methods:** Urinary samples were collected on a sub-sample of 62 women participating in a randomized improved stove intervention community trial in the Purepecha region in the state of Michoacan in central Mexico. Samples were kept frozen until sent to the laboratory at the CDC for analysis of urinary monohydroxy polycyclic aromatic hydrocarbons (OH-PAHs), a class of PAH metabolites used as biomarkers for assessing human exposure to PAHs, by gas chromatography isotope dilution high resolution mass spectrometry. The concentration of these urinary metabolites pre- and post-intervention was compared by paired t-test.

**Results:** Ten out of 19 urinary metabolites determined had enough valid measurements above the limit of detection for a descriptive analysis: the metabolites for naphthalene, fluorene, phenanthrene and pyrene. 46 women had measurements before and after the intervention in order to perform a paired comparison. All 10 metabolites were significantly lower after the intervention, in average there was a 50% reduction in the concentration. The mean for 1-hydroxypyrene (1-PYR)—the most commonly used biomarker for PAH exposure—was 5.8 µg/L urine before the intervention and 2.9 µg/L urine after the introduction of the improved stove. Mean levels for 1-hydroxynaphthalene, 9-hydroxyfluorene and 1-hydroxyphenanthrene were respectively 36.8, 6.0 and 4.2 pre-intervention; 16.7, 4.2 and 2.6 µg/L urine post-intervention.

**Conclusion:** The introduction of an improved chimney stove significantly reduces the exposure to PAHs measured as the urinary metabolites of several parent PAHs compounds. Even after the intervention, the level of 1-hydroxypyrene is above those reported for non exposed population.

#### ISEE-1294

#### Using Oracle Application Express for Rapid Development of CHAD Explorer—a Data Mining Tool for Consolidated Human Activity Database (CHAD)

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**Background:** US EPA has established a Consolidated Human Activity Database (CHAD), which serves as a master database providing access to other human activity databases using a consistent format. To enhance the capabilities of CHAD and provide more services, a new data-mining tool—CHAD Explorer—was developed using the advanced information technology offered by the Oracle Application Express (OAP).

**Discussion:** Using a single workspace for combined database-driven web application, CHAD Explorer was developed at reduced cost but much faster speed than alternative approaches. The OAP approach also simplifies a lot of administrative work associated with developing database-drive web applications in traditional procedures. The whole development process was done in-house without dependency on external sources and resources. This in-house capability of developing a database mining tool is important as our modeling research often requires addition of new data into existing databases or even the establishment of different new databases. In addition, the swift upgrading and enhancement of data mining capability in the existing database is important for meeting the challenges of the changing requirements in research.

**Conclusions:** The successful experience of using this database-driven web application will boost EPA's capability to serve the exposure research community better in the future. The knowledge and skills gained from this rapid development of a dynamic web application may also be useful for developing database-driven and user-friendly web applications for other aspects of exposure assessment and risk analysis.

**Disclaimer:** Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

**ISEE-1296****Factors that Modify the Adoption of an Improved Chimney Stove (PATSARI) Reducing Indoor Air Pollution in Rural Mexico**

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**Background:** The household use of solid fuels is the most wide-spread source of indoor air pollution. In Mexico close to 27 millions people use biomass, particularly wood as primary source of energy. One approach to decrease the health burden related to biomass fuel has been the implementation of improved wood-burning chimney stoves. The installation of an improved stove does not necessarily imply the adoption and use of the new technology. The aim of this study was to identify the factors that modify the adoption process of the improved stove PATSARI.

**Methods:** A total of 612 households in six communities located in the Purepecha region in the highlands of the state of Michoacan were selected and randomized to receive an improved stove (PATSARI) early on or keep their traditional wood fire until the end of the follow up including 10 monthly visits. At each monthly visit the women in the intervention group were asked which type of stove they principally used during the previous month and were classified in 2 categories of stove users: 1) women who reported using the new chimney stove (PATSARI) and 2) women who kept using open wood fire. In order to identify the variables that modify the adoption process, a predictive model of the stove use was constructed using generalized estimating equations (GEE).

**Results:** The households randomized to the intervention group did not fully adhere to it and despite being assigned to the intervention group and having an improved chimney stove, some women continued to use the open wood fire for some cooking purposes. Among women included in the intervention group, in average 50% reported using the improved stove PATSARI and 50% used the open wood fire during the follow up. The indicator variable of community was an important predictor of the stove use. The women using PATSARI were more likely to be from the higher socioeconomic status category, to live in a household with separated kitchen, to eat in the same room where they cook, to have had the PATSARI stove installed a longer period and to have used an elevated cooking device before the installation of the PATSARI.

**Conclusion:** In this study, the adherence to the intervention was of 50% in average, which is relatively low. The adoption of improved stoves requires a close and long follow up to achieve the training in the use and maintenance of the stove. We noticed that the adoption of the new technology was lower in some communities compared with others and identified some characteristics that modify this adoption process.

**ISEE-1297****Assessment of Pulmonary Exposure to Manganese: Uptake of Metals from Inhaled Welding Fumes into the Circulatory System**

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**Background:** Epidemiological studies of occupationally and environmentally exposed populations to airborne manganese (Mn) have reported a relationship between exposure and neurotoxic outcomes. However, the relationship between airborne Mn exposure and Mn uptake from the pulmonary system remains unclear. Toxicological research has indicated that exposure to various forms of Mn (i.e. varying valence states, solubilities, and/or particle size) results in differences in bioaccumulation and appears to affect the time course of Mn uptake throughout the body including the target organ, the brain. Several studies have attempted to use

biomarkers of exposure to assess the relationship between inhalation exposure and biological impact. Results reported from these studies have been inconsistent, especially for blood and urine. Among the problems with studies to date are: inconsistencies in the duration between the exposure and the measurement of the biomarker; timing of biomarker measurements; and differences in sources and routes of exposure. The goal of our study is to identify the time course of uptake of metals into the circulatory system following inhalation exposure in order to more accurately assess the relationship between exposure and biomarkers of exposure.

**Methods and Results:** In this study we selected welding fume as a source of inhalation exposure to fine and ultrafine particles that contains Mn. Participants were asked to wear particle samplers as they welded under their own conditions. Particle samples were analyzed for Mn and other metals for total metal content as well as the size distribution of specified metal particles. Preliminary TEM analysis of particle samples collected to date demonstrate that welding fume particle diameters range from 3–200 nm, and Mn content is not evenly distributed in all particles. Furthermore, in these samples, Mn was found mostly as Mn<sup>2+</sup>. Venous blood and exhaled breath condensate (EBC) samples were collected from participants directly before and at 9 time points following the exposure over the course of one week. Longitudinal data analysis of the measured concentrations of metals in repeated biological samples from each participant allows us to measure the trend of the time course of uptake among participants. Preliminary analysis of biological samples collected from the first 3 participants suggests that concentrations of Mn in blood and EBC peak around 48 hours after the welding inhalation exposure and Mn concentrations return to baseline levels within about 5 days. Further investigation is ongoing.

**Discussion:** Welding fume exposure is relevant to the estimated 2 million people worldwide who weld for their occupation. More generally, inhalation to airborne Mn has implications for a much broader audience. The introduction of methylcyclopentadienyl manganese tricarbonyl (MMT) into gasoline in several countries currently puts the general public at risk for Mn inhalation exposure. An improved understanding the relationship between inhalation exposure to Mn and the timing of uptake in blood and EBC may assist in interpretation of findings from past epidemiological studies and provide guidance in the selection and timing of biomarker collection in future studies assessing the hazards of Mn exposure in occupational populations, as well as the in the general public.

**ISEE-1298****Development of a Cumulative and Aggregate PBPK Model for Chlorpyrifos and Diazinon**

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**Background:** Following the Food Quality Protection Act of 1996, it has become increasingly important to assess cumulative and aggregate exposure and determine route and pesticide contribution to total body burden. Calculation of aggregate dose is necessary to characterize exposure and absorption by different routes, and take into account different resistance properties of absorption membranes. Chlorpyrifos and diazinon are both organophosphate pesticides widely used in agriculture and previously used residentially with the same non-specific metabolites. We developed a physiologically based pharmacokinetic (PBPK) model to estimate aggregate and cumulative dose from exposure to these pesticides. Outputs include concentration-time course profiles of chlorpyrifos, diazinon and their metabolites in blood, tissues and urine.

**Methods:** Within the PBPK model, separate PBPK modules were developed for chlorpyrifos, diazinon and their metabolites to characterize their distinct distribution in the body based on previously developed and

rigorously evaluated models. It is assumed that the pesticides are absorbed through the lungs, skin and gut and exit the body through exhalation, metabolism, renal or fecal excretion. The metabolite models are linked to the parent pesticide models through metabolism in the liver. Input parameters were obtained from the experimental literature, estimated or optimized during model simulation. Data from human volunteer studies was used to evaluate model. Modeled results for each scenario were compared with measured values. Concentration time course profiles were obtained for chlorpyrifos and metabolites in the different tissues. A sensitivity analysis was completed.

**Results:** Several published human volunteer studies were analyzed with the model. For each study, the model reasonably approximated the measured data, and confirmed that the oral dose is absorbed, metabolized and eliminated faster than the dermal dose for both pesticides. Following exposure to chlorpyrifos, modeled metabolite urine concentration decreased too rapidly following ingestion exposure and too slowly following dermal exposure. The model approximated measured data more closely for diazinon pharmacokinetics. Model simulations of ingestion and dermal exposure to chlorpyrifos demonstrated route-specific differences in pharmacokinetics. Following ingestion exposure, chlorpyrifos is metabolized and eliminated rapidly from the body due to first-pass metabolism. However, following dermal exposure, chlorpyrifos is absorbed directly into the blood and more can partition into fat. Thus, higher concentrations of the more toxic parent compounds are present in the blood, which take longer to be eliminated from the fat reservoir. The model was most sensitive to changes in octanol-water partition coefficients, plasma protein binding, and stratum corneum thickness.

**Discussion and Conclusions:** The PBPK model is capable of adequately describing the absorption, metabolism, distribution, and elimination of chlorpyrifos and diazinon over a broad range of exposure scenarios. The model could be refined by accounting for lateral diffusion in the stratum corneum, including a more detailed representation of intestinal absorption of lipophilic chemicals and additional pharmacokinetic data. Model simulations and human volunteer studies demonstrate that urinary excretion of chlorpyrifos, diazinon and their metabolites are route dependent. Following dermal exposure a greater amount of the absorbed dose is retained by the body. These results indicate that biomonitoring of urine metabolites might underestimate body burden from dermal and inhalation exposure.

#### ISEE-1300

#### Integrating Stereochemistry into Modern Risk Assessment: Implications for Exposure and Pharmacokinetic Modeling

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**Background:** As a conservative estimate, approximately one-third of registered pesticides consist of chiral or structurally asymmetric active molecules. For synthetically practical reasons and lack of regulation mandated for these chemicals, the pesticides are often manufactured and marketed as multiple stereoisomeric forms of the active molecules in either equimolar (racemic) or enriched stereoisomeric mixtures. When considering the number of unique configurations enumerated over all stereocenters, this “one-third” chiral component starts to surpass “one-half” of unique chemical entities, resulting in a majority of unaccounted for unique stereoisomeric forms. The ability to elucidate which stereoisomeric form of a given environmental chemical may result in an adverse effect becomes difficult, if not impossible when carrying out a risk-assessment on a stereoisomeric mixture. In modern safety assessment, being able to meld attributable risk at a molecular level of accountability requires the appropriate means of integrating stereochemistry into *in silico*, *in vitro* and *in vivo* schema. Similarly, resultant toxicity outcomes are contingent on the effects continuum brought about by differential

exposure of the individual stereoisomers in chiral mixtures, which are never exactly equivalent amongst stereoisomers in homochiral biological systems (*i.e.*, all living organisms).

**Methods and Results:** We provide a meta-analysis of a large chemical inventory (“Catalog of chiral agrochemicals”, merged with EPA Pesticides and Toxic Chemicals) and discuss some key examples of stereoisomerism in specific pesticide classes and the implications of treating stereoisomers in a mixture context (1) on a per chemical basis or (2) by lumping schemes. Next, we provide a workflow of how exposure sources (indoor versus outdoor and biota-rich) can lead to environmental enantioselectivity and thus differential exposure. Similarly we demonstrate from *in silico* analyses of our chiral chemical inventory just how the differences in ADME (adsorption, distribution, metabolism and excretion) properties could be rationally integrated into PBPK (physiologically-based pharmacokinetic) models. Finally, we discuss how some of these predicted parameters could be integrated in field study scenarios to reconstruct enantiomerically enriched exposure profiles.

**Discussion:** We anticipate that integrating stereochemistry into exposure and dose-response modeling will enable identification of key exposure response characteristics. These details are essential to develop both a more complete and accurate risk assessment and certain dose reconstruction estimates, and will allow the assignment of risk to specific stereoisomeric forms in chemical mixtures.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

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#### ISEE-1301

#### Development of a Cumulative and Aggregate Exposure and Dose Model for Children

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**Background:** Among other directives, the Food Quality Protection Act of 1996 mandates that evaluations of pesticide health risks take into account aggregate exposure and cumulative risk, with particular emphasis on protecting children’s health. Thus, methods are needed to quantify contribution of each route and pesticide to dose, which is typically assessed through measurements of non-specific biomarkers in urine. We have developed a cumulative and aggregate exposure and dose model called the Child-specific Aggregate Cumulative Human Exposure and Dose (CACHED). We developed CACHED by attempting to retain the physical processes of exposure and dose through incorporation of micro-level activity time series (MLATS), exposure mechanisms, and physiologically based pharmacokinetic (PBPK) components. Target chemicals used during model development were the organophosphate pesticides, chlorpyrifos and diazinon. Chosen based on their widespread residential and agricultural use, common mechanism of toxicity and extent of available literature data.

**Methods:** CACHED is composed of separate modules: non-dietary exposure (inhalation, non-dietary ingestion, dermal), dietary exposure, and a PBPK model for chlorpyrifos, diazinon, and their metabolites. It is physical-stochastic and combines MLATS with environmental concentrations to estimate exposure from various chemicals. Dietary exposure estimates are obtained through sampling of national databases for food consumption and pesticide residues on food. Exposure estimates are then used to estimate dose with a PBPK model. CACHED also includes functions to account for children’s changing physiology. MLATS provide sequential second-by-second records of dermal, hand-to-mouth and object-to-mouth contacts, allowing for a more physically representative estimation of dermal and non-dietary ingestion exposure not previously possible from other forms of activity data.

Outputs include exposure and absorbed dose estimates for each route and chemical distribution in tissues, blood, exhaled air and urine. Each module has been validated independently.

**Results:** CACHED was evaluated by quantifying cumulative and aggregate exposure and dose estimates for a population of young (6–26 months old) children. MLATS of children collected concurrently with residential measurements of chlorpyrifos and diazinon were used to simulate 115,000 exposure scenarios. Modeled median dermal exposure estimates of children from CACHED utilizing their MLATS were within a factor of 2 of measured values from dosimeters worn by the same children. Modeled dietary exposure estimates were also very similar to values measured in duplicate diets. The dermal and ingestion absorption, and full body PBPK modules were calibrated with data from human volunteer studies in adults. Finally, the complete CACHED modeling framework was evaluated by estimating DAP concentrations in the children's urine. Estimated metabolite urine concentrations were not statistically different than concentrations measured in the urine of children from the same population.

**Conclusions:** CACHED provides a framework for linking environmental concentrations, children's activities and biomarker levels. The model is capable of simulating the exposure-route dependent processes of absorption, distribution, metabolism, and elimination of chlorpyrifos and diazinon. CACHED's unique incorporation of MLATS facilitates the identification of specific exposure-prone behaviors and their contribution to overall absorbed dose. CACHED is a valuable tool for assessing route and chemical contribution to internal dose and can be used to develop and evaluate intervention strategies.

#### ISEE-1302

#### Organophosphate Pesticide and Exposure Route Contribution to Aggregate and Cumulative Dose for Young Farmworker Children

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**Background:** The Food Quality Protection Act of 1996 mandates that the evaluation of pesticide health risks take into account aggregate exposure and cumulative risk with particular emphasis on protecting children's health. While all children may be exposed to pesticides through drinking water, diet and residential-use pathways, potential sources of additional pesticide exposure for children in farmworker homes includes aerosol drift from agriculture and occupational take-home contamination. We have previously developed and validated the Child-Specific Aggregate Cumulative Human Exposure and Dose (CACHED) model for chlorpyrifos and diazinon. Using pesticide concentration and activity data from homes of farmworkers' children, CACHED was used to estimate aggregate and cumulative exposure and dose for these children. Subsequent analysis was conducted to determine route and pesticide contribution to urine metabolite levels.

**Methods:** CACHED, a physical-stochastic model, combines micro-level activity time series (MLATS) with environmental concentration distributions to estimate exposure for multiple routes and various chemicals. The exposure estimates are then used to estimate dose with a physiologically based pharmacokinetic model (PBPK). CACHED was utilized to quantify cumulative and aggregate exposure and dose estimates for a population of young farmworker children. MLATS of farmworker children collected concurrently with residential measurements of pesticide concentrations were used to simulate 115,000 exposure scenarios. Target chemicals were the organophosphate pesticides chlorpyrifos and diazinon. They were chosen based on their historical residential and widespread

agricultural use, common mechanism of toxicity (inhibition of acetylcholinesterase) and density of available literature data.

**Results:** Estimated metabolite urine concentrations were not statistically different than concentrations measured in the urine of children from the same population. Median dermal exposure estimates from the model were within a factor of 2 of measured values from dosimeters worn by the same children. Route and pesticide contribution analysis indicates that in general, chlorpyrifos dietary exposure accounts for the largest portion of the metabolites in urine, however much variability was observed among the 115,000 simulations. Non-dietary ingestion exposure of both chlorpyrifos and diazinon also contributed substantially to children's aggregate dose, and the positive correlations established between dose and mouthing activity confirms the importance of the "micro-activity" approach. The risk metrics computed from the 115,000 simulations, indicate that greater than 90% of these scenarios might pose a risk to children's health from aggregate chlorpyrifos exposure.

**Conclusions:** CACHED is capable of estimating realistic urine biomarker estimates. While chlorpyrifos dietary exposure accounted for the largest portion of urine metabolites, the children with the highest dose and urine metabolite estimates received the majority of their additional exposure from non-dietary ingestion. The variability observed in the route and pesticide contributions to urine biomarker levels demonstrate the importance of accounting for aggregate and cumulative exposure in establishing pesticide residue tolerances in food. The risk metrics computed from the dose estimates indicate that a high percentage of these children may be potentially at-risk from aggregate chlorpyrifos exposure. Further analysis should be conducted to determine if children from non-agricultural families have similar risk. The CACHED model can be used in the future to evaluate intervention.

#### ISEE-1303

#### Estimation of Age-Specific Physiological and Pharmacokinetic Parameters for PBPK Modeling of Children

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**Background:** Factors influencing pharmacokinetics of chemicals in the body are physiological (e.g., tissue volumes, blood flow rates, and renal clearance values), physicochemical (e.g., tissue:blood partition coefficients), and biochemical (e.g., rates of chemical metabolism). Not only are infants and young children much smaller than adults, their bodies have different compositions, and physiological processes are immature. Thus, age-specific data on physiological parameters, metabolizing enzymes and tissue composition need to be assembled and documented to enable the construction of physiologically based pharmacokinetic (PBPK) models for children of various age groups. We have previously validated a PBPK model for simultaneous exposure to chlorpyrifos and diazinon for adults. We have developed functions for to be used with PBPK models to calculate the necessary age-specific parameters as a function of age, gender, body weight and height.

**Methods:** Based on a review of the literature, we have created distinct functions to estimate age-specific tissue volumes and perfusion rates, tissue composition, fugacity capacities, protein binding, metabolic parameters, exposed skin surface area, renal clearance rates and creatinine excretion. Whenever possible, we used equations for parameters derived from correlations of experimental measurements and demographic information (i.e., age, weight, height and gender). A linear relationship was assumed in cases where only tabulated data as function age was available. Simulations were conducted with each function utilizing national data sets for body weight and height for both genders from 2 weeks to 75 years of age. To evaluate the effects of age and gender on estimates from the PBPK model, simulations were conducted utilizing

constant inhalation and dermal exposures to chlorpyrifos and diazinon for individuals of both genders at various ages.

**Results:** Simulations with the national data sets indicate that tissue volumes, perfusion, ventilation, metabolic, renal clearance and creatinine excretion rates all increase with age. Most parameters reached stable values by 20 years of age. Tissue volumes and perfusion rates were somewhat different with gender and began to decrease around 55 years of age in the fat and slowly perfused compartments. Tissue composition, which alters fugacity capacities, is quite age dependent in childhood especially for fat and richly perfused tissues. PBPK model simulations with constant inhalation and dermal exposure to chlorpyrifos and diazinon for individuals of both genders for a variety of ages indicated that one-year olds had the greatest steady state urine metabolite concentration (0.04 nmol dialkyl phosphates per mmol creatinine). The pesticide metabolite concentrations were higher for females than for males. This became more pronounced in adulthood, where urine metabolite concentrations were 0.013 and 0.009 nmol dialkyl phosphates per mmol creatinine for female and male 20 year olds, respectively.

**Conclusions:** Through examination of the experimental literature and careful assumptions, functions were developed that are capable of estimating age-specific PBPK parameter values. PBPK model simulations demonstrate the age-related differences in pharmacokinetics of these pesticides and their metabolites, and underscored the importance of utilizing gender- and age-specific parameters especially during the first two years of life. As additional age-specific data becomes available these functions can be improved to more accurately assess physiological changes with age.

#### ISEE-1305

#### Factors that Predict Serum PCB, PCDD, AND PCDF Concentrations in Michigan, USA

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**Background:** We studied factors that predict serum concentrations of the 29 polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) for which WHO Toxic Equivalency Factors (TEFs) exist, using data from 946 participants in the University of Michigan Dioxin Exposure Study (UMDES) in Michigan, USA. This study provides a valuable opportunity to identify potential environmental exposure pathways for PCBs, PCDDs and PCDFs. **Methods:** Participants were interviewed regarding potential exposure pathways (sport caught fish and game, diet, activities in the contaminated area, occupations, residential locations), demographics, smoking, and breast feeding. Samples of blood, soil, and household dust were analyzed for PCBs, PCDDs and PCDFs using HRGC/HRMS. Data were analyzed using linear regression for complex survey data, in which the  $\log_{10}$ (serum PCB) was a linear function of predictors.

**Results:** Serum PCB concentrations were detectable in at least 98% of subjects for all congeners except PCB 81 (53% above LOD). The most important congener was PCB 126 because it typically contributes about 10% to the TEQ (using 2005 WHO TEFs), whereas all the other PCBs combined contribute less than 10% to the TEQ. Serum PCDD and PCDFs were detectable in a high proportion of participants for almost all congeners. The regression model for PCB 126 explained 52 percent of the variation in the serum concentration (adjusted  $R^2$ ). Most of the variation

was explained by demographic factors (age, BMI, and sex), and smoking. Age was positively associated with serum levels, while smoking was inversely associated with serum levels. Neither living on contaminated soil nor contaminated household dust was associated with increased serum PCB 126 levels. Living on a farm in the 1940s–1950s and eating sport caught fish from outside the contaminated area were positively associated with serum levels of PCB 126. None of the other environmental exposure factors we investigated, whether related to the Midland/Saginaw area or not, were significant predictors of serum PCB 126 levels. The regression models explained between 60 and 70 percent of the variation in serum congener concentration (adjusted  $R^2$ ) for most congeners. Most of the variation in PCDD and PCDF levels was explained by demographic factors (age, sex, BMI, BMI loss or gain in the past year), breastfeeding, and smoking. Age was positively associated with serum levels, while breast feeding was inversely associated with serum levels. Smoking was inversely associated with 2378-TCDD but not other PCDD congeners. Household dust concentrations and soil concentrations of PCBs, PCDDs, and PCDFs showed no appreciable relationship to serum concentrations.

**Conclusions:** This study has strengths that make it valuable. Since it is a population-based study, the results apply to the general population of Midland and Saginaw Counties. Few other studies have concurrent measurements of serum, soil, and household dust PCBs, as we have, nor do they include as many subjects. Our serum analyses were based on large samples (80 ml of blood), which allowed us to have measurable PCB levels for almost all subjects. Few other studies have achieved these levels and, as a result, have been limited by large numbers of non-detectable serum levels.

#### ISEE-1307

#### Emissions Measurements to Characterize Residential Exposures to Indoor Pollutants from Printers

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**Background:** Several recent studies have identified printers as a potential source of indoor pollutants. Standardized approaches for measuring pollutant emission rates from electronic devices are available but significant and unexplained variability in emission rates among devices and under differing conditions with the same device is often encountered. This is especially true for particles emitted from printers when emissions are assessed in terms of particle number rather than particle mass. Particles that are released during printing are primarily in the ultrafine (< 100 nm) size range that is not easily quantified with gravimetric methods. In addition, particle emissions are not necessarily constant during printing or between repeated print jobs; this variability leads to uncertainty in measured emission factors.

**Objective:** The goal of this project was to measure printer-specific emission factors for a range of pollutants and conditions to facilitate the assessment of residential exposures.

**Methods:** Measurements were first conducted in a large environmental chamber ( $\sim 20 \text{ m}^3$ ) where we quantified a range of pollutants emitted from groups of similar printers from different manufacturers. Volatile organic compounds (VOCs), ozone and particles were measured under pseudo-steady-state conditions.

**Results:** We used the results from the large chamber experiments to identify target pollutants and conditions that were studied in more detail for individual printers using a smaller test chamber. For several of the laser printers tested, the first print job from a cold unit often produced an initial burst of ultrafine aerosol while the constant emission rate from repeated print jobs was much lower. Pollutant-specific emission factors were measured for both the initial print and repeated prints, and the influence of a range of environmental and operational factors was assessed. The measured emission factors were used with assumptions

about printer use based on manufacturers' recommended duty cycles to provide a data set for estimating indoor pollutant concentrations and for exploring the importance of user proximity when estimating exposure concentrations.

#### ISEE-1308

#### VOC and Aldehyde Emissions from Four FEMA Temporary Housing Units

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**Methods:** Four unoccupied new or reconditioned FEMA temporary housing units (THUs) were studied to assess their indoor emissions of volatile organic compounds including formaldehyde. Measurement of whole-THU VOC and aldehyde emission factors ( $\mu\text{g h}^{-1}$  per  $\text{m}^2$  of floor area) for each of the four THUs were made at FEMA's Purvis MS staging yard using a mass balance approach. Measurements were made in the morning, and again in the afternoon. Steady-state indoor formaldehyde concentrations ranged from  $378 \mu\text{g m}^{-3}$  (0.31 ppm) to  $632 \mu\text{g m}^{-3}$  (0.52 ppm) in the AM, and from  $433 \mu\text{g m}^{-3}$  (0.35 ppm) to  $926 \mu\text{g m}^{-3}$  (0.78 ppm) in the PM. THU air exchange rates ranged from  $0.15 \text{ h}^{-1}$  to  $0.39 \text{ h}^{-1}$ . Small (approximately  $0.025 \text{ m}^2$ ) samples, 19 types, representative of all materials with exposed indoor surface area in each of the four THUs were collected and shipped to Lawrence Berkeley Laboratory for analysis. Quantification of VOCs was done via gas chromatography-mass spectrometry and low molecular weight aldehydes via high performance liquid chromatography. Material samples were analyzed for VOC and aldehyde emissions in small stainless steel chambers using a standard, accurate mass balance method. Material specific emission factors ( $\mu\text{g h}^{-1}$  per  $\text{m}^2$  of material) were quantified. Approximately 80 unique VOCs were tentatively identified in the THU field samples, of which forty-five were quantified either because of their toxicological significance or because their concentrations were high. Both whole-trailer and material specific emission factors for 33 compounds were calculated. The THU emission factors and those from their materials were compared against those measured from other types of housing and the materials used in their construction.

**Results:** Whole THU emission factors for most VOCs were typically similar to those from comparative housing. The three exceptions were exceptionally large emissions of formaldehyde and TMPD-DIB (a common plasticizer in vinyl products), and somewhat elevated for phenol. Of these three compounds, formaldehyde was the only one with toxicological significance at the observed concentrations. Whole THU formaldehyde emissions ranged from  $173$  to  $266 \mu\text{g m}^{-2} \text{ h}^{-1}$  in the morning and  $257$  to  $347 \mu\text{g m}^{-2} \text{ h}^{-1}$  in the afternoon. Median formaldehyde emissions in previously studied site-built and manufactured homes were  $31$  and  $45 \mu\text{g m}^{-2} \text{ h}^{-1}$ , respectively. Only one of the composite wood materials tested appeared to exceed the HUD formaldehyde emission standard ( $430 \mu\text{g/m}^2 \text{ h}^{-1}$  for particleboard and  $130 \mu\text{g/m}^2 \text{ h}^{-1}$  for plywood), although it is unclear whether some of the higher emitting materials might have at the time of manufacture.

**Conclusion:** A combination of the high loading factor (material surface area divided by THU volume) of composite wood products in the homes, and low ventilation rates, appear to be responsible for the excessive formaldehyde concentrations observed.

#### ISEE-1310

#### Associations Between Prenatal Exposure to PBDEs and Neonatal TSH levels

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**Background and Objective:** A growing number of studies report human exposure to polybrominated diphenylethers (PBDEs). These chemicals, which have been detected in serum samples collected in the United States, Europe and Japan, are primarily used as fire retardants in electronic products, polyurethane foam (mattresses and furniture), and building materials. Animal studies suggest that PBDEs may be neurotoxicants and may cause reductions in serum free and total thyroxine (T4) and in some cases increases in thyroid-stimulating hormone (TSH) levels. Since thyroid hormones are essential for normal neurodevelopment, the reported neurotoxic effect of PBDEs may be mediated through thyroid hormone disruption. While only one small ( $n = 9$ ) human study previously investigated associations between prenatal exposure to PBDEs and cord blood thyroid hormone levels, no study has investigated associations with thyroid function in neonates. Our aim was therefore to examine whether prenatal exposure to PBDEs was associated with higher TSH levels shortly after birth. For this purpose, we used data collected as part of the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), a birth cohort study of predominantly low-income Latinas who recently immigrated to the United States from Mexico and who live in farmworker families.

**Methods:** Women who were  $\geq 18$  years of age,  $< 20$  weeks gestation, English or Spanish speaking, Medi-Cal eligible (state-sponsored health care) and planning to deliver at Natividad Medical Center, the county hospital, were eligible for inclusion in the CHAMACOS study. We measured the concentration of 7 PBDE congeners (IUPAC Nos 47, 85, 99, 100, 153, 154 and 183) using high resolution gas chromatography/high resolution mass spectrometry with isotope dilution quantification (HRGC/HRMS) in serum samples collected at 26 weeks gestation. We also abstracted medical records and obtained data on TSH levels at birth, which is routinely measured by the California Department of Health Services Genetic Diseases Branch as part of the Neonatal Screening Program. TSH levels were determined in dried blood spots using a solid-phase time-resolved fluoroimmunoassay. Data on exposures and outcomes were available in 224 mother-infant pairs; analyses were performed using multiple linear regression models to control for confounding.

**Results and Discussion:** TSH levels were normal ( $< 25 \text{ mIU/L}$ ) for all neonates (GM = 5.7, GSD = 1.8 mIU/L). Data from a pilot study ( $n = 24$ ) indicates that PBDE levels in the CHAMACOS population were lower than those previously reported in U.S. studies (median for total PBDEs =  $20.6 \text{ ng/g lipids}$ ) and higher than levels measured in Europe and Japan. Analyses including participants for which data are currently available on both exposures and outcomes ( $n = 14$ ) suggest negative associations between all PBDE congeners but BDE-99 and  $\log_{10}(\text{TSH})$ . We will expand our analyses to the full sample of 224 mother-infant pairs.

#### ISEE-1311

#### Assessing the Relationship Between Exposure to Vegetation Fire Smoke and Hospital Admissions when Empirical Air Quality Measurements are Limited: Darwin, Australia, 1996–2005

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**Background:** Air pollution in Darwin, Northern Australia, is dominated by smoke from seasonal fires in the surrounding savanna that burn during the dry season from April to November. Our aim was to study the association between particulate matter less than 10 microns diameter ( $\text{PM}_{10}$ ) and daily emergency hospital admissions for cardio-respiratory

diseases for each fire season from 1996 to 2005. Due to the limited availability of empirical air quality data for this region, we used a previously validated model for deriving ambient PM<sub>10</sub> from visibility and weather data. While visibility data have been used in epidemiological studies of air pollution before, the use of this approach in the study of vegetation fire smoke is an important contribution because cities where fire smoke dominates air pollution tend to be small and atmospheric monitoring networks are rare.

**Methods:** Daily PM<sub>10</sub> exposure levels were estimated for the population of the city from an existing predictive model which uses visibility and weather data. This model had been developed previously for a study assessing the changes in Darwin's air quality over a 50 year period. Using the model we were able to assess daily air quality across a ten year period for which hospitalization data were available. We used over-dispersed Poisson generalized linear models with parametric smoothing functions for time and meteorology to examine the association between hospital admissions and PM<sub>10</sub> at lags of 0 to 3 days.

**Results:** The predictive model had been previously validated using observations from 2005. The predicted ambient PM<sub>10</sub> correlated well with the observations with an r<sup>2</sup> of 0.68, and a slope of 0.90. The mean deviation between the predicted and measured values was -2 µg/m<sup>3</sup> with a standard deviation of 3.6. The model had been further tested by assessing peaks in the predicted PM<sub>10</sub> against both satellite records and written documentation of the date and location of significant fire activity. Using the estimated daily PM<sub>10</sub> we found both positive and negative associations with cardio-respiratory hospitalizations, although our estimates had wide confidence intervals. There was a positive association for total respiratory admissions with same day estimated PM<sub>10</sub>, with a 10 µg/m<sup>3</sup> rise being associated with a 4.81% increase in daily admissions (95% CI: -1.04%, 11.01%). The subgroups of respiratory diseases (infections, asthma and chronic obstructive pulmonary disease) all had positive associations with same day estimated PM<sub>10</sub>. The small associations for all cardiovascular diseases and ischemic heart disease were all negative or zero and not statistically significant.

**Conclusions:** We used a previously developed model which estimates unmeasured particulate air pollution data using visibility and weather data to expand our epidemiological study of air pollution from vegetation fire smoke that had been limited by the short period of observed data. Positive associations were found between estimated vegetation fire smoke and daily hospital admissions for respiratory diseases. While this study was limited by the use of estimated rather than measured exposure data, the results are consistent with the currently small evidence base concerning this source of air pollution.

#### ISEE-1312

##### Passive Air Monitoring for a Childhood Leukemia Study

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**Background:** Previous studies of childhood leukemia and exposure to air pollutants have observed mixed results. Few of these studies have measured concentrations of potentially carcinogenic air pollutants inside or outside the homes of study children.

**Methods:** We used passive organic vapor monitors to measure air pollutant concentrations in the bedrooms of children over a two week period. Subjects were selected for air monitoring if they lived in the same residence since the diagnosis date (or reference date for controls) and were under eight years of age. Passive monitors were analyzed to determine the mass of benzene (n = 454), para-dichlorobenzene (n = 340) and toluene (n = 227) using gas chromatography. We calculated time weighted average concentrations using the chemical mass, sampling time and diffusion constant. We evaluated predictors of measured pollutant levels using the Kruskal-Wallis one-way ANOVA by ranks test.

Risk estimates were calculated using unconditional logistic regression adjusting for age, gender, race/ethnicity and household income.

**Results:** Benzene, para-dichlorobenzene and toluene were detected in 32%, 15% and 99% of the samples respectively. The mean concentration of benzene was 2.9 µg/m<sup>3</sup> and the 90<sup>th</sup> percentile was 5.4 µg/m<sup>3</sup>. Toluene concentrations were about an order of magnitude higher with mean and 90<sup>th</sup> percentile concentrations of 25 and 45 µg/m<sup>3</sup>. Sampling season was a significant predictor for all compounds measured. Residences with an attached garage had significantly higher benzene levels, and reported use of mothballs resulted in higher para-dichlorobenzene levels. The odds ratio for acute lymphocytic leukemia among subjects with benzene concentrations above 6 µg/m<sup>3</sup> compared to those below 3 µg/m<sup>3</sup> was 1.5 (95% CI, 0.8–3.0). The odds ratio for acute lymphocytic leukemia among subjects with measured para-dichlorobenzene levels above 12 µg/m<sup>3</sup> compared to those less than 4 µg/m<sup>3</sup> was 1.4 (95% CI, 0.6–3.3). The odds ratio for acute lymphocytic leukemia among subjects with toluene concentrations greater than 45 µg/m<sup>3</sup> compared to those below 7 µg/m<sup>3</sup> was 0.6 (95% CI, 0.2–1.8).

**Discussion:** This study demonstrated the feasibility of measuring air pollutant levels in the bedrooms of children enrolled in a leukemia study. Repeat samples are needed from a subset of homes to assess the variability of pollutant concentrations over time. A larger sample size is required for adequate power to detect modest increases in the risk of acute lymphocytic leukemia and to evaluate the relationship between acute myeloid leukemia and exposure to air pollutants.

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#### ISEE-1313

##### The Effect of Temperature on Hospital Admissions in Nine California Counties

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**Background:** Elevated temperature has been associated with mortality in the United States and many other countries. Fewer studies, however, have focused on the effect of temperature on morbidity, and none has focused on California, where humidity is generally lower than in other regions of the U.S. This current study examines the association between mean daily apparent temperature, a measure which incorporates both temperature and humidity, and hospital admissions for several diseases including: all cardiovascular diseases, ischemic heart disease, all respiratory diseases, pneumonia, dehydration and gastrointestinal infectious diseases in 9 counties throughout California from May to September 1999–2003. We also conducted age-stratified analyses on these diseases.

**Methods:** Weather data were obtained from the California Irrigation Management Information System and the U.S. EPA. Hospital admission data were obtained from the California Department of Health Services. We conducted a time-stratified case-crossover study limited to cases whose residential zip codes were located within 10 kilometers of a temperature monitor to minimize exposure misclassification. If multiple monitors were available, apparent temperature was assigned to each case using the closest monitor. We first obtained county-specific estimates and then combined them using a random effects meta-analysis.

**Results:** A total of 561,840 hospital admissions were included. A 10°F increase in unlagged mean apparent temperature corresponded to a 1.4% (95% CI = 0.1, 2.7) increase in ischemic heart disease a 1.9% (0.8, 3.1) increase in all respiratory diseases, a 3.3% (1.6, 4.9) increase in pneumonia, and an 11.5% (8.7, 14.3) increase in dehydration. Among children between ages 5 and 18 years, we found a 22.8% (4.8, 40.8) increase in gastrointestinal infectious diseases. We did not, however, find any evidence of an association between apparent temperature and admissions for all cardiovascular disease.

**Conclusions:** Even without extremes in apparent temperature, we observed an association between temperature and hospital admissions in California. Reducing heat exposure through air conditioning use and

mitigating the effects of heat through adequate hydration during hot weather are important steps in reducing heat-related morbidity.

#### ISEE-1314

#### Cumulative Risk Estimation in Humans after Potential Oral Exposure of Three N-methyl Carbamates: Carbaryl, Aldicarb, and Carbofuran

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**Introduction:** The cumulative risk resulting from the aggregate exposure to three N-methyl carbamate insecticides—carbaryl, aldicarb, and carbofuran—was investigated for a sample population developed with the Stochastic Human Exposure Dose Simulation (SHEDS) model.

**Methods:** The SHEDS model simulated dietary exposure patterns along with exposure to aldicarb from drinking water. The resulting time-series exposure scenarios were then used as inputs to a cumulative human physiologically-based pharmacokinetic/pharmacodynamic (PBPK/PD) model implemented in the Exposure Related Dose Estimating Model (ERDEM) system (the latest version, ERDEM V 6.0, supports model parameter optimization and sensitivity analysis). Distributions of acetylcholinesterase (AChE) activities in the red blood cells (RBC) and brain, and urinary biomarker concentrations were evaluated for 19,714 one-day and 10,191 7-consecutive-day studies over the SHEDS population aged from 6 to 59 years. The population distributions of the above toxicological endpoints were assessed.

**Results:** The simulated results indicated the cumulative AChE inhibition was at trace levels (95<sup>th</sup> percentile is 99.99% of control level). When aldicarb exposure from drinking water was examined separately, the AChE level in RBC and brain was still not a health concern (95<sup>th</sup> percentile is 99.99% of control level). The urinary biomarker levels of carbaryl and carbofuran were also shown to be at trace levels (< 2 µg/L or 2 µg/g creatinine).

**Conclusion:** The methodology used in this study demonstrates a plausible method for *in silico* human population risk assessment using a PBPK/PD model linked with an exposure estimation model.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

#### ISEE-1315

#### Neighborhood Environmental Health and Risk Factors for Type 2 Diabetes in the English Longitudinal Study of Ageing

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**Background:** The rising prevalence of Type 2 diabetes imposes a growing burden in industrialized and developing countries alike. Physical and social factors in the neighborhood environment may influence the risk of diabetes through such risk factors as inactivity, diet, and obesity. Residents in neighborhoods with fewer parks, more traffic, higher crime, and poorer perceived safety may be less physically active. Further, the chronic stress of living in an unsafe or deprived neighborhood may lead to insulin resistance and metabolic syndrome, which can increase the risk of Type 2 diabetes. This study investigates how neighborhood environmental factors affect the risk of Type 2 diabetes.

**Methods:** This research uses data from a nationally representative, longitudinal study of around 12,000 older people and their partners living in the community in England. The longitudinal data include data from face-face questionnaire interviews and physical measurements and biological samples (including fasting blood sugar levels and glycosylated hemoglobin) taken by nurses. Neighborhood-level variables include vandalism, graffiti, and the perception of whether the neighborhood is safe for walking alone after dark. Two waves of questionnaire data were merged with the nurse data. Regression models were used to examine longitudinal relationships between neighborhood-level variables and incidence of diabetes.

**Results:** After adjustment for individual-level characteristics (age, gender, and frequent/regular vigorous activity), neighborhood conditions were found to be associated with a higher incidence of Type 2 diabetes. For the report of vandalism and graffiti in the neighborhood, the association was statistically significant ( $OR = 1.6$  (95% CI = 1.08, 2.3),  $P$ -value = 0.02).

**Conclusions:** The association between physical and social conditions of the neighborhood environment and Type 2 diabetes among older adults deserves further investigation. A deeper understanding of this association could suggest interventions useful in the prevention of diabetes.

#### ISEE-1316

#### Water Adherence Factors for Human Skin

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**Background:** Dermal contact may occur to chemicals in neat form, mixtures, water solutions or solid media such as soil or sediment. Exposure assessment for occupational and environmental risk characterization typically includes a determination of the absorbed chemical dose from dermal contact. A key determining factor for assessing dose is the amount of chemical agent that adheres to the skin, and is available for systemic absorption. Although soil adherence factors have been developed by researchers and adopted by EPA and other regulatory agencies for risk assessment, measurements of water adherence on human skin have not been developed. Currently, dermal dose is not typically determined by quantifying the mass of chemical that remains on skin after contact with contaminated water; rather, dermal dose estimates are based upon dermal flux rates with the assumption that there is an infinite amount of chemical available for absorption through the skin and that steady-state permeation has been reached. Real-life occupational and environmental exposures to contaminated water, however, frequently involve only brief contact, such as splashing, stepping into puddles or hand immersion, where the available chemical for absorption is limited by the amount of water adhering to the skin.

**Methods:** We conducted studies in human volunteers to investigate the mass or volume of water adhering to the skin per unit area after brief water contact. Two different exposure conditions were evaluated: application of water to a 10-cm<sup>2</sup> area of the lower leg, foot and hand using a micropipette, and brief immersion of the foot and hand in water.

**Results:** In males, using a micropipette for direct application of water to the skin, water adherence ranged from a minimum of 1.93 µL/cm<sup>2</sup> on the dorsal surface of the foot to a maximum of 7.13 µL/cm<sup>2</sup> on the lower leg. In the females, it ranged from 1.10 µL/cm<sup>2</sup> on the lower leg to 4.83 µL/cm<sup>2</sup> on dorsal surface of the hand. Hand and foot immersion resulted in relatively higher values of 6.89 µL/cm<sup>2</sup> and 4.97 µL/cm<sup>2</sup>, respectively, in males, and 5.40 µL/cm<sup>2</sup> and 6.70 µL/cm<sup>2</sup> in females. Water adherence was affected by the amount of body hair on the exposed area, presence of creases or folds in the skin, and the type of exposure (i.e., direct application or immersion). Application of commercial skin moisturizer did not significantly impact water adherence.

**Conclusions:** Water dermal adherence factors in combination with chemical concentration data can be used to ascertain the mass of chemical applied to skin, which may be used to calculate the applied dose per unit

area for exposure scenarios involving intermittent water contact scenarios. Mass of substance per unit area of skin can provide a more reliable estimate of dose received than simply the measure of concentration of a chemical agent in water. Dermal adherence factors can also be applied to finite dermal dose models being developed to assess more realistic exposure scenarios and include factors such as chemical volatilization from the skin surface.

#### ISEE-1317

##### **Extreme Temperature Effects: A Study of the Effects of Heat, Cold, and Heat Waves on Human Mortality in 107 U.S. Cities**

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**Background:** Many studies have linked temperature to health risk, with non-linear J- or U-shaped relationships exhibiting increased risk of mortality at both extremely high and extremely low temperatures. The possible increase in the frequency and intensity of heat waves due to climate change and the occurrence of major events such as the 2003 European heat wave have recently increased interest in the health effects of heat waves in addition to extreme temperature effects. This study considers several important questions regarding the effect of temperature on human mortality including the window of exposure (short-term lags of a few days and longer term lags up to 25 days) and factors that cause different responses among cities, such as socioeconomic conditions, age, and air conditioning use.

**Methods:** This national study uses data for 107 U.S. urban communities over a 14-year period (1987–2000). Time-series models were fit individually to each community allowing a non-linear relationship between temperature and daily mortality rates. Heat-related mortality was most associated with a shorter lag period (average of same and previous day), with an average increase of 3.00% (95% P.I.: 2.40, 3.61%) in mortality rate comparing the 99<sup>th</sup> to the 90<sup>th</sup> percentile temperatures for the community. Cold-related mortality was most associated with a longer lag period (average of current day up to 25 days previous), with an average 4.23% (P.I.: 3.20, 5.27%) increase in mortality rate comparing the 1<sup>st</sup> to the 10<sup>th</sup> percentile temperatures for the community. Heat waves were defined by several categorizations relating to their intensity and duration.

**Results:** Results indicate that mortality risk increases with heat waves' intensity or duration. Under the one of the heat wave definitions considered, mortality risk increased 6.08% (posterior interval (P.I.): 4.02%, 8.18%) during heat waves compared to normal temperature. Heterogeneity was observed in the temperature-mortality association across cities. Some of this heterogeneity could be explained by community characteristics including average temperature, population size, median income, and air conditioning use. Sensitivity analysis determined that effect estimates were robust to adjustment by ozone and particulate pollution. This study also explores regional differences in the temperature-mortality relationship for the U.S. Results have implications for community efforts to address weather-related mortality and the potential human health impact of climate change.

#### ISEE-1318

##### **Residential Traffic and Current Asthma in the East Bay Children's Respiratory Health Study**

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**Background and Objectives:** Living near traffic has been associated with asthma and other respiratory symptoms; however, most studies have

been conducted in areas with high background levels of ambient air pollution, making it challenging to isolate an independent effect of traffic. Additionally, most investigations have used surrogates of exposure; few have measured traffic pollutants directly as part of the study. This current study builds on an earlier study where we found modest associations between respiratory symptoms (bronchitis and asthma symptoms in the last 12 months) and traffic pollutant concentrations measured at neighborhood schools (Kim et al., *Am J Resp Crit Care Med*, 2004, 170(5): 520–6). In this project, we developed individual-level estimates of traffic exposure for this study population based on residence for use in health analyses.

**Methods:** We conducted a cross-sectional study of children, ages 8–12, (N = 1080) attending neighborhood schools at varying distances from high-traffic roads in the San Francisco Bay Area, a highly urbanized region in Northern California characterized by good regional air quality due to coastal breezes. Information on children's respiratory health and possible confounders (e.g. socioeconomic indicators including race, ethnicity, and household income), family health history, and home environmental factors including exposure to environmental tobacco smoke) was collected by parental questionnaire. Measures of residential proximity to traffic included: (1) GIS-based traffic metrics that measure residential distance to major road and traffic density within a 150 m buffer; and (2) residential estimates of nitrogen dioxide (NO<sub>2</sub>) based on a validated land use regression model (LUR). In this project, individual level estimates of traffic exposure based on residential location were developed using geographic information systems (GIS) methods. Multivariate logistic regression methods were used to evaluate associations between respiratory outcomes and residential traffic using multivariate logistic regression.

**Results:** GIS-based traffic-metrics were moderately correlated with actual pollutant measurements, especially nitrogen oxides (NO<sub>X</sub>) and nitric oxide (NO) (Spearman  $\rho \sim 0.4$ –0.6). We found that various efforts to refine estimates of traffic exposure resulted in stronger associations with respiratory morbidity, particularly current asthma (asthma symptoms in the last 12 months). For example, we found associations with: (1) GIS-based residential measures of traffic density (OR for IQR increase = 1.16; 95%CI : 1.02, 1.32); (2) residential NO<sub>2</sub> based on the LUR that included a term for prevailing wind direction (OR for IQR of 2.4 ppb = 1.31; 95%CI : 1.06, 1.61; and (3) log-transformed distance to freeway (OR for IQR decrease in log-distance = 1.43; 95%CI : 1.04, 1.54). In examining various distance intervals ranging from less than 75 m to greater than 300 m, we found that the highest risks of current asthma were among those living within 75 m of a freeway/highway.

**Conclusions:** Our findings provide evidence that even in an area with good regional air quality, proximity to traffic is associated with adverse respiratory health effects in children.

#### ISEE-1319

##### **Proximity to Agricultural Pesticide Use and Concentrations in Carpet Dust**

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**Background:** Residential proximity to agricultural pesticide applications has been used to estimate pesticide exposure in epidemiological studies, although little is known about the correlation between residential proximity to agricultural pesticide applications and pesticide levels in the home.

**Methods:** We collected carpet dust samples from 89 residences in Northern and Central California. We mapped agricultural land use within

0.8 miles (1250 meters) of each location. Dust samples were analyzed using gas chromatography–mass spectrometry to determine concentrations (nanograms per gram of dust) of five pesticides used extensively for agriculture: carbaryl, chlorpyrifos, chlorthal-dimethyl (Dacthal), iprodione and simazine. California has a mandatory pesticide reporting system (Pesticide Use Report [PUR]) that requires growers and applicators to provide for all commercial applications the active ingredient, pounds applied, crop treated, date and geographic location. We used a geographic information system (GIS) to estimate agricultural pesticide use near each residence from PUR data alone and by combining the PUR data with land use maps to estimate pesticide use at a finer spatial scale. We calculated agricultural pesticide use density (pounds per square mile) for the 89 residences using two distances from the residence (500 and 1250 meters) and two time periods (6 months and 24 months before sample collection). We determined the sensitivity and specificity of the GIS-based estimates of agricultural pesticide density for predicting detections of the pesticide in carpet dust samples. We used the Spearman rank correlation coefficient to compare the continuous values of pesticide use density and dust concentration and the Kruskal-Wallis one way ANOVA test of ranks to compare the distribution of dust concentrations in residences near reported agricultural pesticide use to those with no nearby agricultural use reported.

**Results:** The five pesticides were detected in 34% (iprodione) to 95% (chlorpyrifos) of carpet dust samples. The prevalence of reported agricultural pesticide use within 500 meters of residences during the 24 months prior to sample collection ranged from 3% for Dacthal to 81% for chlorpyrifos. We observed the highest specificity with detections in carpet dust using a 500 meter buffer around the residences. The use of crop maps improved the specificity. GIS-based estimates of pesticide use density were moderately correlated with carpet dust concentrations ( $r = 0.2-0.5$ ). Residences with reported agricultural pesticide use within 500 or 1250 meters during the previous 24 months had significantly higher carpet dust concentrations for four of the five pesticides examined ( $P < 0.05$ ) than residences with no reported agricultural pesticide use.

**Conclusion:** Reported pesticide use during the previous 24 months was a consistently better predictor of carpet dust levels than reported use during the previous 6 months. Although the GIS-based estimates were not highly correlated with dust concentrations, they were generally able to separate homes with high dust concentrations from those with low dust levels.

#### ISEE-1323

#### Prenatal Phthalate Exposure and Decrease in Ano-Genital Distance in Mexican Male Newborns

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**Objective:** To explore the association between phthalate concentration levels during pregnancy and the anogenital distance (AGD) and anthropometric measurements in Mexican male newborns.

**Materials and Methods:** Toxicological associations between phthalate exposure and reproductive effects have been previously documented, particularly dibutyl phthalate (DBP), di-2-ethylhexyl phthalate (DEHP), benzylbutyl phthalate (BBP), and di-isobutyl phthalate (DINP). Phthalates act as endocrine disruptors during the developing stage in males by means of anti-androgenous pathways, causing a reduction in androgen-dependent tissues in the seminal vesicles, epididymis, prostate, and ano-genital distance (AGD). This study represents an analysis of data from an hospital-based cohort of 73 Mexican pregnant women 18 years of age or older, who were on their last-trimester of pregnancy, residents of the city of Toluca and surrounding areas, and their male newborns to determine if

an association existed between exposure to mono-2-ethylhexyl phthalate (MEHP), monobenzyl phthalate (MBzP), monoethyl phthalate (MEP) and monobutyl phthalate (MBP) levels during pregnancy and the AGD and anthropometric measurements of their male newborns. Two-sample t-tests were used to calculate differences in mean phthalate exposure levels, and linear regression analyses to determine the relationship between phthalate exposure, AGD and anthropometric measurements of the newborns, gestational age, and maternal age, for each of the phthalate metabolites.

**Results:** The study found statistically significant association between prenatal exposure to MBzP phthalate and a reduction in the length of the stretched penis ( $P < .05$ ), and penis width ( $P < .01$ ); and exposure to MEP phthalate with a reduction in the distance from the center of the anus to the posterior base of penis ( $P < .05$ ), and from the center of the anus to anterior base of penis ( $P = .001$ ).

**Conclusion:** Our findings support the evidence that phthalates are endocrine disruptors during the anti-androgenic developmental stage, and that adverse biological effects are mediated by the exposure. A reduction of AGD can serve as a biological marker for fetal androgen disruption.

#### ISEE-1324

#### Comparison of Street and Parcel Geocoding Methods: Implications for Environmental Exposure Assessment

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**Background:** Environmental health scientists strive to make their exposure assessments as accurate as possible to ensure the power and validity of their studies. Increasingly, in environmental health studies geocoding is used to assign geographical positions to street addresses in order to better estimate exposure based on where people live. We compared streetfile geocoding to parcel geocoding by match rate, population density, and differential exposure assignment for deaths from 1999 in Santa Clara County, California. We used three methods of assigning fine particulate matter ( $PM_{2.5}$ ) exposure to addresses: nearest monitor, buffer distances around monitors, and inverse distance weighted (IDW) interpolation of monitor values.

**Results:** Streetfile and parcel geocoding address match rates were 97.5% and 82.8%, respectively. Distances between the geolocated points from the two methods ranged from 2.8–3400 m. These distances, on average, increased as population density decreased. We found that match rates increased with population density for streetfile geocoding, but the highest match rate occurred in middle density areas for parcel geocoding. The maximum difference in exposure assignment between streetfile and parcel geocoding for all three methods of assigning  $PM_{2.5}$  exposure was less than  $3 \mu g/m^3$ .

**Conclusion:** While many studies have shown that parcel geocoding is more positionally accurate than streetfile geocoding, within each of three exposure assignment methods, we found minimal differences of exposure assignment between the streetfile and parcel geocoding methods.

#### ISEE-1327

#### Self-reported Child Hunger in Relation to Socioeconomic Status in the U.S. and Across 36 Countries in the Health Behavior in School-Children Study

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**Background:** Healthy child development requires secure access to food of adequate quantity and quality over the time of growth and development,

spanning from the prenatal over the adolescent time period. Children may be affected by moderate food insecurity that may not be a risk for adults. Reported "child hunger" has been suggested as an indicator of poverty related conditions and severe deprivation, and potentially related to food insecurity. Different measures are suggested to capture child food insecurity, including terms such as "risk of hunger" and "food insecurity". The aim of this analysis was to investigate whether children's self-reported hunger is related to individual or country level socioeconomic status.

**Methods:** This analysis is based on the Health Behavior in School-Aged Children Study (HBSC), a WHO Collaborative Cross-National Study in which a self-report survey is conducted with nationally representative samples of school children in WHO European Region Member countries, and in the US and Canada every 4 years. The survey assesses health and well being in young people in the age groups 11, 13, and 15 years. The 2005 assessment included the question: Some young people go to school or bed hungry because there is not enough food at home. How often does this happen to you? ("always/often," "sometimes," "never"). Additional items comprised a Family Affluence Scale (FAS) and were used as an indicator of individual-level socioeconomic status. The Gross National Product (GNP) per Capita was used as indicator of country-level socioeconomic status. We conducted Poisson regression analyses to explore the relation of "always/often hunger" in quantiles of GNP. Within the US sample ( $n = 9011$ ), the relation to individual level socioeconomic status based on the FAS was investigated with a trend test analysis (Jonckheere-Terptsra test).

**Results:** The frequency of reported hunger in the category "always or often" ranged from 0.73% in the Netherlands to 6.13% in the Russian Federation. In the Poisson regression analysis ( $P < 0.05$ ), the average prevalence of "hunger" was lower in the mid-categories of GNP compared to the lowest quantile ( $\leq 10$  percentile) of GNP. Above the 75<sup>th</sup> percentile of GNP, the prevalence was not significantly lower compared to the lowest GNP category. Within the US—the country with the highest GNP but with a relatively high prevalence of reported "hunger" (5.7%)—"hunger" was associated with family level socioeconomic status with 7.91% in the lowest, 4.45% in the middle and 3.58% in the highest FAS category (test for trend:  $P < 0.01$ ).

**Conclusions:** Children's reported hunger may be related to socioeconomic factors on the macro-country level in countries with low to mid GNP levels among countries participating in the HBSC study. However, as indicated by the observations within the US sample, the socioeconomic situation of the family also appears to play a role. The role of other dietary, environmental and family factors deserve further investigation.

#### ISEE-1329

#### Exploring Markov Models to Simulate Children's Sequential Micro-Level Activities for Exposure Assessments

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**Background:** Physical-stochastic models assessing children's dermal and non-dietary ingestion exposure often require micro-level activities on the order of seconds to minutes. These activities can take several forms and may be simulated using a variety of methods. Researchers have surveyed, and typically dismissed, Markov models for simulating macro-level activities (i.e., activities on the order of minutes to hours), stating the resulting models were too complex and fairly inaccurate. Such previous explorations, however, were limited to lower-order models (e.g., 0th and 1st order Markov chains). This study further explores the use of Markov models by simulating sequential micro-level activities using 0th–5th order Markov models, All-Kth Order Markov models, and selective Markov models.

**Methods:** Original activity sequences, consisting of information on objects contacted with hands and placed in the mouth, were collected via videography methods and utilized in this exploration. These sequences

formed training sets for model development and testing sets used in evaluating measures of model performance (accuracy, complexity, coverage, and model accuracy). Accuracy describes the predictive ability of the model based on the test set. Complexity refers to the number of states (e.g., categorical descriptions of activities) in the model. Coverage measures the number of times the model was able to compute a prediction. Model accuracy is defined as the accuracy of the subset of the test set that was covered by the specification of the model.

**Results:** While general accuracy and model accuracy tended to increase with increasing order, coverage tended to decrease, and complexity increased. The All-Kth Order Markov model, formed by training and then combining varying order models, aided in reducing coverage but exacerbated the problem of model complexity. Selective Markov models reduced overall complexity without significant improvements in model accuracy.

**Discussion:** Such exploration of simulation methods may aid in improving the specification of children's sequential micro-level activities and in generally improving human exposure assessments via modeling techniques. Further work may include collecting statistically representative activities and incorporating methods for simulating micro-level activities within existing macro-level activity databases in creating an activity pattern generator.

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#### ISEE-1330

#### Potential Preparation Artifacts Associated with Historical Preparation of Joint Compound Samples and Reported Airborne Asbestos Concentrations

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**Background:** Airborne samples collected for drywall workers using asbestos-containing joint compounds in the 1970s were likely prepared and analyzed according to NIOSH Method P&CAM 239, which was the precursor to NIOSH Method 7400. Experimentation with a reformulated asbestos-containing, carbonate-based joint compound suggests that analysis following sample preparation by different methods produces different fiber concentration estimates, likely because of reaction (or absence of reaction) between the different solvents or fixing agents used in these methods and the calcium carbonate in the joint compound.

**Methods:** A formal comparison of air samples of sanded asbestos-containing joint compound prepared according to NIOSH Method P&CAM 239, NIOSH Method 7400, and an alternate method with solvents (RI Fluids) that were intentionally selected to be less reactive with carbonate, was undertaken to characterize and quantify differences in analytical results introduced by the effects of the solvents employed in these methods.

**Results:** Results show that NIOSH Method P&CAM 239 yields fiber concentration estimates that are significantly different than estimates derived using either NIOSH Method 7400 or the alternate preparation method. Fiber concentrations from filter sections prepared by NIOSH Method P&CAM 239 were two to three times higher than those for filter sections prepared by NIOSH Method 7400 or the alternate method.

**Conclusions:** These findings indicate: 1) NIOSH Method P&CAM 239 preparation chemicals react with carbonate-based joint compound, which causes fiber counts to be inflated relative to counts derived using other methods; 2) this reaction may be unique to carbonate-based joint compound; and 3) this preparation artifact should be considered when interpreting historical air samples for drywall workers prepared by NIOSH Method P&CAM 239.

**ISEE-1331****Optimization and Evaluation of a Sampling and Analytic Method for the Measurement of Hexavalent Chromium in Ambient Air**

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**Background and Methods:** Hexavalent chromium (Cr-6) compounds have been listed as one of the core Hazardous Air Pollutants by the U.S. Environmental Protection Agency. However, it is a challenge for the measurement of airborne Cr-6 given its low concentration and potential inter-conversion between chromium species, particularly between Cr-6 and trivalent chromium (Cr-3). The latter is an essential nutritional trace element for humans. Our previous study reported a sampling and analytical method for the measurement of airborne Cr-6 with collection of airborne Cr-6 particulate matter on a sodium bicarbonate pre-treated cellulose filter, extraction with nitric acid ( $\text{pH} = 4$ ), separation by ion chromatography (IC), and detection by Inductively Coupled Plasma Mass Spectrometry (IC/ICPMS). This study further optimized the analytical conditions and evaluated the protocols for filter cleaning, method precision and accuracy.

**Results:** The optimal mobile phase for IC was found to be 60% nitric acid and 40% water at a flow rate 1.25 mL/min, which provided a good separation and sensitivity for Cr-6 and Cr-3 without elevating instrumentation background. Cleaning filter with 10% nitric acid was sufficient to remove Cr-6 but not for Cr-3. The NIST1648 urban particulate matter spiked with Cr-6 and Cr-3 isotopes was used to evaluate recovery and inter-conversion rate. With the method developed, the recovery of Cr-6 was greater than 80% (%CV = 1.40%) while the interconversion rate was less than 20% from Cr-6 to Cr-3 and < 40% from Cr-3 to Cr-6. The Cr-6 certified soil, which is the only available material with certified Cr-6, was used to assess the accuracy of the method developed. The Cr-6 concentrations (%cv, n = 3) was determined to be 111.7 (15%) ng/mg, which was close to the certified value provided by the company (116.96  $\pm$  17.66 ng/mg, with a range of 64–170 ng/mg). Further tests will be conducted in a controlled environmental chamber to investigate effects of environmental factors on the stability of Cr-6, including ozone, sulfur dioxide and nitro dioxide, airborne particle type, temperature and humidity.

**ISEE-1332****Outdoor Air Pollution and Severe Asthma in the San Joaquin Valley, California**

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**Background:** The San Joaquin (SJ) Valley in California experiences some of the worst air pollution in the United States, with exceedances of both long and short term average standards for ozone and  $\text{PM}_{10}$ . The Valley also shows a high prevalence of asthma symptoms and a high rate of asthma-related hospitalizations. Using California Health Interview Survey (CHIS) data, we examined associations between asthma morbidity and air pollution in this region. Because of the absence of an asthma registry in the United States, population-based data such as those from CHIS are essential for such a study.

**Methods:** Eligible subjects were SJ Valley residents from whom health data were collected as part of CHIS 2001 (n = 10,307) and who reported physician-diagnosed asthma (n = 1,502, 14.6%). Respondents were asked to report the frequency of asthma symptoms (such as coughing and

wheezing) and asthma-related emergency department (ED) visits or hospitalizations during the past 12 months. We defined cases as having: (1) daily or weekly asthma symptoms, or (2) at least one 1 ED visit or hospitalization due to asthma. Subjects with asthma who reported monthly, yearly, or no symptoms and no ED visits or hospitalizations were defined as noncases. Based on US Census 2000 population densities at the block level, we identified the population-weighted centroid of residential zip codes for respondents and linked them to the closest government air monitoring station within a 5-mile radius. We then assigned annual average concentrations of ozone,  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  for the one-year period prior to the interview date to each subject.

**Results:** Adjusting for age, gender, race/ethnicity, poverty level, and insurance status, we observed a 23% increase in the odds of daily or weekly asthma symptoms per 1 ppm increase in ozone (OR: 1.23, 95%CI: 0.94, 1.60), a 29% increase per 10  $\mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{10}$  (OR: 1.29, 95%CI: 1.05, 1.57) and an 82% increase per 10  $\mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{2.5}$  (OR: 1.82; 95%CI: 1.11, 2.98). We also observed a 49% increase in prevalence of asthma-related ED visits or hospitalizations per 1 ppm increase in ozone (OR: 1.49, 95%CI: 1.05, 2.11) and a 29% increase in odds per 10  $\mu\text{g}/\text{m}^3$  in  $\text{PM}_{10}$  (OR: 1.29, 95%CI: 0.99, 1.69). Analyses stratified by age (0–17 years versus 18+ years) suggested exposure to these air pollutants increased ED visits and hospitalizations for children but not daily or weekly symptoms, while the opposite pattern was observed for adults. However, the relatively small sample size available for children resulted in imprecise estimates for these analyses.

**Conclusions:** Overall, these findings suggest that asthmatic individuals living in high O<sub>3</sub> and particle areas in the San Joaquin Valley are at increased risk for daily or weekly asthma symptoms and asthma-related ED visits and hospitalizations. To better understand these relationships we will look at long-term (12-, 24-, and 36-month) air pollutant exposure indicators, as well as additional exposure indicators developed using geostatistical modeling and residential traffic density and their associations with other asthma-related health outcomes, including absences from school/work and medication use among CHIS 2003 and 2005 respondents.

**ISEE-1333****An Evaluation of Exposure Estimation Methods for a Large Cohort Study Using Personal-Indoor-Outdoor Measurements for 51 Children in Windsor, Canada**

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**Methods:** From 2004–2006, Health Canada conducted several studies investigating the respiratory health of school-aged children (ages 10–12) in Windsor, Ontario. In 2004, cross-sectional symptom data was collected from 12,694 children. In 2005, 2,402 of these children also participated in a cross-sectional study of lung function. Chronic exposure to air pollution for these participants was estimated using averages from the fixed-site monitors, land-use regression (LUR) models for NO<sub>2</sub> and proximity to roadway measures. In 2006, a subset of children (n = 51) participated in a personal-indoor-outdoor exposure monitoring study. To evaluate and refine exposure estimates (for long-term exposure) used in the larger population survey, we compared the personal exposure study results to modeled estimates of exposure that were used in the larger studies. Each of 51 asthmatic children completed one or two 5-day sampling sessions during the winter and/or summer of 2006, which included carrying a small backpack with sampling equipment and having sampling equipment installed in their home and outdoors in their back yard. Concentrations at the children's homes were estimated using five different LUR models (annual average, spring, summer, fall and winter). These previously developed LUR models (for NO<sub>2</sub>) were based on 2-week samples at 54 sites (located on city light poles) in Feb, May, August and October of

2004. We also obtained daily measurements from 2 fixed-site monitoring stations in Windsor. Measurements (personal, indoor, outdoor and fixed-site average) from each sampling session were averaged to provide a longer term time-scale (5-day average) for comparison with seasonal and annual LUR estimates. Mean measurements for personal/indoor/outdoor/fixed site NO<sub>2</sub> were 7.9/7.8/12.3/15.1 ppb in the summer and 13.1/11.9/21.0/20.6 ppb in the winter.

**Results:** Season-specific LUR models did not show improved correlations with season-specific measurements; best results were obtained using annual models. Comparisons with annual LUR models (mean = 12.3 ppb) and fixed-site data revealed differences by sampling season. Summer-only outdoor samples correlated with annual LUR models (Spearman's rho = 0.60) better than with a 5-day average from the fixed-site monitors (rho = 0.47). Winter samples correlated with LUR models (rho = 0.27) worse than with fixed-site monitor (rho = 0.48). Personal measures were more strongly associated with indoor and outdoor measurements in the summer (personal-indoor rho = 0.75; personal-outdoor rho = 0.38) than in the winter (p-i rho = 0.67; p-o rho = 0.27). The modest personal-outdoor correlations could be due to air conditioning use (summer) and well insulated (low infiltration) homes (winter).

**Conclusions:** The use of season-specific LUR models did not improve the ability of LUR models to predict either personal or outdoor exposures for asthmatic children. Using comparable time-scales, in the summer only, LUR models for NO<sub>2</sub> were more closely associated with a child's outdoor measurements than averages based on central site monitoring; however this was not the case in the winter. Further analysis will investigate multiple pollutants (e.g. PM<sub>2.5</sub>) and differences between the LUR models' performance in summer and winter. Relatively low correlations between personal and outdoor measures in this population suggest additional analyses to characterize personal exposure using outdoor exposure models, activity data, mobility and/or property data that is available for the large population study.

#### ISEE-1334

#### Including Caline3 Dispersion Model Predictions into a Land Use Regression Model for NO<sub>x</sub> in Los Angeles, California and Seattle, Washington.

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**Methods:** We used predictions from a simple line source dispersion model (Caline3) as one of the covariates in a land use regression framework to predict NO<sub>x</sub> in Los Angeles, CA and Seattle, WA. The Caline3 model prediction at a given location incorporates information regarding traffic volume, diurnal traffic patterns, meteorology (wind speed, wind direction, atmospheric stability), but assumes a unit emission factor for all roadway segments (1.0 g/m/sec). By including this prediction as a covariate, we allowed the measurement-based LUR model to fit the observations without making further assumptions about the traffic emission rates. In both cities the road network was limited to major roadways within 1.0 km of the receptors. In LA, the A1 and A2 roadways were modelled together with annual average daily traffic (AADT) estimates specifically included for each road segment. The CFCC A3 roads were uniformly assigned an AADT of 20,000 vehicles per day (vpd) regardless of actual traffic volume. In Seattle, major roadways were defined as having AADT greater than 10,000 vpd. For comparison with the Caline3 predictions, we used the length of major roads within a given buffer radius. Additional spatial covariates derived from the same buffers in LA and Seattle included commercially zoned land and population density. In addition, we used distance to the coast in LA to capture large scale variation. The NO<sub>x</sub> measurements for LA and Seattle were obtained from a comprehensive measurement campaign that is part of the Multi-Ethnic Study of Atherosclerosis Air Pollution Study (MESA Air) (<http://depts.washington.edu/mesaair/>). The measurement campaigns in

both cities were approximately 2 weeks in duration employing 145 measurement sites in Greater LA and 27 sites in Seattle. The sampling strategy in LA attempted to more accurately assess the near road gradient and upwind/downwind dynamics with monitors arranged in clusters of 6 at various distances (50–330 m) either side of the roadways. The Seattle network did not have such groups of monitors, but rather consisted of single monitors spread over the study area. The meteorological data were obtained from the National Climatic Data Center (NCDC) for Los Angeles International Airport (LAX) and Boeing Field (BFI). Similar results were obtained when other local meteorological data sources were employed.

**Results:** The Caline3 model predictions alone for LA and Seattle had adjusted R<sup>2</sup> values of 0.26 and 0.48, respectively. The best LUR model obtained without the inclusion of the Caline3 predictions had adjusted R<sup>2</sup> values of 0.40 and 0.67 for LA and Seattle, respectively. When the Caline3 variable was included instead of roadway density, the unadjusted R<sup>2</sup> values were 0.70 for both LA and Seattle. While these results demonstrate that when meteorological variables, namely wind speed, wind direction and atmospheric stability, are incorporated into the hybrid LUR/dispersion model, the estimates of roadway generated NO<sub>x</sub> are improved by varying degrees over traditional traffic variables used in LUR modelling. The improvement is notably better in LA where the sampling was focused on near-road gradients.

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#### ISEE-1335

#### How Quality Exposure Assessment Elucidates Epidemiological Relationships, e.g., Between Secondhand Smoke and Breast Cancer

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**Background and Discussion:** The contribution of quality exposure assessment to epidemiological studies is often not well appreciated. Random misclassification of dichotomous exposure status will bias results toward the null, and so may obscure true relationships between exposure and disease. Careful assessment of exposure is important for several reasons. Even if a relationship between an exposure and a disease has been established, e.g., benzene and leukemia, quantitative exposure assessment is needed to perform appropriate risk assessment and to set occupational exposure limits (OEL). Although workers in the pliofilm industry had a 5 fold increase in leukemia, that alone did not provide sufficient information to set an OEL; the fact that leukemia rates increased with the number of years exposed to benzene strengthened the interpretation that there was a causal association, but still did not inform risk assessment. Only the careful calculation of cumulative exposure of these workers to benzene, in ppm-years, informed the setting of an OEL. The recognition of the importance of exposure assessment in setting benzene threshold limit values and permissible exposure limits has led to several studies to assess and re-assess these exposures. Correct assessment of exposure status is especially important if the actual relative risk small, in which case a bias towards the null may lead to an insignificant result; the mixed literature on the relationship between passive smoking and breast cancer provide a recent example. When California EPA recently reviewed the literature on the health effects of secondhand smoke (SHS), 13 of 14 epidemiology studies identified among younger women found an elevated risk, and 7 were statistically significant. Many of these studies relied on the smoking status of these women's husbands, with no attention to childhood and teenage exposure. Although the pooled risk estimate from the meta-analysis was 1.7, the estimate was 2.2 for the studies which had more complete exposure assessment. Exposure should be evaluated at the time appropriate to the disease. For example, the breast is thought to be most vulnerable to carcinogens between puberty and the delivery of the first baby. One study of smokers last year evaluated number of packs of

cigarettes smoked before the first childbirth separately from those smoked afterwards. A significant positive association is seen for breast cancer and exposure prior to childbirth, while exposure after childbirth is nonsignificantly negative. A second example examines the relationship between passive smoking and heart disease, which is probably related to recent exposure. SHS exposure was evaluated from one serum cotinine. The increased risk for those in the upper 3 quartiles compared to those in the lowest quartile declined over the follow-up period, from 3.7 in the first 5 years, to 1.95, 1.13, and 1.04 in each of the next 5 year increments. Thus, a quantitative exposure marker at one point in time indicated a strong relationship to outcomes proximate in time; when the exposure assessment was more remote from the health outcome, the actual exposure conditions likely changed and the exposure marker became less accurate, with the consequent decline in observed relative risk.

#### ISEE-1336

#### **Psychometric Scores of Children and Methylmercury Exposure: Isolated Riverines (High Fish Consumers) Versus: Agrarian Communities (Non Fish-Consumers)**

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**Introduction:** Amazonian riparian communities are chronically exposed to high levels of methylmercury (MeHg) due to fish consumption. This environmental difference (based on fish MeHg exposure) between an Amazon riverine community and a rural agrarian community (geographically distant, culturally distinct and isolated poor non-urban communities) were examined in relation to neurocognitive performance.

**Methods:** Neurocognitive scores of Amazonian riverines (AmRiv, n = 38) and rural agrarian children (RuAg, n = 32) from Iúna, Espírito Santo were compared. Individual cognitive abilities were assessed by the Wechsler Intelligence Scale for Children-III (WISC-III) and the Human Figure Drawings (HFD), both validated versions for Brazilian children; nutritional status was estimated by anthropometry (Z-scores).

**Results:** Median HHg concentrations were  $14.4 \text{ } \mu\text{g.g}^{-1}$  and  $0.25 \text{ } \mu\text{g.g}^{-1}$  respectively for AmRip and RuAg children ( $P = 0.000$ ) but the slightly elevated Z-scores for the RuAg children was not statistically significant. Spearman correlation between attained growth and psychometric scores were statistically significant between height-for-age Z-score and Object Assembly subtest ( $r = 0.269$ ;  $P = 0.043$ ), Perceptual Organization Index scores ( $r = 0.302$ ;  $P = 0.023$ ), Performance-IQ ( $r = 0.311$ ;  $P = 0.019$ ), and  $\Sigma\text{TOT}$  ( $r = 0.319$ ;  $P = 0.016$ ). Both groups showed similar median HFD scores but very poor performance in WISC-III test battery: median of sum of WISC-III subtests scores ( $\Sigma\text{TOT}$ ) were 17.9 and 28.6 for AmRiv and RuAg children, respectively (percentage scale).

**Discussion and Conclusions:** Despite of paradoxical HHg concentrations, in these isolated communities there are stronger determinants of neurocognitive poor performance than fish-MeHg exposure. Global strategies for reducing human exposure to methylmercury (MeHg) by curtailing fish consumption are unreal decisions for riverine subsistence populations and are not justifiable to prevent low cognitive scores.

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#### ISEE-1337

#### **Association of Short-Term Exposure to Air Pollution and Heart Rate Variability Among Cardiovascular Elderly in Beijing, China**

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**Rationale:** Epidemiologic studies have shown the association between air pollution and cardiopulmonary mortality, though the underlying mechanisms are not well understood. Decrease on heart rate variability (HRV), a marker may reflect the alternations in autonomic balance of the heart, have been found associated with exposure to  $\text{PM}_{2.5}$  (fine particles with diameter  $< 2.5 \text{ } \mu\text{m}$ ) in several panel studies. To assess the effect of particles on susceptible Chinese population, a panel of 38 nonsmoking elderly with diagnosed cardiovascular diseases was studied to examine the changes in HRV in response to  $\text{PM}_{2.5}$  exposure in summer 2007.

**Methods:** Repeated 24-hr ambulatory ECG monitoring for each participant was conducted during study period, and data from 88 person-day visits were available for analysis. Mixed models were used to assess the short- and medium-term moving average exposures to  $\text{PM}_{2.5}$ , black carbon, as well as gaseous pollutants, controlling for subject body mass index, gender, time of day, temperature and relative humidity.

**Results:** Strong negative associations between HRV (5-minute average of SDNN, rMSSD, LF, HF) and exposures to  $\text{PM}_{2.5}$  and black carbon were found, while the associations with gaseous pollutants were much weaker. Among the four examined HRV parameters: a 1.5% decrease (95%CI,  $-2.5\%$  to  $-0.5\%$ ) in SDNN, a 3.1% decrease (95%CI,  $-4.7\%$  to  $-1.4\%$ ) in rMSSD, a 5.5% decrease (95%CI,  $-8.2\%$  to  $-2.7\%$ ) in LF, and a 7.9% decrease (95%CI,  $-10.8\%$  to  $-4.8\%$ ) in HF were found in association with  $25 \text{ } \mu\text{g/m}^3$  increase of  $\text{PM}_{2.5}$  exposure, after adjusting for potential confounders. For every  $1 \text{ } \mu\text{g/m}^3$  increase of black carbon exposure, a 0.9% decrease (95%CI,  $-2.0\%$  to  $0.1\%$ ) in SDNN, a 0.2% decrease (95%CI,  $-1.0\%$  to  $-0.7\%$ ) in rMSSD, a 2.6% decrease (95%CI,  $-4.9\%$  to  $-0.2\%$ ) in 5-minute average of LF, and a 2.1% decrease (95%CI,  $-4.1\%$  to  $-0.1\%$ ) in 5-minute average of HF were found. Effects of mid-term exposure were assessed using moving averages from 1 to 48 hours prior to HRV measurements, results suggested that cumulative effects begins to increase shortly after exposure begins and to decrease after certain periods (hours).

**Conclusions:** The study results showed strong negative associations between short-term exposure to particulate exposure and heart rate variability reduction among elderly subjects with cardiovascular diseases.

#### ISEE-1341

#### **Patterns of Residential Mobility Among Lead Poisoned Children in Wisconsin**

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**Background:** Data from the Wisconsin Childhood Lead Poisoning Prevention Program (WCLPPP) suggest that the population for which annual blood lead level testing is mandated (WIC and Medicaid enrollees one and two years of age) exhibits a high degree of residential mobility. Thus implementation of effective state and local programs to mitigate the burden of lead exposure in this population is problematic. First, children in the mandatory testing population are often difficult to locate. Second, intervention efforts targeted to the population may have decreased effectiveness if targeted toward the individual (i.e. case management) rather than the environment (i.e. home abatement). For example, provision of education or behavioral interventions to a highly mobile family may be less effective compared to home or environmental remediation projects,

particularly if families move among homes with high likelihood of lead exposure. As a result, the evaluation of lead poisoning prevention programs may demonstrate diminished degrees of effectiveness. Lastly, highly mobile populations may demonstrate other health needs and challenges that are difficult to track and treat, which may add a considerable burden to public health resources in local communities.

**Objectives:** The goal of this project is to ascertain the patterns of residential mobility among lead poisoned children enrolled in the WIC program in Wisconsin. We sought to identify the lead prevalence of the in-migrant population for communities with high levels of migration, as well as identify the prevalence of lead poisoning of in-migrants for communities with a high prevalence of lead exposure.

**Methods:** Currently, approximately 150,000 children in Wisconsin are enrolled in the WIC program, 53,000 of whom were tested for blood levels during 2007. The lead poisoning prevalence for this population (blood lead levels  $\geq 10 \mu\text{g}/\text{dl}$ ) was 3.1%, which is comparable to the prevalence for the Medicaid population (3.2%), and considerably greater than the prevalence for Wisconsin children in neither WIC nor Medicaid (0.71%). Preliminary results suggest that in-migrant children within WIC are lead-poisoned at far greater rates compared to the non-mobile WIC population. Of the ten communities with the highest level of in-migrant WIC children, the prevalence of lead poisoning among the in-migrant group was 4.3% compared to 2.4% among the non-mobile group. Fully 58% of known lead poisoning cases in these communities were from among the in-migrant group, which collectively accounts for only 33% of the WIC population.

**Results:** Of the Wisconsin cities with 500 or more WIC clients with at least 20 cases of lead poisoning ( $n = 18$ ), the median percentage of lead poisoned children who were in-migrants to the community was 34% (range: 4%–66%). Cities with large in-migrant populations are highly variable in terms of population size, demographics, and geographic location in the state. With regard to race and ethnicity, Native Americans families represented the smallest racial/ethnic category of WIC enrollees, yet had the highest rate of mobility (28.6%).

**Conclusion:** Results from this analysis will help to inform the development of salient strategies to effectively monitor a pervasive, but easily overlooked reportable disease in a highly mobile and diverse population.

#### ISEE-1342

#### Residential Concentrations of Polycyclic Aromatic Hydrocarbons and Childhood Leukemia Risk

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**Background:** Polycyclic aromatic hydrocarbons (PAHs) consist of several compounds that have been classified as known or probable human carcinogens. Indoor household sources of PAHs include tobacco smoke, gas burning appliances, and foods grilled or charred indoors such as meats. Outdoor sources of PAHs include road traffic and domestic wood burning. Little is known about the relationship between exposure to PAHs and the risk of childhood leukemia.

**Methods:** We collected carpet dust samples from the homes of 210 cases with childhood leukemia and 227 healthy controls in an exposure measurement sub-study of the Northern California Childhood Leukemia Study. Children under eight years of age that were living in the same residence as the date of diagnosis for cases or reference for controls were eligible for carpet dust sampling. Carpet dust concentrations (nanograms per gram (ng/g)) of nine PAH compounds were measured using gas chromatography-mass spectrometry. Concentrations were categorized into quartiles based on the distributions among controls. We evaluated the association of each PAH with childhood leukemia in separate models

using unconditional logistic regression, adjusting for age, gender, race/ethnicity, household income, season sample was collected, and the time between diagnosis/reference date and sample collection.

**Results:** PAHs were detected in over 90% of dust samples. Among controls, the median concentrations ranged from 11 ng/g for dibenz[a,h]anthracene to 51 ng/g for chrysene. Spearman rank correlations for concentrations among the individual PAH compounds ranged between 0.13 and 0.90. In single-PAH risk models, we observed elevated odds ratios for childhood leukemia in the highest concentration quartiles compared with the reference category for three PAHs: benzo[b]flouranthene (2.0, 95% confidence interval (CI): 1.0–3.9), benzo[k]flouranthene (1.8, 95%CI: 1.0–3.5), and indeno[1,2,3-cd]pyrene (1.7, 95%CI: 0.9–3.2), as well as for the highest quartile of total PAH concentration (1.7, 95%CI: 0.9–3.2). Quartile-specific ORs for these compounds were consistent with a positive monotonic exposure-response pattern. Restricting the cases to those with acute lymphocytic leukemia, the most common subtype (89% of cases), did not alter the magnitude of these effect estimates. Future analyses will evaluate all PAHs simultaneously using hierarchical regression to incorporate prior chemical-specific cancer potency information to stabilize the effect estimates of compounds with similar properties and to account for multiple comparisons and the high degree of correlation between compound concentrations.

**Discussion:** These findings support the hypothesis that exposure to PAH compounds are an environmental risk factor for childhood leukemia. Future studies will collect repeated carpet dust samples from residences to assess the variability of PAH concentrations over time and the impact of this variability on estimates of childhood leukemia risk.

#### ISEE-1345

#### Personal Air Pollution Monitoring and Lung Health of Asthmatic Children Living in Windsor, Ontario

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**Background:** The acute effects of exposure to air pollution upon asthmatic children's lung function have recently been investigated using continuous personal measures of fine particulate matter ( $\text{PM}_{2.5}$ ). Delfino et al (2004) observed greater reductions in  $\text{FEV}_1$  when considering personal exposures to  $\text{PM}_{2.5}$  than with ambient monitoring sites. Liu et al, (2003) also identified that the  $\text{PM}_{2.5}$  personal exposures of asthmatic children were higher than those measured at corresponding indoor, outdoor and ambient monitoring sites. Very few studies have combined simultaneous personal exposure assessments to air pollutants among asthmatic children with lung health assessments due to the challenges of having these children carry a range of air pollution monitoring devices for extended periods.

**Methods:** This study, conducted in Windsor, Ontario, in 2006, followed 51 asthmatic children aged 9–12 years at enrolment during two seasons for a total of 10 days of repeated measures each. The children were asked to complete both morning and evening peak flow measurements, as well as to carry personal monitoring devices to characterise their 24 hour average exposures to  $\text{PM}_{2.5}$ , elemental carbon, nitrogen dioxide and ozone. At their residence, indoor and outdoor measures for the same suite of pollutants were collected, as well as information on the children's daily activities and symptoms, housing characteristics, and proximity to sources.

**Results:** Preliminary analysis indicates that there are seasonal differences between the 24 hour average personal exposures for nitrogen dioxide concentrations, these were higher in winter than summer with median and standard deviations of 11.8 (7.6) ppb compared to 6.6 (5.1) ppb respectively ( $P < 0.05$ ). The  $\text{PM}_{2.5}$  concentrations were similar in both seasons, 7.8 (5.8)  $\mu\text{g}/\text{m}^3$  in winter and 7.3 (5.8)  $\mu\text{g}/\text{m}^3$  in summer. Ozone was only measured in the summer and concentrations were 1.89 (1.9) ppb. Lung function measures of  $\text{FEV}_1$  and PEF were taken in the morning and

evening of each day. Preliminary results indicate that winter lung functions were reduced compared to the summer,  $FEV_1 = 2.05$  (0.72)% compared to 2.33 (0.48)%. In the winter, the morning  $FEV_1$  was on average lower than the evening, 2.05 (0.72)% compared to 2.12 (0.86)%. Linear mixed effects models will be used to evaluate the relationship between personal  $PM_{2.5}$  exposures and  $FEV_1$ . Within this approach, we will consider the potential confounding influence of age and sex, investigate various lags of pollution metrics, and evaluate the extent in which effects are modified by medication use.

#### ISEE-1346

#### **Income Inequality as an Effect Modifier of the Association Between $PM_{10}$ and Self-Rated Health—a Multi-Level Study**

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**Background:** This study examined whether community-level (Gu) income inequality was an effect modifier of the association between air pollution and health when controlling for the individual's demographic and socio-economic characteristics.

**Methods:** We combined (1) individual-level data of 6,403 household respondents from the third Korea National Health and Nutrition Examination Survey (KNHANES III) collected in 2005, (2) community-level  $PM_{10}$  data from Korea atmospheric measurement station in 2005, and (3) community-level income inequality (Gini index) derived from 20,000 household income distribution of 2005 Seoul Survey. A multi-level logistic regression model was used.

**Main Results:** Seoul residents living in the communities with higher income inequality are more likely to report fair or poor health associated with  $PM_{10}$ . Odds ratio (OR) of fair or poor self-rated health was 1.04(95% Confidence Interval 0.94–1.16) corresponding to  $10 \mu\text{g}/\text{m}^3$  increase of  $PM_{10}$  for the 10th percentile of community-level Gini index after controlling for gender, age, education attainment, monthly household income, smoking and asthma. OR for the 40th, 60th and 90th percentile were found to be 1.11(1.03–1.19), 1.17(1.07–1.27), and 1.19(1.08–1.31), respectively. We also used the ratio of income means between upper and lower 10% as an indicator of community-level income inequality. The odds ratios for the 10th, 40th, 60th, and 90th percentile were 0.99(0.91–1.07), 1.07(1–1.14), 1.12(1.05–1.2), and 1.41(1.26–1.57), respectively.

**Conclusions:** The study suggests that community-level income inequality modifies the association between  $PM_{10}$  concentration and self-rated health status in Seoul, Korea.

#### ISEE-1347

#### **Environmental Exposures and Adult Brain Cancers**

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**Background:** Adult gliomas continue to be an aggressive form of brain cancer with a poor prognosis and few known risk factors. This work focuses on assessing the risk of human exposures to known animal neurocarcinogens in the context of a case-control study of brain cancer.

**Methods:** A carefully researched environmental questionnaire was constructed in an effort to assess human exposures to a series of known animal neurocarcinogens. Information from primary glioma cases ( $n = 190$ ) and friend controls ( $n = 309$ ) were obtained from two centers: Evanston Northwestern Healthcare and Duke University Medical Center. Data were obtained using a web-based survey with modules allowing participants to complete sections at their leisure. Exposure was assessed using individual questions and chemical specific exposure scores made up from a composite of relevant questions. Preliminary analyses were

conducted using conditional logistic regression to estimate odds ratios and 95% confidence intervals controlling for age and gender.

**Results:** Some general environmental living conditions appeared to increase the risk of brain cancer: living in a building with 10 or more apartments ( $OR = 2.9$ , 0.9–2.7), living within 2 blocks of an industrial facility or a landfill ( $OR = 3.0$ , 1.3–7.0), living in a building with the outside made of aluminum siding ( $OR = 2.0$ , 1.1–3.8), living in a building with a crawlspace/basement for more than 9 years ( $OR = 2.9$ , 1.6–5.2). With the exception of bromoethane, preliminary chemical specific indices do not appear to be associated with brain cancer. Variables related to living in a residence with wood burning heat in childhood ( $OR = 0.5$ , 0.2–1.0) or adulthood for greater than 9 years ( $OR = 0.3$ , 0.1–0.9) show protective associations with brain cancer. Consistent with other epidemiologic studies, having certain pets in the household (cats, birds, horses) appeared to increase the risk of adult glioma two-fold and adulthood radiation exposures to the head, face, neck, or upper spine (three or more MRI or CT scans and radiation treatment) were associated with two-fold increased risks of glioma.

**Conclusions:** Based on these preliminary analyses, it appears that there are some general environmental living conditions associated with the occurrence of brain cancer. However, questionnaires of environmental exposures to address specific chemical exposures in the human environment may not be adequately sensitive to be informative in epidemiologic studies and subsequent work will focus on biomarkers of exposure. Additional estimates, controlling for potential confounders such as socio-economic status, family history and history of allergies will be presented and discussed.

#### ISEE-1349

#### **The Impact of Occupation-Related Noise Exposure on Hearing Thresholds in Middle-Aged and Elderly Men: The Normative Aging Study**

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**Background:** Hearing loss is one of the leading health conditions affecting older adults and is associated with a significant impact on disability and mood. Hearing loss occurs for many reasons, of which a major known cause is occupational noise exposure. Research on hearing loss in the general population would benefit from well-validated estimates of occupational noise exposure that can be generated by occupational histories. We used an occupational noise exposure/hearing loss classification system generated by Tak and Calvert (2008)<sup>1</sup> and that takes the form of 5 occupational categories ranked by noise-related adjusted prevalence ratio of hearing difficulty to estimate noise exposure and test its association with audiometrically-measured hearing loss in a well-established longitudinal cohort of men, the Normative Aging Study.

**Method:** The study population consisted of 1011 older adults aged between 44 and 82 years from the Normative Aging Study. We used data on air and bone conduction hearing thresholds measured by pure-tone audiometer (Grason-Stadler 1701) between 1978 and 1993. We classified individuals into five occupation categories designated by Tak and Calvert. We fit linear regression models using dummy variables for the occupation categories and compared hearing thresholds in 0.5, 2, and 4 kHz, using the occupational category a priori associated with the lowest noise-induced hearing loss as the reference category. All models were adjusted

for age, education, hypertension, diabetes mellitus, smoking status, and pack-years of cumulative cigarettes.

**Result:** High frequency hearing threshold (at 4k Hz) was significantly associated with higher occupational noise exposure by occupation category (*P*-value for trend < 0.01). The most problematic occupational category was estimated to have a mean hearing threshold of 4.62 (95%CI: -0.96, 10.2) decibels higher than the lowest occupational category.

**Conclusion:** In this study, hearing thresholds of elderly men were strongly associated with a priori estimates of occupational noise exposure using an ordinal classification system. The effect of occupation-related noise exposure on hearing loss in the general population is significant and measurable. This classification system may prove useful in future studies of hearing loss in the general population, including those trying to disentangle environmental from occupational risk factors.

*I. Tak and Calvert. Hearing difficulty attributable to employment by industry and occupation: an analysis of the National Health Interview Survey—United States, 1997 to 2003. J Occup Environ Med 2008;50:46–56.*

#### ISEE-1350

##### Ecologic Measures of Exposure: Can They Cause Ecologic Bias?

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**Background and Discussion:** Because of the difficulty of collecting individual measures of exposure, environmental epidemiologists often use ecologic measures of exposure as proxies. While employing individual-level outcome and confounder (or modifier) data, participants are assigned exposure as groups, e.g., as measured at a central air monitor or water distribution system. While we can think of such partially ecologic studies as having exposure measurement error, it is not obvious that ecologic bias is avoided or how it might compare with that occurring in fully ecologic studies. These problems can be theoretically evaluated for continuous outcomes (e.g., birth weight) where we apply ordinary least squares to individual level data and population-weighted least squares to fully ecologic data. For crude exposure-outcome models, we show that partially ecologic and fully ecologic studies are equivalent. While the exposure measurement error can be Berkson in form (substituting the group mean for the individual exposure), this does not preclude ecologic bias from other sources such as confounding. Adding a covariate to the model may reduce but does not necessarily eliminate ecologic bias. We also show that measuring exposure individually but a confounder ecologically can control for confounding between groups but not within groups. We illustrate these results using birth weight data from a cohort on Cape Cod, Massachusetts, comparing individual-level results with those from partially and fully aggregated data. These findings have important implications for the design and evaluation of environmental epidemiology studies.

#### ISEE-1351

##### Prenatal Phthalate Exposure and Gender Role Behavior in Preschool Children from Central Taiwan

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**Background:** Phthalates exposure was found to be associated with decreased anogenital index in newborns across the US. It is hypothesized that male sex hormone might be altered and gender role behavior changed in relation to phthalates exposure.

**Methods:** We investigated the relations of testosterone and the Pre-School Activities Inventory (PSAI) to 11 phthalate monoester metabolites, by fully automated LC-LC/MS-MS-system, in a birth cohort of 300 newborns established in 2001 and followed till 2006 in central Taiwan. Phthalate exposure was associated with decreased testosterone (TT) concentrations at the years of 0 (cord carboxyl-mono-isobutyl phthalate (cx-MiNP) and cord TT: spearman correlation  $r = -0.49$ ,  $P < 0.05$ ), 2–3 (urinary mono-benzyl phthalate (MBzP) and serum TT:  $r = -0.44$ ,  $P < 0.05$ ), and 5–6 (MBzP and TT:  $r = -0.27$ ,  $P < 0.05$ ) years, with more significant  $r$  in boys at 0 year (cx-MiNP and PSAI:  $r = -0.61$ ,  $P < 0.05$ ) and with more significant  $r$  in girls at 2 and 5 years (MBzP:  $r = -0.91$ ,  $P < 0.001$ , and  $r = -0.46$ ,  $P < 0.05$ , respectively).

**Results:** Prenatal exposure to phthalates was associated with decreased PSAI scores at the age of 5 years, indicating stereotyped feminine toys and activities: Pearson correlation  $r$  between maternal urinary MBzP and PSAI score was  $-0.32$  ( $P = 0.06$ ,  $n = 55$ ) adjusted for gender and education of the major caretaker, and was  $-0.66$  ( $P = 0.01$ ) when maternal TT was further adjusted. Urinary MBzP was associated with decreased PSAI score ( $r = -0.54$ ,  $P = 0.01$ ) in 5–6 year old girls, adjusted for the education and their TT. Children with PSAI less than the median experienced significantly higher prenatal exposure to MBzP, MnBP, (both being BBP metabolites), and OH-MiNP and oxo-MiNP (DiNP metabolites).

**Conclusion:** It is firstly reported that testosterone levels decreased with increasing phthalates exposure consistently in the young children at the ages of 0, 2 and 5 years. The feminine role was found associated with prenatal exposure to BBP and DiNP metabolites. The decreased PSAI scores might associate partly with decreased TT and some other substantial factors that await further investigations.

#### ISEE-1352

##### Relationship Between Environmental Polycyclic Aromatic Hydrocarbons and Missed Abortion in Early Pregnancy in a Chinese Population

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**Background:** Polycyclic aromatic hydrocarbons (PAHs) released from combustion sources are important carcinogens. Prior animal and epidemiological studies have linked transplacental PAH exposure to various measures of intra-uterine growth retardation. PAH biologic effective doses (PAH-DNA adducts or BaP-DNA adducts as their proxy), provide a chemical-specific genetic damage that has been associated with increased risk of adverse birth outcomes.

**Objectives:** We aimed to examine associations between the levels of BaP-DNA adducts in maternal blood and on chorionic villus, and missed abortion in early pregnancy in Tianjin, an industrial city in northern China.

**Methods:** We enrolled 81 missed abortion cases and 81 hospital controls (abortion for other reasons) between 1 April 2007 to 9 December 2007. Subjects were restricted to nonsmoking women without occupational exposure who had resided in Tianjin for at least one year. Cases and controls were matched on maternal age, gravidity, parity, hospital, and gestational weeks. An environmental risk questionnaire (50 questions) was administered for each subject shortly after the abortion operation. BaP-DNA adducts in maternal blood and on chorionic villus were analyzed using the high-performance liquid chromatography-fluorescence (HPLC) method. Logistic models were used to examine the association of BaP-DNA adducts and missed discharge, while linear models were used to

examine the association of BaP-DNA adducts and certain environmental variables.

**Results:** We found that BaP-DNA adducts in maternal blood and on chorionic villus were significantly higher in the case group than in the control group ( $P < 0.001$ ). BaP-DNA adducts in chorionic villus was significantly higher than those in maternal blood ( $P = 0.001$ ), but no significant correlation was found between the two. BaP-DNA adducts in maternal blood was found to be a significant risk factor for missed abortion (OR = 3.63; 95% confident interval (CI): 1.49–8.87), after adjusting for maternal education and household income levels. Maternal blood adduct level was also positively and significantly correlated with traffic jam condition on the roadway nearest to the residence ( $P = 0.04$ ). Chorionic villus adducts level was not associated with any environmental factors, but was positively and significantly correlated with gestational week ( $P = 0.04$ ).

**Conclusion:** BaP-DNA adducts in maternal blood were associated with traffic-related pollution, and were a significant risk factor for missed abortion in early pregnancy.

#### ISEE-1354

#### Addressing Uncertainty and Variability in Ecological and Human Exposure Assessment: A Comparison

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**Background and Discussion:** Characterizing uncertainty and variability is perhaps the foremost challenge among those conducting human and ecological exposure assessments. In this paper we identify and evaluate the differences and similarities between ecological and human exposure assessment in addressing uncertainty and variability. We follow the protocol of referring to the overall degree of variation attributable to all sources as “uncertainty” and to variation in the specific case of heterogeneity as “variability”, which is an important subset of overall uncertainty. Uncertainty depends on the quantity, quality and relevance of data; the reliability and relevance of models used to fill data gaps or replicate known results; and the assumptions, scenarios, and decision options used in applying the assessment. In its draft report on treatment of uncertainty in exposure assessment, the International Program on Chemical Safety (IPCS) has proposed four tiers for addressing uncertainty ranging from the use of default assumptions (assuring one-sided confidence) to sophisticated probabilistic assessments. Based on these IPCS tiers, we examine archetypal human and ecological exposure assessments to contrast the extent to which each discipline engages default approaches, qualitative approaches, bounding sensitivity analyses, and probabilistic methods.

#### ISEE-1356

#### Initial Results of Outdoor, Personal, and Indoor Particulate and Gaseous Concentrations for College Students in Taichung Metropolitan Area

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**Background:** The COPIA study (Characterization of Outdoor, Personal, and Indoor Air Pollutants) characterizes the outdoor, personal, and indoor concentrations of particulate and gaseous pollutants for college students in Taichung Metropolitan Area.

**Objective:** The overall goal of this study is to better understand not only the relationship between ambient concentrations and personal exposures to particulate matter (PM) and related air pollutants but also the contributing

factors in different weather and culture system that might affect personal exposures to air pollutants.

**Methods:** Monitoring was performed for 18 walking commuters and 21 motorcycle commuters for 5 consecutive days in the year of 2007. During each sampling day, the participant wore a multi-pollutant sampler to collect simultaneous 24-hr integrated samples for each of the following pollutants: PM<sub>2.5</sub> (including sulfate, nitrate, elemental carbon (EC), organic carbon (OC), and polycyclic aromatic hydrocarbons (PAHs)), PM<sub>10</sub>, PM<sub>2.5–10</sub>, O<sub>3</sub>, NO<sub>2</sub>, and SO<sub>2</sub>. In addition, residential indoor concentrations and outdoor levels at a central monitoring site were measured simultaneously using the same multi-pollutant sampler. Housing characteristic information and time-activity diaries were also obtained. On average, college students commuting by walking spent 68.5% of each school day within their residences, while motorcycle-commuting students spent only 56.5% of their time at home.

**Results:** Initial results showed that 24-hr mean personal exposures to PM<sub>10</sub>, for example, were 67.0 ( $\pm 22.3$ )  $\mu\text{g}/\text{m}^3$  for walking commuters and 52.2 ( $\pm 24.6$ )  $\mu\text{g}/\text{m}^3$  for motorcycling commuters, while corresponding ambient levels were 81.0 ( $\pm 39.4$ )  $\mu\text{g}/\text{m}^3$  and 57.5 ( $\pm 27.9$ )  $\mu\text{g}/\text{m}^3$ , respectively. The mean personal PM<sub>2.5</sub> concentrations for students commuting by walking were 53.6 ( $\pm 21.5$ )  $\mu\text{g}/\text{m}^3$ , with the corresponding ambient PM<sub>2.5</sub> concentrations of 63.7 ( $\pm 33.0$ )  $\mu\text{g}/\text{m}^3$ . For motorcycle-commuting students, mean personal PM<sub>2.5</sub> was 38.3 ( $\pm 20.6$ )  $\mu\text{g}/\text{m}^3$  and ambient levels was 42.5 ( $\pm 27.4$ )  $\mu\text{g}/\text{m}^3$ . In general, personal PM exposures were lower than corresponding ambient concentrations, while the motorcycling participants showed higher mean personal/outdoor ratios of PM as compared to those for participants commuting by walking. Finally, for gaseous pollutants, outdoor concentrations of O<sub>3</sub> and NO<sub>2</sub> were significantly higher than corresponding personal exposure levels, where personal exposures to gaseous pollutants varied significantly between subjects. Personal exposures were medium-correlated with corresponding outdoor levels for NO<sub>2</sub> and SO<sub>2</sub>, but the personal-outdoor association was weak for O<sub>3</sub>. Personal exposures to ozone were only weakly correlated with corresponding personal NO<sub>2</sub> exposures, and the association pattern also applied in outdoor levels between these two pollutants.

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#### ISEE-1358

#### Analysis of Age-Dependent Congener Patterns of PCDD/PCDFs in General Population of Taiwan Using Multivariate Statistical Method

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**Background:** Polychlorinated dibenzo-*p*-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) are ubiquitous pollution, persist in the environment, bio-accumulate in human and animal tissues and can potentially cause adverse effects to human health and the environment. A congener profile could be regarded as a signature of patterns for PCDD/PCDF mixtures associated with particular median or exposure sources of these compounds.

**Methods and Results:** In this study, serum samples from 251 subjects of the general population in Taiwan were collected during 2001 to 2006 and analyze for seventeen PCDD/PCDFs. The proportion of specific 2,3,7,8-substituted PCDD/PCDF to the total seventeen 2,3,7,8-substituted PCDD/PCDF congeners was used to develop the PCDD/PCDF congener profile in the serum sample. Pearson correlation coefficients between age and the proportions of individual PCDD/PCDF to the total seventeen PCDD/PCDFs indicated that two congeners, OCDF and 1,2,3,6,7,8-HxCDD, had median associations with age ( $|r|$ : 0.53 and 0.45,  $P < 0.01$ ), twelve congeners are low associations ( $|r|$ : 0.19–0.29,  $P < 0.01$ ), and others are no associations ( $|r|$ : 0.02–0.14,  $P < 0.01$ ). It revealed that the

PCDD/PCDF congener profiles may associate with age. Further, subjects are divided into four groups according to age, including group A: 18–29 (N = 72), B: 30–39 (N = 67), C: 40–49 (N = 68), and D: 50–59 (N = 44) years old. The congener patterns for these four groups derived from the average congener profiles of the subjects in the specific group and were analyzed by the multivariate statistical method, multivariate analysis of variance, to evaluate where the four congener patterns are difference. The result indicated that the congener pattern for the A group was difference to other three groups and for B group was difference to D group ( $P < 0.001$ ). Among the seventeen PCDD/PCDF congeners, the numbers of congeners which significant difference to the compared group were 8, 5, 3, 1 for the pairs of A&D, A&C, A&B, and B&D, respectively using the Scheffe post hoc test. Age was associated with the PCDD/PCDF congener profiles and patterns of the serum samples in the general population of Taiwan which regarded as a signature for PCDD/PCDF mixtures associated with particular median or exposure sources of these compounds.

**Conclusion:** The associations may reveal that the exposure sources of the population change with time. However, identification of exposure-sources change in human requires further investigation.

#### ISEE-1364

#### Man Made but Woman Consumed? Gender Differences in Risk Perception of Nanotechnology

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**Introduction:** Public opinions and risk perceptions of emerging technologies are key factors in shaping governance policies. A substantial body of risk research indicated that risks tend to be judged lower by men than by women. Taiwan has been invested profoundly in the development of nanotechnology in recent years. Most of the novel man-made materials, however, are used in consumer products targeting on the women's market.

**Methods:** Questions regarding nanotechnology were included in a telephone survey of environmental health risk perception in Taiwan. Participants were adults selected from nation-wide households registered in the database of the computer-assisted Telephone Interviewing (CATI) system via two-stage geographically stratified systematic sampling. A total of 1,251 persons successfully completed the telephone interviews administered by trained interviewers. Only those who had heard of "nanotechnology" or "nano products" (81.3%, n = 1,017) were further interviewed for their opinions and risk perceptions of nanotechnology.

**Results:** There were a significantly higher percentage of women (84.0%) than men (78.4%) who had heard of nanotechnology. Those who had heard of nanotechnology were younger, not married and with higher education. Among those who had heard of nanotechnology, 45.6% worried about the safety of nano products. There was no significant difference between men and women concerning the safety issue. There were, however, significantly more men (39.6%) than women (25.0%) who said that they knew what nanotechnology was. Further, men were more optimistic about nanotechnology. Knowing what nanotechnology was and judging the technology more positively were negatively correlated with the safety concerns of nanotechnology in both genders.

**Discussion and Conclusion:** The gender differences in the risk perception of nanotechnology provided a wonderful chance to investigate the sociopolitical factors in risk judgments. Contrary to a similar survey study of Genetic Modified Organisms in Taiwan, our study indicates that there are more women than men who have heard of nanotechnology. Nevertheless, women claim to know less about nanotechnology and judge it less positively. We suggest that women have experience nanotechnology as consumers in their everyday life. A theoretically informed gender perspective is needed to improve the understanding of women's and men's risk perception of nanotechnology.

#### ISEE-1365

#### Associations Between the Ratio of Fine and Coarse Particles of Ambient Air and Daily Mortality in Seoul, Korea

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**Background:** Several studies reported that ambient fine and coarse particles are associated with health effects such as daily mortality, emergency room visits and hospitalizations. However, the associations of different sizes of the particles have not been fully investigated. In Korea, the concentration of air pollutants varies highly under the influence of Asian dust and the ratio of fine and coarse particles could be considered as an important index. The aim of this study is to evaluate the association between the ratio of PM<sub>2.5</sub> to PM<sub>10</sub> for the air quality and daily mortality in Seoul, Korea.

**Methods:** The association between the ratio of PM<sub>2.5</sub> to PM<sub>10</sub> and the daily mortality was evaluated by generalized additive model (GAM): using a Poisson regression adjusting for the confounders such as temperature, humidity, air pressure, and days of week. The study period of this study was from April 2003 to December 2005.

**Results:** The daily ratios of PM<sub>2.5</sub> to PM<sub>10</sub> are unstable and the average is  $0.70 \pm 0.19$  (Mean  $\pm$  SD). We found that rate ratio (RR) of daily death counts was 1.016 (95%CI 1.006–1.027) corresponding to 0.19 (one standard deviation) increase of the ratio of PM<sub>2.5</sub> to PM<sub>10</sub> with lag of one day. RR for the elderly whose age is over 65 (RR = 1.020, 95%CI 1.006–1.034) was estimated higher than that of people whose age is less than 65 (RR = 1.009, 95%CI 0.994–1.024).

**Conclusions:** The ratio of PM<sub>2.5</sub> to PM<sub>10</sub> has effect on daily death, especially in elderly group. We concluded that the ratio of PM<sub>2.5</sub> to PM<sub>10</sub> could be an important measure in evaluating health effects of fine particles.

#### ISEE-1368

#### Association Between Ambient Pollution and Respiratory Health Effects in Elementary School Children in Beijing, China

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**Background:** Studies have shown association between air pollution and increased respiratory acute inflammation, decreased lung function and increased incidence of respiratory disease. However, the underlying mechanism remains unclear, and the effects of specific pollutant constituents have not been well studied. This study was designed to assess the association between urban ambient pollution and respiratory health effects in elementary school children in Beijing, using exhaled nitric oxide (eNO) as a marker of respiratory inflammation.

**Method:** A panel of 38 elementary school children (18 boys, 20 girls, age  $10 \pm 0.5$  years) in Beijing was recruited into this study. Among the recruited subjects, 31 are healthy children, and 7 children had asthma history. eNO was measured once a day on each subject at noon time for 10 days in June and 10 days in September 2007, and lung function was measured every other day during same study period. The exposures to ambient PM<sub>10</sub> (particulate matter with diameter  $<10 \mu\text{m}$ ) and PM<sub>2.5</sub> (particulate matter with diameter  $<2.5 \mu\text{m}$ ), as well as to black carbon and gaseous pollutants were measured on daily basis. The associations between eNO and ambient pollution were assessed using Mixed model, controlling for subject asthma history, age, height, weight, temperature and relative humidity.

**Results:** Significant associations were found between eNO increase and exposures to ambient pollution. Overall, in response to  $25 \mu\text{g}/\text{m}^3$  increase of PM<sub>2.5</sub> exposure in proceeding 24 hour, the increase of eNO was 3.12 ppb (95%CI: 2.22 ~4.01); per  $25 \mu\text{g}/\text{m}^3$  increase of PM<sub>10</sub> exposure, the

increase of eNO was 2.36 ppb (95%CI: 1.01~3.73). In response to 1  $\mu\text{g}/\text{m}^3$  increase of black carbon exposure, the increase of eNO was 3.28 ppb (95%CI: 1.83~4.74); per 1  $\mu\text{g}/\text{m}^3$  increase of total black carbon exposure, the increase of eNO was 2.06 ppb (95%CI: 1.25~2.87). The observed effect further increased in response to prior 48 hour exposure, then diminished for prior 72 hour exposure. The increase of eNO among asthmatic children was significantly greater than that among non-asthmatic children.

**Conclusion:** The results showed significant associations between short-term exposure to ambient pollution and respiratory inflammation effect among children in China, and the observed effects were stronger among asthmatic children.

#### ISEE-1370

#### Estimation of Burden of Disease Attributable to Indoor Air Pollution in Andhra Pradesh, India

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**Background:** Indoor air pollution (IAP) associated with domestic solid fuel use is a major contributor to the burden of disease (BOD) in India. Emissions from biomass use in household stoves can contribute to greenhouse gases (GHGs) and adverse health impacts. Initial results on emissions, concentrations, exposures and burden of disease attributable to solid fuel use are presented from a study in Andhra Pradesh, a southern state in India that applies comparative health risk assessment (CRA) procedures to evaluate the effectiveness of various interventions on the basis of potential to reduce both health risks and emissions. Initial results of state and district level BODs attributable to solid fuel use in Andhra Pradesh (AP), India.

**Methods:** A district level emission profile for particulate matter (PM) and GHGs was generated, using district level fuel use information and emission factors for specific fuel stove combinations. District level concentration / exposure profiles for PM (used as an indicator pollutant for health damaging pollutants) were generated using background primary data from 420 households across three districts. The burden of disease for two health endpoints, acute lower respiratory infections (ALRI) and chronic obstructive pulmonary disease (COPD) were calculated for AP, using the recently published WHO guide. Background fuel use and population information were taken from the Census 2001 data. BOD estimates for India for the year 2000 were used to calculate attributable burdens.

**Results:** State level results are shown. The attributable burden (DALYs lost) from biofuel use for ALRI in children, <5 yrs is 9,01,374, deaths are 25,449. Similarly for COPD in women >30 yrs, DALYs lost are 102,080 and Deaths are 5720 and for COPD in men DALYs lost are 98,280 and Deaths are 5252.

**Conclusions:** BOD estimates generated using district/state level fuel use information are being compared to BOD estimates generated using household level concentration/exposure data from previous studies by the same investigators in AP and the NFHS database. BOD calculations are being used as an input for ranking various intervention options and will aid in their priority setting.

#### ISEE-1371

#### Job-Hazard-Exposure-Health Profiles for Certain Occupational Sectors in Southern India (Textile, Tannery, and Municipal Solid Waste Sector)

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**Objectives:** This study is aimed at health impact assessment for tannery, textile and municipal solid waste workers in Tamil Nadu.

**Methods:** Exposures were assessed for total/respirable dusts (NIOSH protocol 0600), noise (ANSI-S12.19-1996) and heat- stress (ACGIH-Criteria). Health assessments (that included occupational history, physical examination, blood chemistry, serology, biological monitoring, spirometric and audiometric tests) were performed in 438 textile, 256 tannery and 400 conservancy workers.

**Results:** Environment: 8-hour TWA exposures ranged from 0.05 to 7.0  $\text{mg}/\text{m}^3$ . 8-hr TWA exposures for noise ranged from 62.2. to 106.2 dBA. 325 heat stress measurements were made in 15 locations with WBGT indices ranging from 24.1~39.4°C. Levels of respirable dusts (5~25  $\text{mg}/\text{m}^3$ ) and noise (95~110 dB) were the biggest concern in most work locations and improvements were made in many tanneries by implementing locally designed, low-cost engineering controls. Micro-environmental determinations of respirable particulate concentrations indicate that the residents in neighboring communities and workers at both dumpsites are exposed to levels of criteria air pollutants that are in excess of national and international guideline values. The noise level measurements suggested that most locations within the dump-sites, especially the weigh bridge, exceeded prescribed limits of noise level exposure. Health assessments showed the prevalence of respiratory impairments to be much higher in shop floor workers as compared to office- workers in both textile and tannery workers. Audiometric assessments show that the prevalence of noise-induced hearing loss to be around 33% in textile and 70% in tannery workers. Both respiratory and hearing impairments were correlated significantly with job exposures. 55% of conservancy workers gave a history of injury while working and 30% had history of respiratory illness. The pulmonary functions were significantly low in sweepers compared to loaders and drivers. Pulmonary function declined with increasing years of working. The pulmonary functions were significantly lower than their predicted values. Regression analysis showed that conservancy workers had an increased risk of nearly 3.3 times the unexposed population for respiratory illness ( $\beta = 1.209$ ; SE = 0.237; -Exp  $\beta = 3.35$ ;  $P = 0.005$ ).

**Conclusions:** This study has provided the job- exposure–hazard-health baseline profile of conservancy workers, textile and tannery workers in Tamilnadu. This profile has identified the hazards and is used for the implementation of corrective and preventive measures and also to assess the efficacy of the interventions. Baseline health assessments provide the necessary inputs for design of surveillance programs. The data generated from this study can also be used to plan larger epidemiological studies in the same region. These profiles are expected to aid the development of a regional occupational health database for use in local regulation and resource allocation for interventions.

#### ISEE-1372

#### Association Between Gene Polymorphisms of Xenobiotica-Metabolizing Enzymes and Eczema in Boys but Not in Girls

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**Background:** Genetic risk factors for the development of atopic diseases may differ between males and females. Using the birth cohort study LISA we investigated the relationship between gender, gene polymorphisms of xenobiotica-metabolizing enzymes and atopic eczema (AE).

**Methods:** LISA is a longitudinal birth cohort study. Information was gathered by structured questionnaires, which were answered by the parents, and by examinations by a physician. Data were collected at the 1st, 1.5th, 2nd, 4th and 6th year of children's life. The study population was genotyped for genetic variations in enzymes of biotransformation

involved in metabolism of industrial pollutants, tobacco smoke and in defence against oxidative stress. Logistic regression based on complete enumeration was used for calculating the most significant effects. To exclude interfering effects, the models were adjusted for parental history of atopy, infectious diseases of the mother during pregnancy, traffic exposure and renovation activities during pregnancy as well as during children's first three months of life.

**Results:** N = 401 girls and N = 480 boys were genotyped and had no missing information in the variables under consideration. The prevalence of AE did not differ significantly between boys and girls. Interestingly, boys carrying *CYP2D6*\*wt/\*wt; *GSTM1* as well as *GSTM1* with at least one functional allele showed a statistically significant elevated risk for eczema at the age of 1 year (OR 2.4; 95%CI: 1.34–4.46) at the age of 1.5 years (OR 2.2; 95%CI: 1.29–3.63), and a still slightly elevated risk at the age of 2 years (OR 1.6; 95%CI: 1–2.66), 4 years (OR 1.5; 95%CI: 0.97–2.46) as well as 6 years (OR 1.5; 95%CI: 0.95–2.39). No associations were found between the above mentioned genotype combination and AE in girls.

**Conclusion:** Differences of other atopies (e.g. asthma) between boys and girls were already reasoned and described. For eczema gender specific differences in the surface pH as well as the level of hydration of the stratum corneum in the skin were discussed as explanation for the differences in prevalence. Possibly, the gender-specific epidermal barrier function could be one reason for the susceptibility towards environmental factors. In this way the identified association indirectly point to xenobiotics as etiologic agents for eczema. That is why we need more focus on multifactorial interactions including gene-environment-interactions.

#### ISEE-1373

#### Chronic Obstructive Pulmonary Disease in Biomass Fuel Users in Tamil Nadu—a Pilot Study for Assessment of Prevalence and Implications for the Burden of Disease in Rural Women

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**Background:** Indoor exposures due to the combustion products of biomass fuels expose about half of the world's population in rural areas of the developing countries to the highest levels of air pollution thereby resulting in the development of chronic obstructive pulmonary disease (COPD).

**Objectives:** To estimate the prevalence of COPD among females through a primary household level clinical and spirometric assessment in a rural district of TamilNadu, India and to evaluate the association between biomass fuel use and COPD and also to evaluate the contribution of other confounding factors in the development of COPD.

**Materials & Methods:** This cross sectional study was conducted among 900 females above 30 years, residents of 45 different rural villages (selected by cluster sampling) of Tiruvallur district, located in the North East part of TamilNadu. Exposure and health questionnaires were administered and clinical examination was done after acquiring an informed consent. PFT was done for all suspects of COPD cases to confirm the diagnosis. Data was analyzed using R statistical software and prevalence rates were calculated.

**Results:** Overall crude prevalence of COPD was found to be 2.44% (95%CI 1.43–3.45).

- 0.89% of the population were at risk for COPD (GOLD stage 0)
- 1% of the population had moderate COPD (GOLD stage 2)
- 0.22% of the population had severe COPD (GOLD stage 3)
- 0.33% of the population could not use a spirometer.

In the older >50 years stratum, the prevalence was 3.9% for the exposed and 2.2% for the non-exposed. COPD prevalence was higher in biomass

fuel users than the clean fuel users 2.5% Vs 2%, (OR1.24; 95%CI 0.36–6.64) and it was two times higher (3%) in women who spend more time in the kitchen involved in cooking (>2 hours/day) and it was also higher in women with cooking duration of >20 years (2.9% Vs 1.2%). Prevalence rate was higher (2.9% Vs 2.3%) among passive smokers.

**Conclusion:** This is the first ever study to have been conducted in nonsmoking women for estimation of prevalence of COPD in TamilNadu. The analysis of COPD individuals showed that a significant proportion of them are 'at risk stage' of the disease and this observation emphasizes the need for the Indian health-care system to identify this "silent" category of patients in order to prevent progression of the disease and also to implement interventions to reduce the exposure and possibly the risk of COPD. The data generated from this study can be used to compare the prevalence of COPD with other studies conducted among different sections of population in different parts of the country and can be used to generate a regional data base for COPD.

#### ISEE-1374

#### Secondary Metabolites of Di-n-butyl phthalate (DnBP) and Di-iso-butyl phthalate (DiBP) in Urine as Valuable Biomarkers of Exposure

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**Background:** Di-n-butyl phthalate (DBP) and di-iso-butyl phthalate (DiBP) are widely used in consumer products, enteric-coated tablets and as plasticizers for polymers. DnBP and DiBP are metabolized in humans to their monoesters mono-n-butyl phthalate (MnBP) and mono-iso-butyl phthalate (MiBP). These primary metabolites are currently used in human biomonitoring approaches to assess internal exposures. However, the simple monoesters are prone to external contamination and have rather short half-times of elimination. These shortcomings could be overcome using oxidized, secondary metabolites, when applicable.

**Methods:** We investigated 160 spot urine samples (partly repeated from 110 volunteers) with no known occupational phthalate exposures for oxidised metabolites of both isomers with oxo-, hydroxy- and carboxy-functional groups. 3-carboxy-MPP (3cxMPP) was detected in 90% of the samples with a median concentration of 0.66 µg/L (95th percentile [95P]: 2.70 µg/L). 3-cxMPP is a metabolite of DnBP but also of other higher molecular weight phthalates, thus not specific to DnBP exposure.

**Results:** 3cxMPP was comparably weakly correlated with MnBP ( $r = 0.56$ ;  $P < 0.001$ ) and weaker with MiBP ( $r = 0.30$ ;  $P < 0.001$ ). 3-hydroxy-MnBP (3OH-MnBP) was detected in 97% of the samples with a median of 1.73 µg/L (95P: 13.3 µg/L). 3OH-MnBP was highly correlated ( $r = 0.91$ ;  $P < 0.001$ ) with MnBP (median: 20.9 µg/L; 95P: 110.7) but excreted at about 10-fold lower concentrations. Regarding oxidised DiBP metabolites we detected OH-MiBP in all samples and at high concentrations (median: 10.5 µg/L; 95P: 119.4 µg/L). OH-MiBP was highly correlated with MiBP ( $r = 0.90$ ;  $P < 0.001$ ) and excreted at roughly half the concentration of MiBP (median: 27.3 µg/L; 95P: 193.0 µg/L). Thus, OH-MiBP is an excellent additional biomarker of DiBP exposure, supplementing MiBP. With limits of quantification of 0.1 µg/L for all metabolites, we detected no metabolites with a keto (oxo) functional group.

**Conclusion:** Overall, our findings suggest that there are considerable differences in DiBP and DnBP metabolism which have to be taken account of when interpreting biomonitoring data.

**ISEE-1376****Biological Monitoring of Environmental Nicotine and Tobacco Smoke Exposures: Cotinine, 3-Hydroxycotinine and Nicotine in Urine of Non and Passive Smokers**

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**Background:** Exposure to environmental tobacco smoke (ETS) is carcinogenic in humans. Therefore, exposure assessment of ETS is of primary interest in public health. Biological monitoring of ETS exposure by the analysis of nicotine (NIC) or its metabolite cotinine (COT) in biological samples such as urine, plasma or saliva is considered a promising tool for exposure assessment. Analytical methods currently used are capable to clearly identify smokers. However, current limits of quantification in all media are not capable to sufficiently distinguish varying levels of low ETS-exposures in non-smokers or children. Moreover, dietary intake of solanaceous vegetables may contribute to low doses of NIC. Here, we present an ultrasensitive and selective two-dimensional HPLC-MS/MS method for the simultaneous determination of three biomarkers of ETS exposure in urine: NIC, COT and 3-hydroxycotinine (3OHC).

**Methods:** After enzymatic hydrolysis, NIC, COT and 3OHC are extracted from urine on a polymeric phase (Oasis HLB) under turbulent flow conditions (1st dimension) and are subsequently separated on an analytical RP phase (Synergi Fusion-RP, 2nd dimension) by 2D-HPLC. Finally, detection of all three metabolites is carried out by tandem mass spectrometry. Internal standardisation and quantification is carried out by isotope dilution using deuterium-labelled internal standards. Limits of quantification (LOQ) are 0.1 µg/L for all three biomarkers. Relative standard deviations between days ( $n = 10$ ) at 8 µg/L were 9% or lower. The method was applied in a population of 37 non-smoking volunteers with no known ETS exposure within the last 48 hrs.

**Results:** Median levels of NIC, COT and 3OHC were determined to be 0.3, 1.0 and 1.7 µg/L, ranges were below LOQ-0.9, 0.1-2.9 and 0.2-7.7 µg/L. COT and 3OHC were highly correlated even at these low concentrations ( $r = 0.80$ ;  $P < 0.001$ ). 3OHC is excreted in higher concentrations than COT and was previously shown to have a prolonged half-life of elimination. Therefore, 3OHC should be considered a biomarker of ETS exposure in future studies in addition to COT.

**Conclusion:** With the above method we are capable to assess exposure to ETS down to lowest levels in occupational and environmental settings. Based on the differences in elimination kinetics between NIC, COT and 3OHC, time points and heights of ETS exposures within the last 48 hrs could be evaluated in detail via differential diagnostics on an individual basis.

**ISEE-1377****Variable Selection Methods Influence the Identification of Factors That Predict Serum Dioxin Concentrations in Michigan, USA**

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**Methods:** Linear regression models were performed to identify important factors that were associated with serum dioxin concentrations in the Midland and Saginaw Counties in Michigan, using data from 946 participants in the University of Michigan Dioxin Exposure Study (UMDES) that were selected from the study area by a complex sample

design. We used two different variable selection approaches in the linear regression models: backward selection and forward stepwise selection. The influential diagnostics were then performed to investigate the influence of influential observations on the regression coefficients, by using DFBETAS. The purpose of this paper is to compare the results from these approaches and investigate which approach is more sensitive to the influential observations in the data. In linear regression when the number of potential predictors is relative large compared with the number of observations, there are typically not enough degrees of freedom to run a single step of backward selection from the complete variable list. Although this problem is often addressed by using a multi-stage backwards selection procedure, there is no guarantee that the resulting model will be optimal. Forward stepwise selection allows variable selection in a single step, but there is no software available to implement this in the setting of multiply-imputed survey data. We solved this problem by writing a SAS macro that implements forward stepwise selection in the setting of multiply-imputed survey data.

**Results:** We found that the most important predictors of serum dioxins (age, gender, body mass index, smoking status, the length of breastfeeding, etc.) were consistently identified by using either backward or forward stepwise variable selection in our regression models. These factors were stable (in terms of parameter estimates and p-values) and collectively explained a large proportion of the variance in serum dioxin levels (measured by the adjusted  $R^2$ ). However, some factors that were dependent on a small number (1 to 3) of observations tended to be identified in backward selection, but not in forward stepwise selection. These factors should be interpreted with caution insofar as the associations were highly dependent on a few influential observations, the factors explained little of the variation in serum dioxin levels, and their inclusion in the model was dependent on the variable selection procedure. For example, living in Midland or Saginaw Counties in the 1940s and 1950s was identified in backward selection and was statistically significant associated with increased serum 2378-TCDD ( $P$ -value = 0.019). If the most influential observation is excluded from the regression analysis, there is not statistically significant association between the years living in Midland or Saginaw Counties in the 1940 and 1950s and serum 2378-TCDD. But this factor was not identified by the forward stepwise selection even the most influential observation is included in the regression analysis.

**Conclusion:** Based on the above findings, we recommend using forward stepwise variable selection in linear regression analysis in studies like ours. Our implementation of a SAS program to do this is a substantial forward step in the analysis of multiply-imputed survey data.

**ISEE-1378****Associations of Child Care Center Carbon Dioxide and Bacteria with Lower Respiratory Infections Among Attending Preschool Children**

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**Introduction:** Among immune-naïve preschool children, child care center (CCC) attendance has been linked to lower respiratory infections (LRI) exposures. However, little has been reported on the important exposures that influence this association. Here, we study the associations of carbon dioxide ( $\text{CO}_2$ ) and bacteria within CCCs with LRI among attending preschool children.

**Methods:** We examined ventilation rates in 14 low and 12 high LRI prevalence CCCs in Singapore obtained from 104 randomly selected CCCs. The validated American Thoracic Society-Division of Lung Disease questionnaire was used to solicit the period prevalence of LRI for 1452 children in the past year. Daily average  $\text{CO}_2$  measurements were performed using IR absorption technique. Human- and environmental- bacteria levels

were measured using standard impactor-culture techniques. Exposure levels were analyzed in tertiles. Computation of adjusted prevalence ratios (PR) using modified Cox proportional hazard regression model with constant risk period assumption controlled for other confounders were used to determine associations between exposures and LRI.

**Results:** Mean exposure levels for CO<sub>2</sub> in the first, second and third tertiles were 400, 500 and 790 ppm. For human bacteria, the corresponding levels were 690, 1420 and 3080 CFU/m<sup>3</sup> while environmental bacteria, the levels were 66, 1230 and 3560 CFU/m<sup>3</sup>. There was dose response relation for the association between CO<sub>2</sub> and environmental bacteria with LRI. We found increased risks for LRI with exposures to CO<sub>2</sub> in the second (PR: 1.22 95%CI: 0.80–1.86) and third tertiles (PR: 1.99 95%CI: 1.34–2.96) and environmental bacteria in the second (PR: 2.11 95%CI: 1.36–3.28) and third tertiles (PR: 2.17 95%CI: 1.41–3.34) than those in the first tertile exposure (reference) group. We find non-significant positive association for human related bacteria exposures with LRI (PRs: 2<sup>nd</sup> tertile 1.33; 3<sup>rd</sup> tertile 1.28).

**Discussion:** Lower ventilation rates, indicated by higher CO<sub>2</sub>, can amplify LRI by increasing the indoor levels of airborne infectious agents produced by other sick children. This concurs with findings of scientific reviews demonstrating the associations between ventilation in buildings and the transmission/spread of infectious diseases and Myatt et al (2004) reporting associations of probability of detecting airborne rhinovirus and CO<sub>2</sub> levels in an office study. Exposures to environmental bacteria appear to be important probably due to its virulence and high pathogenic effects (Burge, 1995). Commensal bacteria exhibit enormous diversity, co-evolving with their hosts and under some conditions, able to overcome protective host responses and exert pathologic effects (Tlaskalová-Hogenová et al., 2004). This could explain why its association with LRI were positive but non-significant.

**Conclusion:** This study shows that exposure to environmental bacteria and CO<sub>2</sub> in CCCs are important associated factors of LRI among attending preschool children in Singapore.

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#### ISEE-1380

##### Estimation of the Exposure Levels of Heavy Metals by Traditional Herbal Medicines in Korea

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**Background:** Traditional herbal medicines are regularly used to treat for disease or promote one's health in Korea. The national quality control of herbal medicine is important to protect public health.

**Objective:** The purpose of this study was to assess the exposure of heavy metals according to intake of traditional medicines on Korean general population.

**Methods:** Our investigation was on arsenic, cadmium, lead, and mercury of heavy metal in herbal materials on the market. The herbal medicine which was extracted by boiling in water was ingested. The intake rates of herbal medicines were based on the frequently prescriptions by the researched of KFDA (2006).

**Results:** The average exposure levels of heavy metals in herbal medicine by intake were  $3.4 \times 10^{-5} \sim 1.65 \times 10^{-4}$  mg/kg b.w./day for lead,  $4.69 \times 10^{-6} \sim 1.88 \times 10^{-5}$  mg/kg b.w./day for cadmium,  $2.19 \times 10^{-5} \sim 1.20 \times 10^{-4}$  mg/kg b.w./day for arsenic, and  $2.22 \times 10^{-4} \sim 9.41 \times 10^{-3}$  µg/kg b.w./day for mercury. In this study, the average exposure

levels of the lead, cadmium and mercury in the herbal medicines were under the 5% compared with PTWI (previously tolerable weekly intake) by FAO/WHO.

**Conclusion:** The exposure level of arsenic can not be compared with PTWI because the PTWI were just limited to inorganic arsenic not total arsenic. We can suggest that exposure of heavy metals from herbal medicine didn't be expected to change of total exposure level in this study. However, total exposure level of heavy metals should be considered to other exposures from pathway such as food, air and water, etc.

#### ISEE-1381

##### Oxidative Stress from Environmental Exposure to PAHs, VOCs and Formaldehyde in the Elderly

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**Background:** Recent evidence from epidemiological studies has shown that air pollution is associated with adverse health effects such as an increase in cardiovascular and pulmonary disease. However, contribution of the environmental chemicals to health effects has not been adequately evaluated. Moreover, little is known about the effects of environmental chemical exposure to fragile populations such as the elderly. Because oxidative stress has been regarded as early biological effects from exposure to environmental chemicals and as intermediate process leading to cardiovascular and pulmonary disease, we conducted a study to assess oxidative stress from environmental exposure to PAHs, VOCs and Formaldehyde in a panel of 161 elderly subjects.

**Methods:** We studied subjects once a week for up to 8 weeks and measured exposure biomarkers of PAHs (1-OHP and 2-Naphthol), VOCs (Benzene, Toluene, Ethylbenzene, Xylene) and Formaldehyde in urine. Oxidative stress was measured by lipid peroxidation biomarker, urinary Malondialdehyde. We used a mixed linear regression model to estimate the association between environmental chemical exposures and oxidative stress. Age, sex, body weight, height, day of the week, and meteorological variables were controlled in the model.

**Results:** Despite the non-existence of major local sources near residential place of the elderly participants, the concentrations of urinary biomarkers of PAHs, VOCs and Formaldehyde were detectable in most of the samples. 1-OHP and 2-Naphthol were measured by HPLC-FC, and Formaldehyde and Malondialdehyde were measured by HPLC-UVD. Urinary concentrations of Benzene, Toluene, Ethylbenzene, and Xylene were measured using Headspace GC-FID. We found significant association between urinary Malondialdehyde concentrations and exposure biomarker levels of PAH, VOC and Formaldehyde.

**Conclusions:** In conclusion, the elderly are susceptible population to outdoor/indoor pollution effects of producing oxidative stress. Identification of oxidative stress induced by environmental chemicals adds the evidence of adverse health effects attributable to outdoor/indoor air pollution.

#### ISEE-1382

##### Contribution of Mexican Health Sector to Global Pollution by Mercury. Risk Assessment

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**Background:** Results of the Risk Assessment performed in Mexico like a first phase of the program: "Health Care without Harm-Mercury", are

presented. Mercury pollution is a classic example of a global pollutant and human health problem. For that reason, in order to establish prevent measurements is important to know the contribution to it, of each region and country on the word.

**Methods:** A questionnaire to measure the attitudes, knowledge and common practices in relation to mercury was formulated. The tool was applied to a sample of dentists, physicians, nurses, students and chemists. The characterization was made considering the two main sources: amalgams and mercury thermometers. Indexes were constructed and validated in order to be able to estimate the contribution that each sector has. In the case of the dentists, the index was built according to the number of dentists in the country, the proportion of those who are active, the percentage of non-encapsulated amalgam use per sector (both public and private) and the observed practices. As to thermometer use, the indexes were built with censables pediatric and adult beds and with non-censables beds.

**Results:** The results show that more than 50% of health professionals possess little knowledge concerning mercury and its effects on the environment and health. Medical practices do not include any environmental protection since, in the majority of the cases, mercury is directly released into water. The indexes of adult beds showed an average of 1 thermometer per bed per month, in the pediatrics case, the index ascends to 1.5 and close to 2 for non-censables beds. The risk characterization shows that more than 3.5 tons of mercury exclusively originating from amalgam residues and close to 2 tons of mercury originating from thermometers is annually released into water in a direct form. The attitude examination showed a constant acceptance to change.

**Conclusions:** A serious risk of big contribution to mercury global contamination coming from health sector in Mexico was detected mainly from two sources: amalgams and thermometers and related with the bad training of human health resources. An intervention on several levels was started which include formal and informal training, working with authorities and administrative personnel and a net and cascade organization of public universities around the country, that are generating a visible change.

#### ISEE-1383

#### Airborne Particulate Matter Concentration at Day Nurseries in Urban Environments, Korea

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**Background:** Airborne particulate matter (PM) has become a major problem in the large urban areas around the world. It is reported that particulate matter exposure may affect children with bronchial hyper-responsiveness and asthma that is one of the most common chronic diseases of childhood. PM has been classified by aerodynamic diameter. PM less than 10  $\mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{10}$ ) has been used to indicator for suspended particles in the air until now and PM less than 2.5  $\mu\text{m}$  in aerodynamic diameter ( $\text{PM}_{2.5}$ ) is an important indicator of risk to health from particulate pollution. This study investigates the concentration of  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  at day nurseries in Korea.

**Methods:**  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  were sampled during day care hours using particulate mass monitor (SIBATA, GT-331) in each season from February to October 2006. Sampling sites were classroom, dining room and lobby at day nurseries of 29 for children under 5 years in Seoul. Outdoor concentration of  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  were measured as control. Information of sampled facilities such as floor area, local position, number of little children and air cleaner system was collected.

**Results:** The average floor area and number of little children at each day nursery was 743.4  $\text{m}^2$  and 161. The overall average concentration of  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  in 29 day nurseries was 68.6  $\mu\text{g}/\text{m}^3$  and 16.72  $\mu\text{g}/\text{m}^3$ . The proportion of the indoor  $\text{PM}_{2.5}$  concentration to the indoor  $\text{PM}_{10}$  concentration was averagely 0.24 at day nurseries in urban environments.

The indoor concentration of  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  had a seasonal variation. The highest seasonal  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  concentration measured in fall was 95.9  $\mu\text{g}/\text{m}^3$  and 28.7  $\mu\text{g}/\text{m}^3$  and the lowest seasonal  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  concentration measured in summer was 22.2  $\mu\text{g}/\text{m}^3$  and 5.3  $\mu\text{g}/\text{m}^3$ . When indoor  $\text{PM}_{10}$  concentration was observed in fall, the concentration showed 80.1  $\mu\text{g}/\text{m}^3$  in lobby, 92.9  $\mu\text{g}/\text{m}^3$  in dining room, 104.7  $\mu\text{g}/\text{m}^3$  in classroom. Also, indoor  $\text{PM}_{2.5}$  concentration in fall was 21.3  $\mu\text{g}/\text{m}^3$  in lobby, 37.0  $\mu\text{g}/\text{m}^3$  in dining room, 30.8  $\mu\text{g}/\text{m}^3$  in classroom. Indoor PM concentration at day nurseries close to roads was little different from those at day nurseries in residential area. During sampling period, the average  $\text{PM}_{10}$  concentration was 69.6  $\mu\text{g}/\text{m}^3$  at day nurseries close to roads and 68.3  $\mu\text{g}/\text{m}^3$  at day nurseries in residential area. The average  $\text{PM}_{2.5}$  concentration was 19.7  $\mu\text{g}/\text{m}^3$  at day nurseries close to roads and 14.3  $\mu\text{g}/\text{m}^3$  at day nurseries in residential area. The ratio of indoor and outdoor (I/O ratio) PM concentration was calculated. The daily average I/O ratio of  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  concentration were 1.36 and 1.14. In this study, the daily indoor  $\text{PM}_{10}$  concentration at day nurseries in urban area, Korea was higher than urban background levels (43.2  $\mu\text{g}/\text{m}^3$ ) in Europe. The daily indoor  $\text{PM}_{2.5}$  at day nurseries in urban area, Korea was similar to urban background levels (around 15–20  $\mu\text{g}/\text{m}^3$ ) in Europe.

**Conclusion:** So far, the results of this study suggest that indoor  $\text{PM}_{10}$  level at day nurseries reduce preferentially for little children's health.

#### ISEE-1384

#### Glutathione S-Transferase Genetic Polymorphisms Modify the Effect of Exposure to Solvents During Pregnancy on Risk of Birth Defect

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**Background:** Occupational exposures to solvents of women of childbearing age are frequent. Previous studies have reported conflicting results regarding the risk posed by this exposure on pregnancy outcomes. We hypothesized that polymorphisms in glutathione-S transferase (GST) genes, responsible for the metabolism/detoxification of numerous xenobiotics, may influence this risk.

**Methods:** This study is a nested case-control study carried out from a mother-child cohort conducted in Brittany (France). A total of 3421 pregnant women were enrolled between 2002 and 2005 by gynaecologists and ultrasonographers at their initial visit, before 19 weeks amenorrhea. We collected data from a self-administered questionnaire at the inclusion and samples of cord blood at delivery. Several adverse pregnancy outcomes were defined in the cohort. For this analysis we investigated: birth defects, premature births and intrauterine growth restriction (IUGR) taking into account maternal obstetrical and anthropometric characteristics. Controls ( $n = 505$ ) were randomly selected among the liveborn singletons without any adverse pregnancy outcomes. Occupational exposure to solvents during pregnancy was assessed from a job-exposure matrix using both the main occupation of the mother during pregnancy and the corresponding industrial activity [Ferrario et al. 1988]. Cord blood samples had been collected for 39 children with major congenital anomaly (56% of all major birth defects), 37 premature births (29%), 86 IUGR births (48%) and 427 controls (85%). DNA was extracted and genotyping was performed blindly to the case-control status. Genotypes were successfully determined for all but 4 blood samples. The GSTM1 and the GSTT1 deletions were revealed in the same reaction by PCR amplification determining the homozygous-type deletion (the null genotype) versus the others (the not null genotype).

**Results:** The job-exposure matrix assessment classified 22% of working mothers exposed to solvents during pregnancy among the control group; a higher percentage was found among mothers having babies with birth defect (34%; OR = 1.8, 95%CI: 1.0–3.2) whereas no association was suggested for prematurity or IUGR. Among the control group, the frequency of the null genotype was 19% for the GSTT1 gene and 49% for the GSTM1 gene. Similar frequencies of GST null genotypes were

observed in each of the three groups of adverse pregnancy outcomes. No interaction between the GSTT1 null genotype and the exposure to solvents during pregnancy was observed for birth defects. However, a statistically significant heterogeneity of the association with solvent exposure was observed across the GSTM1 genotype (OR\_notnullG\_notE = ref; OR\_notnullG\_Exposed = 4.0(1.5–11); OR\_nullG\_notE = 1.4(0.6–3.4); OR\_nullG\_Exposed = 0.9(0.2–4.2);  $P = 0.05$ ). We found no evidence of interaction for prematurity or IUGR. Adjusted analyses for maternal age, maternal education, smoking and drinking status showed similar results.

**Discussion:** This prospective study suggests that exposure to solvents during pregnancy is associated with an increased risk of birth defects and that key metabolizing enzymes may modify this risk. These results are preliminary and will be extended using biomarkers of exposure to glycol ethers from urine samples collected at the beginning of pregnancy, the most appropriate time period for covering organogenesis.

#### Reference

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#### ISEE-1385

#### Is Oxidative Stress from Environmental Chemical Exposure Causing Insulin Resistance in Urban Population?

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**Background:** Little information is available on the role of oxidative stress from environmental chemical exposure to cause insulin resistance. This study was to investigate whether oxidative stress from exposure to smoking, PAH, VOC, Bisphenol A or Phthalates affect indicators of insulin resistance in adult urban population.

**Methods:** A total of 1,007 adult subjects were enrolled for the Biomarker Monitoring for Environmental Health between April and December 2005, of which 536 participants were from Seoul and 461 from Incheon, Korea. Correlations and multiple regressions were used to evaluate the relationships among biomarkers and estimate the effects of environmental chemical exposures on insulin resistance.

**Results:** Biomarkers of exposure to PAH were more associated with smoking exposure while VOCs, BPA and phthalates were more closely associated with each other. All of the biomarkers for exposure to environmental chemical were significantly associated with at least two biomarkers from four oxidative stress indicators (MDA, 8-OHDG, rGTP, and NOx). The oxidative stress biomarkers affected significantly indicators of insulin resistance, particularly glucose level. When exploring the relationship between biomarkers of environmental chemical exposure and indicators of insulin resistance, direct contribution to insulin resistance by exposure to environmental chemical was not found evidently in this acute exposure context.

**Conclusions:** This study demonstrates the role of environmental chemical exposure to increase oxidative stress that is significantly associated with indicators of insulin resistance. In particular, glucose level was found to be affected by levels of oxidative stress biomarkers, indicating that environmental chemical exposure might contribute to cause metabolic syndrome or diabetes mellitus by increase of oxidative stress.

#### ISEE-1386

#### Urinary Metabolites of Organophosphorus Pesticides and Thyroid Function in Mexican Floriculture Workers

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**Background:** The exposure to organophosphorus pesticides is widespread. Greenhouse workers are the population with highest exposure to them. The effects of organophosphorus pesticides on human thyroid function has not been sufficiently evaluated in epidemiological studies. In a previous study conducted in men from Boston, an increase in 3,5,6-trichloro-2-pyridinol (TCPY) levels, a metabolite of chlorpyrifos and chlorpyrifos-methyl, was associated with an increase in thyroid stimulating hormone (TSH). In rats acute methamidophos exposure was found to be associated with a decrease in thyroxine ( $T_4$ ) level. Organophosphorus pesticides act as cholinesterase inhibitors, and an association between cholinesterase inhibitors and altered thyroid function has been previously reported.

**Objective:** To assess the effects of organophosphorus exposure on human thyroid function in floriculture workers from two states of Mexico (Morelos and State of Mexico).

**Methods:** A longitudinal study was undertaken during July 2004 to May 2005. A total of 137 men of 18 to 65 years old agreed to participate in this study. The day after the pesticides were sprayed, serum and urine samples from all participants were obtained during the rainy season (July and October 2004) and from 85 of them again during dry season (January and May 2006). All urine and blood samples were taken between 08.00 and 10.00 a.m. Samples were kept refrigerated at 4°C and transported to laboratory, where they were firstly centrifuged to separate serum and after were kept frozen at -70°C until analysis. Urine samples were analyzed for six dialquilphosphates (DAP) metabolites of Organophosphorus pesticides: dimethylphosphate (DMP), diethylthiophosphate (DEP), dimethylthiophosphate (DMTP), dimethyldithiophosphate (DMDP), diethylthiophosphate (DETP), diethyldithiophosphate (DEDTP) by gas chromatography. Serum samples were analyzed for free  $T_4$  and total  $T_3$  (triiodothyronine) by immunoassays. A general questionnaire was filled out to obtain information about socioeconomic characteristics, pathological antecedents, occupational history and exposure to specific pesticides. We calculated total molar quantities ( $\mu\text{mol/L}$ ) of dimethyl DAP and diethyl DAP by combining individual metabolites according their chemical structures. We evaluated the association between DAP concentrations and serum thyroid hormones levels, using Generalized Estimated Equation (GEE) models. The models were adjusted by age, body mass index, tobacco smoke and job activity. Data analysis was performed using SPSS version 14.0.

**Results:** In both seasons, creatinine adjusted Dimethyl DAP concentrations in urine samples were higher than diethyl DAP concentrations (geometric mean concentrations in rainy season were 1.50 and 0.29  $\mu\text{mol/L}$ , and in dry season 0.29 and 0.13  $\mu\text{mol/L}$ , respectively). A statistically significant positive trend was found for Dimethyl DAP tertiles and TSH ( $p$ -trend < 0.001) and  $T_4$  ( $p$ -trend < 0.001). For diethyl DAP concentrations we observed a significant positive association with TSH ( $p$ -trend 0.003) but not with  $T_4$ . No significant association was found between Dimethyl DAP tertiles or Dimethyl DAP and  $T_3$ .

**Conclusion:** Exposure to organophosphorus pesticides or their metabolites could be associated with altered thyroid function in human males.

**ISEE-1387****Residential Mobility During Pregnancy in the North of England**

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**Background:** Many epidemiological studies assign exposure to an individual's residence at a single time point, such as birth, hospitalisation or death. This approach makes no allowance for individuals who have migrated into (or out of) the population, or for daily or periodic spells away from the current residence where different levels of exposure may be experienced. This may result in exposure error or misclassification. Studies on congenital anomalies outcomes, with short exposure windows and lag periods are less susceptible to this bias, as there is less time in which the population can migrate. However, several studies on populations in North America have indicated that pregnant women are a highly mobile group. **Aims** To assess the mobility of pregnant women in the north of England using data from the Northern Congenital Abnormality Survey (NorCAS).

**Methods:** Data were extracted from NorCAS, a prospective, population-based register of congenital anomalies in pregnancies delivered to residents of the former Northern health region of the UK, for the period 1985–2003. For this study, eligible cases were those with a gestational age at delivery of >24 weeks (a viable delivery). We assessed mobility between time at booking (gestational age ~14 weeks) and delivery. The influence of maternal age and socio-economic status (as measured by the index of multiple deprivation (IMD) at the super output area level) on mobility was also investigated.

**Results:** Out of 7,965 eligible women for whom the address at booking and delivery were known, 709 (8.9% (95%CI 8.3–9.5)) moved between booking and delivery. Of the women who moved, the mean and median moving distance was 9.7 and 1.4 km respectively, indicating that the majority of moves were made locally. The mean maternal age at delivery was significantly lower in women who moved (mean age 25.4 versus 27.3 ( $P < 0.01$ ) in movers versus non movers respectively), and those who moved tended to live in more deprived areas (mean IMD at booking 38.7 versus 33.6 ( $P < 0.01$ ) in movers and non movers respectively).

**Conclusions:** Our analyses, based on prospectively collected population-based data, suggest that 8.9% of pregnant women resident in the Northern region of the UK move between the time of booking and delivery. This mobility is considerably lower than that reported in populations in North America and lower than a previous figure of 23.1% quoted for the UK. Consistent with these other studies, we found that mobility was related to maternal age and socio-economic status, and that the majority of moves were over a relatively short distance. Although this population is relatively stable, exposure misclassification may still be introduced into any study using postcode at delivery as a proxy for maternal exposure during pregnancy, and this potential for migration bias should be considered in future studies.

**ISEE-1388****A Community-Based Study on the Association Between Hypertension and Air Pollution**

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**Purpose:** The purpose of this study is to investigate the association between hypertension and air pollution.

**Material and Methods:** Our study population includes 18,867 subjects in 12 communities who have participated in a community-based integrated screen programs for multiple diseases from 2001 to 2005 in Taiwan. The

classification of participant's hypertensive status was based on the JNC7 criteria. The air pollution data in each community including sulfur dioxide, particulate matter (PM), and nitrogen oxide from 1993 to 2005 were obtained from the Taiwan Environmental Protection Agency air pollutant monitor network. We used generalized linear mixed models to investigate the association between hypertension and air pollution items adjusted for gender, age, body mass index, smoking, drinking, exercise, education level, and family history.

**Results:** All studied air pollution concentrations in each community were below current ambient air quality standard in Taiwan. Air pollution concentration in 12 communities ranged from 2.3–12.7 ppb for sulfur dioxide, 47.7–84.0  $\mu\text{g}/\text{m}^3$  for PM<sub>10</sub>, and 4.5–27.4 ppb for nitrogen dioxide. On average, the age adjusted prevalence rate of hypertension was 23%, ranging from 10% to 31%, among the 12 communities. We found hypertension was associated with sulfur dioxide (OR: 1.21, 1.12–1.29), PM<sub>10</sub> (OR: 1.10, 1.06–1.15), and nitrogen dioxide (OR: 1.16, 1.08–1.25) in pollutant-only models. Hypertension was also significantly associated with other risk factors, including gender, age, BMI, cigarette smoking, drinking, HDLC, glucose, exercise behavior, educational level, and hypertension family history in our subjects. After controlling these risk factors in our models, we also found significant magnitude and patterns of sulfur dioxide (OR: 1.14, 1.07–1.23) and nitrogen dioxide (OR: 1.09, 1.00–1.18) on hypertension. Further multiple pollutant models showed that all these three pollutants remained significantly associated with hypertension (OR: 1.03–1.17), especially sulfur dioxide.

**Conclusion:** Our study shows air pollution of sulfur dioxide, particulate matter, and nitrogen dioxide is an important environmental risk factor of hypertension.

**ISEE-1389****The Impact of Heat Waves on Mortality in 9 European Cities, 1990–2004**

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**Background:** During summer 2003 Europe experienced one of the worse heat wave events of the last century with a dramatic effect on mortality in several countries. However, comparisons in terms of mortality are difficult given the large variability of the meteorological conditions experienced and the heterogeneous definitions of heat wave events.

**Objective:** As a response, a European project (EuroHEAT) was carried out to evaluate excess mortality associated to heat waves and to analyse the temporal and geographical variations of the heat wave effect in nine European cities (Athens, Barcelona, Budapest, London, Milan, Munich, Paris, Rome, Valencia) during the period 1990–2004 using a standardised methodology. Furthermore, the study developed an operational definition of heat waves used for the direct comparison of the results and to evaluate the specific contribution of heat wave characteristics in terms of duration, intensity and timing within the summer season.

**Methods:** The impact of heat-waves during summer (June-August) on total and cause-specific mortality (cardiovascular, cerebrovascular and respiratory) was analyzed by gender and age. Heat-waves were defined as a period of at least two consecutive days with maximum apparent and minimum temperature above the 90<sup>th</sup> percentile. For all cities a common GEE model was applied and the effect of heat waves was estimated in terms of the percent increase in mortality compared to non heat-wave days. Summary estimates were also provided grouping the cities into "Mediterranean" (Athens, Barcelona, Milan, Rome, and Valencia) and "North-Continental" (Budapest, London, Munich and Paris) according to geographical and climatic criteria.

**Results:** Large heterogeneity of the impact of heat-waves on daily mortality among cities was observed, with the highest effects in Milan (+33.6%) and lowest in Munich (+7.6%). The impact of heat-waves of longer duration (4–5 days or more) was found to be from 1.5-fold to 5-fold greater than the short period heat-waves. Only in some cities a strong impact of the first heat-wave of the summer was observed. In all cities the mortality risk increased with age and females were at higher risk than males in all age-groups. The cause-specific analysis revealed a major effect on respiratory causes both among females and males. The impact of heat waves was higher in the Mediterranean cities than in the North-Continental cities.

**Conclusions:** This study represents the first attempt to evaluate the impact of heat-wave episodes on mortality in the elderly with a standardized protocol for data collection and analysis which enables a direct comparison between different European cities. Results of the present analysis provide a quantification of the impact of heat-waves on mortality, taking into account the specific characteristics of a heat-wave. The results of this multi-city study confirm the impact of heat-waves especially on the elderly population and provide a further evidence of females being at major risk for mortality during heat wave episodes.

#### ISEE-1390

#### The Association of Maternal Exposure to HCHO and Birth Weight Using Path Analysis: MOther and Children's Health and Environment (MOCHE)

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**Objective:** A multi-center birth cohort study, MOthers and Children's Health and Environment (MOCHE) program has been initiated in Korea since 2006. Recent studies reported that formaldehyde (HCHO) may be associated with adverse birth outcome. In this study we explored the potential risk factors for birth weight by using a path analysis to examine the interactions of those factors and causal paths.

**Materials and Methods:** We collected the eligible data from 770 pregnant women until 2007. We evaluated the relationship among residential factors, personal exposure to air pollutants, and birth weight. Three collaborating centers of MOCHE were built in Seoul (metropolitan area), Ulsan (industrial area), and Cheonan (medium-sized urban area) in 2006. Well-trained nurses interviewed participants with questionnaire regarding residential factors and general characteristics and recorded delivery data from medical record. Environmental hygienists assessed personal exposure to formaldehyde (HCHO) of 171 houses. To find associations among residential factors, exposure to air pollutant, and birth

outcome, we performed maximum likelihood path analysis by AMOS 6.0 (SPSS Inc). A Structural Equation model (SEM) was structured to describe the sequential relationships by comparing alternative assumptions about the associations among residential factors; house age, presence of nearby factory and separated kitchen; concentration of HCHO of personal level, and birth weight. We adjusted the final model for maternal age, educational level, and smoking history as confounding factors. For assessment of model fitting, we used various indices such as  $\chi^2/df$ , root mean square of approximation (RMSEA), and comparative fit index (CFI).

**Results:** The mean concentrations of personal HCHO was  $65.71 \pm 42.9(\mu\text{g}/\text{m}^3)$  and mean birth weight was  $3261.92 \pm 429.54(\text{g})$ . Through the path analysis, a path from presence of nearby factory within 2 km to personal exposure of HCHO ran in a negative direction ( $\beta = -13.37$ ,  $P = 0.08$ ) but it did not reach to statistical significance. And the path from separated kitchen to HCHO level was  $26.01(P = 0.007)$ . The birth weight was affected by HCHO with statistical significance ( $\beta = -2.21$ ,  $P = 0.02$ ). The total effect size of the path from separated kitchen to HCHO and birth weight were  $-0.202$  and  $-0.46$ , respectively.

**Conclusions:** This result demonstrates that the residential factors of mothers such as presence of nearby factory and separated kitchen could potentially affect concentration of HCHO and reduce the baby's birth weight. We need to find out more potential environmental factors which could be a threat to mother's and their children's health through a well-defined pathway.

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#### ISEE-1391

#### The Italian Heat/Health Warning System for Prevention of Heat Health Effects; Evaluation of Summer 2008

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**Background:** A national project for the prevention of heat-health effects during summer was implemented by the Italian Department for Civil Protection in 2003. The main objectives of the project are: the implementation of city-specific warning systems (HHWWS), the development of "real time" surveillance systems for monitoring the impact of heat on mortality and to evaluate the performance of warning systems. The warning systems are integrated in prevention programs developed at the national and local level. In 2007 the project included 17 operational warning systems and 15 of these had an integrated prevention program.

**Methods:** An evaluation on the impact of heat during summer 2007 and on the effectiveness of HHWWS and prevention programs was carried out. Mortality data retrieved from the real time mortality surveillance system was used to evaluate the impact of heat on mortality during heat wave periods and during the entire summer season. Daily excess mortality was calculated as the difference between baseline and observed values. To evaluate the temporal variation in the temperature-mortality relationship and the possible reduction of the impact of heat on mortality due to prevention strategies introduced, dose-response curves in a reference period, prior to prevention programs, and for recent years in which warning systems and prevention programs have been activated were analysed.

**Results:** During summer 2007 three heat wave episodes occurred. During the first heat wave a significant excess in mortality was observed mainly in the south of Italy (Bari, Catania, Palermo and Rome) with a percent increase between 11–40%. The second heat wave interested the whole country, however the impact on mortality was greatest in the centre (+10–41%) and south (11–56%) of Italy. During the third heat wave the

greatest excess in mortality was registered in Rome (+25%) and Naples (+45%). An overall excess in mortality during the entire summer season was observed in Campobasso, Catania, Bari, Milan, Naples, Rome and Venice with percent increase ranging from 22% to 8%. Geographical heterogeneity in the temperature-mortality relationship was observed among the cities; with a typical j-shaped relationship with the lowest mortality rates recorded at moderate temperatures, rising progressively as temperatures increase in the reference period. Furthermore a temporal variation in the relationship, depending on the levels of exposure and on adaptation strategies introduced was observed. In summer 2007 curves show an effect of high temperatures on mortality in most cities. In Milan and Rome the 2007 curve show a greater effect of mild temperatures but a weaker association between high temperature, possibly as a result of prevention programs introduced during heat waves. On the contrary, in cities like Bari and Catania that experienced extreme heat waves in 2007, showed a greater impact of high temperatures on mortality compared to the reference period. Moreover, the 2007 curve in Bari is similar to that of 2003 with a linear-like trend and steeper right hand slope.

Results from 2008 will also be presented to evaluate the impact on mortality and to evaluate the effectiveness of warning systems and prevention programs introduced in each city.

#### ISEE-1394

#### Environmental, Behavioral, and Dietary Factors Related to the Manganese Exposure of Early School Age Children

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**Background and Objectives:** Manganese is an essential element, but excessive exposure to manganese in earlier life can affect neurodevelopment, and could possibly be associated with development of neurodegenerative disorders. This study was conducted to explore the sources of manganese exposure in early school age children in metropolitan area.

**Subjects and Methods:** We have enrolled 531 children (279 males and 252 females) between six and eight years old (mean  $6.9 \pm 2.9$  years), from four elementary schools in two metropolitan areas (Seoul and Busan) of Korea. Questionnaire survey on the general characteristics, developmental history, disease history, current behavioral features, residential status, and environmental exposure were done on the parents of the children. Food frequency questionnaire designed to evaluate the children's dietary habit was used for the diet survey. Relationships between blood manganese level and environmental and nutritional factors were analyzed.

**Results:** Mean blood manganese level was  $14.6 \pm 4.2 \mu\text{g/L}$  (range  $6.4 \mu\text{g/L}$ – $52.0 \mu\text{g/L}$ ). More than 50% (276) children had blood manganese concentration higher than the reference level. Blood manganese level was positively correlated with the number of rooms of the residency, with mother's but not with father's educational level, and maternal smoking and drinking during pregnancy. Height, body weight, and waist circumference were significantly related with blood manganese level. After calculation for the weighted amount of food intake, instant noodles, hamburgers, eggs, tuna can, lettuce, water melon, low fat milk including cereal diet, and chocolate were significantly related to the blood manganese level.

**Discussions and Conclusions:** Among the children in this study, we could not find a prominent environmental source of manganese exposure. Blood manganese level was relatively narrow in its range. Dietary intake was the main source of manganese intake among children.

#### ISEE-1395

#### Exposure of Children to Chemicals, Biological Factors and Noise — the German Environmental Survey on Children (Geres IV)

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**Background:** From 2003 to 2006 the German Federal Environment Agency (Umweltbundesamt) conducted a cross-sectional representative population study on 1790 children aged 3 to 14 years living in Germany to elucidate exposure to chemical, biological and physical factors and the impact of exposure on their health. This German Environmental Survey on Children (GerES IV) is part of a health related environmental surveillance system conducted in co-operation with the Robert Koch Institute's National Health Interview and Examination Survey for Children and Adolescents (KiGGS).

**Methods:** GerES included the analysis of exposure to more than 100 environmental pollutants (heavy metals, pesticides, persistent organochlorines, PAH, phthalates, VOCs, aldehydes) by human biomonitoring and/or ambient monitoring in drinking water, indoor air, and house dust. Information from questionnaires covered exposure sources to reveal their contribution to body burden.

**Results:** GerES supplies results like the following ones:

##### Exposure via indoor air pollutants

Most important and health relevant source is still tobacco smoke. Children's exposure increased slightly since 1992.

##### Exposure via house dust

Children specific habits, such as mouthing behaviour, support exposure via house dust. However, some (DDT, PCB, PCP, DnBP), but not all chemicals in house dust show a small but significant contribution to children's body burden.

##### Exposure via drinking water

Levels of metals in drinking water exceed limit values of the German drinking water ordinance in up to 10 percent of the samples. However, this is – with the exception of uranium – not significantly correlated with the children's exposure levels.

##### Exposure via food consumption

Food is a main exposure source for organochlorines, biocides, and phthalates. Exposure to organophosphorus pesticides is mainly influenced by age, consumption of fresh fruit and fruit juice. Consumption of at least half a glass of fruit juice is related to a significant increase in organophosphorus metabolites in urine.

The organochlorine levels (such as HCB, HCH, DDE and PCB) in blood are higher in children from families with a higher socio-economic status and in breast-fed children. This can be explained by more frequent and longer breast-feeding in women with a higher socio-economic status. The exposure levels of the children decreases with increasing age. However, even in the oldest participating children organochlorine levels remain higher when they had been breast-fed. Levels also increase with increasing age of the mother at time of birth. Children from immigrants show higher mean values of DDE and beta-HCH but lower ones of PCB. Children from East-Germany show higher mean values of DDE than children from West-Germany but lower ones of PCB. This might be due to the use of DDT in East-Germany until 1990, whereas West-Germany banned DDT completely in 1972. Even after the ban, children have been exposed to PBT organochlorines for decades.

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**ISEE-1396****Indoor Residential Assessment Using ConsExpo**

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**Background:** ConsExpo is a software tool to evaluate human exposure to chemicals in consumer products. The tool is developed at the RIVM on behalf of the Dutch Food and Consumer Product Safety Authority and is recommended for the evaluation of consumer exposure under the European REACH legislation in the Reach Implementation Project guidance documents. The ConsExpo software contains a wide variety of mechanistic, first principle models that simulate typical product uses and the emission of chemical substances from these products. The program offers different models for the dermal, inhalation and oral routes of exposure and integrates multi-route exposures using uptake models. The deterministic models can be used for single point estimates but the tool also features a 1-dimensional Monte Carlo simulation engine and sensitivity analysis tools to include variability or uncertainty analysis in the assessment. In support of the models, fact sheets are developed in which available information on exposure factors for different product groups is compiled. At present fact sheets on pest control products, cosmetics, paints, cleaning products, children's toys, do-it-yourself products and disinfectants have been developed. Data from these fact sheets have been implemented in a database that is distributed with the ConsExpo software.

**Discussion:** Validation of the ConsExpo models is ongoing. Experimental studies have been performed to test the performance of the ConsExpo spray model. Currently, studies are performed on the evaporation of solvents from cleaning products, paints and glues. At present the software considers exposure scenario's for one chemical and one product only. Current efforts are to implement combined (aggregate) population exposure assessment to chemicals from multiple products in multiple scenarios. For the model comparison study, the ConsExpo tool will be used to assess the exposure following an indoor aerosol application of a pyrethroid insecticide spray. Evaluated scenarios include the inhalation of aerosol by the user and dermal post-application exposure of children.

**ISEE-1397****German Environmental Survey for Children (GerES IV): Metabolites of DEHP, DnBP, DiBP, BBzP, and DiNP in Urine**

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**Background:** The German Environmental Survey (GerES) is a nationwide population study which has been carried out repeatedly since the mid-1980s. GerES IV was the first GerES focussing solely on children and was performed from 2003 to 2006 in conjunction with the German Health Interview and Examination Survey for Children and Adolescents (KiGGS). In the framework of GerES IV we analysed eleven metabolites of phthalates in urine of children aged 3 to 14 years. The 600 urine samples were randomly chosen from stored samples of GerES IV.

**Methods:** The morning urine samples were analysed for the metabolites of di(2-ethylhexyl)[[Unsupported Character-Codename &shy;]]phthalate (MEHP, 5OH-MEHP, 5oxo-MEHP, 5cx-MEPP, and 2cx-MMHP), of di-n-butylphthalate and di-iso-butylphthalate (MnBP and MiBP), of butylbenzylphthalate (MBzP), and of di-iso-nonylphthalate (OH-MiNP, oxo-MiNP and cx-MiNP) by LC-MS/MS analysis.

**Results:** All metabolites could be detected in nearly all urine samples. Preliminary data analysis leads to mean concentrations of 5-OH-MEHP and 5-oxo-MEHP of 48 µg/l and 37 µg/l, respectively. The mean concentration of

OH-MiNP was 11 µg/l. The concentrations of most DEHP and all DiNP metabolites decreased with increasing age and thus children aged 3 to 6 years had the highest mean concentrations. No effect of age could be found for the metabolites of BBzP and DiBP. Explorative results indicate a gender difference only for children aged 3 to 6 years. In this age group girls showed a significantly higher mean concentration than boys. Possible reasons for these findings will be discussed, inter alia, on the basis of data on the nutritional pathway which was gathered via interviews and questionnaires in GerES IV and KiGGS. Phthalates were also measured in 600 house dust samples. Significant correlations between the phthalates in house dust and the respective metabolites in the urine were found for DBP, DIBP and BBP. The concentrations of the DEHP metabolites in urine were not influenced by the concentration of DEHP in house dust. The German human biomonitoring value (HBM I) for exposure to DEHP is 500 µg/l (sum of 5OH-MEHP and 5oxo-MEHP). This value was exceeded by some of the children examined in GerES IV. The 95<sup>th</sup> percentiles measured for MnBP (310 µg/l) and MiBP (308 µg/l) are relatively high compared to values measured in Germany for adults so far.

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**ISEE-1399****High Sensitivity C-reactive Protein in Polycyclic Aromatic Hydrocarbons Exposed Workers**

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**Objective:** Polycyclic aromatic hydrocarbons (PAHs) exposure has been suggested to be involved in human cardiovascular dysfunction. It has been reported that benzo[a]pyrene, an carcinogenic PAHs, is involved in atherogenesis. Occupational PAHs exposure may cause fatal ischemic heart disease. Therefore, it is vital to conduct the research for the association for PAHs and biomarker of cardiovascular effect. This study attempted to evaluate the exposure of PAHs on the cardiovascular effect biomarker for coke oven workers and restaurant workers.

**Materials and Methods:** Study participants included 192 male coke oven workers and 289 male restaurant workers. Participants' demographic data, work condition, life style, and health condition were collected by a questionnaire survey. We measured the 1-hydroxypyrene in urine as a biomarker for PAHs exposure. The measurement of high sensitivity C-reactive protein in serum was used as a cardiovascular effect biomarker. Student *t* and  $\chi^2$  statistics were used to compare personal covariates, 1-hydroxypyrene, high sensitivity C-reactive protein between coke oven workers and restaurant workers. Logistic regression was used to evaluate between the risk of high sensitivity C-reactive protein abnormality and PAHs exposure, and worksite. A statistical significant level was set at  $\alpha = 0.05$  for all test in this study. All data analyses were performed by using the SAS 9.1 statistical package.

**Results:** For coke oven workers, mean urinary 1-hydroxypyrene concentration was  $40.4 \pm 68.2 \mu\text{g/L}$ . this level was significantly higher than the restaurant workers which was  $3.4 \pm 5.6 \mu\text{g/L}$  ( $P = 0.001$ ). We found that coke oven workers had 2.5-fold higher risk to have high sensitivity C-reactive protein elevation than restaurant workers (odds ratio = 2.5, 95% confidence interval = 1.6–3.9).

**Conclusion:** Coke oven workers have higher risk of cardiovascular effects than restaurant workers. We need further studies to prove this finding.

**ISEE-1400****German Environmental Survey for Children (GerES IV): Exposure via Indoor Air**

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**Background:** The German Environmental Survey (GerES) is a large scale population study which has repeatedly been carried out since the mid-1980s. Main objectives are to generate, update, evaluate and communicate representative data on the exposure of German children to environmental pollutants. GerES IV (2003 - 2006) is the first survey focusing solely on children. It was performed in co-operation with the National Health Interview and Examination Survey for Children and Adolescents (KiGGS), which was conducted by the Robert Koch Institute, Berlin.

**Methods:** In GerES IV 1,790 children aged 3 to 14 years from 150 locations all over Germany were selected at random from the representative cross-sectional sample ( $N = 17,641$ ) of KiGGS. The investigation program comprised, e.g., the administration of questionnaires, and human biomonitoring. In addition, more than 70 volatile organic compounds (VOC) and aldehydes in indoor air were quantified in a random sub-sample of 600 participants. Samples were taken in the room of the home where the child spent most of the day. Three types of diffusive samplers (tube type Perkin-Elmer, 3M OVM-3500 and SKC UMEx-100 badge type) were used over a sampling period of approx. 1 week.

**Results:** The overall geometric mean concentration of benzene in indoor air was  $1.9 \mu\text{g}/\text{m}^3$  (toluene:  $13.6 \mu\text{g}/\text{m}^3$ , ethylbenzene:  $1.59 \mu\text{g}/\text{m}^3$ ). Questionnaire data obtained from children and parents allow the identification of relevant exposure factors and sub-groups of higher exposure: Recent redecoration of the children's room, inter alia, had a significant influence on the concentration of toluene and ethylbenzene. Smoking at home, inter alia, correlated significantly with benzene concentrations in indoor air. Approximately one quarter of the 3- to 14-year-old non smoking children in Germany were exposed to environmental tobacco smoke (ETS) at their homes (as reported by their parents). Depending on the number of smokers in the household, the geometric mean cotinine concentration in morning urine differed significantly:  $< 2 \mu\text{g}/\text{L}$  (no smoker),  $2.6 \mu\text{g}/\text{L}$  (one smoker),  $4.8 \mu\text{g}/\text{L}$  (more than one smoker). Multivariate evaluation reveals that maternal smoking caused higher ETS exposure than paternal smoking. ETS exposure was also significantly correlated with socioeconomic status.

**Conclusions:** Indoor air is an important exposure pathway for German children concerning a variety of pollutants. Strategies for exposure reduction have to be pursued in order to reduce environment-related influences on their health.

**Acknowledgements:** We thank all children and parents who have participated in this study. The financial support of the Federal Ministries for the Environment, Nature Conservation and Nuclear Safety and of Education and Research is gratefully acknowledged. Field work was carried out by the Robert Koch Institute.

**ISEE-1401****Traffic Data in Air Pollution Exposure Assessment Using a GIS Environment**

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**Objective:** For a densely populated area in the Netherlands, air pollution exposure assessment in a GIS environment is under development at this moment. Apart from data on highway traffic, information on traffic along major and local roads will be incorporated into our GIS. As traffic intensities at local roads were provided by many different local authorities, validation was performed.

**Methods:** Traffic data were gathered from national and local authorities, a total of 94 sources provided mean weekday 24-hrs traffic intensities and information on the proportion of truck traffic at road section level. To validate this data, automated traffic counts were performed at 80 local roads resulting in two 24-hr mean intensities in which truck traffic could be distinguished from cars.

**Results:** From the provided data, a traffic intensity could be assigned to all highway and major road sections, and about 60% of the local road sections. Mainly the smallest streets have missing data, almost full coverage is reached for the main routes. As a pilot we focused on the urban area around Amsterdam, the Netherlands. This area has a surface of  $890 \text{ km}^2$  and 1.5 million inhabitants, living at 760 thousand addresses. The total road length in this area is 6248 km. The summary statistics of the traffic data available in this region are presented in table 1.

Road length (km) Total traffic intensity Truck traffic intensity

Total Intensity	known	Mean	SD	Median	Mean	SD	Median
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All roads 6248 4021 72101 17800 2310 776 2297 130

Highway 456 456 88907 47952 93372 10324 5804 11350

Major road 236 236 16432 9629 14423 1511 1389 1036

Local road 5556 3329 4352 5634 2025 370 593 106

Table 1: Summary statistics of traffic data in the urban area around Amsterdam, the Netherlands.

Preliminary results of the traffic counts show that the two performed 24-hr counts show very similar intensities (correlation coefficient: 0.99). In general, the counted traffic intensities are equivalent to the intensities as provided by the authorities. For quiet streets with intensities around 1000 vehicles or less per 24-hours, the data are less comparable. The correlation coefficient for counted and provided traffic intensity is 0.76. For truck traffic, the provided intensities were about twice as high as counted. Also, correlation between counted and provided intensity was poor (0.45). Additional analysis of the available data will show which factors affect these differences.

**Conclusions:** It is possible to collect very detailed traffic data. The quality of the data, however, needs attention. Especially at roads with lower intensities, provided and counted data can be dissimilar. Additional analysis will be performed on local truck traffic in the exposure assessment, as truck related exposure showed to be of importance in health effects studies. Additional counting will be performed, focusing on local roads within housing areas. Using this data, the effect of the traffic data quality in air pollution exposure assessment and health effect estimations will be explored.

**ISEE-1402****Residential Outdoor Levels of Polycyclic Aromatic Hydrocarbons in PM<sub>2.5</sub>**

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**Background:** Numerous epidemiological studies have shown associations between exposure to fine particles and health effects. Airborne particulate matter contains several organic and inorganic species. Polycyclic aromatic hydrocarbons (PAHs) are of great importance since the group includes several potent carcinogens. PAHs are formed by incomplete combustion in a variety of processes. In Sweden, domestic wood burning and traffic are the two most important sources of PAHs released into the air.

**Methods:** Residential outdoor measurements of PM<sub>2.5</sub> were performed at the homes of 30 randomly selected study subjects in Gothenburg, Sweden. Along with these samplings, parallel measurements at an urban background site were carried out. The study took place during two spring and two fall periods, respectively, in 2002 and 2003. Sampling was performed using GK2.05 (KTL) cyclones connected to BG1400S sampling pumps (4 L/min) for the residential outdoor measurements and with an EPA-WINS impactor (16.7 L/min) at the urban background site. The participants lived within

approximately 0.8–15 km of this central monitoring site. Teflon filters were used for all samples and these were weighed before and after sampling. The particle mass was thereafter analyzed for its content of nine different PAHs: benzo(a)antracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a) pyrene, perylene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)antracene and benzo(g,h,i)perylene. The PAHs were extracted from the filters with dichloromethane, and analysis and detection were then performed using gas chromatography (GC) connected to mass spectrometer (MS) in selective ion-recording (SIR) mode. Statistical analysis was performed using SAS, version 9.1. Statistically significant refers to  $P < 0.05$ .

**Results:** The median residential outdoor concentration of PM<sub>2.5</sub> was 6.4  $\mu\text{g}/\text{m}^3$  (range 2.1–28  $\mu\text{g}/\text{m}^3$ ), and the median urban background level was 5.6  $\mu\text{g}/\text{m}^3$  (range 3.0–31  $\mu\text{g}/\text{m}^3$ ). The median concentration of benzo(a)pyrene was 13 pg/m<sup>3</sup> (range 6.1–36 pg/m<sup>3</sup>) for the residential outdoor measurements, and 8 pg/m<sup>3</sup> (range 1.5–140 pg/m<sup>3</sup>) at the urban background site ( $P = 0.02$ ). Residential outdoor levels were highly correlated with the corresponding levels of PM<sub>2.5</sub> at the urban background monitoring site ( $r_s = 0.90$ ,  $P < 0.0001$ ). Statistically significant correlations between levels outside the residences and the urban background monitoring site were also found for benzo(a)pyrene ( $r_s = 0.72$ ,  $P < 0.0001$ ), and for the other PAH components  $r_s$  varied between 0.46 and 0.76. All different PAH compounds were also highly correlated with each other. There was, however, no correlation between the particle mass and the different PAH components for neither the residential outdoor measurements nor the urban background levels.

**Conclusions:** Levels of benzo(a)pyrene well below the Swedish health based guideline value of 0.1 ng/m<sup>3</sup> were found in PM<sub>2.5</sub> mass collected in Gothenburg, Sweden. The urban background monitoring site provided a good estimate of the residential outdoor levels of both PM<sub>2.5</sub> and some particulate phase PAHs within the city. PM<sub>2.5</sub> mass did, however, not reflect the particle-bound PAH levels.

#### ISEE-1404

##### Heatwaves and Mortality in Dublin, Ireland

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**Background:** In recent years, especially in 2003 increases in mortality have been reported in Europe, associated with heatwave events. We investigated if similar patterns are observed in Dublin Ireland. Dublin exhibits a strong seasonal mortality pattern, with increased mortality in winter, however, it also exhibits a "U" shaped relationship with temperature, with increasing mortality observed also for extreme summer temperatures.

**Methods:** Mortality data by causes (total, cardiac, respiratory) and age groups (0–64, 65–74, >75 years-old) were recorded for the period 1981–2003. Summer was defined as April to September. Heatwave periods were identified using four definitions based on intensity, temperature differences within days and duration: 1) minimal temperature above the 90<sup>th</sup> percentiles during at least two days; 2) minimal and maximal temperature above the 90<sup>th</sup> percentiles during at least two days; 3) a difference on minimal temperature of 5°C or more between two days; 4) a difference on minimal temperature of 5°C or more between two days and one of the temperature being above the 90<sup>th</sup> percentile of the temperature distribution. Percentiles were computed on five-year periods.

**Results:** Between 1981 and 2003, maximal temperatures have been increasing, while there is a significant trend of decreasing minimal temperatures. Depending on the definition, the frequency of heat wave-days varied. The definition based on a difference of 5°C or more between two days resulted in rarest heat waves, although the frequency of such events increased since 1994. Relying on the percentiles, the years with the more heat wave days were 1983 (23 days), 2003 (19 days), 1984 (18

days), 1995 and 1999 (17 days). In 1983, a first heat wave was experienced between the 10 and 16 of July, a second between the 15 and the 26 of August. A peak in total mortality and in cardiac and respiratory mortality was observed for people above 75 years, a few days after the second heat wave. In 2003, a first heat wave was experienced between the 6 and 9 of August, a second between the 22 and the 26 of August. However, no clear impact on mortality was observed.

**Conclusion:** This work has shown that moderate heat waves have been experienced in Dublin in 1983, 2003 and 1984. A mortality response was experienced in 1983. Further investigation is needed to better understand the temperature mortality relationship of this population, with a focus on the influence of large temperature variation between days. This is particularly so with concern over climate change.

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#### ISEE-1405

##### Measurement of Water Consumption Behavior by Questionnaire and Diary for Estimation of DBP Absorption in Sydney, Australia

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**Objectives:** To assess individuals' patterns of water consumption and exposure (drinking, showering, bathing and swimming) for estimating absorption of disinfection by-products (DBPs) from water, and the validity of information obtained by a questionnaire compared to a water use diary.

**Materials and Methods:** 20 of 38 Local Government Areas (LGAs) in metropolitan Sydney were selected to represent the city's distribution of mean concentrations of DBPs. We used the Australian Electoral Roll to identify and obtain 100 participants equally distributed by sex, age (in 3 groups: 18–34, 35–54, 55–74 years) and LGA; 896 people were contacted in six stages and water use questionnaires were mailed first. To validate the questionnaire information, diaries were sent out a few weeks after receiving the completed questionnaires. Participants were asked to keep diaries for a 7 day period. Water samples were collected from participants' garden taps to analyse for DBP species. The intraclass correlation coefficient (ICCR) was calculated to assess agreement between questionnaire and diary information.

**Results:** 119 participants completed the questionnaire (Q) and 75 (63%) the diary (D). Questionnaire data showed that 76% of people drank tap water at home, 6% did not use tap water and 14% drank tap water as well as other water. There was a statistically significant trend for increasing consumption of hot water with increasing age; the trend for cold water was opposite. Showering frequency and duration fell with increasing age. Comparing questionnaire and diary data in the participants who completed both: for water likely to contain DBPs, that is water drunk straight from the tap, the ICCR was 0.73 (95% CI: 0.52 to 0.85) with means of 1.9 (Q) and 2.3 (D) 250 ml cups/day for water drunk at home and for water drunk at work it was 0.92 (95% CI: 0.85 to 0.95) with means 0.7 (Q) and 0.59 (D). For all other type of tap water, that is filtered or boiled, whether drunk hot or cold, which is unlikely to contain DBPs, the ICCR was 0.31 (95% CI: 0.12 to 0.69) and the means 2.6 (Q) and 3.8 (D). For daily frequency and duration of showering the ICCRs were 0.62 (95% CI: 0.40 to 0.76), means 1.21 (Q) and 1.14 (D) times/day, and 0.85 (95% CI: 0.63 to 0.92), means 8.7 (Q) and 8.1 (D) minutes/day, respectively. Only one person reported bathing (in a bath) in the diary while in the questionnaire 28% reported bathing, but infrequently (average 0.48 times/week). No-one reported swimming in a swimming pool in their diary; 34% reported it in the questionnaire (average 2.2 times/week).

**Conclusion:** There is good agreement between questionnaire and diary for water likely to contain DBPs while for other water it is not good. The period of diary keeping was not sufficient to compare bathing or swimming behaviour. The questionnaire data will be used for estimating DBP absorption with appropriate acknowledgment of the limitations.

**ISEE-1406****Association of Brain Cancer with Residential Exposure to Petrochemical Air Pollution in Taiwan**

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**Background:** To investigate the relationship between petrochemical air pollution and brain cancer (29 yr of age or younger), the authors conducted a matched case-control study using deaths that occurred in Taiwan from 1995 through 2005.

**Methods:** Data on all eligible brain cancer deaths were obtained from the Bureau of Vital Statistics of the Taiwan Provincial Department of Health. The control group consisted of subjects who died from causes other than neoplasms or diseases that were not associated with respiratory problems. The controls were pair matched to the cases by sex, year of birth, and year of death. Each matched control was selected randomly from the set of possible controls for each case. The proportion of a municipality's total population employed in the petrochemical industry in a municipality was used as an indicator of a resident's exposure to air emissions from the petrochemical industry. The subjects were divided into tertiles according to the levels of the index just described.

**Results:** Subjects who lived in the group of municipalities characterized by the highest levels of petrochemical air pollution had a statistically significant higher risk of developing brain cancer than the group that lived in municipalities with the lowest petrochemical air pollution levels after controlling for possible confounders (OR = 1.65, 95% CI = 1.00–2.73).

**Conclusion:** The findings of this study warrant further investigation of the role of petrochemical air pollution in the etiology of brain cancer.

defined as a cumulative monthly proportion of these high ozone concentration days. Air quality data from each region was then linked to health outcomes and individual risk factors. Time dependent Cox Proportional Hazards Models were used to assess the association between cumulative ambient daily maximum ozone and first time hospitalization for asthma. These models were adjusted for maternal and birth characteristics as well as geographic regions.

**Results:** The median follow-up time is 11 months for children hospitalized with asthma and 30 months for children not hospitalized. In New York City we found significantly elevated adjusted hazard ratios (HR = 1.09, CI: 1.03–1.16), however in the nine other regions we found no effect (adjusted HR = 0.90, CI: 0.78–1.04). Selected maternal and birth characteristics considered; Mother's age (Hazard Ratio = 0.97, 95% Confidence Interval: 0.98–0.99); female (HR = 0.47, CI: 0.42–0.53); Black (HR = 2.01, CI: 1.77–2.29); maternal smoking (HR = 1.56, CI: 1.38–1.78); low birth weight (HR = 1.75, CI: 1.45–2.11) and pre-term birth (HR = 1.33, CI: 1.12–1.57) were significantly associated with asthma hospitalization.

**Conclusion:** An elevated risk for asthma hospitalization was found among children with higher cumulative monthly proportion of days where ozone levels exceeded 104 ppb in New York City region but not other areas of New York State. Further study is needed to confirm this finding and to investigate the disparity between New York State regions.

**ISEE-1408****Association of Childhood Leukemia with Residential Exposure to Petrochemical Air Pollution in Taiwan**

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**Background:** To investigate the relationship between petrochemical air pollution and childhood leukemia (19 yr of age or younger), the authors conducted a matched case-control study using childhood deaths that occurred in Taiwan from 1995 through 2005.

**Methods:** Data on all eligible childhood leukemia deaths were obtained from the Bureau of Vital Statistics of the Taiwan Provincial Department of Health. The control group consisted of children who died from causes other than neoplasms or diseases that were not associated with respiratory problems. The controls were pair matched to the cases by sex, year of birth, and year of death. Each matched control was selected randomly from the set of possible controls for each case. The proportion of a municipality's total population employed in the petrochemical industry in a municipality was used as an indicator of a resident's exposure to air emissions from the petrochemical industry. The subjects were divided into three levels (< or = 25th percentile; 25th–75th percentile; > 75th percentile) according to the levels of the index just described.

**Results:** After controlling for possible confounders, results showed that children who lived in the group of municipalities characterized by the highest levels of petrochemical air pollution had a statistically significant higher risk of developing leukemia than the group that lived in municipalities with the lowest petrochemical air pollution levels.

**Conclusion:** The results of this study shed important light on the relationship between the Taiwan petrochemical industry and human health risks.

**ISEE-1407****Chronic Exposure to Ambient Ozone and Asthma Hospital Admissions Among Children in New York State**

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**Background:** Many studies assessed the associations between acute air pollution exposure and asthma, but few looked at chronic ozone exposure and controlled for maternal and infant characteristics. The purpose of this study is to investigate the association between chronic exposure to summer time high ozone ( $O_3$ ) levels and childhood asthma hospital admissions in New York State (NYS) and to assess what and how maternal and birth characteristics interact with air pollution on asthma hospitalization.

**Methods:** This retrospective cohort study used a unique integrated child health information system (ICHIS) which combined data from birth certificates, death certificates, immunization registry and hospital discharge data to provide longitudinal information with respect to a birth cohort. There are 1,201,327 children born in NYS during 1995–1999 who were followed to the first admission for asthma or until December 31, 2000. A principal diagnosis of Asthma, (ICD9 = 493) was used as the outcome. Home addresses for the entire birth cohort were geocoded. NYS was divided into ten  $O_3$  regions and each participant was assigned a region based on home address. Daily ambient ozone data was provided by Environmental Protection Agency and aggregated to the ten NYS regions. For each child, the number of days in a month where maximum daily levels between the hours of 10AM to 6PM exceeded EPA's level of 104 ppb (unhealthy for sensitive groups) was identified. Chronic exposure was

**ISEE-1410****Rural Population Exposure to Pesticides and Risk of Reproductive Disorders in Armenia**

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**Methods:** Large observational study on pesticide use practice and its impact on rural population health have been conducted. Respondents from 2336 households randomly selected from 26 villages of Ararat valley of Armenia were interviewed to examine details of pesticides use practice and health status. Self-reported data was obtained. As indicators of pesticide exposure the following surrogates such as amount of pesticides used in one season, number of days (contacts) of applications, total duration of applications in one year was used. The top quartile of each variable was compared with the bottom one.

**Results:** Total number of days of work with pesticides and its duration were more informative indicators of exposure rather than total amount of chemicals used in one season. The total duration of more than ten days of application in season was a significant risk factor for male's reproductive function. Their spouses more likely have premature delivery (OR 3.51, 95% CI 1.56–7.88) and stillbirth (OR 3.08, 95% CI 1.10–8.62) than those who worked less than four day. In case when women were exposed to pesticides more than ten days in a season, both odds of premature delivery (OR 7.69, 95% CI 2.56–23.06) and frequency of complications of pregnancy (OR 2.46, 95% CI 1.00–6.68) significantly increase in comparison with bottom quartile. The most dangerous were dressers. In case of female exposure to the dressers the risk of premature delivery increased (OR 4.46, 95% CI 1.90–10.46). In case of male exposure to this group of pesticides the risk of miscarriages (OR 1.90, 95% CI 1.20–2.99) and stillbirth (OR 2.41, 95% CI 1.11–5.00) among their spouses increased as well. Exposure to herbicides and livestock pesticides is also associated with premature delivery. The population risks of different reproductive disorders were estimated as well. Attributable risk of premature delivery made 3.38 per 1,000, complications of pregnancies 19.99 per 1,000, miscarriages 6.04 per 1,000, and stillbirth 4.40. The fraction of attributable risk for total population varied from 4.71% for premature delivery to 19.78% for stillbirth.

**Conclusion:** Pesticides use intensity and pattern, assortment, tools and methods of applications, can seriously affect reproductive health of rural population in Armenia.

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**ISEE-1411****Contributions of Airport Activities to Air Pollution Levels in Surrounding Neighborhoods**

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**Background:** There is growing concern in communities surrounding airports regarding the contribution of various emission sources (such as aircraft and ground support equipment) to nearby ambient concentrations. Within this study, we conducted extensive monitoring in neighborhoods surrounding T.F. Green Airport in Warwick, RI, to determine the marginal contribution of the airport to concentrations of various pollutants and to determine the subset of pollutants where airport emissions contributed appreciably to measured concentrations.

**Methods:** Monitoring was conducted in three intensive one-week campaigns, across three seasons in 2007 and 2008. Numerous pollutants were measured at three stationary sites surrounding the airport in different wind directions, including continuous measurements of ultrafine particle

counts, black carbon, fine particulate matter ( $PM_{2.5}$ ), and nitric oxide, along with integrated samples of  $PM_{2.5}$ , PAHs, nitro-PAHs, VOCs, and carbonyls. The integrated samples had averaging times ranging from 6-hour to 24-hour, capturing diurnal variability in concentrations when feasible. Passive samplers for nitrogen dioxide were deployed at numerous sites near the fenceline and at varying distances from the airport and major roadways. Mobile continuous monitoring of ultrafine particle counts, particle-bound PAHs, and  $PM_{2.5}$  was conducted to determine spatial patterns of these pollutants across multiple neighborhoods, using GPS instruments to record location as well as significant source events. In addition, real-time wind speed and direction data were collected with multiple sonic anemometers, and noise monitoring was conducted to provide a real-time determination of flight activity. The timing of flight take-offs and landings was also gathered within a database that included aircraft type.

**Results:** Analyses suggest spatial heterogeneity in nitrogen dioxide across the sampling domain, with higher levels in areas near the terminal building and downwind from major roads. Evaluation of continuous measurements at the stationary sites indicates higher concentrations of particle-bound PAHs, ultrafine particle counts, and black carbon during periods when the sites were downwind from the airport grounds. VOC and carbonyl data demonstrated a high detection rate and significant correlations among BTEX compounds. Formal regression analyses on continuous monitoring data utilizing flight activity as well as meteorological data suggest significant influences of wind speed and direction and provide for quantification of the marginal contribution of airport sources relative to other nearby sources.

**Conclusions:** We conclude that intensive multi-pollutant monitoring campaigns surrounding airports or other defined sources can be an informative way to determine the marginal contribution of these sources to ambient concentrations, especially for pollutants and geographic domains that are not easily captured with atmospheric dispersion models.

**ISEE-1412****Chemical and Redox Characteristics of Particulate Matter Emitted from Diesel Engine**

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**Background:** Particulate matter (PM) originating from mobile sources is thought to be responsible for a myriad of adverse health outcomes, ranging from cancer to cardiopulmonary disease. Vehicles have been shown to emit significant particulate mass and numbers in the form of combustion byproducts and debris from mechanical wear. Exhaust after treatment, such as catalytic converters and diesel particle filters (DPFs), has resulted in significant reductions in the masses of both gaseous and particulate pollutants. However, total particle number emissions have not been equally reduced, with some studies reporting increases in these emissions due to particle nucleation occurring downstream of after treatment devices. The mechanisms of PM-related health effects are still incompletely understood, but a hypothesis under investigation is that many of the adverse health effects may derive from oxidative stress, initiated by the formation of reactive oxygen species (ROS) within affected cells. High levels of ROS cause a change in the redox status of the cell, thereby triggering a cascade of events associated with inflammation and, at higher concentrations, apoptosis. PM has been shown to participate in these electron transfer reactions.

**Objective and Methods:** The objective of this study is to relate PM chemistry to chemical assays that quantitatively measure of redox activity with respect to diesel engine. This goal was accomplished by simultaneously collecting filter samples from diesel engine for determination of particle chemical characteristics and chemical assays for redox activity. We used D6Da diesel engine of 6.6L displacement and

collected each sample for particulate matter by after-treatment system. Engine operated by 3 type of After-treatment systems(base(w/o after-treatment system, Partial DPF, DOC+DPF) and 3 mode of engine conditions(ND-13, Idling, 2085RPM(50%), 2500RPM(100%). After collecting sample of particulate matter, we tried assessing heavy metal and DTT assay.

**Results and Conclusion:** The results indicate that the DTT based measure of redox activity correlates with PM content of heavy metals. Results showed a positive correlation between redox activity of PM and several heavy metals by operating engine conditions and after-treatment systems. The positive association between DTT and PM/its contents shows promise for predicting PM toxicity of a given engine's exhaust based on its chemical characteristics.

#### ISEE-1413

##### Exposure to Phthalate Emitted from Vinyl Flooring and Sorbed to Interior Surfaces, Dust, Airborne Particles and Human Skin

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**Background:** There is an urgent need to characterize potential risk to human health and the environment that arises from the manufacture and use of tens of thousands of chemicals. Computational tools and approaches for characterizing and prioritizing exposure are required: to provide input for selection of chemicals; to select doses for toxicity tests; and to interpret and extrapolate results of in vitro tests. In this paper, a three-room model is developed to estimate di(2-ethylhexyl) phthalate (DEHP) emission from vinyl flooring in a realistic residential environment. There are serious health concerns associated with phthalate esters. Hardell et al. (1997) conducted a case-control study of 163 patients in Sweden and observed a surprisingly high risk of testicular cancer associated with exposure to PVC plastics. When administered orally to pregnant experimental animals, Gray et al. (2000) found that certain phthalate esters have significant effects on the developing male reproductive system. Some studies have also shown that inhalation exposure to phthalates adsorbed to suspended particles increases the risk of asthma (Bornehag et al. 2005). As phthalates are not chemically bound in polymers, slow emission from the products to air or other media usually occurs. Phthalate esters have been recognized as major indoor pollutants (Wensing et al. 2005). In the recent EPA-sponsored CTEPP (Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants) study (EPA 2005), concentrations of over 50 target compounds were measured in multimedia samples from the homes and daycare centers of 260 pre-school age children. The two phthalates targeted in the CTEPP study were detected in residential air and house dust, and on interior surfaces and dermal wipe samples. Measured phthalate concentrations in the CTEPP study were amongst the highest of any of the targeted compounds, including pesticides, PAHs and PCBs.

**Discussion:** Adsorption isotherms for plasticizers on several indoor surfaces, including human skin, were obtained by analyzing the CTEPP data as well as experimental data from a chamber study. Relationships between adsorption isotherms and vapor pressures were developed. A screening-level exposure analysis shows that for children, oral ingestion of dust is the primary exposure pathway for DEHP. A sensitivity analysis is used to identify the factors that most strongly influence exposure (concentration of DEHP in vinyl flooring, surface area of vinyl flooring, air exchange rate, vinyl flooring/air partition coefficient, rate of mass transfer through external boundary layer, total suspended particle concentration, dust/air partition coefficient, dust ingestion rate, skin surface area, and air inhalation rate) while an uncertainty analysis reveals the expected range of exposure in the general population. The approach is used to link the emitting source to the metabolic sink and provides

valuable insight on the determinants of exposure. Because it is based on fundamental mechanisms, simply variants of the model should be able to predict exposure to other SVOCs, such as flame retardants and biocides, emitted from a wide range of building materials and consumer products.

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#### ISEE-1414

##### Atmospheric Polycyclic Aromatic Hydrocarbons in Ultrafine and Nano Particles at Roadside in Korea

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**Background:** There has been given increasing attention to atmospheric ultrafine and nanoparticle in recent decade. Several epidemiologic studies have shown that exposure to ultrafine particles can lead to adverse health effects. Due to the fact of their carcinogenic and/or mutagenic properties, in recent years, PAHs has been concerned over widespread in ambient air and potential human health effects.

**Objective:** The aim of this study was to understand the size distribution of particle-phase PAHs in roadside of Seoul.

**Methods:** In this study, Particle samples were collected in winter period of December 2007 to February 2008 at roadside. The ambient particle concentration was collected by a MOUDI (Micro-orifice Uniform Deposit Impactors (Models 110, MSP)). The flow rate was 30L/min, and ranges of available cut size diameter were 18–10, 10–5.6, 5.6–3.2, 3.2–1.8, 1.8–1.0, 1.0–0.56, 0.56–0.32, 0.32–0.18, 0.18–0.1 and 0.1–0.056 um.

**Results:** Total concentrations of all size fraction raged from 40.16 to 109.35 $\mu\text{g}/\text{m}^3$  in roadside (mean concentration: 59.13 $\mu\text{g}/\text{m}^3$ ). It indicates the size distribution of suspended particle exhibits two modes. The size ranges of the particles in these two modes are between 0.56–1.0 and 1.8–3.2 um, respectively. On average 6.9% and 63.5% of the mass of PM<sub>10</sub> particles were found to be <0.1 um (transient nuclei mode) and <1.8 um (accumulation mode), respectively. Each stage samples are being analyzed for 16 PAHs by gas chromatography with mass selective detection (GC-MS).

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#### ISEE-1415

##### Characterizing Emissions of Phthalate Plasticizer from Vinyl Flooring in a Specially-Designed Chamber

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**Background:** Phthalates have been used as plasticizers to enhance the flexibility of rigid polyvinylchloride (PVC) products (Latini et al. 2004), with worldwide phthalate production exceeding 3.5 million tons/year (Cadogan and Howick 1996). About 90% of phthalates are used as plasticizers in polymers (e.g., PVC) and are found in a wide range of consumer products including floor- and wall covering, toys, car interior trim, clothing, gloves, footwear, and artificial leather (Afshari et al. 2004; Bornehag et al. 2005). Because phthalates are not chemically bound in polymers, slow emission from the products to air or other media usually occurs (Müller et al. 2003). Phthalate esters have been recognized as major indoor pollutants (Bornehag et al. 2005; Clausen et al. 2004). Di-2-ethylhexyl phthalate (DEHP) is most widely used and accounts for more than 50% of total phthalate production (Bornehag et al. 2005). The main use of DEHP is in PVC products such as vinyl flooring, where it is typically present at concentrations of 20%–40% (w/w) (Clausen et al. 2004; Deisinger et al. 1998). Despite serious health concerns, only a few studies of phthalate emission characteristics are available. This is probably due to the difficulties associated with sampling and analysis of SVOCs (Clausen et al. 2004). Uhde et al. (2001) measured emission of several

phthalates from PVC-coated wall-coverings in test chambers under standard room conditions. Clausen et al. (2004) measured emissions of DEHP from vinyl flooring for more than a year in both the FLEC (field and laboratory emission cell) and the CLIMPAQ (chamber for laboratory investigations of materials, pollution, and air quality). In their experiments, they found that about one-half of the emitted DEHP was deposited on the internal surfaces of both the FLEC and the CLIMPAQ. Based on the Clausen et al. (2004) experiments, Xu and Little (2006) developed a model to predict the emission rate of phthalates from polymer materials. Their analysis revealed that while emissions of volatile organic compounds (VOCs) are generally subject to "internal" control (the material-phase diffusion coefficient), emissions of the very low volatility semi-volatile organic compounds (SVOCs) (such as DEHP) are subject to "external" control (partitioning into the gas phase, the convective mass-transfer coefficient, and adsorption onto chamber surfaces).

**Methods:** The emission of di-2-ethylhexyl phthalate (DEHP) from vinyl flooring was studied in a specially-designed stainless steel chamber. The gas-phase concentration versus time curve reached steady state at 0.7  $\mu\text{g}/\text{m}^3$ . Increasing the area of the vinyl flooring and decreasing that of the stainless steel surface significantly reduced the time to reach steady state (50 days vs >1 year). The sorption isotherm of DEHP on the stainless steel surface of the chamber was measured, as well as the concentration of DEHP in the vinyl flooring.

**Results:** Strong linear sorption of DEHP on the stainless steel surface was found. Good agreement between model predictions and gas-phase DEHP concentrations was obtained, indicating that the mechanisms governing DEHP emissions are accurately characterized.

#### ISEE-1416

##### Is Epidemiology the Key to Cumulative Risk Assessment?

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**Background and Discussion:** Although cumulative risk assessment is intended to evaluate the joint effects of chemical and non-chemical stressors, studies to date have not generally considered both dimensions, in part because epidemiological evidence has not been utilized within cumulative risk assessment. Given cumulative risk assessments oriented around characterizing or developing solutions to existing problems, and with a community orientation and interest in social-environmental interactions, epidemiology should be a central component of cumulative risk assessment. I propose a framework within which epidemiological studies could be formally evaluated for their inclusion into cumulative risk assessment, including extensions of the chemical mixtures framework to include non-chemical stressors and consideration of quantitative adjustments to dose-response functions to account for effect modifiers and vulnerability characteristics of the population. In the long term, broadening the applicability and informativeness of cumulative risk assessment will require enhanced communication and collaboration between epidemiologists and risk assessors, in which the structure of social and environmental epidemiological analyses may be informed in part by the needs of cumulative risk assessment.

#### ISEE-1419

##### The Decision-Making Rationale in the French Heat Watch Warning System

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**Background:** Following the 2003-heatwave, France developed a plan to prevent heat-related health impacts during heat-waves. It includes a heat-warning system designed to identify adverse weather situations and to trigger heat-alerts. The system is mainly based on the monitoring of three-day average of the minimal and maximal temperatures. A heat-alert is

issued when these averages are above defined thresholds. The heat-warning system is operated by the French Institute for Public Health Surveillance since summer 2004. Feedback from its yearly evaluation showed the interest of taking into account additional qualitative criteria such as humidity, air pollution, social background and possible health impact. It also revealed that the analysis of these criteria could substantially differ depending on the person operating the system. A tool was thus developed to improve the reproducibility of the analysis of the criteria to support decision making.

**Methods:** The tool was designed based on the consultation of the users of the warning system. Two dimensions were taken into account: the temperatures, which remain the basis of the system, and several risks factors, either environmental or social. Risk factors were identified from the literature and selected accounting for their relevance in the French context and the availability of data to be included in the tool. Real time surveillance of health data was also considered to maintain or not an alert. The tool was tested using data for July 2006, when a heatwave was experienced in France.

**Results:** Following the consultation, it was decided to take into account the probability of being above the alert threshold for minimal and maximal temperatures. These probabilities are defined in five classes, from "almost zero" to "very high" probability. Six risk factors were selected: exceptional social events, which can be defined in advance, minimal or maximal temperatures 4°C above the threshold, ozone and PM10 levels, and humidity above 80%. The tool was applied on data from July 2006. Comparing its outcomes with the alert decisions taken in 2006 on one hand, and the observed data on the other hand, it appeared that the tool was more specific and less sensitive than the human operators. Identification of the risk factors is useful to support the decision when the probabilities of being above the meteorological thresholds are moderate. Errors in temperature forecasting remained the first cause of abusive or missed alerts.

**Conclusion:** The test shows that the tool improves the reproducibility of the analysis and is useful to identify the role of each risk factor in the decision-making. However, a human expertise is always needed to take the final decision. The tool will be used at the national level from 1<sup>st</sup> June to 31<sup>st</sup> August 2008 under real conditions. It will be evaluated at the end of the summer 2008, to be improved and implemented regionally in 2009.

#### ISEE-1420

##### Depressive Symptom and the Risk for Occupational Injury in Small and Medium-Sized Companies

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**Objectives:** The survey was designed to determine whether depressive symptom had an effect on the rate of occupational injury in South Korea.

**Methods:** We conducted a prospective follow-up survey of workers at 44 small- to medium-sized companies classified into manufacturing business or service business, and 1,350 questionnaires were used in the final analysis. The first survey requested information regarding personal characteristics, work characteristics, and depressive symptom (DES-D), and the second survey queried participants of the first survey about occupational injuries experienced in the previous 4 months. Odds ratios (OR) were calculated through logistic regression analysis using whether to have occupational injury experience during the previous 4 months as a dependent variable and depressive symptoms as independent variables.

**Results:** After adjusting for confounders, among the female workers, those with depressive symptoms showed 2.11 times higher occupational injury experience rate (95% C.I. = 1.20–3.72) than those without. Among the male workers, however, the odds ratio was not statistically significant. When analysis was made limitedly for blue collar workers, the risk of occupational injury experience was 2.27 times higher (95% C.I. = 1.21–4.26) in female workers with depressive symptoms.

**Conclusions:** It was found that, among female workers, the risk of occupational injury experience is higher in those with depressive symptoms. However, the mechanism of how depressive symptoms affect occupational injuries has not been explained yet. Thus, we need additional research to verify the results of this study.

#### ISEE-1421

#### Hot Temperatures and Morbidity Among Elderly People in 101 U.S. Cities

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**Objectives:** To estimate the association between outdoor temperatures and daily hospital admissions for specific causes among elderly people.

**Materials and Methods:** We obtained daily counts of all-cause non-elective hospital admissions between 1985 and 2003 among Medicare beneficiaries aged  $\geq 65$  years residing in 101 US cities. Admissions were stratified into counts of hospitalizations with primary discharge diagnoses of cardiovascular disease (CVD), (including myocardial infarction, congestive heart failure, coronary artery disease, and cerebrovascular disease), diabetes, respiratory disease, and heat-specific diagnoses, including heat stroke, heat exhaustion, and syncope. We obtained daily temperature measures in each city from the National Climatic Data Center. In each city, we estimated the association between mean daily temperature and same-day counts of admissions during May through September of each year using Poisson regression. We modeled temperature as a linear continuous variable and controlled for temporal trends (natural splines, 3 degrees of freedom per year) and day of week. We used standard random-effects meta-analytic techniques to obtain a summary estimate of the association across the 101 cities.

**Results:** A 10°C increase in mean daily temperature was associated with a 2.1% (95% confidence interval (CI): 1.6%, 2.5%) excess risk of hospitalization for all causes, a 0.5% (95% CI: 0.03%, 1.0%) excess risk for CVD hospitalizations, a 6.0% (95% CI: 4.7%, 8.2%) excess risk for diabetes hospitalizations, a 5.3% (95% CI: 4.0%, 6.6%) excess risk for respiratory hospitalizations, and a 44.7% (95% CI: 37.7%, 52.2%) excess risk of heat-specific cause hospitalizations on the same day. Geographic and temporal variability of these associations will be presented.

**Conclusions:** Among the elderly, higher mean daily temperatures were associated with excess risk of hospitalization, and associations were stronger for heat-related causes, respiratory diseases, and diabetes. Since few studies evaluate temperature and morbidity outcomes, this provides new information about associations in a nationally-representative cohort of Medicare beneficiaries.

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#### ISEE-1422

#### The Biosand Filter: A Robust and Sustainable Technology for Household Water Treatment in Developing Countries

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**Background and Discussion:** More than 1 billion people in the developing world lack access to improved sources of drinking water; even more lack microbiologically safe drinking water. Annually, 3-5 billion cases of diarrhea result in 1.6 million deaths. Recently, a number of household water treatment and safe storage technologies have been

documented for their ability to reduce diarrheal disease and improve microbiological water quality. The biosand filter (BSF), a household-scale, intermittent-flow slow sand filter, is a promising household water treatment technology in use by more than 500,000 people globally. Yet since its creation in the 1990's, there has been little scientific evidence of its ability to improve microbiological water quality in the field and reduce diarrheal disease in users. Recent laboratory studies suggest that the biosand filter can achieve high (>99.9%) removals of parasites, moderate removals of bacteria (99-99.9%) and modest removals of viruses (80-95%). However, new laboratory research has identified simple modifications of filter design and operation for even further improvement of microbe reductions from water, specifically by increasing the residence (contact) time of the water in the filter. Perhaps even more significant is the recent field research evidence that is elucidating the health impact of the filter, especially its ability to reduce diarrheal disease. In three separate community-based epidemiological studies, the biosand filter has demonstrated significant improvements in drinking water quality and reductions (typically >40%) in diarrheal disease in households using a biosand filter compared to non-user households. During a randomized controlled trial in the Dominican Republic (2005-2006), BSF households reported 47% less diarrheal disease compared to control households. When revisited one year later (2007), more than 90% of all BSF households in the initial Dominican Republic study were still using their filter, and when compared to control households, they experienced significantly less diarrheal disease (about 60% fewer reported cases). In addition to research from the Dominican Republic, a recent post-implementation study of BSFs undertaken in Cambodia (2006) also documents high levels (88%) of continued filter use for as long as 8 years post-implementation and significantly less diarrheal disease associated with the use of the biosand filter (>40%) compared to matched households never having a filter. This new evidence on the performance of the biosand filter suggests that it is a robust and sustainable technology and deserves to be considered as an important option for household water treatment to increase sustained access to safe water and reduce the global burden of waterborne infectious disease.

#### ISEE-1423

#### Phthalates Exposure and Related Demographic Factors in Two Cities

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**Background:** Phthalates are widely used industrial chemicals in our environment. There are several phthalates with reproductive toxicity, carcinogenicity and developmental toxicity in animal. Humans can be exposed to these phthalates through food, water, phthalate-containing products and etc.

**Methods:** We enrolled 534 subjects in the BIOMES (Biological Monitoring for Environmental Surveillance) project. They are 257 men and 277 women aged over 40 years who have lived in Seoul and Incheon, Korea. We collected demographic factors through a comprehensive face-to-face interview and analyzed urine samples for 3 phthalates.

**Results:** Levels of urine phthalates in Mono-(2-ethyl-5-hydroxyhexyl) phthalate(MEHP) and Mono-(2-ethyl-5-oxohexyl) phthalate(MEOHP) were different with demographic factors such as sex, age and passive smoking in two cities. The mean values of MEOHP were 25.98  $\mu\text{g/g}$  cr(SD 23.78) for men and 35.80  $\mu\text{g/g}$  cr(SD 68.74) for women. But Mono-N-Butyl Phthalate(MBP) did not have difference in region, age, sex and smoking.

**Conclusion:** Our findings suggest that the importance of phthalates exposure in non-occupational environment and that there might be demographic variations in exposure of phthalates.

**ISEE-1429****Radiation Levels in Environmental Samples: Health Implications for the Population Living in an Enhanced Natural Radiation Area in Monte Alegre, State of Para, Brazil**

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**Background:** The association between natural radiation exposure and cancer remains debatable and matter of investigation worldwide. Monte Alegre is a small city with a population of 62 thousand inhabitants settled in the Brazilian Amazon, wherein the Brazilian Nuclear Industry has investigated an uranium occurrence in the region, but the low uranium content in the occurrence, made it inappropriate for economical explorations. Further, rocks from this area were removed by the population to be used to construct residences, sidewalks and streets paving. Overall, such situation either triggered data collection on natural radiation ascertainment and further debate about the health consequences of such exposure. Local population began to associate all cases of cancer to natural radiation exposure. The polemic has become so seriously that the Brazilian Health Ministry is supporting an epidemiological descriptive investigation in the region with natural radioactivity exposure.

**Objective:** The aim of this paper is to present an environmental radiological characterization of Monte Alegre, taking into account radionuclides determination (Unat, Thnat 226Ra, 228Ra and 210Pb) in environmental samples such as soil, food, water and also indoor radon exposure assessment and an external gamma survey in urban and rural areas of this city.

**Methods:** The committed effective dose to the population was estimated according to the dose assessment methodology described in UNSCEAR guidelines. Based on the analysis of food (chicken and yucca flour) and water, the estimated ingestion of natural radionuclides was 0,25 mSv/year, similar to the normal background of 0,23 mSv/year. According to radon measurements either carried out in indoor or outdoor sets, the dose was 1,40 mSv/year in the urban area and 2,50 mSv/year in the rural area, considering the last one higher than the normal background (1,20 mSv/year). According to the references, the levels in High Background Radiation Areas are 0,60 mSv/year to ingestion and 10,1 mSv/year received from inhalation. The observed radiation levels in Monte Alegre city are similar to others Brazilian High Background Radiation Areas.

**Conclusion:** These results suggest that the low estimated effective doses ascertained in Monte Alegre seems to not pose higher risks to local population health. Aiming to confirm such hypothesis, data collection to evaluate cancer incidence and mortality in Monte Alegre and in other two neighbor counties (Prainha and Alenquer), with populations showing similar socio-demographic profiles but unexposed to natural radioactivity, is in progress.

**ISEE-1430****Seasonal Variation of Benzo(A)Pyrene in Suspended-Particle in Belgrade City, Serbia**

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**Background:** Polycyclic aromatic hydrocarbons (PAHs) are formed during incomplete combustion or pyrolysis of organic material and in connection with the worldwide use of oil, gas, coal and wood in energy production, vehicle exhaust, industrial generations, aluminum production, cement manufacture, production coal tare, coke and asphalt, and petroleum catalytic cracking. Additional contributions to ambient air levels arise from tobacco smoking, while use of invented heating sources can increase PAH

concentrations in indoor air. Because PAH is a mixture, rather than a single compound, benzo(a)pyrene (BaP) may be adopted as a marker for the overall PAH mixture, because the available monitoring data from a variety of locations show that this compound makes a consistent contribution to the total carcinogenic activity of the overall mixture of PAH. BaP is the PAH most widely studied, and abundance of information on toxicity and occurrence of PAHs is related to this compound. Current annual mean concentrations of BaP in major European urban areas are in the range 1–10 ng/m<sup>3</sup>. In rural areas, the concentrations are <1 ng/m<sup>3</sup>. The risk assessment would imply that about 9 per 100.000 exposed people may die from cancer of the respiratory tract as a result of spending a lifetime in ambient air containing an average level of 1 ng BaP per m<sup>3</sup> mixed with all the other PAH and related substances in coke-oven emissions.

**Material and Methods:** Air samples for analysis of BaP in suspended-particle are collected at 16 monitoring sites within municipal air quality monitoring network. Air samples for analysis of BaP are the same that are used for analyses Black Smoke (soot) according to ISO 9835:1993. Samples were taken at height of 1.5–2 m above ground level over 24-hour periods at WHATMAN 1 filter paper, with sampling flow of 0.5 LPM. Collected samples are prepared following laboratory SOP and analyzed monthly by gas chromatography GC Agilent 6890N with mass selective detector Agilent 5973N.

**Results and Discussion:** The monitoring of BaP in Belgrade was first performed ten years ago. In this presentation we have taken in consideration and evaluation results from the last four years, from beginning of 2004 till the end of 2007. Obtained results are processed as the monthly variations at graphs for all sampling sites, as: annual average, minimum value, maximum value, as well as number of exceeding limit value according to national regulation. During winter season i.e. heating season concentrations were higher at almost all measuring sites. There was found significance difference in level of BaP between sampling sites that belong to municipal monitoring network (traffic, residential, industrial, etc.). In the period of 2004–2007 annual averages values were over limit value of 1.0 ng/m<sup>3</sup>. Future work will be to investigate the concentrations of BaP in smaller solid fractions in air pollution, PM<sub>2.5</sub> and smaller as the most important for adverse health effects.

**ISEE-1431****Genes in the Pathways of Inflammatory Lung Diseases, Particulate Air Pollution and Heart Rate Variability**

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**Background:** Cardiovascular disease (CVD) is a complex disease that involves interactions between genes and environment, and inflammation plays a key role in the disease. Particulate air pollution has been emerging as an important risk factor for CVD because of wide-spread exposure. Recent epidemiologic studies suggest that persons with certain genotypes for antioxidant mechanisms (glutathione-S-transferase M1, heme oxygenase-1) and iron metabolism (hemochromatosis genes) may be more vulnerable to particle cardiac toxicity. However, little is known about potential candidate genes which increase susceptibility to particle exposure. This study identified tagging and functional single nucleotide polymorphisms (SNPs) on potential candidate genes in the pathways of inflammatory lung diseases, in relation to decreased heart rate variability (HRV), a marker of cardiac autonomic dysfunction, in a community-based older population. We also examined whether such SNPs modified the impact of ambient fine particles (PM<sub>2.5</sub>) on HRV.

**Methods:** Standard deviation of NN intervals (SDNN), high frequency (HF), low frequency (LF) and total powers of HRV were measured among

676 men in the Normative Aging Study with 1071 total observations.  $PM_{2.5}$  measured at a stationary ambient monitoring site and averaged 48 hours before HRV measurements were used as the exposure variable. We used linear mixed effect models with random intercepts for individual subjects adjusting for age and body mass index (BMI) to account for subject-specific variations of HRV. Log-transformed HRV measures were fit for either SNP only (main effect models) or SNP,  $PM_{2.5}$  and an interaction between SNP and  $PM_{2.5}$ . A total of 1313 SNPs were analyzed in half the population (training set) and SNPs associated with at least 2 HRV measures at the  $P < 0.1$  level were selected for replication in the remaining half (validation set). An association was confirmed in the validation set if the  $P$ -value was  $< 0.05$  in the same direction as in the training set. We then re-examined all confirmed associations in the entire cohort.

**Results:** Average age and BMI for 676 men at baseline were 73.2 ( $\pm 6.7$ ) years and 28.3 ( $\pm 4.1$ ) kg/m<sup>2</sup>, respectively. We found that 5 SNPs met the criteria for associations with HRV measures: corticotrophin-releasing hormone receptor 1 (CRHR1: rs878887, rs1876828, rs16940665, rs17689824) and collagen type II alpha 1 (COL2A1: rs10219510). In the analyses of SNP- $PM_{2.5}$  interaction, a SNP in CRHR1 (rs3785877) significantly modified the association of  $PM_{2.5}$  with both HF and LF. We also found that the SNPs in CRHR1 which had significant main effects on alterations in HRV measures (rs878887, rs1876828, rs16940665, rs17689824) significantly modified the association between  $PM_{2.5}$  and LF. Significant interactions were observed between  $PM_{2.5}$  and two SNPs in glutathione-S-transferase P1 (GSTP1: rs947894, rs596603) on HF, and a SNP in matrix metalloproteinase 12 (MMP12: rs11225445) on SDNN.

**Conclusion:** This study suggests that a gene related to stress responses, CRHR1, may be associated with alterations in cardiac autonomic function. Genes associated with asthma or chronic obstructive pulmonary disease, such as CRHR1, GSTP1, and MMP12, may play a role in cardiac particle toxicity.

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## ISEE-1432

### Asthmatic Children Exposure and Inhaled Dose of PM, O<sub>3</sub> and NO X

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**Background:** The Portuguese research project “The Health and the Air we breathe—SaudAr” aims to assess the relationship between ambient levels of atmospheric pollutants and school children’s health. One main objective of the project was the estimation of exposure and inhaled dose of pollutants, which is the work presented here.

**Methods:** This study was conducted in a town with 100000 inhabitants located in the inland central region of Portugal. Two groups of children were identified, one attending school in an urban location and another in a suburban location. The ISAAC (International Study of Asthma and Allergies in Childhood) questionnaire was applied to more than 800 children identifying approximately 80 asthmatic ones, of which 60 were available to participate in the study. To estimate exposure and inhaled dose of pollutants two main tasks were carried out: a) the estimation of the daily activity profile of each child for a typical summer and winter school weeks, which allowed the identification of the microenvironments frequented by those children and the time spent in each one and b) the air quality characterization of those microenvironments. The daily activity profile was established through personal interviews of parents and child during the medical consulting hour. The air quality evaluation in the identified microenvironments, both outdoor and indoor, was performed

using a multi-strategy approach: measurements during field campaigns and local and mesoscale air quality modelling simulations to characterise areas where measurements were not possible. Campaigns and model simulations were performed both in winter and summer time to take into account seasonal variability of pollutant levels. With these data daily personal exposure to particulate matter ( $PM_{10}$ ), ozone ( $O_3$ ) and nitrogen oxides ( $NO_x$ ) was calculated for each child for a week in summer and winter time. According to the information obtained in the daily activity profiles, and the child gender, age and weight, a ventilation rate was established for each situation allowing the calculation of the inhaled dose of pollutants.

**Results and Discussion:** According to the state-of-the-art, results show that the only pollutant attaining levels of concern is  $PM_{10}$ . The mean  $PM_{10}$  exposure was 56.3  $\mu\text{g.m}^{-3}.\text{h}^{-1}$  in winter and 50.5  $\mu\text{g.m}^{-3}.\text{h}^{-1}$  in summer, being statistically higher in children living in the urban area than in children in the suburban location. The mean inhaled dose of  $PM_{10}$  was 20.8  $\mu\text{g.h}^{-1}$  in winter and 19.3  $\mu\text{g.h}^{-1}$  in summer. The inhaled dose calculation showed higher variability in results, demonstrating that children exposed to the same air quality can inhale a significantly different amount of pollutant, according to their activity level and weight. This study intends to contribute for general knowledge on exposure and dose levels highlighting the importance of their estimation for the definition of air quality standards.

## ISEE-1433

### Traffic-Related Air Pollutants and Cardiovascular Mortality in Central Taiwan

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**Objective:** This study aims to investigate the relationship between cardiovascular mortality and traffic-related air pollution.

**Method:** Traffic-related air pollutants, including  $PM_{2.5}$ ,  $PM_{10}$ ,  $NO_2$ , and CO, and six volatile organic compounds (VOCs), i.e. propane, iso-butane, propylene, benzene, m,p-xylene, and o-xylene, were measured by a fixed-site air monitoring station and a photochemical assessment monitoring station (PAMS) in an urban area of central Taiwan. Daily mortality data of cardiovascular diseases (ICD-9-CM 430-437) from January 1993 to December 2006 were used as outcome variables. Poisson Generalized additive models (GAM) were used to estimate the effects of elevated air pollutant levels on daily mortality adjusting for meteorological conditions and temporal trends.

**Results:** Cardiovascular mortality ranged from 1 to 9 per day. Daily air pollution levels ranged 9–363  $\mu\text{g/m}^3$  for  $PM_{10}$ , 10–167  $\mu\text{g/m}^3$  for  $PM_{2.5}$ , 0.5–80.5 ppb for  $NO_2$ , and 0.1–3.5 ppm for CO. The ranges of daily VOC concentrations were 0.6–2.7 ppb for propane, 0.3–1.0 ppb for iso-butane, 0.3–0.9 ppb for propylene, 0.2–0.6 ppb for benzene, 0.3–1.6 ppb for m,p-xylene, and 0.02–0.6 ppb for o-xylene. Single-pollutant models showed cardiovascular mortality was significantly associated with CO and  $NO_2$  lagged 0–2 days, and  $PM_{10}$  lagged 0–1 day using 14-year data, and was also associated with each of the six VOCs at 0 day lag using 4-year data. The relative risk (RR) for an interquartile (IQR) increase in air pollution levels were: 1.022–1.029 for CO, 1.027–1.031 for  $NO_2$ , 1.019–1.042 for  $PM_{10}$ , 1.065 for propane, 1.055 for iso-butane, 1.049 for propylene, 1.059 for benzene, 1.039 for m,p-xylene, and 1.047 for o-xylene. Two-pollutant models did not show such association.

**Conclusion:** Daily cardiovascular mortality is associated with acute exposure to traffic-related air pollutants including  $PM_{10}$ ,  $NO_2$ , CO, and VOCs.

**ISEE-1434****Water Intake and Fetal Growth**

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**Background:** Previous epidemiological studies suggest elevated exposure to drinking water disinfection by-products (DBPs) may be associated with fetal growth outcomes. Although much less consistent, other studies have also reported associations with water intake and adverse birth outcomes. We examined the relationship between tap water intake and birth weight as well as with risk of small for gestational age (SGA) infancy.

**Methods:** The study population included 1,854 women who were enrolled in a prospective cohort study conducted from 2000-2004 across three study sites and delivered a term live birth. We collected water use data from two interviews conducted at baseline (by 16 weeks of gestation) and follow-up (between weeks 20 and 25). At each interview, women were asked about daily consumption and typical size of glasses of tap water and tap water-based drinks. Birth weight was analyzed as a continuous measure and SGA was defined as an infant with a birth weight below the tenth percentile for his/her gestational age at birth, gender, maternal race/ethnicity (non-Hispanic White, Non-Hispanic Black, or Hispanic), and parity. Associations between water consumption and fetal growth were assessed using log-binomial regression for SGA and linear regression for birth weight. Maternal age, race/ethnicity, education level, annual household income, employment status, pre-pregnancy body mass index, smoking status, caffeine intake, bottled water consumption, and study site were considered as potential confounders.

**Results:** Unadjusted results suggested a positive association between tap water consumption and infant birth weight. Risk ratios (RRs) and 95% confidence intervals (CIs) comparing women who reported drinking > 32–61, > 61–96, and > 96 versus 0–32 ounces of tap water per day at follow-up were 0.9 (0.5, 1.6), 0.7 (0.4, 1.3), and 0.7 (0.4, 1.3), indicative of a decreased risk of SGA with increased water consumption. Respective changes in mean birth weight in grams (95% CIs) were 17 (−46, 80), 86 (29, 143), and 71 (10, 132), reflecting increased birth weight with greater water consumption. However, these associations were attenuated after adjustment for confounding: respective adjusted RRs for SGA were 1.0 (0.6, 1.9), 0.9 (0.5, 1.6), and 0.9 (0.5, 1.7), and respective adjusted changes in mean birth weight in grams were −18 (−85, 49), 38 (−25, 100), and 9 (−58, 76). Results for tap water consumption at baseline were null for SGA but were similar to the results for tap water consumption reported at follow-up for birth weight in grams. Results for daily cold tap water at follow-up for mean birth weight were similar to total water intake, although the increase was larger for the >96 category (59 grams; 95%CI: −11, 130). Maternal education, income, bottled water consumption, and study site were consistently retained in the regression models as confounders using a change-in-estimate (10% change), backwards elimination approach.

**Conclusions:** These preliminary results indicate that the crude association between tap water consumption and fetal growth may be largely due to confounding by maternal demographics and other predictors of fetal growth. Additional analyses of total water intake and other water use activities (e.g., swimming, bathing and showering) in relation to fetal growth are ongoing.

**ISEE-1435****Environment, Equity, and Health—the Rome Longitudinal Study (EEH-RoLS)**

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**Background:** Long-term exposures to traffic-related air pollutants have been considered in relation to incidence, aggravation and mortality from various chronic diseases, especially cardiac and respiratory illnesses. Although available estimates of the effects of air pollution are primarily based on exposure-response relationships established in studies from North America, a limited number of investigations have been conducted in Europe. Studies contrasting exposures within cities are particularly important in this context. We aimed at establishing a large cohort of residents in Rome with a set of measures of long-term exposure to environmental factors and a complete follow-up on morbidity and mortality.

**Methods:** We included in the cohort all residents in Rome at October 20, 2001, who were interviewed during the Census and had valid residential addresses (84% of the Census population). Each subject was provided with a unique personal identifier in all databases. For each individual, information on marital status, educational level, occupation, and housing tenure were available from the Census. An area-based socioeconomic position index was assigned to all participants. Each subject's residence at the baseline was geocoded and geographical information system (GIS) indices were developed. Road and traffic density within a buffer of 200 meters from residence were estimated. Nitrogen dioxide ( $\text{NO}_2$ ) concentrations were assessed by a land-use regression model ( $R^2 = 0.69$ ) for each individual residence. Hospital admissions of the subjects, five years before the enrolment and during the follow-up (up to the end of 2007), were available both from public and private hospitals to evaluate the morbidity history. Residential history and vital status were assessed through the municipal registry office. Mortality data (2001–2007) were available from the Regional Registry of Causes of Death.

**Results:** A total of 2,118,670 subjects were included in the study and followed for 6 years with more than 12 million person-years of observation. More than 100,000 subjects died during the study period, most of the subjects (77%) did not change the address they had five years before the enrollment, and 80% of participants did not change the residence in the follow-up period. Due to demographic and urbanization characteristics, exposure to traffic air pollution (traffic density and estimated  $\text{NO}_2$  concentration) increased with age and with socioeconomic position. Taking account of age, those with a university degree were 62% more likely to live in areas with the highest  $\text{NO}_2$  quartile than those with primary school education.

**Conclusions:** This cohort can represent a valuable database for several epidemiological studies on short and long-term health effects of air pollution and their interaction with the socioeconomic conditions of the population.

**ISEE-1436****The Alignment of Immediate Health Effects of Multi-Hour Exposure Periods**

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**Objective:** Exposure to fine airborne particulate matter ( $\text{PM}_{2.5}$ ) has been associated with cardiovascular outcomes, including acute effects on endothelial dysfunction. With such immediate effects, the choice of the exposure timeframe may be a critical factor. This analysis compares the effects of a marker of endothelial dysfunction within different exposure time windows.

**Methods:** A prospective panel study was conducted on 22 adults with type-2 diabetes in Chapel Hill, NC, from Nov 2004-Dec 2005. Each subject was studied for 4 consecutive days. Brachial artery flow mediated dilatation (FMD) was measured by brachial artery ultrasound during each

subject visit at around 10 am. On the rooftop of the patient examination site, 24-hour PM<sub>2.5</sub> measurements were made from 9 am to 9 am. At an airport monitoring station (3.5 km north of the patient examination site), 24-hour PM<sub>2.5</sub> measurements were conducted from midnight to midnight. FMD measurements were analyzed using random effects models adjusting for season, weekday and meteorology. Results are presented for an increase of 10 μg/m<sup>3</sup> PM<sub>2.5</sub> as percent changes of mean FMD with a 95% confidence interval. We examined three exposure metrics on the day of the subject's visit: the rooftop measures starting at 9am, the rooftop measures ending at 9am, and the airport measures starting at midnight.

**Results:** The correlation between the two rooftop exposure windows was only moderate ( $r = 0.54$ ). The airport measures (midnight to midnight) were more highly correlated with the rooftop measures starting on the day of the subject's visit ( $r = 0.80$ ) than with the rooftop measures ending on the day of the subject's visit ( $r = 0.69$ ). FMD decreased by -17.3% [-34.6%; 0.0%] in association with airport PM<sub>2.5</sub> exposure starting at midnight of the day of the subject's visit. The FMD association was stronger for the rooftop measures starting at 9am on the day of the subject's visit (-23.9% [-42.0%; -5.8%]) than for the rooftop measures ending at 9am on the day of the subject's visit (-2.0% [-20.3%; 16.4%]).

**Conclusion:** The stronger correlation of the midnight-to-midnight measures with those rooftop measures starting at 9am suggests that both exposure windows may be influenced by similar factors, perhaps factors present early in the day. The stronger FMD association with the PM measures beginning at 9am is surprising and suggests that these early-day factors may be important in understanding endothelial dysfunction. We are using hourly network data to further analyze the influence of the 9-, 6- and 4-hour PM averages preceding the FMD assessment.

*This abstract of a proposed presentation does not necessarily represent EPA policy.*

#### ISEE-1438

#### Comparative Health Risk Assessment and Economic Valuation of Environmental Health Damage in Chennai, India

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**Background:** The following paper presents the results of a comparative health risk assessment study executed in Chennai, India. The project was primarily aimed at quantifying health risks attributable to air pollutants and comparatively ranking them against other environmental concerns so as to provide scientific inputs for the design of an environmental management plan for the city and aid environmental resource allocation.

**Methodology:** Quantitative health risk assessment procedures developed by the USEPA were used for most assessments along with dose-response information obtained specifically from developing countries. Cross-sectional epidemiological information was also gathered to corroborate predicted health risks. Finally, available environmental and health information was mapped using GIS.

**Results:** The following air pollutants were ranked: PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, lead, indoor air pollutants, ozone, and select volatile organics including benzene and formaldehyde.

- Risk calculations reveal that risks from PM<sub>10</sub> levels are the greatest followed by lead and carbon monoxide. Except for a few select zones within the city, the risks from other pollutants are much smaller.
- Risks from indoor air pollutants, largely due to use of bio-fuels was very high in municipal wards that had a high concentration of homes using these fuels. However since use of bio-fuels was not very prevalent, the overall ranking for indoor air pollutants was lower than for outdoor air pollutants.

**\$300**

- GIS Mapping shows strong spatial associations between regions of high air pollutant loads and the prevalence of respiratory symptoms/ impairments.
- Although risks from air pollutants are substantial, they are outweighed by risks from microbial contamination of water in most parts of the city.
- The total impact of all health costs for air, water and solid waste concerns amounts to a total of Rs. 5683/- lakhs with air concerns contributing to Rs. 1652/- lakhs, water concerns contributing to Rs. 2278/- lakhs and solid waste concerns contributing to Rs. 1668/- lakhs. These total costs do not include costs of premature mortality. The total health care cost translates to roughly Rs. 2693/- per person/year for the study zone.

**Conclusion:** Integration of health risks into the environmental management process is crucial for sustainable environmental health initiatives in developing countries. The present study represents one of the first such local efforts in Southern India. The study will generate quantitative environmental health risk estimates for several criteria pollutants and it is expected to contribute significantly in designing the framework for an environmental management plan for the city of Chennai.

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#### ISEE-1442

#### Respiratory Effects of Exposures to Diesel Exhaust Among Children Bus Riders Before and After the Diesel Bus Engine Retrofit

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**Background:** Diesel exhaust (DE) has been associated with worsening asthma and allergies, among other important health effects. Reducing DE exposures among children has become a major regulatory initiative, with authorities investing billions of dollars in retrofitting diesel engines in school buses.

**Methods:** This study assesses DE exposure and respiratory health of children who commute by diesel buses before and after the diesel engine retrofit in school bus fleets during three school years (2005–2008). 450 children (ages 9–11) in the Seattle area were recruited representing exposure of those: 1) riding newer diesel buses in school year 2005–06 (Y1) which were retrofitted with diesel oxidation catalysts (DOC) and crankcase ventilation case (CVC) in school year 2007–08 (Y3); 2) riding older buses in Y1 which were retrofitted with CVC and DPF in summer 2006 (before Y2 or school year 2006–07); and 3) car riders as the control group. Monthly measures of lung function, pulmonary inflammation assessed by exhaled nitric oxide (eNO), and medication usage are obtained on all children during the school year. Individual exposure measurements of PM<sub>2.5</sub>, black carbon, and NO<sub>2</sub> is performed over 24h on a subset of the subjects (N = 100), with additional monitoring of PAHs and ultrafine particles on the buses (N = 100) they ride, and in a hybrid car driven in front of the bus.

**Results and Discussion:** Concentrations aboard school buses were four and two times higher than ambient and roadway levels, respectively. Exposure models constructed for individual subjects' monthly exposures to PM<sub>2.5</sub> on the bus indicated that bus concentrations were influenced by bus age, DOC, and roadway concentrations. Roadway exposure (for car riders) on the other hand was dominated by ambient PM<sub>2.5</sub>. A lung growth slope for each child is obtained using a linear regression model adjusting for age, gender, body-mass index, and height. These slopes are compared across exposure groups as well as individual exposure estimates. Concentrations and variation of eNO are compared within and across groups between 2006 and 2007. Preliminary results of the cross-sectional analysis of eNO measurements in 2006 (before retrofit) indicated no differences across exposure groups, although asthmatic children riding buses with manufacturer-installed DOC had significantly lower eNO than

those riding standard buses. For cross-sectional lung function analysis, bus riders showed lower forced expiratory volume (FEV) during Year 1. This paper will present both cross-sectional and longitudinal exposure and health results from the study years 1 and 2.

#### ISEE-1444

#### Chromosomal Instability in Women of Mexican Origin from Two Texas Regions: Agricultural Río Grande Valley and Industrial Baytown, Texas, USA

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**Objective:** To compare the frequency of chromosomal aberrations (CA: breaks) in the lymphocytes of women of Mexican origin residing in industrial vs. agricultural regions of Texas.

**Materials and Methods:** Higher frequency of CAs is indicative of an increased risk for cancer. The fluorescence in situ hybridization cytogenetic technique is widely employed to measure genotoxic effects in populations exposed to environmental contaminants. Frequency of CAs were measured in a subset of women of Mexican origin (N = 125) enrolled in the "Biomarkers of genetic susceptibility in environmentally-exposed migrant and seasonal farmworker children study".  $\chi^2$  and two-sample-t-tests were used to describe participants' characteristics; two-sample-t-tests to compare differences in mean CAs between groups, and linear regression to determine the relationship between CA and participants' characteristics (age, country of birth, genotype, residence, occupation, pesticide exposure, cancer diagnosis, alcohol and smoking status).

**Results:** Overall, both groups of women shared similar characteristics, with the exception of nativity status [more U.S.-born women resided in the Río Grande Valley (RGV) 24.1% vs. Baytown 6.3%; P = .006], and use of pesticides in the previous month (RGV: 75.9% vs. Baytown 52.1%; P = .023). Overall, study participants had a mean  $\pm$  standard error of 4.4  $\pm$  .28 CAs per 1,000 cells, with the highest frequency observed in women with cancer (11.5  $\pm$  6.5 vs. 4.3  $\pm$  .26; P = .001), and RGV residents (5.4  $\pm$  .75 vs. 2.9  $\pm$  0.25; P < .001), even after adjusting for age, nativity, occupation, pesticide exposure, alcohol use and smoking status (P = .001).

**Conclusions:** Our data substantiates that individuals suffering from cancer have higher frequency of CAs, and it suggests that residing in an agricultural setting may be a higher risk for genetic (chromosomal) instability than residing in an industrial setting. There is the need to conduct a biomonitor study among the population of the RGV to evaluate if the higher frequency of CAs observed may be due to the region's extensive agricultural activities and/or exposure from living in proximity to two EPA designated superfund sites contaminated with organochlorine pesticides and polychlorinated biphenyls.

#### ISEE-1446

#### Pesticide Sales and Adult Male Cancer Mortality in Brazil: An Ecological Study

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**Objective:** Epidemiologic studies suggest that pesticide exposure may increase the risk of specific types of cancer. In Brazil, where the use of pesticide grows rapidly, studies that evaluate the impact of pesticide

exposure on cancer incidence and mortality are very scarce. In this study, we evaluated the degree of correlation between pesticide sales in eleven Brazilian states in 1985 and cancer mortality rates during 1996–1998.

**Material and Methods:** Information of all cancer deaths occurring in men, 30 to 69 years old, from 1996 to 1998 were collected from the National Mortality System. Age-adjusted cancer mortality rates were calculated using population census estimates. Spearman's correlation coefficients were then obtained for pesticide sales (per capita) and the following types of cancer: prostate, soft tissue, larynx, leukemia, lip, esophagus, lung, pancreas, bladder, liver, testis, stomach, brain, non-Hodgkin lymphoma, and multiple myeloma. In addition, states were divided into three groups according to their level of pesticide use (tertiles) and cancer mortality rate ratios (MRR) were then calculated using first tertile as reference.

**Results:** Pesticide sales showed high correlation with cancer mortality rates for prostate ( $r = 0.78$ ;  $p = 0.004$ ), soft tissue ( $r = 0.75$ ;  $p = 0.007$ ), larynx ( $r = 0.73$ ;  $P = 0.011$ ), and leukemia ( $r = 0.70$ ;  $P = 0.016$ ). We also observed moderate correlation between pesticide sales and mortality rates for the cancers of lip ( $r = 0.65$ ;  $P = 0.030$ ), esophagus ( $r = 0.62$ ;  $P = 0.043$ ), pancreas ( $r = 0.57$ ;  $P = 0.066$ ), bladder ( $r = 0.57$ ;  $P = 0.066$ ), liver ( $r = 0.54$ ;  $P = 0.089$ ), testis ( $r = 0.53$ ;  $P = 0.096$ ), and stomach ( $r = 0.50$ ;  $P = 0.117$ ). For most of the specific-sites, cancer mortality rates were significantly higher in the states of moderate (2nd tertile) and high (3rd tertile) pesticide use, with MRR's ranging from 1.11 to 5.61.

**Conclusions:** Moderate-to-high correlation coefficients between pesticide sales and several types of cancer were observed. The results suggest that population exposure to pesticides in the 1980s in some Brazilian States may have been associated with selected types of cancer observed a decade later.

#### ISEE-1447

#### Annoyance Analysis Based on EU Strategic Noise Mapping in the Czech Republic

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**Background:** The EU member states were obliged to elaborate Strategic noise maps till June 2007. This duty was given them by the Directive 2002/49/EC (Directive) of the European Parliament and of the Council relating to the assessment and management of environmental noise. Member States should have applied the noise indicators  $L_{den}$  (overall annoyance) and  $L_{night}$ . The presentation is based on results of the Strategic Noise Mapping in the Czech Republic (SNM) and focused on annoyance analysis and comparison with limit values. The National Reference Laboratory for using GIS in Public Health was delegated by the Czech Ministry of Health with the task to elaborate a part of strategic mapping and to prepare a completion of the SNM for EU.

**Data and Methods:** According to criteria of the Directive 300 km of major railways, 1,370 km of major roads, 1 major airport and 3 agglomerations were analysed. The "Recommended Interim Computation Methods by Directive" was used for elaboration of SNM. The input population data were obtained from the Czech Statistical Office - to each building the real number of permanently living inhabitants was assigned. For assigning noise levels to buildings (and thus people) calculation points at 0.1 metres in front of the façade with spacing of 3 metres between calculation points around the façade was used. The mapping results were grouped by 5 dB. It was evaluated the estimated number of people located in an area exposed to noise, the estimated number of dwellings, schools and hospitals in a certain area that are exposed to specific values of a noise indicator, the exceeding of a limit value and dwellings with a quiet

façade. All this results were evaluated separately for different sources of noise.

**Results:** The results of annoyance analysis were performed as a sum of population (houses, school and hospitals) living/being situated in the noise level by 5 dB. The predominated source of noise exceeding limit values in people annoyance is noise from roads. In exposure of noise from major roads exceeding limit values live 226,700 people for indicator  $L_{den}$  (70 dB) and 278,800 people for  $L_{night}$  (60 dB). In exposure of noise from major railways exceeding limit values live 14,800 people for  $L_{den}$  (70 dB) and 600 people for  $L_{night}$  (65 dB). In exposure of noise caused by industry exceeding limit values live 700 people for  $L_{den}$  (50 dB) and 1,500 people for  $L_{night}$  (40 dB). In exposure of noise from airports exceeding limit values live 1,600 people for  $L_{den}$  (60 dB) and 2,400 people for  $L_{night}$  (50 dB).

**Conclusions:** The results of annoyance analysis indicated population living and houses being situated in areas exceeding the limit noise level and will be used for decision on noise reduction. At present the Actions Plans for reduction of the noise annoyance of population in most affected areas are prepared.

#### ISEE-1449

#### Urinary Pesticide Metabolite Concentrations in Children and Adults and the Relationship to Environmental Concentrations Following Indoor Pesticide Applications

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**Methods:** An analysis of urinary pesticide metabolite and environmental measurement data from three observational exposure measurement studies was conducted. The purposes of the analyses were to 1) better understand children's potential exposures following indoor pesticide applications, 2) evaluate the relationships between various environmental, personal, and biological concentrations for selected pesticides and their corresponding urinary metabolites, and 3) compare the children's estimated potential exposures from the studies to exposure estimates obtained from the US EPA's Residential Exposure Assessment SOPs and various residential exposure model estimates. Individual analyses of the data were undertaken using regression analysis and repeated measures analysis of variance where appropriate.

**Results:** Initial individual study-specific data analyses indicate that fogger applications were associated with the greatest increase in urinary metabolite concentrations and that the increase is not transient and appears to persist in some cases for several weeks. Trends in urinary levels were observed between family members in which the concentrations increased or decreased over time in a synchronized fashion. Consumer-applied handheld indoor aerosol applications were associated with increases in urine metabolite concentrations that were variable and ranged from concentrations not discernable from pre-application concentrations to concentrations similar to fogger applications. Crack and crevice applications were associated with slight and transient increases in urine concentrations compared to the individual's baseline concentrations. Initial individual study-specific data analyses of the environmental media indicate associations between analyte concentrations on socks and indoor air data and measured urinary metabolite concentrations. This poster presentation will highlight more detailed individual and combined analyses of the three studies.

*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

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#### ISEE-1450

#### Traffic-Related Pollutants are Associated with Heart Rate-Corrected QT Interval

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**Background:** Acute exposure to ambient air pollution, particularly traffic-related pollutants, has been associated with acute changes in cardiac outcomes, including heart rate variability (HRV) and arrhythmia. The impact of traffic-related pollutant exposures on other important cardiac outcomes, including the repolarization marker QT interval (QTc), however, has not been extensively examined in the elderly.

**Methods:** We investigated the relationship between ambient traffic pollution and QTc in a longitudinal study of 548 men from the VA Normative Aging Study, an elderly cohort living in greater Boston, Massachusetts, seen between November 2000 and June 2007. The protocol involved 5–10 minutes of continuous ambulatory electrocardiography (ECG) monitoring, with the recordings analyzed for several parameters including the QT interval. QTc was calculated using the Bazett's formula and was averaged for every ECG measurement. Linear mixed effects models were fit for the averaged QTc and air pollutant (fine particulate matter (<2.5  $\mu$ m in aerodynamic diameter ( $PM_{2.5}$ )), ozone ( $O_3$ ), black carbon (BC), nitrogen dioxide ( $NO_2$ ), carbon monoxide (CO), and particle number (PN)) concentrations in lags up to 10 hours preceding ECG measurement, with a random subject effect and adjusting for confounders (individual, a natural spline of time trend with 24 degrees of freedom, and temperature).

**Results:** The traffic pollutants were related to longer QTc. An interquartile range (IQR) change in BC measured four hours prior to the ECG measurement was associated with an 8.96% (95% Confidence Interval [CI]: 0.64%, 17.28%) standard deviation change in QTc. Standard deviation changes in QTc of similar magnitude were found for IQR changes in  $NO_2$  and CO in the 5<sup>th</sup> hour ( $NO_2$ : 9.97%; 95% CI: 0.04%, 19.89%; CO: 7.93%; 95% CI: 0.52%, 15.35%) and in PN during the 6<sup>th</sup> (10.46%; 95% CI: 0.72%, 20.19%), 7<sup>th</sup> (10.81%; 95% CI: 0.39%, 21.22%) and 8<sup>th</sup> (12.88%; 95% CI: 1.23%, 24.53%) hours prior to ECG measurement. In contrast, no association was found between QTc and ambient  $PM_{2.5}$  and  $O_3$ . The associations between QTc and both ambient  $NO_2$  and BC were stronger in people with diabetes. No effect modification by body mass index and season was observed.

**Conclusions:** Traffic-related pollutants (BC, CO,  $NO_2$ ) in greater Boston area may stimulate an acute cardiovascular response (longer QTc) and possible arrhythmia among elderly.

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#### ISEE-1451

#### Impact of Hot Weather Conditions on Respiratory and Cardiovascular Hospital Admissions in New York City, USA

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**Objective:** This time-series study assessed the potential impact of hot weather conditions on hospital admissions due to cardiovascular and respiratory diseases in New York City (NYC), and explored if the weather-disease relationship varies with socioeconomic status.

**Method:** The effects of temperature and humidity on health were investigated by linking daily cardiovascular/respiratory hospitalization counts with meteorological data (1991–2004) during summer (June –

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August). Daily mean temperature, daily mean apparent temperature, and 3-day moving average of apparent temperature were used as the exposure indicators. Threshold effects for health risks of meteorological conditions were assessed by log-linear regression models, after controlling for Ozone, day of week, holidays, long-term trend and seasonal variations. Stratified analyses were used to evaluate the differences on health effects by disease and socioeconomic status.

**Results:** For all three exposure indicators, each degree increase above the turning point (threshold) of the temperature-health effect curve was significantly associated with a 1.17%–1.73% increase in hospitalizations due to respiratory diseases on the same day, and an increase of 0.78%–2.00% in hospitalizations due to cardiovascular diseases with delayed effects (1 to 3 day lag). For respiratory diseases, the increased risks for Hispanics were higher compared with non-Hispanics (3.37%/°F vs. 0.93%/°F); people living in low income neighborhoods were at higher risks compared with those in high income neighborhoods (2.23%/°F vs. 0.58%/°F). Elderly also tended to have higher increased hospitalization risks because of high temperature for both diseases. Our results also demonstrate a trend for a positive interaction between temperature and humidity on both respiratory and cardiovascular admissions when temperature exceeded the threshold (higher than 84 °F).

**Conclusions:** This study suggests that extreme high temperature may increase hospital admissions for cardiovascular and respiratory disorders in NYC. The susceptibility to the adverse effect of weather for elderly and people with low socioeconomic status merits further investigation.

#### ISEE-1452

#### Comparison of Four Methods for Characterizing Traffic-Related Air Pollution (TRAP) Exposures in Boston's Inner Core

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**Background:** Inner-city traffic burdens are difficult to characterize due to the complexity and heterogeneity of the roadway networks. Our analysis compares four different methods for consistency in estimating relative magnitude of TRAP burden.

**Methods:** The study subjects were obtained from a larger study into the effects of TRAP on biomarkers of inflammation in Puerto Rican adults residing in the Boston area. A subset of cases ( $n = 48$ ) subjected to intensive positional confirmation was selected to minimize errors commonly associated with geocoding of participant addresses, inappropriate extrapolation of traffic volume data and spatial misalignment of data sources. TRAP exposures were assessed using: (1) representative traffic counts for specific road segments; (2) GIS-based road density analysis within 50m of each residence; (3) estimates of vehicle miles travelled per square mile (VMT/SM); and (4) modeled levels of selected TRAP parameters including carbon monoxide (CO) and oxides of nitrogen (NO<sub>x</sub>). VMT/SM, CO, and NO<sub>x</sub> estimates were specific to individual Traffic Analysis Zones in which the residence was located. TAZs are defined by state planning organizations and used in calibrating transportation planning models according to state and federal protocols.

**Results:** All 48 cases lived directly on one of Boston's most highly trafficked roads (>25,000 average weekday traffic volume). Complicating the positional confirmation process in Boston's inner core, there are 18 distinct neighborhoods with over 200 instances of the same road name being used for two or more different non-contiguous locations. Twenty four cases lived directly on street segments where traffic count stations were located (as matched by neighborhood name or zip code). Seventeen cases lived on the same street segment characterized by the same traffic counts, yet they were located in 3 different TAZs. VMT/SM estimates ranged from 65,000 to over 197,000. CO and NO<sub>x</sub> emissions estimates varied by factors of 2.9 and 2.8, respectively. Road densities within a 50m radius differed by nearly 6-fold among the 17 cases and for cases within the same TAZ road densities varied as much as a factor of 2.8. Another

eight of these cases lived on another street characterized by the same traffic counts, though within 2 different TAZs. Estimated VMT/SM, CO, and NO<sub>x</sub> for this set of locations varied by factors of 3.6, 3.5 and 3.0, respectively. Road density varied by a factor of nearly 2.5 within one of the TAZs but was relatively consistent for all cases in the other TAZ.

**Conclusions:** This study illustrates that the relative magnitude of estimated TRAP burden can vary depending on the exposure characterization method that is used. Our findings suggest a strong potential for exposure misclassification when traffic counts and proximity measures are the primary methods of characterization. For health outcomes research, two relatively accessible and cost-effective tools, a combination of TAZ data and weighted road density analysis, could provide a more comprehensive picture of the intra-urban, and much localized, variations in TRAP burden.

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#### ISEE-1453

#### Detecting Demographic Variations of AIDS Mortality in Florida- a New Application of Spatio-Temporal Analysis

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**Background:** There is sparse literature examining the extent and level of disparity of AIDS mortality by gender and age groups among most affected regions in the U.S., such as the state of Florida. The purpose of the present study is to characterize, geographically and temporally, the patterns of AIDS death disparity in Florida, and to determine if detected trends vary by demographic characteristics.

**Methods:** The Space-Time Scan Statistic proposed by Kulldorff et al. was employed to examine potential geographic and temporal excess of AIDS mortality by age, race, and gender in 67 Florida jurisdictions between 1987 and 2004. Results were geographically referenced in maps using Epi Info and Epi Map made available by the CDC.

**Results:** Among 40,106 AIDS deaths in Florida between 1987 and 2004, 48.5% occurred in the African-American/Black population, whereas 51.3% were found in the White population. AIDS-related mortality in the White population peaked earlier in the study period whereas mortality in African-American peaked in the later periods persisting until 2004. Excess deaths of AIDS in all demographic groups were detected in Miami-Dade, Broward, Martin, Palm Beach, Union, Monroe, Hillsborough, St. Lucie, Orange, Duval, and Lee County. AIDS mortality peaked in 1995 and then sharply dropped until 1998 when it stabilized.

**Conclusions:** We provide a new application regarding spatio-temporal characteristics on AIDS mortality employing practically statistical method. By accounting for the temporal dimension of disease clustering, the present study captures the persistence of geographic clusters, which is not often afforded by other geographic detection methods. These findings may inform medical resources allocation and focus public health intervention strategies for AIDS care.

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#### ISEE-1456

#### Identification of a Major Source of Perfluorooctane Sulfonate (PFOS) at a Wastewater Treatment Plant in Brainerd, Minnesota

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**Background:** Perfluorooctane sulfonate (PFOS) is a globally distributed persistent contaminant in environmental and biological media. Due to the history of perfluorochemical (PFC) manufacture and waste disposal in the state, the state of Minnesota has been evaluating the presence of PFCs in

drinking water and fish. PFOS has been shown to bioaccumulate in fish tissue, and the detection of elevated concentrations of PFOS in fish in a number of lakes and rivers in Minnesota has resulted in the issuance of PFOS-based fish consumption advice in some instances. While PFC waste disposal sites have been identified as one potential source, currently, little is known about other source(s) of PFOS in lakes and rivers in Minnesota.

**Methods:** In 2007, the Minnesota Pollution Control Agency (MPCA) conducted a study of PFCs in influent, effluent, and sludge at 28 public and private wastewater treatment plants (WWTPs) throughout Minnesota. Samples of influent ( $n = 32$ ), effluent ( $n = 28$ ), and sludge ( $n = 23$ ) were analyzed for 13 PFCs by Axys Analytical Services, British Columbia, Canada.

**Results:** Several WWTPs, mainly in urban areas, had elevated levels of individual or multiple PFCs that could reasonably be attributed to local sources, including known PFC contamination in drinking water sources or the use of PFC containing products at an industrial facility or airport. A notable exception was PFOS in the influent, effluent, and sludge from the City of Brainerd WWTP, operated by Brainerd Public Utilities (BPU). The plant is located about 135 miles northwest of St. Paul, and discharges to the Mississippi River. This plant had the highest detections of PFOS in all three media of any of the wastewater treatment plants tested, with an effluent PFOS level of 1.51 micrograms per liter ( $\mu\text{g/L}$ ). Samples from wells supplying drinking water to the city of Brainerd showed no PFCs. BPU conducted an investigation of the wastewater collection system to identify the source(s) of the PFOS contamination. The main source (~95%) of the PFOS was identified as a large chrome plating operation in the city who reported using a legal surfactant product to control hexavalent chromium emissions. The product reportedly contained "organic fluorosulfonate" between 1% and 7% by weight. Samples collected within the plating facility by BPU staff identified the specific points where PFOS remains in the plating solution tanks. An alternate surfactant product that does not contain PFOS is currently being used by the facility and levels of PFOS in wastewater from the facility and the BPU WWTP are expected to drop over time.

**Conclusions:** The findings of the Brainerd investigation represent the first comprehensive look at PFOS inputs to a WWTP, and the first documentation of the importance of chrome plating as a possible source of PFOS in WWTP effluent. Little is currently known about levels of PFOS in agricultural fields where PFOS-containing sludge from such facilities is applied, and the uptake of PFOS by crops has not been extensively studied.

#### ISEE-1457

#### Observational Study of the Risks and Exigencies Faced by the Brick-Makers As Well As the Use and Exposure of Sewage or Treated Waters in the Work Process: A Case Study of Chihuahua State, México

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**Objectives:** The goal of this study was to determine the occupational risks and exigencies during the manufacturing process of the bricks, in which the brick-makers were exposed, as well as classified them according to their nature, and to develop solution proposals to avoid the impact of those in the worker's health.

**Methods:** The developed method to make this study was through an observational diagnosis, by means of which it was possible to characterize each one or the phases in the brick manufacture process. An observation guide was also created, based on the classification of the nature of the risks and exigencies. In addition, personal interviews were carried out with the workers.

**Results:** According to the classification of the risks and exigencies in the diagnose realized, it was found that exposure to high temperatures, dusts and fumes derived from brick firing, exposure to wastewater pathogens, physical activity of a high intensity, ergonomic exigencies as stressful

positions, highly repetitive movements, incorrect manipulation of heavy loads, and dynamic and static efforts, all those mentioned, exist in the majority of the stages of the process of the manufacturing of the bricks. Ergonomic issues were the main problem, since they were strongly related to musculoskeletal problems like painful joints, low back and neck pain. There were also dermatological and fungi infections, and conjunctivitis among other problems.

**Conclusions:** Brick manufacturers are a vulnerable population stratus, since they have low economic incomes, lack of health care, low educational level, unstable job, and inadequate nutrition, and their only way of subsistence is a highly demanding activity and with a high potential of health damage.

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#### ISEE-1458

#### Accuracy and Precision of an Advanced K-x Ray Fluorescence (KXRF) in vivo Bone Lead Measurement System

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**Objective:** The data obtained from K-x ray fluorescence (KXRF) technology are valuable to research the association between chronic low level lead exposure and adverse health effects. A highly sensitive system was developed recently, and it has a detection limit three times lower than the standard systems installed in most of the KXRF laboratories worldwide. In 2005 and 2006, a Bone Lead Standardization Program XRF Inter-Laboratory Study was carried out by researchers at Wadsworth Center and Mount Sinai School of Medicine. The goal of this study is to investigate the accuracy and precision of this advanced system as a complementary part of the bone lead standardization program.

**Methods:** Nine goat tibiae encompassing a range of lead concentrations were obtained from animals orally dosed with lead acetate. The lead concentration was measured by the advanced system, as well as by three conventional systems. The counts of the K-x ray peaks and the elastic scattering (coherent) peaks were calculated by a peak extraction program. The data before calibration and after calibration were analyzed. The precision of these systems was estimated by standard deviations obtained from five measurements. The accuracy of the systems was estimated by comparing the results with the values obtained from inductively coupled plasma mass spectrometry (ICP-MS).

**Results:** The ratios of ( $K_{\alpha}/\text{coherent}$ ) and ( $K_{\beta}/\text{coherent}$ ) for the advanced system have standard deviations three times lower than those of the ratios for the conventional systems. When comparing the inverse-variance-weighted mean concentrations from  $K_{\alpha}$  and  $K_{\beta}$  of the advanced system, obtained using an assumed calibration line, with the concentrations obtained by ICP-MS, the difference is not significant. However, the concentrations obtained by the advanced system are consistently lower (albeit insignificantly) than those from the ICP-MS. When comparing the concentrations obtained by the advanced system and the two conventional systems with consistent concentrations from  $K_{\alpha}$  and  $K_{\beta}$ , the concentrations are marginally ( $1\sigma$  to  $3\sigma$ ) lower for the advanced system at bone lead levels higher than 30 ppm.

**Conclusions:** The results show that the advanced system is highly precise for repeated measurements of lead in dissected goat bones and in phantoms. However, its accuracy requires further investigation.

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#### ISEE-1459

#### Arsenic Exposure and Global DNA Methylation

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**Background:** It has been hypothesized that inorganic arsenic (iAs), an important environmental carcinogen of global public health significance, induces epigenetic changes including aberrant DNA methylation. Both DNA methylation and arsenic metabolism require Sadenosylmethionine (SAM) as the methyl donor. This competitive demand between arsenic metabolism and DNA methylation for SAM may decrease the percentage of methylated CpG dinucleotides throughout the genome. Arsenic has been shown to produce global hypomethylation in both in vitro and animal models. However, few studies have investigated the effect of iAs exposure on genomic DNA methylation in humans.

**Methods:** We evaluated the relationship between iAs and DNA methylation in maternal and cord blood samples collected as part of a pilot study that recruited 52 pregnant women before their 28th week of gestational age in Serajdikhan, Bangladesh. Of the 52 women recruited into this pilot study, cord blood was successfully collected from 29 of the 44 births attended. DNA was extracted using the Puregene DNA isolation kit (Gentra Systems, Minneapolis, MN). DNA was shipped to University of Milan where genomic DNA was subjected to bisulfite modification and global methylation content was determined by PCR-pyrosequencing analysis for LINE-1 and Alu repeated elements. This technique measures the percentage of methylation in three specific CpG positions in LINE-1 and in three specific CpG positions in Alu repeated elements that are present in several thousand copies in a single genome. Maternal exposure to iAs was measured in drinking water samples collected at the time of enrolment using ICP-MS.

**Results:** Drinking water iAs ranged from <1 to 734 µg/L and the average percent methylation of global LINE-1 and ALU repeats was 78.5% (range: 74.93–88.0%) and 24.57% (range: 20.9–25.9%), respectively. Separate linear regression models evaluated the relationship between the average for LINE-1 and Alu and drinking water arsenic while controlling for exposure to environmental tobacco smoke and chewing betel nuts. We observed that drinking water iAs was associated with decreased methylation at average LINE-1 repeated elements ( $\beta = -2.35$ ; SE: 1.07,  $P$ -value = 0.04) and for average Alu in cord blood samples ( $\beta = -0.67$ , SE: 0.031,  $P$ -value = 0.04). However, no association was observed when DNA methylation was measured in maternal blood. This suggests that the fetus may be the most susceptible to epigenetic effects of iAs exposure.

**Conclusion:** While the biological significance of these findings remains unclear, these results support the concept that arsenic exposure results in global genomic hypomethylation. We are currently analyzing additional samples to confirm the results of this pilot study.

#### ISEE-1461

#### Hospital Admissions of the Elderly During Heat Waves in Five U.S. Cities, 1985–2003

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**Background:** Understanding the health impact of hot weather on vulnerable populations is a priority in light of warming trends under climate change. Previous studies have found an association between increased summer temperatures and mortality, but the association between increased summer temperatures and morbidity is less clear. Furthermore, no universally accepted definition of a heat wave exists, and heat-wave related morbidity estimates may vary depending on weather criteria and thresholds used to define the heat wave. We examined the association between hospital admissions of the elderly using different definitions of a heat wave in five U.S. cities.

**Methods:** Hospital admissions of individuals aged 65 and over were obtained from Medicare billing records during 1985–2003. Heat waves were defined as temperatures above a given threshold for at least two days, and thresholds were based on local daily minimum temperature (tmin), daily maximum temperature (tmax) or daily mean apparent temperature (AT). 95th, 99th and 99.5th percentile thresholds for each of the three temperature types were calculated from city airport monitor data over all seasons over the study period. A time-stratified case-crossover design was used to control for individual confounders, season and time trend. Day of the week and ozone were controlled for in the analysis. Interaction terms for race (non-white), sex or age (>78) were subsequently included.

**Results:** The percent excess relative risks of hospitalization during a heat wave vs. during moderate temperatures (excess risks) for each definition of a heat wave at each percentile threshold were all greater than 1% for Chicago and New York. The excess risks (and 95% confidence intervals) for days at or above the 99.5th-percentile-of-tmax threshold were highest and were 14% (10%, 17%) in Chicago and 13% (10%, 15%) in New York. Excess risk in Chicago was 17% (10%, 26%) among non-whites and 13% (6.8%, 20%) among individuals over 78. Excess risk was not apparent in New York among non-whites but was 6.5% (2.6%, 11%) among individuals over 78. Relative risk of admission during heat waves was not higher than during moderate weather in Phoenix, Los Angeles or Houston for most heat wave definitions and was significantly lower with some definitions in Phoenix and Los Angeles. For example, using the 99.5th-percentile-of-tmax heat wave definition, excess risk was -0.58% (-3.6%, 2.6%) in Los Angeles, 0.69% (-3.3%, 4.9%) in Houston, and -5.1% (-9.9%, -0.01%) in Phoenix. Race or age interactions were not present in Los Angeles, Houston or Phoenix for most of the heat wave definitions. The excess risks among individuals over 78 were 12% (1.5%, 22%) in Phoenix and 14% (0.92%, 28%) in Houston using the 99.5th-percentile-of-tmin heat wave definition. Risk of admission did not differ between men and women in any city.

**Conclusion:** Risk of hospital admission among the elderly in Chicago and New York increased during heat waves as defined here, but the association did not hold in the cities in warmer climates. Older individuals were often at greater risk, but sex and non-white race were not consistent effect modifiers.

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#### ISEE-1462

#### Measured Pollutants and Comfort Parameters in a Commercial Aircraft on Intercontinental Flights

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**Introduction:** Today, more than 1,670 million passengers are transported by the commercial airlines. Complaints about cabin air were found in several questionnaire studies, and concern has increased about possible health effects of pollution in the cabin air. Those pollutions in the cabin air could result from leakage of jet engine oil containing tricresyl phosphates (TCPs), tributyl phosphates (TBPs) and other pollutants through the ventilation system into the aircraft cabin.

**Aims:** This study was to determine in-flight exposure of specific pollutants and comfort parameters. The measured concentrations were compared with corresponding values from previous indoor air measurements.

**Study Methods:** Air humidity, temperature, carbon dioxide (CO<sub>2</sub>), ultra fine particles, nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), volatile organic compounds (VOC), and tricresyl phosphates (TCPs), tributyl phosphates (TBPs) was measured in cabin and flight deck during cruise. The measurements were performed during 6 intercontinental flights with Airbus 340 and 2 with Airbus 330.

**Results:** The relative air humidity during cruise conditions can be extremely low. Cabin temperature varied but was within proposed temperature standards. The carbon dioxide was mostly low during cruise. The concentration of nitrogen dioxide and carbon monoxide was below detection limit. The concentration of ultra fine particles was extremely low during cruise. The average concentration of tricresyl phosphates (TCPs) and different VOC was extremely low in the cabin air during cruise, compared with indoor measurements in Swedish office and home environment.

#### ISEE-1463

##### Seasonal and Inter-Personal Variability of 1-hydroxypyrene in Urine

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**Background:** Urinary 1-hydroxypyrene (1-OHP) has been used as a biomarker of polycyclic aromatic hydrocarbons (PAHs) exposure in occupational and environmental settings.

**Methods:** To better understand the implication of using a single measurement of urinary 1-OHP to characterize PAH exposure, we estimated within- and between-variance component of air, diet, and urine measurements of pyrene or 1-OHP. Personal air and diet PAH concentrations and urinary 1-OHP concentrations were measured from 100 persons with a wide range of PAH inhalation exposure. The subjects included 50 coke oven workers and 50 urban residents, all non-smokers. Each participant was sampled two times over 6 to 9 months.

**Results:** For the coke-oven workers, a significant seasonal difference was found only on personal air pyrene measurements. For non-coke workers, only dietary pyrene intake differed significantly by season. Measured concentrations of personal air pyrene and urinary 1-OHP were similar in both seasons. Results also showed that within-person variance was larger than between-person variance for personal air pyrene, dietary pyrene intake, and urinary 1-OHP. For coke oven workers, the highest variance ratio (within- to between-person) was found in urinary 1-OHP (1.22), followed by dietary pyrene intake (1.18), and personal air pyrene (1.05). Non-coke-oven workers had similar results as coke oven workers. The Intra Class Correlation (ICC) of personal air pyrene concentrations within person over time was 0.49 for coke workers and 0.48 for non-coke workers. The ICC of dietary pyrene intake within person over time was 0.46 for coke workers and 0.45 for non-coke workers. The ICC of urinary 1-OHP within person over time was 0.46 for coke workers and 0.43 for non-coke workers.

**Conclusion:** These results suggest the importance of repeated measurements on same individuals in order to obtain a reliable measure of average daily PAH exposures.

#### ISEE-1466

##### Statistical Methods to Study Windows of Vulnerability

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**Background:** Studying windows of vulnerability to environmental exposures is an active area of research in epidemiology. A popular statistical approach is to fit separate multiple regressions for each window of vulnerability. The estimated associations for each window are then compared across models in an ad-hoc manner.

**Objective:** We examine the utility of two alternate statistical methods in identifying windows of susceptibility to environmental exposures and subsequent health outcomes, which provide formal statistical tests of differences in windows of vulnerability. We utilize prenatal lead exposure data and child's neurodevelopment from the ELEMENT Study (Early Life Exposures in Mexico to Environmental Toxicants).

**Methods:** Maternal blood lead levels collected at each trimester of pregnancy were used as a biomarker of fetal exposure to lead. Child development was assessed using the Bayley's scale of mental development at 24 months. Covariate information was also available (e.g., maternal age and education). The analysis sample consists of 146 mother baby pairs with complete covariate and outcome information and at least one measure of fetal exposure. We first estimate multiple regression models (for each trimester) to estimate the association between maternal blood lead levels and child development at 24 months. Next we utilize a random effects model (random intercept and slope) to capture the changes in exposure within each mother over the course of pregnancy. The random effect estimates are used as predictors of child development. Finally, we adapt "multiple informants" methods to jointly fit the associations between child development and lead exposure during each trimester, and the null hypothesis that the associations are equal across trimesters is tested.

**Results:** The alternate methods acknowledge the inherent correlation in the multiple measures of exposure over time and can include all observations, even those with some missing data. This leads to increases in power to test the associations between exposure and health outcomes. For example, for first trimester exposure, the multiple regression *P*-value is 0.025 (*n* = 111), but is 0.010 (*n* = 146) from the multiple informant approach. First trimester lead exposure is a significant predictor of development; but, the test for differences in the associations between exposure and outcome across the windows of vulnerability was not significant (*P*-value = 0.70). On the other hand, the random effects approach showed that changes in exposure (random slope) throughout the pregnancy were not a significant predictor of outcome (*P*-value = 0.24) after adjusting for the significant effect first trimester exposure (random intercept, *P*-value = 0.015).

**Conclusions:** We present statistical models applicable to test for differences in associations between exposure and outcomes at different windows of vulnerability and demonstrated the advantages of these methods over multiple linear regressions using data from a cohort study of prenatal lead exposure and child development. Both methods find a significant association between first trimester exposure and neurodevelopment, but have divergent conclusions about differences in windows of vulnerability due to differing underlying assumptions. The methods are applicable to other areas of environmental epidemiology.

#### ISEE-1468

##### Lead Associated Deficits in Executive Function and Behavior in 3–7 Year Old Children in Chennai, India

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**Background:** Increased lead exposure is associated with significant deficits in neurocognition and behavior in children. However there are few studies that have assessed in depth the impact of lead on specific domains of behavior, such as executive function, attention and aggression. These behaviors influence learning and functioning in daily life.

**Objective:** The objective of this study was to evaluate the associations between lead and neurobehavior among 3–7 year old children in India and to assess the relative sensitivity of different dimensions of neurobehavior to lead.

**Methods:** A total of 756, 3–7 year old, children were enrolled from 12 schools in 4 industry and traffic zones in Chennai, India, from 2003–2006. Blood lead level was determined using the ESA lead care analyzer. Covariate information was collected using questionnaires completed by the child's primary caregiver. To assess neurobehavioral outcomes, each child's class teacher completed three questionnaires. The Conner's Rating Scales-Revised (CRS-R) yields scores for Aggression, Anxiety, and Sociability. The Conner's ADHD/DSM-IV Scales (CADS) yields score for Inattention, Hyperactivity, and an ADHD index and the Behavior Rating Inventory of Executive Function (BRIEF) yields scores on Behavioral Regulation, Metacognition, and General Executive Composite. Data analysis was carried out using multivariate linear regression and generalized estimating equations that accounted for clustering by school and teacher. All analyses controlled for age, gender, hemoglobin, maternal and paternal education, family income and number of other children in the family. The relative strength of the associations between blood lead and the different domains of behavior and executive function was evaluated by conducting analyses on Z-scores, with positive values denoting worse outcomes.

**Results:** The mean blood lead was 11.5 µg/dL (SD = 5.3, range 2.6–40.5), and 54.5% of children had a blood lead level greater than 10 µg/dL. Each log unit increase in blood lead level was associated with an increase of 12.7 points in the raw global executive functioning score (*P*-value < 0.001) and 1.45 points on the CADS ADHD index score (*P*-value = 0.02). An increase of one unit of log blood lead was associated with an increase of 0.25 in the mean Z-score for attention (CADS and CRS-R), and an increase of 0.20 points in the mean Z-score for Hyperactivity (*P*-value = 0.007). The magnitude of the association between lead and executive function was greater (*P*-value < 0.001) than the magnitude of its associations with the other behaviors assessed (ADHD, Aggression, Anxiety, Sociability).

**Conclusions:** High lead exposure remains an important public health issue in Chennai, India. Higher blood lead levels were associated with increased risk of neurobehavioral deficits, with executive function and attention appearing to be particularly vulnerable domains.

#### ISEE-1469

##### Spatial and Temporal Distribution of Vehicle Exhaust Emission Gradients Near Highways in Somerville, Massachusetts

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**Background:** Populations living in the vicinity of highways, freeways or major roads may be at risk of adverse health effects, such as reduced lung function, asthma, cardiovascular disease, and lung cancer, due to the elevated levels of automobile exhaust pollutants. To date, relatively little work has been done to characterize air pollution gradients near heavily trafficked roadways. In January 2008, we conducted a study to measure near-highway air pollutant gradients in temperatures < 0°C in the greater Boston area.

**Objectives:** The objectives of the study were to characterize the spatial and temporal distribution of pollutants, to determine the extent of the air pollution gradient, and to look for correlations between individual pollutants in near-highway air.

**Methods:** Several pollutants were studied, including particle-bound polycyclic aromatic hydrocarbons (PPAH), nitrogen oxides (NO<sub>x</sub>), carbon oxides (CO<sub>2</sub> and CO), aromatic hydrocarbons (benzene, toluene and xylene isomers), size and chemically-speciated particulate mass loadings, and total particle number concentrations (CPC; 7 nm to 2.5 µm). Pollutant concentration, temperature, wind speed and direction data were collected using a mobile air-monitoring laboratory. Continuous measurements of pollutants were repeatedly taken along four transects perpendicular to

Interstate 93 in Somerville, Massachusetts, from 6 AM to 11 AM, resulting in data showing air pollution gradients in real-time over the course of the morning.

**Results:** Downwind transect results indicate that CO decreased approximately 2-fold (800 to 400 ppb) over a 200-m distance from the highway, CO<sub>2</sub> decreased only slightly (425 to 400 ppm), NO<sub>x</sub> decreased approximately 4-fold (50 to 13 ppb), and CPC decreased approximately 3-fold (90,000 to 30,000 particles/cm<sup>3</sup>). Upwind transect results indicate that CO decreased approximately 3-fold (2100 to 700 ppb) over a 50 m distance from the highway, CO<sub>2</sub> decreased slightly from 430 to 400 ppm, NO<sub>x</sub> decreased approximately 4-fold (48 to 12 ppb), and CPC decreased approximately 3-fold (60,000 to 20,000 particles/cm<sup>3</sup>). All pollutant concentrations declined following sunrise, likely due to the break-up of the nocturnal thermal inversion, which reduces vertical mixing of surface emissions. CO, CO<sub>2</sub>, NO<sub>x</sub>, and CPC concentrations decreased 4-fold (800 to 400 ppb), slightly from 425 to 400 ppm, 5-fold (50 to 10 ppb), and 4-fold (80,000 to 20,000 particles/cm<sup>3</sup>), respectively, for both upwind and downwind transects between 7:00 and 10:00 AM. PPAH and aromatic hydrocarbon data were substantially scattered, a result possibly related to emission sources. The *number* concentration of fine particulate matter was dominated by particles less than 60 nm in diameter. Particle number concentration displayed a more pronounced gradient than the particle mass gradient. The highway enhancement in the *mass* of particulate matter consisted mainly of organic and sulfate particulate matter.

#### ISEE-1471

##### Seasonality of Pediatric Enteric Infections in Tropical Climates: Time-Series Analysis of Data from a Birth Cohort on Diarrheal Disease

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**Background:** Proper understanding of seasonality of enteric infections will improve our knowledge of host-pathogen biology and enhance our capability to predict future outbreaks. Rotavirus and cryptosporidiosis have distinct seasonal patterns depending on geographic location. Rotavirus shows distinct peaks during cooler months in temperate climate but no such seasonality is observed in tropical climates. On the other hand, cases of cryptosporidiosis tend to increase during warm rainy season in the tropics, whereas it peaks during winter and fall in temperate zones. This study assessed seasonality of childhood diarrhea in general, and diarrhea due to rotavirus and *Cryptosporidium* spp. in particular.

**Materials and Methods:** We conducted a weekly time-series analysis of data available from a birth cohort study in Vellore, South India. A total of 452 children were recruited at birth and followed up for three years on a twice-weekly basis. Fecal samples were collected from all children fortnightly as part of routine surveillance. Additionally, fecal samples were collected from any child who developed diarrhea, identified either by a routine field worker visit or self-referral by the mother. Data on all diarrheal episodes experienced by the cohort were extracted and merged with the database containing stool microbiology results. For rotavirus, only those samples positive by RT-PCR was considered positive. *Cryptosporidium* spp. was identified by microscopy of stool samples. Staggered recruitment was adjusted for by assessing seasonality of prevalence rates per 1000 child weeks. Seasonality was assessed for all diarrheal episodes as well as for the rotavirus and cryptosporidial diarrhea separately. Linear and quadratic trend were adjusted to account for potential changes in symptomatology due to protective immunity associated with re-exposure in the aging cohort.

**Results:** The cohort experienced a total of 2005 episodes of diarrhea, out of which 289 were due to rotavirus and 57 due to *Cryptosporidium* spp. Diarrhea overall peaked in the first week of June (week 24). In the last week of August in the second and fourth year of follow-up peaks of

diarrhea due to *Cryptosporidium* spp. were detected. Rate of rotavirus diarrhea peaked in second week of October (week 42) and had high amplitude in the first year that diminished over time. G1 and G2 were the most common genotypes for rotavirus whereas *C. hominis* was the most common species of *Cryptosporidium* identified. Strain-specific analysis showed both G1 and G2 rotavirus to have a well-defined seasonality with a significant negative trend. G1 appeared to exhibit a biannual peak with high intensity, whereas G2 strain appeared in an annual basis with less intensity. Coinciding peaks of G1 and G2 amplified the overall rotavirus intensity.

**Conclusion:** This study uses data from a community-based diarrheal disease study to look at the seasonality of diarrhea overall, and rotavirus and cryptosporidial diarrhea in children in south India. Preliminary findings suggest a strong seasonal pattern in potentially waterborne infection that was pronounced during hot and dry season. Further analysis will control for meteorological parameters including temperature and precipitation, behavioral factors, and water quality.

#### ISEE-1473

##### Arsenic Exposure and Prevalence of Type 2 Diabetes in U.S. Adults

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**Background:** High-chronic exposure to inorganic arsenic in drinking water has been related to diabetes development in Taiwan, Bangladesh and Mexico. However, the effect of exposure to low-moderate levels of inorganic arsenic on diabetes risk is unknown. In contrast, arsenobetaine, an organic arsenic compound derived from seafood intake, is considered non-toxic.

**Objective:** To investigate the association of arsenic exposure, as measured in urine, with the prevalence of diabetes in a representative sample of US adults.

**Methods:** Cross-sectional study in 998 adults  $\geq 20$  y who participated in the 2003–2004 National Health and Nutrition Examination Survey (NHANES) and had urine arsenic determinations. Total arsenic and arsenic species (arsenite, arsenate, methylarsonate [MA], dimethylarsinate [DMA], and arsenobetaine) were measured at the Environmental Health Sciences Laboratory of the National Center for Environmental Health using inductively coupled-plasma dynamic reaction cell-mass spectrometry (ICP-DRC-MS) and high performance liquid chromatography (HPLC)-ICP-DRC-MS, respectively. 96%, 92%, 65%, 16% and 28% of sample participants had arsenite, arsenate, MA, DMA and arsenobetaine levels below the limit of detection, respectively. Diabetes was defined as a fasting serum glucose  $\geq 126$  mg/dL, a self-reported physician diagnosis of diabetes, or self-reported use of insulin or oral hypoglycemic medication.

**Results:** The median urine levels of total arsenic, DMA and arsenobetaine were 8.3, 4.0, and 1.1  $\mu\text{g}/\text{L}$ , respectively. After adjustment for diabetes risk factors and markers of seafood intake (the main source of organic arsenicals), participants with diabetes had 20% higher total arsenic, 8% higher DMA, and similar arsenobetaine levels than participants without diabetes. Consistently, the odds ratios (95% confidence interval) for diabetes were 3.08 (1.31, 7.25), 1.45 (1.07, 1.96), and 0.86 (0.43, 1.71) comparing participants at the 80<sup>th</sup> vs. the 20<sup>th</sup> percentiles of total arsenic, DMA and arsenobetaine levels, respectively. The positive association between total urine arsenic and diabetes after adjustment for markers of seafood intake was consistent for subgroups defined by sex, age, race, body mass index, smoking status, and alcohol intake, and among participants who had no seafood intake in the past 24 h.

**Conclusions:** After adjustment for seafood intake, total urine arsenic and urine DMA, but not arsenobetaine, were associated with increased prevalence of diabetes. These findings support the hypothesis that low levels of exposure to inorganic arsenic in drinking water, a widespread exposure worldwide, may play a role in diabetes. Elucidating the

contribution of inorganic arsenic exposure to the diabetes epidemic is a public health research priority.

#### ISEE-1474

##### Health Impact of Air Pollution at Regional Level (Lombardy Region, Italy)

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**Background:** Currently health impact assessment of air pollution was applied to urban areas. The present study aims to calculate the burden of disease at regional level using data from the Lombardy Health Impact Assessment Project.

##### Data and Methods

**Risk estimation:** We estimate the effects of air pollution on hospital admissions for cardiac and respiratory acute conditions using data from all Lombardy towns with more than 50000 inhabitants, smaller towns provided they represent Province capitals and from the Lodi area, a homogeneous country site, for the period 2003–2006. The statistical analysis was based on a two stage procedure [1]. At the first stage we model the city-specific daily time series of cause-specific morbidity with respect to each air pollutant ( $\text{NO}_2$ , CO,  $\text{PM}_{10}$ ,  $\text{O}_3$ ). At the second stage of the analysis, first stage estimates are combined in a Bayesian random effects meta-analysis.

**Exposure Assessment:** We use a Bayesian kriging model to predict the average level of each air pollutant over the whole region during reference year 2006 [2]. Monitor data, population density, altitude and land use characteristics were included in the kriging model.

**Health Impact Evaluation:** Meta-analytic effect estimates, predicted exposure surface and morbidity information were combined to compute the number of events attributable to air pollution during 2006 in all the Lombardy municipalities.

**Results:** For example, we report results for nitrogen dioxide. City-specific effects appeared substantially homogeneous. The overall meta-analytic estimate of the percent increase in hospital admissions associated to a 10  $\mu\text{g}/\text{m}^3$  increase in air pollutant level is equal to 2.7% (95% credibility interval = 0.6 to 4.7%) for cardiac diseases and 2.4% (1.0 to 3.7%) for respiratory diseases (lag 0–3). The impact estimates on reference year 2006 for the Province capitals of Lombardy are reported in the table (percent of cause-specific hospital admissions attributable to  $\text{NO}_2$  concentrations higher than 10  $\mu\text{g}/\text{m}^3$  and attributable number of events per year in brackets).

**Conclusion:** The number of attributable cases depends on the air pollution level and the baseline rate observed in each municipality. The smaller impact in terms of attributable fractions is observed in the Lodi area, in Mantua and Sondrio, where the average daily levels of  $\text{NO}_2$  are lowest. The highest impact is observed in Milan (MI), Como (CO), Lecco (LC) and Brescia (BS).

#### ISEE-1477

##### ISEA 2008 Abstract for ECOC & Elements

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**Background:** Elemental and organic carbons, as well as selected toxic elements in  $\text{PM}_{10}$  (arsenic, copper, lead, manganese, nickel, zinc) were measured in ambient air at four sites in Paterson City, NJ. Measurements were conducted at three spatially different source-dominated sites located in Paterson, including commercial, industrial and mobile, and a background site located in Chester over a course of one year. Chester is located 58 km west/southwest of Paterson.

**Methods and Results:** Each sampling site was selected to represent specific land use type and local sources dominated in the area. Sampling monitors were placed on the roof of public school buildings (approximately 10 m above the ground) for industrial and mobile sites and Paterson Department of Health building (approximately 13 m above the ground) for commercial site in Paterson. The monitors for background site were located at the ground level of the State ambient air monitoring site in Chester. Kruskal-Wallis tests were performed to examine the spatial and temporal variations for the target species. The concentrations of EC, OC and most toxic elements (except arsenic) measured in Paterson were statistically higher than those measured in Chester ( $P < 0.05$ ); however, no significant differences in concentrations were observed among the three sites located in Paterson. A multiple linear regression model was constructed for each pollutant to determine how much of the variability in concentrations observed could be explained by the dominated local sources. The regression results showed that 20.1% to 63.8% (overall  $R^2$ ) of the variability could be explained by the model, varying by species. Land use type as well as precipitation and wind speed were significant predictors for all constructed regression models.

**Conclusion:** The information obtained will be useful for development of evaluation tools and risk reduction strategies that can be applied in other highly urbanized and populated communities like Paterson City, NJ.

#### ISEE-1478

##### Human Contamination to Organochlorine Pesticides and Birth Weight Distribution in Cidade Dos Meninos, State of Rio De Janeiro, Brazil

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**Antecedents:** In the early sixties, a pesticide factory producing HCH, DDT and other organochlorine compounds located in a rural settlement in Brazil named Cidade dos Meninos interrupted its activity. A thousand tons of pesticides remained in the facilities without major control procedures and were used by the population living around the factory.

**Methods:** A survey was carried out among Cidade dos Meninos residents aiming to evaluate the magnitude of contamination to such chemicals, biological samples (blood, human milk, blood cord and placenta) were collected, and local residents were interviewed. Blood levels of selected organochlorine pesticides were ascertained by electron capture chromatography. The survey was approved by an Ethics Committee. Birth weight distribution from 244 interviewed women according to the respective birth cohort and quartiles of DDE and beta-HCH were analyzed by ANOVA.

**Results:** A mean birth weight of 3,045 g was observed in the 1924–49 birth cohort, 3,072 g, in the 1950–62 birth cohort, 3,126 g in the 1963–75 birth cohort, 3,310 g in the 1976–91 birth cohort and 3,014 g in the 1991–2003 birth cohort ( $P$  linearity = 0.23). Mean birth weight among residents with both p-p'-DDE and beta-HCH high levels (4<sup>th</sup> quartile) was 3,172 g ( $s = 400$  g), while 3,123 g ( $s = 600$  g) among those with both organochlorine levels within the 1<sup>st</sup> quartile.

**Discussion:** The observed results do not suggest that birth weight distribution among Cidade dos Meninos residents has been affected as a consequence of a long term organochlorine exposure among parents, hence showing an average birth weight decline in subsequent cohorts. In this sense, our observations seem to not support an association between long term DDT and HCH exposure and subsequent low birth weight in affected populations.

#### ISEE-1480

##### Indoor Residential Assessment Using CARES®

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**Background and Discussion:** This poster is associated with the symposium: "State-of-the-Science Probabilistic Aggregate and Cumulative Residential Exposure Models and Recent Residential Exposure Measurement Studies: How the Data and Models Compare." The purpose of the symposium is to understand the relationships between environmental and biological concentrations and to also compare predictive model outputs to measured biological concentrations. The CARES® (Cumulative and Aggregate Risk Evaluation System) model has been developed to probabilistically estimate human exposure to pesticides by different pathways and routes (dermal, inhalation, and oral exposure). This population-based model estimates exposure using standard (U.S. EPA) or custom algorithms for each exposure route. The U.S. EPA utilizes CARES in its residential risk decision making process and therefore understanding the relationship between model predictions and measured biological concentrations is critical. A hypothetical case study based on a typical indoor residential application scenario of foggers in a household will be used to compare the results of different residential models used by EPA to residential exposure study measured results. Discussion will address the underlying model assumptions, product use data, predictive equations, and the specific input parameters. Model outputs will show the range of input parameters and the distribution of estimated exposure for specific populations.

#### ISEE-1482

##### Arsenic Exposure: Reliability of Spot Urine Samples in Epidemiological Studies

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**Background:** Urinary arsenic concentrations are often used as biomarkers of arsenic exposure. The 24-hour urine sample has been considered the most reliable sample type. First morning void (FMV) samples are more concentrated, and the metabolites obtained from the analysis are known to be in contact with the bladder for a longer period of time. However, both 24-hour samples and FMV samples are more expensive and difficult to collect compared with spot samples.

**Methods:** FMV samples and their corresponding spot urine samples from 131 participants enrolled in a case-control study in southeastern Michigan have been used to determine the correlation between FMV and spot urine samples. Urine samples were stored at  $-20^{\circ}\text{C}$  for an average time of 41 days and analyzed using HPLC and ICPMS for seven different arsenic species: AsB, As[III], As[V], MMA[V], MMA[III], DMA[V], and DMA[III]. Bland-Altman plots and correlation procedures were calculated to evaluate the relationship between FMV and spot urine samples after adjusting for specific gravity. DMA[III] and MMA[III] were not detected in any of the samples.

**Results:** A significant correlation ( $r = 0.795$   $P < 0.001$ ) was observed for total arsenic concentration (As[III] + MMA[V] + DMA[V] + As[V]) between FMV samples and their corresponding spot samples. Spot and FMV samples were the most correlated for MMA[V] ( $r = 0.831$   $P < 0.0001$ ), and DMA[V] was also strongly correlated ( $r = 0.774$   $P < 0.0001$ ) between samples.

**Conclusions:** Using urinary arsenic species concentrations suggest that spot samples are adequate for measuring arsenic exposure. In addition, FMV and spot samples showed a strong correlation of MMA[V], the excretion of which has been related to an increase risk of arsenic-related diseases. The benefit of using spot urine samples, instead of 24-hour or FMV urine samples, is the potential reduction in budgetary requirements and logistic strategies in epidemiological studies.

#### ISEE-1485

##### Evaluating Mercury Exposure and Dietary Metrics for Its Prediction in a U.S. Recreational Fishing Community

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**Objective:** The goal of this study was to assess mercury exposure in a group of recreational anglers in coastal Louisiana, and to determine the type and quality of dietary information necessary to accurately characterize and predict such exposures.

**Material and Methods:** During summer and fall of 2006, a total of 534 recreational anglers living in Louisiana were recruited either at dockside or through a web-based survey. Anglers completed a questionnaire detailing how frequently they consumed 88 different types of fish and shellfish over a 3-month period. Hair samples were collected from 402 of these anglers, and the proximal portion (up to 2 cm) was analyzed for total mercury (representing inorganic mercury plus methylmercury). Total mercury intake was estimated for each participant by several combinations of fish consumption data and fish mercury concentrations obtained from existing databases. Results were examined using linear regression. Principal component analyses were conducted on fish consumption data for those participants in the upper and lower quartiles of hair-mercury concentrations in order to identify qualitative dietary patterns associated with hair-mercury.

**Results:** Anglers' median hair-mercury concentration was 0.81 µg/g (range: 0.02–10.7 µg/g). In separate multivariate linear regressions, fish consumption ( $P < 0.0001$ ) and estimated total mercury ingestion ( $P < 0.0001$ ) were both significantly associated with hair-mercury after controlling for age, gender, body mass index, race, education level, and type of recruitment (web or in-person). However, these models explained only 17% and 18%, respectively, of the variance in hair-mercury concentrations. Principal component analysis identified several significant components of diet in both upper and lower quartiles of hair-mercury, but none of these components explained more than 9% of the variance in the data.

**Conclusions:** Anglers had higher hair-mercury concentrations and higher reported levels of fish consumption, as compared to those reported for the general US population. Multiple measures of fish consumption and mercury ingestion were significantly associated with hair-mercury concentrations in this group. However, low correlations between consumption and biomarker data indicate that such dietary information may not be sufficient to quantitatively assess mercury exposure in anglers, a group with easy access to an unusually wide range of fish choices. The low correlations may be due in part to the complexity of anglers' diets, a long recall period, or error in the estimated mercury content of anglers' diets. Principal component analysis, a more qualitative assessment of the relationship between diet and hair mercury, was also insufficient for predicting exposure. Consistent with this work, previous research has found that while retrospectively collected fish consumption information is generally associated with biomarkers of mercury exposure in fish consumers, correlations between these two measures are often low. Our observations raise questions about the ability of retrospective measures of fish consumption to accurately characterize mercury exposure, even when combined with estimates of mercury content in the fish consumed.

#### ISEE-1486

#### Air Pollution and Preeclampsia Among Pregnant Women in California, 1996–2004

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**Background:** Ambient air pollution exposures have been linked to hypertension and other cardiovascular events. Air pollution has also been associated with preterm delivery, of which preeclampsia is considered to be an important risk factor. Maternal hypertension during pregnancy is one of the symptoms of preeclampsia. We evaluate the relationship

between air pollution and preeclampsia in pregnant women in California to assess the possible contribution of air pollution to preeclampsia.

**Data and Methods:** Birth certificate information for California between 1996 and 2004 was linked to air pollution monitoring data from the California Air Resources Board. Singleton live birth, gestational age between 32 and 44 weeks and a plausible birth weight were eligible for the study. We assigned air pollution estimates for each singleton live birth by the mother's residence at the time of birth. We required a valid geo-code for mother's residence (1990 census tract, 2000 census tract, or 2000 ZIP Code Tabulation Area), and monitors with valid pollutant exposure estimate for any of the six criteria air pollutants for particulate matter (PM<sub>2.5</sub>, PM<sub>10</sub> and coarse PM), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. We coded each maternal address to the corresponding census tract and zipcode. We projected the selected monitors onto a California map in the Teale-Albers projection. We then calculated a network of Thiessen polygons to define the region closest to each monitor. For geo-codes entirely contained in one of the Thiessen polygons, we assigned the concentration estimate of that polygon's monitor. For geo-codes spanning more than one of these Thiessen polygons, we created an area-weighted average based on the area of the geo-code closest to each monitor. We then generated an average exposure estimate for the entire pregnancy. Conditions of preeclampsia and eclampsia coded on the birth certificate were evaluated for those women who had at adequate prenatal care and who did not have pre-existing chronic conditions such as hypertension, diabetes, heart disease or kidney problems prior to pregnancy. Logistic regression was used to evaluate the relationship between air pollution and outcomes, accounting for maternal characteristics on the birth certificate (race, age, parity, marital status, maternal education), neighborhood characteristics (poverty, unemployment, home ownership rates), and year and season of exposure.

**Results:** Our analysis included 2,307,366 births. After adjustment for maternal characteristics and neighborhood demographic we found adjusted odds ratios of 1.08 [95% confidence interval (CI), 1.02–1.14] for high CO exposures ( $>75$ th percentile) among mothers during their entire pregnancy who were residing within a 10 kilometer distance of a monitor. We also observed an elevated odds ratio of 1.14 [95% confidence interval (CI), 1.05–1.23] for high SO<sub>2</sub> exposures ( $>75$ th percentile). We did not find consistent positive relationships between other air pollutant exposures and risk of pre-eclampsia and eclampsia.

**Conclusions:** This study suggests that maternal CO and SO<sub>2</sub> exposure during pregnancy may be a risk factor for pre-eclampsia and eclampsia. Given the paucity of research on this subject, the association between air pollution exposures and risk pre-eclampsia and eclampsia should be further studied.

#### ISEE-1487

#### Reanalysis of the Risk of Breast Cancer and Tetrachloroethylene-Contaminated Drinking Water in Cape Cod, Massachusetts Using a Modified Exposure Assessment

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**Background:** In our prior epidemiological studies of PCE-contaminated drinking water in Cape Cod, Massachusetts, we used a simple model to retrospectively assess exposure. We found a small to moderate increased risk of breast cancer among highly exposed women. Since then, technical developments and increased availability of water distribution modeling software allowed us to modify the exposure assessment.

**Methods:** EPANET 2.0 is a publicly available software package that allowed us to incorporate sophisticated determination of water flow and direction to subject residential locations directly into the PCE exposure model. The current analysis uses EPANET-generated PCE exposure estimates to test exposure model assumptions, compare the exposure

distributions using the prior and current methods, and re-examine the risk of breast cancer among exposed women.

**Results:** With EPANET we detected exposures among individuals previously classified as unexposed; most of these people had low exposure. As a result, the overall exposure distribution was shifted downward resulting in a lower cut point for the 90th percentile (the definition of "high exposure" in the epidemiologic analyses). The refinement of the exposure assessment method changed (and arguably reduced) misclassification of unexposed subjects, but did not significantly affect the odds ratios for PCE exposure and breast cancer. A modest increase in the risk of breast cancer was seen again for women with high PCE exposure levels.

#### ISEE-1488

##### Aethalometer Black Carbon: Data Quality Issues and Data Analysis Methods

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**Background and Discussion:** The Magee Scientific Aethalometer is widely-used instrument for sustained measurement of aerosol "black carbon" mass concentration at high time resolution. The Aethalometer continuously collects particles onto a filter and measures the wavelength-dependent transmission of light through the deposit. Several investigators have noted this measurement can be influenced by the complex particle-photon interactions in the particle-filter matrix. A first principles model has been developed and published which shows the effective mass absorption efficiency of the deposited aerosol changes with the mass loading of absorbing particles onto the filter. This "optical saturation" effect is most-commonly observed as a step discontinuity in the reported concentration upon advancing the filter tape to deposit aerosol onto a clean filter spot instead of a particle-laden filter spot. The implication is that for the time period the aerosol is depositing onto the same filter tape spot, the reported black carbon concentration will decrease with time when the sampled aerosol has a constant black carbon concentration. We have found the optical saturation effect to have a distinct climatology in both Boston and St. Louis, presumably due to the presence of high summertime sulfate concentrations which can suppress optical saturation. Various equations have been developed to adjust Aethalometer data to compensate for the optical saturation effect, and one of these approaches has been incorporated into the Aethalometer data post-processing software distributed as freeware by the author. The approach relies on the concentration jump across tape advances and can be influenced by changes in the true black carbon concentration during such periods. Due to the noise inherent in the tape advance-specific compensation parameter estimation, it is necessary to perform time averaging on the compensation parameter. Thus, while changes in ambient aerosol composition (specifically, the aerosol single scattering albedo) often change on the order of days as synoptic weather fronts pass through an area that affect the mix absorbing and scattering aerosols, the minimum time scales for adjusting to changes in optical saturation is on the order of weeks. The presentation will demonstrate the nature of the optical saturation artifact in Aethalometer black carbon data and the influence of applied compensation factors on time series data. Data analysis methodologies to resolve emission source locations, such as frequency filtering of the data and nonparametric wind regression, also are briefly discussed.

#### ISEE-1489

##### Pilot Study of Serum Biomarkers of Polyfluoroalkyl Compounds in Young Girls

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Cincinnati, OH, USA; ‡Centers for Disease Control and Prevention, Atlanta, GA, USA; §California Department of Public Health, Richmond, CA, USA; and Division of Research, Kaiser Permanente, Oakland, CA, USA.

**Background:** Polyfluoroalkyl compounds (PFCs) such as perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) have been detected in humans and wildlife, and are associated with adverse health effects in laboratory animals and humans.

**Methods:** Through the NIH Breast Cancer and the Environment Research Centers (BCERC), in 2005 we conducted a pilot study of PFC environmental biomarkers in 6–8 year-old girls from Greater Cincinnati (N = 27) and the San Francisco Bay Area (N = 28). Discovery of elevated PFOA concentrations in one area within the Greater Cincinnati study center, higher than the national average, led to a second study at that center, in 2006.

**Results:** Five PFCs were detected in >95% of the girls. Geometric mean serum concentrations of PFOA differed at the two sites (4.9 vs. 14.7 ng/ml serum), an unexpected finding. Of the 27 girls from the Greater Cincinnati site, 14/15 girls living in one area of Northern Kentucky (NKY) had PFOA concentrations above the NHANES 2003–2004 95<sup>th</sup> percentile value for children 12–19 years (8.6 ng/ml). In a second expanded study of 42 girls from that area of NKY, the geometric mean serum PFOA concentration was 16.8 ng/ml; 38 girls were above the NHANES 95<sup>th</sup> percentile. Number of years lived in NKY ( $P = 0.009$ ) and being breast fed ( $P = 0.08$ ) were associated with higher concentrations. The analysis of the girls' residential history data suggested that the exposure was present throughout Northern Kentucky (NKY) and not limited to one area. Associations between PFOA and variables involving a location (including being born in NKY and breast fed) all were stronger when the location was defined as NKY rather than the one area. The relationship between the time of residence in NKY and serum PFOA concentration suggested that the time of primary exposure was prior to 2002. For 12 girls, the mean difference between PFOA measures, one year apart, was -10.2 ng/ml. In analyses of potential health effects, we found no relationship between PFOA serum concentration and BMI percentile, stage of breast development, serum triglyceride, or total, HDL and LDL cholesterol.

**Conclusions:** Most girls in the BCERC pilot study have had some exposure to PFOA and 4 other PFCs, demonstrating that their biomarkers are detectable and with sufficient variation in levels to enable studies of the association with pubertal maturation. Girls living in one area of Greater Cincinnati had significantly elevated serum PFOA concentrations, but no source of PFOA exposure has yet been identified. The elevated serum concentrations in this population justify additional measurements in a larger population to assess the extent of exposure and identify a source.

#### ISEE-1490

##### Indoor Air Quality: Influence on Health of Schoolchildren in Austria

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**Background:** In industrialized countries people spend approximately 90% of their time indoors. Hence, indoor air quality could have a significant influence on health and productivity of humans. Especially young children should be protected from exposure to indoor chemicals because of their higher vulnerability to pollutants in comparison to adults. Poor indoor air quality (IAQ) can cause acute health symptoms and illnesses requiring absence from school. Furthermore, a person's ability to perform specific

mental tasks, especially those that are cognitively demanding or that decrease performance while at school, can be reduced.

**Objective:** It should be tested whether differences in respiratory health, cognitive performance and concentration of contaminants in biological tissue of school children are associated with differences in indoor air quality. The project aimed at identifying sources of indoor pollution in schools. The project LuKi (Air and Children) is an Austrian contribution to the WHO CEHAPE (Children's Environment and Health Action Plan for Europe).

**Material and Methods:** Indoor air pollutants were continuously monitored for two 1-week periods in nine participating elementary schools. In addition, both house dust and air samples of particulates were investigated in order to cover the whole indoor air relevant matrices. The screening comprised of semivolatile compounds in particulate matter ( $PM_{10}$ ,  $PM_{2.5}$ ) and household dust (e.g. PAHs, PCBs, PBDE, trisphosphates phthalates, synthetic musks, pyrethroids, heavy metals). Moreover volatile organic compounds (VOCs) were measured in air samples and  $NO_2$  was monitored. Indoor humidity, temperature,  $CO_2$  concentration were also measured. These monitoring periods were accompanied by medical check-ups of pupils (aged 6–8 years) and by administering a parents' questionnaire on environmental and housing conditions and respiratory health of the children. Lung function was assessed by spirometry, cognitive performance by Standard Progressive Matrices (SPM). Furthermore, a biomonitoring for heavy metals in scalp hair samples and milk teeth was carried out. Woodlouses were collected and analyzed as bioindicators for heavy metals at school. Children were involved in the whole program in order to give them an impression of the complex relationship in their environment.

**Results:** 449 of 596 children parents answered a questionnaire. Spirometry was performed in 433, cognitive tests in 436, biomonitoring in 324 children. Significant differences in lung function (FEV, FEV<sub>1</sub>, MEF<sub>25</sub>) between the schools were found. Visible mould at home, smoking exposure in the households decreased lung function. History of breast feeding was associated with better values of spirometry. Boys showed (Pb 848  $\mu g/kg$ ; Cd 22  $\mu g/kg$ ) higher lead and cadmium concentrations in hair than girls (Pb 402  $\mu g/kg$ ; Cd 10  $\mu g/kg$ ). Concentration of mercury in hair samples correlates with fish consumption and higher education of parents. SPM Trisphosphates, PBDE and phthalates were found in higher amounts in all schools.

**Discussion:** Due to low background concentrations in Austria children showed low concentrations of heavy metals.

**Conclusions:** Schools should be designed, built, and maintained in ways to minimize and control sources of pollution. Environmental factors in the children's homes should be of concern too.

#### ISEE-1491

#### Indoor Environment and Asthma Linkage in a Nepal Urban Poor Setting

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**Introduction:** A community-based case control study was conducted to explore the linkage between the indoor environment (domestic fuel and passive smoking) in relation to urban poor school-going children.

**Methodology:** The study subjects comprised of 232 middle school children in the neighborhood. A screening tool for asthma was administered to the children. Parents were administered questionnaires assessing passive smoke exposure, domestic fuel use [liquefied petroleum gas (LPG) versus non LPG or mixed fuel use] and possible confounders.

**Results:** In the neighborhood the unadjusted odds ratio (OR) for the association between passive smoking and asthma was found to be 1.84 [95% Confidence Interval (CI) 1.06–3.21]. After adjusting for sex of the child, proximity to highway, socioeconomic status of family and housing

type, OR was found to be 1.58 (95%CI 0.87–2.86). If only the slums in the neighborhood are considered, the unadjusted OR for the association between passive smoking and asthma was found to be 2.30 (95%CI 1.07–4.95) whereas adjusted OR is 1.80 (95%CI 0.78–4.15). Similarly for domestic fuel use the corresponding unadjusted values for the neighborhood were OR 0.91 (95%CI 0.54–1.54) whereas adjusted values were OR 0.79 (95%CI 0.45–1.41). For slums alone unadjusted values were OR 1.05 (95%CI 0.50–2.19) whereas adjusted values were OR 1.00 (95%CI 0.45–2.23).

**Conclusion:** The findings demonstrate inconclusive results (after adjusting for possible confounders) with regard to the linkage between the indoor environment and asthma in developing country urban poor settings. Several other studies from developing countries have also shown conflicting results. Other methodological issues such as extent of LPG use in households with mixed fuel use and possible exposure misclassification for passive smoking also need urgent consideration.

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#### ISEE-1493

#### Modeling Intra-Urban Spatial Variability of Volatile Organic Compounds Using a Land Use Regression Method

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**Background and Objectives:** Land use regression (LUR) has emerged as an effective and economical means of estimating exposures for epidemiological studies. The LUR method relies on saturation monitoring over many spatial locations for short periods, usually one to two weeks. Although numerous studies have employed LUR models to estimate nitrogen oxides and to a lesser extent particulate matter indicators, ambient concentrations of VOCs are much less explored. Some VOCs have high plausibility as the source of health effects observed in epidemiological studies and others are specific indicators of motor vehicle exhaust. This research applies LUR for estimation of spatial variability of volatile organic compounds (VOCs) in Toronto, Canada.

**Methods:** VOCs were measured from July 25 through August 9, 2006, at 46 locations using the TraceAir organic vapor monitors. Measured VOCs included benzene, n-hexane and total hydrocarbons (THC). Nitrogen dioxide was also sampled at those 46 locations during the same period using Ogawa samplers.  $NO_2$  was used to assess agreement between VOCs and criteria pollutants for assigned exposures. To assist in selecting spatial covariates for LUR, 30 or 60 circular area distances (buffers) of interval 50 m were created for each sampler, ranging from 0–50 m, 0–100 m, 0–150 m, and up to 0–1500 m for traffic related sources or up to 0–3000 m for land use, population density and tasseled-cap transformation (i.e., a remote sensing technique that estimates greenness and soil brightness). This gives us a distance decay of correlation to identify optimized buffer distances for model selection. The sensitivity of model parameters was evaluated with corresponding sampling distributions from a nonparametric bootstrap in which each replicate generated a set of random samples (with replacement) and fitted regression coefficients of a linear model. The spatial autocorrelation of each VOC model was tested using the Moran's *I* statistic using a permutation of 999 iterations. The modeled VOCs along with  $NO_2$  were assigned to 5600 subjects from an ongoing health study and then classified into quartile categories for assessment of degree of exposure agreement.

**Results and Discussion:** Among the spatial covariates explored, tasseled-cap transformations have the highest correlations with VOCs and  $NO_2$  levels, and more than 36% of the variance are explained in most of the models with this one variable. The slope gradients of the road link explain 25 and 16% of the variances for expressway  $NO_2$  and Benzene emissions, respectively. The VOC models have  $R^2$  values between 0.65 and 0.73, comparable to the  $NO_2$  model of  $R^2 = 0.70$ . The degree of agreement between VOCs ranks from 48 to 63% for all the four categories with an average of 53%. The degree of agreement increases substantially for those

top and bottom quartile group subjects, up to 75%. By contrast, the degree of agreement between NO<sub>2</sub> and VOCs are much smaller with an average of 36%. Thus, future epidemiologic studies may benefit from using VOCs as a more specific marker of traffic that may directly exert health effects.

#### ISEE-1494

##### Time Trends and Factors Associated with Human Body Burdens of Persistent Organochlorine Compounds Measured in Residents of Washington County, Maryland, 1974 and 1989

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**Background:** Persistent organochlorine compounds (OCs), including DDT and PCBs, were banned or had uses curtailed in the United States in the 1970s due to concerns about human exposure and potential adverse health effects.

**Methods:** We examined concentrations of o,p'-DDE, p,p'-DDE, total PCBs, gamma hexachlorocyclohexane (HCH), beta-HCH, mirex, and transnonachlor (TNA) in blood samples from adult participants, collected in 1974 (843 samples) and 1989 (495 samples). The 1974 blood samples were stored as serum and the 1989 blood samples were stored as plasma. Blood samples were analyzed as part of nested case control studies, conducted in the 1990s, using the CLUE I and CLUE II specimen banks in Washington County, Maryland. Demographic, behavioral, and other factors, such as age, sex, body mass index (in 1989 only), lipid concentrations, and cigarette smoking, collected at the time of blood donation, or analyzed as part of the case control studies, were examined for associations with OC blood concentrations cross-sectionally at the two time points, and as change over the 15-year period in the 246 adults who served as controls in the studies and contributed blood samples at both time periods.

**Results:** Overall, declines in mean blood concentrations of wet weight p,p'-DDE, total PCBs, beta-HCH, and mirex in the larger cross-sectional samples were observed between the two time periods. Mean blood concentrations of gamma-HCH, o,p'-DDE, and TNA were higher in the 1989 sample compared to the mean blood concentration of these chemicals in the 1974 population sample. In these cross-sectional samples, the strongest associations with blood concentrations of the measured OCs were observed for sex, with lesser associations by age. For the paired data, where 246 individuals provided blood samples in both 1974 and in 1989, differences in the degree of change were observed for males and females. The median wet weight p,p'-DDE concentrations for females in 1974 and 1989 were 12 ng/dL and 9 ng/dL, respectively, though approximately one-third of females had no change or an increase in blood p,p'-DDE concentrations. Among males, the median wet weight concentrations in 1974 and 1989 were 23 ng/dL and 7 ng/dL, respectively, and no male had an increase in measured p,p'-DDE in 1989 compared to his 1974 measurement. This difference by sex was also observed, but to a smaller extent, for total PCBs. The female median total PCBs blood concentrations in 1974 and 1989 were 2.5 ng/dL and 1.2 ng/dL, respectively. For males, the median total PCBs concentrations were 6.2 ng/dL and 2.8 ng/dL in 1974 and 1989, respectively.

**Discussion:** Governmental policies that eliminated the continuing use of persistent OCs, including PCBs and DDT-related compounds, in the U.S. have resulted in decreased exposures to these compounds. Though these declines have been observed at the population level, during the period from 1974 to 1989, some individuals may not have experienced a decline.

#### ISEE-1495

##### Genotoxicity and Adverse Human Health Outcomes Among People Living Near Highly Polluted Waste Water Drains in Punjab, India

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**Background:** Depleting water resources, industrialization and rampant use of pesticides and fertilizers in agriculture has led to pollution of water bodies in Punjab. This is associated by acute and chronic morbidities among humans.

**Objectives:** To ascertain the pattern and extent of water pollution and determine association, if any, between exposure to water pollution and adverse human health.

**Methods:** A cross sectional survey was done among 5567 and 2289 persons selected in reference and control area to determine prevalence of systemic and general health morbidities. Effluent, ground and surface water samples along with fodder, vegetable, milk (bovine and human), blood and urine samples were tested to ascertain influence of heavy metal and pesticide pollution of water bodies.

**Results:** Gastrointestinal, water-related, eye, skin and bone diseases were significantly associated among reference area population ( $P < 0.05$ ). Higher prevalence of micronuclei was observed among reference area population while 40% and 10% reference area population was detected as moderate and highly mutated respectively. Mercury, lead, chromium, cadmium and selenium were found in more than permissible limits in ground and surface water. Chlorpyriphos,  $\beta$ -endosulphane, dimethoate, heptachlor and  $\alpha$ -endosulphane were found in samples of effluent and ground water with concentrations exceeding MPL. Heavy metals and pesticides were also detectable in fodder, vegetable, milk, urine and blood samples.

**Conclusion:** Thus the present study brings to light evidence of significantly higher systemic and general health morbidities along with manifestations of genotoxic effect of a cocktail of heavy metal and pesticide contamination of waste water which has infected the ground and surface water. Stringent monitoring of water quality of drains, industry and municipal bodies for organic and inorganic pollution is required. Further studies for identification of DNA adducts are needed to identify the specific heavy metals and pesticides involved in genotoxicity.

#### ISEE-1496

##### DNA Methylation Profiles of the 11-beta HSD2 Promoter are Related to Childhood and Lifetime Trauma in Pregnant Women: Project ACCESS

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**Background:** Determining the range of environmental exposures which might affect the epigenome during critical periods of development is an active area of research. Prenatal maternal stress may have long-lasting programming effects on the physiological development of children mediated through altered activity of the maternal hypothalamic-pituitary-adrenocortical (HPA) axis. Maternal HPA functioning, in turn, may be altered by traumatic life experiences albeit the mechanisms underlying these effects are not fully elucidated. We examined the influence of childhood and lifetime traumatic stressors on gene specific DNA methylation profiles of the 11-beta hydroxysteroid dehydrogenase type 2 (11-beta HSD2) promoter region in 229 pregnant mothers enrolled in the Asthma Coalition on Community, Environment, and Social Stress (ACCESS) project, a prospective urban cohort designed to study the effects of early life stress on childhood asthma risk.

**Methods:** Early life trauma history was collected using the Childhood Trauma Questionnaire (CTQ) and lifetime exposure was ascertained using

the My Exposure to Violence (ETV) survey in approximately mid-pregnancy. Bisulfite-treated genomic DNA extracted from maternal peripheral blood mononuclear cells (pBMCs) was subjected to DNA methylation analysis by quantitative Pyrosequencing. Linear regression analyses predicting percent methylation in the 11-beta HSD2 promoter were adjusted for maternal age, race and education level, childhood and current socioeconomic status, gestational age at blood draw, prenatal smoking, and other current negative life events. For each trauma scale, those in the upper tertile (high trauma) were compared to those with lower scores.

**Results:** Overall mean (SD) values for 11-beta HSD2 methylation was 90.4% (5.1%). Mean (SD) age was 26.4 (5.7) years. Among the women, 62% were Hispanic and 23.5% were African American, 67% had a high school education or lower, and 16.7% smoked during pregnancy. Higher levels of trauma on the CTQ ( $\beta = 2.1, P = 0.005$ ) and lifetime ETV scales ( $\beta = 1.8, P = 0.07$ ) independently predicted increased methylation.

**Conclusion:** Maternal exposure to childhood trauma and cumulative lifetime violence (chronic stress) is associated with hypermethylation of the promoter region of 11-beta HSD2 in mother's leukocyte DNA. Hypermethylation has been associated with decreased expression of 11-beta HSD2 which modulates the intracellular access of glucocorticoids to their receptors. Conversely, up-regulation of 11-beta HSD2 may protect against stress-induced elevated glucocorticoids. This, in turn, may have implications for maternal-fetal cortisol metabolism. Thus, epigenetic modulation of genes influencing prenatal HPA axis response may be one mechanism underlying prenatal programming effects of psychosocial stress on the next generation which warrants further study.

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#### ISEE-1499

#### Cadmium Exposure and Neurodevelopmental Outcomes in NHANES Data

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**Background:** Little is known about the effects of low-dose chronic cadmium exposure on neurodevelopmental outcomes.

**Objective:** We evaluated for potential associations between creatinine-corrected urinary cadmium concentration and Attention Deficit Hyperactivity Disorder (ADHD) and learning disability (LD) using the National Health and Nutrition Examination Survey (NHANES).

**Materials and Methods:** Data were extracted from a subset of participants in the 1999–2004 NHANES who were aged 6–15 years and had spot urine samples taken. Urine cadmium levels were determined using inductively-coupled plasma-mass-spectrometry, and corrected for urine concentration with urine creatinine. Parents/proxy respondents or the child themselves (if over age 12), reported whether a doctor/health professional had ever told them that the subject had ADHD. They also reported whether a school representative/health professional ever told them that the subject had a LD. We used logistic regression (with-SAS), accounting for the complex survey design characteristics of NHANES, to estimate associations between creatinine-corrected urinary cadmium and the outcomes. To account for the non-normal distribution of urine cadmium, and allow for the detection of nonlinear associations, we divided urine cadmium into quartiles, and compared each quartile with the lowest quartile. Preliminary analysis of ADHD was adjusted for age, sex, race/ethnicity, preschool attendance, insurance coverage, mother's-age-at-birth, prenatal-smoke-exposure, poverty-income ratio, report of smoker-in-the-home, serum cotinine, and blood lead. Preliminary analyses of LD were adjusted for age, sex, hemoglobin level, report of smoker-in-the-home, poverty-income ratio, blood lead, and serum cotinine.

**Results:** Report of ADHD was noted in 198 of 2195 children (9.0%), and LD was reported in 276 of 2189 children (12.6%). In the multivariable-adjusted analysis, prevalence of reported ADHD was significantly lower among children in the highest quartile of urinary Cd (adjusted odds-ratio [OR] comparing highest vs lowest quartile of urinary cadmium: 0.41 [Wald95% CI: 0.17–0.99]). In the LD multivariable-adjusted analysis, greater odds of LD may be associated with higher urinary cadmium: the adjusted prevalence OR comparing highest vs lowest quartile of urinary cadmium was 1.75 (Wald95% CI: 0.86–3.56). Notably, the risk for LD appeared to be similar in the second through highest quartiles, and when the upper 3 quartiles were combined and then compared with the lowest quartile, we found an OR of 1.65 (Wald95% CI: 0.93–2.93). In initial model building variations, significance conclusions occasionally varied, but effect estimate trends appeared quite robust to changes in various modeling assumptions/parameters.

**Conclusion:** These preliminary results suggest that higher urinary Cd may be associated with lower risk of ADHD but perhaps also higher risk of LD. Although these data are cross-sectional, urinary cadmium levels integrate exposures over many years. Several possible explanations may underlie these findings, for example: 1) Cd may cause a global dampening of neurological processes such that activity levels are decreased while learning is impaired. 2) There may be reporting bias which correlates with cadmium exposure 3) Children with ADHD or LD may be less/more likely to be exposed to Cd after developing the diagnosis (i.e. exposure could be secondary to behaviors associated with the diagnosis and not causative), and 4) There may be confounding by variables not accounted for in the models.

#### ISEE-1501

#### Spatial Characteristics of Aerosol and Gaseous Co-Pollutant Concentrations During the Fresno Asthmatic Children's Environment Study

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**Background:** Understanding the spatial variability in air pollutant concentrations is important for many epidemiologic studies, like the Fresno Asthmatic Children's Environment Study (FACES), that rely primarily on central site monitoring data to characterize community exposures.

**Objective:** The objective of this analysis is to characterize the spatial variation in ambient anthropogenic and biological aerosols as well as ozone and NO<sub>2</sub> concentrations in a 30-km diameter region centered on Fresno, California.

**Methods:** The analysis database consists of measurements of particulate matter, its chemical components, and gaseous co-pollutants collected as part of FACES. These measurements were taken at the U.S. EPA Fresno First Street Supersite, nine schools associated with FACES subjects, and 80 FACES subject residences. The pollutants include PM<sub>2.5</sub> and PM<sub>10</sub> mass, PM<sub>10</sub> trace metals, PM<sub>2.5</sub> elemental carbon, endotoxin, fungal spores, pollen, ozone, and NO<sub>2</sub> concentrations. The spatial variability of 24-hr average concentrations is quantified using numerous methods, including the mean daily coefficient of spatial variation, the mean coefficient of divergence between site pairs, and the mean absolute spatial variations. The differences in the spatial characteristics are stratified as a function of surface meteorological conditions and season.

**Results:** The results indicate the spatial variability rankings for PM<sub>2.5</sub> and PM<sub>10</sub> mass are low, with average daily coefficient of variations less than 20%. PM<sub>2.5</sub> elemental carbon, PMcoarse mass, endotoxin, and most gaseous pollutants are shown to exhibit moderate spatial variability, with average daily coefficient of variations between 20% and 40%. NO exhibits high spatial variability. The spatial variability of the PM<sub>10</sub> trace metals,

pollens, and spores vary in ranking by component. The variability is illustrated in spatial pollutant surfaces.

**Conclusion:** The implications for epidemiologic studies are that exposure misclassification errors are likely to vary strongly with chemical composition in an urban setting like Fresno.

#### ISEE-1502

#### Comparing Fish Consumption Information Collected via a Telephone Survey and a Food Frequency Questionnaire

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**Background:** The Washington State Department of Health is currently using an established telephone survey (the Behavioral Risk Factor Surveillance System or BRFSS) to collect data on the frequency, amount and types of fish people eat to help plan and evaluate its Fish Advisory Program.

**Objectives:** The objective of this study was to assess the differences in reported fish consumption between the BRFSS telephone survey and a self-administered food frequency questionnaire (FFQ) modified to include more specific questions about fish consumption. The secondary objective was to estimate the distribution of exposure to mercury based on biomonitoring of hair samples. Eating fish containing mercury is the primary route of exposure to mercury for the general public.

**Methods:** A total of 1035 women between 18 and 44 years of age were recruited from among women who had participated previously in the BRFSS and had agreed to be contacted in the future regarding other health studies. The participants were randomly assigned to two groups. The first group responded to the telephone survey first, and then completed the mailed FFQ. The second group completed the study in the reverse order. Participants were invited to provide a self-collected hair sample once they completed both the telephone survey and the FFQ. Participants returned their hair sample by mail along with a short questionnaire to help identify other potential sources of mercury exposure. 799 participated in both surveys and of these 412 also provided hair samples.

**Results:** While the same proportion of respondents reported eating store-bought fish in the past month using the two instruments, a lower proportion reported eating canned tuna and sport-caught fish during the telephone survey as compared to the FFQ responses. There was good agreement between the telephone survey and the FFQ for estimating the mean number of meals reported in the past month for both store-bought and sport-caught fish. The telephone survey and FFQ reported similar proportions of women eating different types of store-bought fish (e.g. salmon, halibut, cod, etc.) in the past month. There was little difference between women who provided a hair sample for mercury analysis compared with those that did not in terms of age, race, income, and fish intake (mean meals in past month). 5.3% of women who provided a hair sample had a mercury level  $\geq 1$  ppm, which is equivalent to EPA's recommended intake limit for methyl mercury. Regression analysis showed that eating certain types of fish (halibut, sole, tuna steak, and canned albacore tuna) is positively associated with mercury levels in hair, suggesting that knowing what types of fish women eat may be a good indicator of high mercury exposure.

**Conclusion:** These results indicate that collecting fish consumption information using a telephone-based survey such as the BRFSS is a valid method for estimating the proportion of the public who eat store-bought fish and the types of fish people eat, and for estimating how frequently they eat store-bought and sport-caught fish.

#### ISEE-1503

#### Traffic-Related Air Pollution in a Densely Populated Urban Area

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**Background:** Somerville and Cambridge, Massachusetts, border each other north of the Charles River in metropolitan Boston and are the first and third most densely populated cities in New England. Interstate 93 (I-93) traverses Somerville and has the highest traffic volumes in Massachusetts (143,000 vehicles per day). Several state highways run through both cities and serve as major arteries for intra-city and inter-city transport.

**Methods:** We conducted a preliminary assessment of air pollution in the cities with the eventual goal of determining a spatial surface of traffic-related air quality in the two communities. Two-week average nitrogen dioxide ( $\text{NO}_2$ ) concentrations were measured simultaneously at up to 68 locations adjacent to highway, surface artery, and residential roads in November 2007 and again in December 2007.

**Results:** In transects perpendicular to I-93,  $\text{NO}_2$  levels were 28 ppb adjacent (20 meters) to the highway. In the prevailing upwind direction,  $\text{NO}_2$  decreased to 17 ppb (40% decrease) within 80 m of I-93. Highway-related levels dissipated more slowly in the prevailing downwind direction where  $\text{NO}_2$  reached 17 ppb approximately 180 m from the highway. Black carbon (BC) was measured continuously at two sites approximately 50 meters from I-93 for approximately 3 weeks during both the winter and summer of 2007. BC was directly related to hourly traffic count and ranged from an average of  $0.7 \mu\text{g}/\text{m}^3$  at 2,000 vehicles per hour to  $1.5 \mu\text{g}/\text{m}^3$  at 10,000 vehicles per hour. Notably,  $\text{NO}_2$  concentrations at sites within 10 meters of surface arteries in areas of high commercial and residential density (e.g., Harvard Square) were 25 ppb and approximately equal to levels adjacent to I-93. Concentrations of  $\text{NO}_2$  along quiet residential streets in Cambridge and Somerville ranged from 13 to 15 ppb. Site-specific  $\text{NO}_2$  concentrations were strongly correlated ( $r = 0.69, P < 0.0001$ ) between the two sampling events.

**Conclusions:** The results of this preliminary assessment reveal substantial spatial and temporal gradients in traffic-related air pollution at the neighborhood and street level across the Somerville-Cambridge area. Future efforts will be directed toward fitting a predictive model to the  $\text{NO}_2$  data that will support assignment of traffic-related air pollution exposures with high spatial resolution throughout the two cities.

#### ISEE-1504

#### Fine Particulate Air Pollution and Its Components in Association with Cause-Specific Emergency Admissions in 26 U.S. Cities

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**Background:** Although the association between exposure to particulate matter (PM) mass and mortality is well established, there remains uncertainty as to whether certain chemical components of PM are more harmful to human health than others.

**Methods:** We used a hierarchical approach whereby we first applied a city and season specific Poisson regression to estimate the association between daily  $\text{PM}_{2.5}$  mass and cause-specific hospital admissions, followed by a meta-regression to examine how this association was modified by season-and city-specific particle composition.

**Results:** For the combined  $\text{PM}_{2.5}$  results we found a 1.9% increase (95%CI: 1.3–2.5) in cardiovascular admissions, a 2.3% increase (95%CI: 1.1–3.4) in myocardial infarction admissions, a 1.9% increase (95%CI:

1.2–2.5) in coronary heart failure admissions, a 2.7% increase (95%CI: 1.3–4.2) in diabetes admissions, and a 2.1% increase (95%CI: 1.2–2.95) in respiratory admissions for a 10  $\mu\text{g}/\text{m}^3$  increase in 2-day averaged PM<sub>2.5</sub>. The effect was stronger in spring compared to the other seasons. The association between PM<sub>2.5</sub> and cardiovascular admissions was significantly ( $P \leq 0.05$ ) modified by Br, Cr, Ni, and Na+. At the 75th percentile in the proportion of Br in PM<sub>2.5</sub> mass, there was a 2.4% increase (95%CI: 1.8–3.0) in cardiovascular admissions associated with a 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub>; a 2.1% increase (95%CI: 1.5–2.6) for Cr, 2.3% (95%CI: 1.7–2.9) for Na+, and 2.1% increase (95%CI: 1.6–2.7) for Ni. The heart failure admissions association was modified only by Br and Ni; the association with myocardial infarction admissions was significantly modified by As, Cr, Mn, OC, Ni, and Na+, with increases between 2–3%. The association between PM<sub>2.5</sub> and diabetes admissions was modified by As, OC, and Sulfate. We found a 3.8% increase (95%CI: 2.0–5.6) at the 75th percentile of the proportion of As in PM<sub>2.5</sub> mass; and a 4.1% increase (95%CI: 2.2–5.9) for sulfate. The relation with OC was negative with higher effect at lower concentration of OC; we found a 4.1% (95%CI: 2.3–5.8) increase for the 25th percentile of the proportion of OC and PM<sub>2.5</sub> mass.

**Conclusions:** The most consistent result we found is that higher proportions of nickel significantly modified the association between PM<sub>2.5</sub> mass and cause-specific hospital admissions. This result suggests that particles from residual oil combustion are particularly toxic.

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#### ISEE-1505

#### Temporal Variation in the Association Between Benzene and Leukemia Mortality

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**Background:** Exposure to benzene occurs in a variety of occupational and environmental settings.

**Methods:** To better understand the leukemogenic effects of benzene, I investigated variation in benzene-related leukemia with age-at-exposure and time-since-exposure. Data from a cohort of 1845 rubber hydrochloride workers were analyzed. Benzene exposure-leukemia mortality trends were estimated by applying proportional hazards regression methods. Temporal variation in the impact of benzene on leukemia mortality was assessed via exposure time-windows and fitting of a multistage cancer model.

**Results:** The association between leukemia mortality and benzene exposures was of greatest magnitude in the 10 years immediately after exposure (relative rate, RR, at 10 ppm-year = 1.19, 95% confidence interval, CI: 1.10, 1.29); the association was of smaller magnitude in the period 10–<20 years after exposure (RR at 10 ppm = 1.05, 95%CI: 0.97, 1.13), and there was no evidence of association 20 or more years after exposure. Leukemia was more strongly associated with benzene exposures accrued at ages 45 years and above (RR at 10 ppm-year = 1.11, 95%CI: 1.04, 1.17) than with exposures accrued at younger ages (RR at 10 ppm-year = 1.01, 95%CI: 0.92, 1.09).

**Conclusion:** Jointly, these temporal effects can be efficiently modeled as a multistage process in which benzene exposure affects the penultimate stage in disease induction. Further attention should be given to assessing the susceptibility of older persons to benzene-induced leukemia.

#### ISEE-1508

#### Evaluation of Metrics Used to Assess Improved Stove Interventions in Mexico

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**Background:** Exposure to health damaging pollutants from the use of solid fuels in cookstoves is associated with approximately 1.6 million deaths per year and 4% of the global burden of disease.

**Methods:** Given such adverse health effects, the impact of installing improved wood burning “Onil” stoves on carbon monoxide (CO) personal exposures, kitchen concentrations, and exhaled breath were evaluated in 43 homes in Chiapas, Mexico, where 80% of residences use fuelwood for cooking.

**Results and Discussion:** Median 24-hour kitchen CO concentrations dropped 88%, from 7.2 to 0.9 ppm ( $P < 0.001$ ), and personal exposure of the primary stove user was reduced by 73%, from 4.1 to 1.1 ppm ( $P < 0.001$ ) after the introduction of the Onil improved stove. Median exhaled breath CO concentration of the primary stove user was reduced 50%, from 6.0 to 3.0 ppm ( $P < 0.001$ ). Reductions in CO concentrations as a result of the improved stove were linearly related to the initial concentrations with the traditional stove, showing consistent performance of the improved stove in reducing CO concentrations to low levels in all participants and homes ( $r^2$  values of 0.92, 0.80, and 0.82 for kitchen, personal exposure, and exhaled breath concentrations, respectively). Perhaps more importantly, these results demonstrate that absolute percentage reductions, which are typically reported, are not the most relevant metric for evaluating the efficacy of improved cookstove programs, and the ratio of the reduction to the initial concentrations with the traditional stove would provide more relevant information on stove performance. Further, these relationships were consistent between 2 different stove types in 2 different areas of Mexico, demonstrating that reductions in CO and particle concentrations can be consistently predicted from initial concentrations with traditional stoves, which significantly reduces the costs and effort in monitoring for epidemiologic and efficacy measurements using these stove types.

#### ISEE-1509

#### Urinary Cadmium and Cerebral Vascular Accident

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**Background:** Cadmium has been associated with cardiovascular effects in animal studies and with peripheral arterial disease (PAD) in the U.S. general population. A previous analysis of a cohort suspected of having exposure to high levels of cadmium in soil showed excess mortality from cerebral vascular accident (stroke). However, the relation of cadmium to stroke risk in the general population has not been explored.

**Objective:** The objective of this study was to investigate the association of measured cadmium exposure with self-report of stroke in the general population. We analyzed data from 2,887 adult participants, aged 30 years and older, in the National Health and Nutrition Examination Survey (NHANES) 1999–2004 for whom information was also available on smoking in pack-years, smoking status, and serum cotinine; self-reported diabetes, heart disease and hypertension; body mass index; alcohol consumption; and socio-demographic characteristics. Urinary cadmium, a marker of cumulative cadmium exposure, was measured by inductively coupled plasma-mass spectrometry. Cadmium levels were creatinine-corrected and log-transformed for statistical analyses.

**Results:** One hundred and twenty-two persons reported a history of stroke at their interviews. After adjusting for demographic and cardiovascular risk factors, a 50% increase in creatinine-corrected urinary cadmium corresponded to a 26% increase in the odds of prevalent stroke [OR: 1.26; 95%CI: 1.09, 1.47]. Limiting the observation to those with cadmium level below the Occupational Safety and Health Administration (OSHA) standards (3  $\mu\text{g}/\text{g}$ ), the odds ratio was 1.32 [95%CI: 1.14, 1.55]. Adjusting for blood lead did not alter the results.

**Conclusion:** In the U.S. general population, low-level community exposure to cadmium is associated with an increased prevalence of stroke.

#### ISEE-1510

#### Seasonal and Spatial Distributions of Nickel in New York City Ambient Air

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**Background:** Fine particle ( $PM_{2.5}$ ) speciation data has indicated that New York City (NYC) has the highest nickel (Ni) concentration of any US city ( $18 \text{ ng/m}^3$ ), while the national average is  $\sim 2 \text{ ng/m}^3$ . The best known source categories of Ni in ambient air are: 1) residual oil combustion in stationary power plants; and 2) deep-water ships in port.

**Methods:** In order to explore whether these sources, which are clearly present in and around NYC accounted for the high levels of Ni in NYC, we collected STN and IMPROVE data in NYC and the neighboring States of NJ and CT on Ni.

**Results and Discussion:** We found the highest levels, by far, were in NYC, and that the Ni levels in NYC were far higher in the winter than in the summer. Furthermore, the highest levels were at sites surrounded by large commercial and residential buildings, implying that space heating with residual oil combustion was the largest Ni source. The extent of the seasonal and spatial variations within NYC was determined by establishing a broader spatial network of samplers. The data on Ni distributions within NYC are being used to model Ni concentrations across the city that, when combined with hospital admissions data on hospital admissions (by zipcode and cause) will determine whether Ni can account for increased admission rates.

#### ISEE-1511

#### Effectiveness of Smoking Policy in the U.S. Trucking Industry Terminals

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**Objective:** There is a large body of epidemiologic evidence supporting an association between secondhand smoke (SHS) exposure and adverse health effects in adults, and this subsequently led to smoking bans in workplaces in the US. However, it is unclear if the implementation of specific policies in the industrial workplace reduces SHS exposure. In this study, we examined the effects of smoking policies and other workplace related factors on SHS exposure, as measured by vapor-phase nicotine levels, among employees in the United States unionized trucking industry.

**Material and Methods:** We visited 25 trucking terminals throughout the US in 2003–2004. Workers were asked to wear personal vapor-phase nicotine samplers on their lapels for two consecutive work shifts on two consecutive days. They completed a questionnaire at the end of personal monitoring, providing information on demographic characteristics, job title and work history, smoking status, SHS exposure (at work, at home, in social situations), workplace smoking policy, location and size of smoking areas, and sensory irritations. We also collected information on the smoking policy and workplace characteristics from the terminal managers.

The nicotine badges were analyzed by gas chromatography with nitrogen selection. Multiple regression analyses using robust variances were used to determine important predictors of nicotine concentrations.

**Results:** 203 non-smoking (median nicotine level  $0.87 \mu\text{g}/\text{m}^3$ ) and 61 smoking workers (median  $5.96 \mu\text{g}/\text{m}^3$ ) participated in this study. The smoking policy (no policy, smoking allowed in designated indoor areas, or outdoor only) differed by terminal, and the policy reported by workers ("perceived") and managers ("official") only agreed 50% of the time. After controlling for terminals and demographic characteristics, perceived smoking policy ( $\beta = 2.7$ , with policy vs. no policy), time spent and the extent of active smoking in designated areas ( $\beta = 1.3$ , in the area for  $>30$  minutes with  $>3$  smokers vs. other), job title ( $\beta = -0.67$ , drivers vs. non-drivers), and work shift ( $\beta = 0.72$ , night shift vs. other shifts) were statistically significant predictors of nicotine levels in non-smokers, but official smoking policy was not. Nicotine levels were statistically significantly lower for workers who reported "indoor designated area policy" and "outdoor only policy," compared to those who reported "no policy." For smokers, both the perceived and official smoking policies did not have a significant effect on nicotine levels.

**Conclusions:** Our findings suggest that the effectiveness of official smoking policies is relatively poor in this industry. The workers' perceived, rather than the official, policy is associated with SHS exposure level among the non-smokers. Further, workplace factors such as job title and work shift were important predictors of SHS exposure in this occupational setting.

#### ISEE-1512

#### Effects of Early Childhood Exposure to Traffic Related Air Pollution on Asthma and Wheeze in School Aged Children in Toronto

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**Background:** Studies have shown that exposure to traffic related air pollution (TRAP) exacerbates symptoms in children with pre-existing asthma and related respiratory conditions. Whether TRAP increases the incidence of such conditions remains unclear. The association between TRAP and asthma and wheeze was examined in a sample of grade 1 and 2 students in Toronto.

**Methods:** Cross sectional data were collected from 5619 children aged 5 to 9 attending publicly funded schools in Toronto in 2006. Current (last 12 months) and ever wheeze, and doctor diagnosed asthma, rhinitis and eczema and use of medication for wheeze were evaluated by questionnaire. Current asthma was defined as ever doctor diagnosed asthma with current wheeze or current use of medication for wheeze. Atopic asthma was defined as current asthma together with doctor diagnosed rhinitis, eczema or any food allergy. Sex, current exposure to environmental tobacco smoke, income adequacy and history of parental asthma were examined as possible susceptibility factors. Information on current home address and addresses at birth and during the prenatal period was collected from a subset of 1498 subjects including all those with asthma and a random sample of control children with no history of wheeze or chronic cough. Exposures were estimated using two approaches. The first consisted of mapping addresses to validated land use regression model surfaces.  $NO_2$  surfaces were based on two-week sampling campaigns over three seasons during 2002, 2004 and 2006 using Ogawa passive diffusion samplers at 143 locations across Toronto. Surfaces were also constructed for selected volatile organic compounds (VOCs) including benzene, toluene, ethylbenzene, m/p-xylene, o-xylene, methyl tert-butyl ether and n-hexane based on sampling from a subset of the locations used for  $NO_2$ . The second approach involved inverse distance weighted interpolation from published Ontario Ministry of the Environment and National Air Pollution Surveillance network annual statistics for  $NO_2$ ,  $O_3$ ,  $PM_{2.5}$  and  $SO_2$  (1992, 1997 and 2002 data). These

approaches were applied to both current addresses and addresses at birth. The latter were the same as prenatal addresses in nearly all subjects. Generalized estimating equations were employed to correct for school clustering effects.

**Results:** Current exposure to  $\text{NO}_2$  and VOCs exhibited no consistent associations with asthma or wheeze. Each 1 unit increase in  $\text{NO}_2$  exposure at birth was associated with an increase in the risk of current asthma (OR 1.15, 95%CI 0.97–1.37), ever asthma (OR 1.19 95%CI 1.01–1.40), current atopic asthma (OR 1.27, 95%CI 1.05–1.54) and ever wheeze (OR 1.20, 95%CI 1.06–1.36). Associations were adjusted for sex, current smoke exposure and income adequacy. No effect modification was seen by sex or history of parental asthma.

**Conclusions:** These results support previous findings from the Netherlands and France that show associations between TRAP exposure in early life and the development of asthma. Further analyses using life-time address history to determine cumulative exposure and exposures during specific time intervals will be conducted to further elucidate this association.

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#### ISEE-1513

#### Impact of Improved Air Quality During the 1996 Atlanta Summer Olympic Games on Cardiovascular and Respiratory Outcomes

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**Objective:** Substantial evidence supports an association between ambient air pollution, particularly particulate matter and ozone, and acute cardiovascular and respiratory morbidity. There is increasing interest in evaluating whether actions taken to reduce air pollution levels will result in reduced morbidity. This study capitalized on a unique opportunity to evaluate the impact of a local, short-term intervention effort to reduce traffic in Atlanta during the 1996 Summer Olympic Games (July 19, 1996–August 4, 1996).

**Materials and Methods:** Information on daily visits to emergency departments was collected from hospitals serving the metropolitan area for the time period 1993 through 2004. Ambient air pollution concentrations from sites in Atlanta and from around the southeastern United States were collected. Air pollution levels both within and outside of Atlanta were examined during the Olympics compared to other time periods in the same and other years. Emergency department (ED) visits for were examined in a similar manner in order to evaluate changes in usage patterns during the Olympics. ED visits for respiratory and cardiovascular conditions and ventricular arrhythmias from patients with implantable cardioverter defibrillators were examined in relation to the Olympic time period using Poisson time series analysis adjusting for meteorologic conditions and longer-term time trends in the ED and pollution data.

**Results:** Ozone levels were approximately 30% lower during the Olympic period compared to the four weeks before and after the Olympics. Levels of  $\text{PM}_{10}$ , nitrogen dioxide, and carbon monoxide were also somewhat lower during this time period, while sulfur dioxide levels increased slightly. We observed reductions of ED visits for asthma and for upper respiratory infections, particularly for pediatric age groups (relative risk [RR] = 0.75, 95% Confidence Interval [CI] = 0.55–1.01 and RR = 0.82, 95%CI 0.65–1.02, respectively), during the Olympic time period, as well as an increase in COPD visits during this time period (RR = 1.37, 95%CI = 1.05–1.80). While limited in sample size, we observed fairly large reductions in ventricular arrhythmias in patients with implantable defibrillators during the Olympic time period (RR = 0.32, 95%CI = 0.14–0.72).

**Conclusions:** It is unclear how much of the reduction of pollution levels during the Olympic time period was due to the intervention effort and how much was due to prevailing meteorologic conditions. Regardless, air pollution levels were reduced during this 17-day period, and our results provide evidence for reductions in emergency department visits, particularly for pediatric upper respiratory infections and asthma, and ventricular arrhythmias during this time period.

#### ISEE-1514

#### T-Wave Alternans, Air Pollution and Traffic in Patients with Recent Coronary Events

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**Objective:** Traffic exposure has been linked to the risk of myocardial infarction. We investigated the associations of ambient  $\text{PM}_{2.5}$ , black carbon (BC) and being in traffic with T-wave alternans (TWA), a marker of cardiac electrical instability measured as differences in the amplitude between adjacent T waves.

**Material and Methods:** A population of 43- to 75-year old Boston area residents ( $N = 48$ ) was examined with ECG Holter. Monitoring was conducted for each resident for 24-hours on up to four occasions within one year after an acute cardiac event precipitating a hospitalization. Each 24-h Holter monitoring period was divided into 30-min intervals, and TWA was computed by modified moving average analysis for each interval and reported as the maximum (TWA-MAX) TWA amplitude. From diary data, the location of each participant was determined for each half hour period, with location noted as home or not home, and in traffic defined as driving a car, riding a bus, subway or train. Air pollutant exposures were estimated using concentrations measured at our stationary ambient monitoring site. Estimates for effects of the previous 2-h exposure were scaled by  $10 \mu\text{g}/\text{m}^3$  for  $\text{PM}_{2.5}$  and by  $1 \mu\text{g}/\text{m}^3$  for BC.

**Results:** The median of the differences in TWA-MAX was 21 microvolts ( $\mu\text{V}$ ). In a regression model controlling for subject, day of the week, and penalized splines of hour of day, date, heart rate, mean temperature, and traffic we found increases in TWA-MAX to be associated with increases in levels of  $\text{PM}_{2.5}$  and BC averaged from 1 up to the previous six hours before the TWA measurement. TWA-MAX increased by 2.1% (95%CI: 0.9–3.3) with increased 2-h average BC and by 6.1% (95%CI: 3.4–8.8) if participants were in traffic. TWA-MAX increased by 1.7% (95%CI: 0.7–2.7) with increased 2-h  $\text{PM}_{2.5}$ , and by 6% (95%CI: 3.3–8.7) with traffic exposure. The effect of traffic remained similar with different averaging times of air pollution; air pollution effects did not change when models did not control for time in traffic, showing that traffic and ambient central site-measured PM/BC had independent effects.

**Conclusions:** Short-term exposures to ambient air pollution and traffic are associated with increases in TWA amplitude in vulnerable populations.

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#### ISEE-1515

#### A Multi-Country Study of Secondhand Smoke Exposure in Homes Worldwide: Determinants of Concentrations of Nicotine in the Air of Homes and in the Hair of Women and Children

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**Background:** Despite evidence of a causal association between secondhand smoke (SHS) exposure and lung cancer and other diseases, the Global Youth Tobacco Survey, conducted in 132 countries, found that 46.5% and 43.9% participants (13–15 years) self-reported that they were living with smoking parents and exposed to secondhand smoke at home, respectively. Limited global information is available on the association between non-smoking children's or women's SHS exposure levels and indoor SHS levels.

**Objectives:** The purposes of this study were 1) to evaluate factors, such as housing characteristics, contributing to differences in air nicotine concentrations in homes, and 2) to characterize the association between concentrations of air nicotine in the home and its use as a biomarker for women and children's exposure to SHS.

**Methods:** Forty households from each of 31 different countries in South America, Europe and Asia participated in this study. Passive nicotine monitors were placed for 7 days in the room where the family spent time together. Air nicotine samples were analyzed using gas chromatography and nitrogen/phosphorous detection. Hair samples were collected from non-smoking women and children <11 years to measure nicotine concentrations. Hair nicotine was determined using gas chromatography with mass spectrometry. Self-reported information about house characteristics and subjects' demographic information were also collected. Multilevel linear regression modeling was used to evaluate determinants of SHS exposure.

**Results:** Housing characteristics, including house type, construction materials and the number of doors and windows, were not associated with air nicotine concentrations. However, there was a dose-response relationship between the number of cigarettes smoked in the house and air nicotine concentrations after adjustment for housing characteristics. Unit increase of air nicotine concentration ( $\mu\text{g}/\text{m}^3$ ) was associated with 3% and 1% increase of hair nicotine concentration among nonsmoking children and women, respectively, after controlling for age, time spent at home, and other socio-demographic characteristics. Children's hair nicotine concentrations decreased as age increased. There was no association between age and hair nicotine levels among women. Additionally, women with chemical hair treatment had lower hair nicotine concentration than women without hair treatment by a factor of 0.9 (95%CI = 0.7, 1.1), indicating that hair nicotine concentrations might be slightly underestimated among women with hair chemical treatment.

**Conclusions:** Increased air nicotine concentrations, reflecting the number of cigarettes smoked in the home, were associated with increased hair nicotine concentrations in non-smoking women and children from 31 countries worldwide. Promoting nonsmoking policies in homes can reduce SHS exposure in the home and protect nonsmoking women and children from involuntary exposure to tobacco smoke.

#### ISEE-1516

#### Integrating Demographic, Clinical, and Environmental Exposure Information to Identify Genomic Biomarkers Associated with Subtypes of Childhood Asthma

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**Background:** Childhood asthma is a multifactorial disease with a disturbingly high incidence in urbanized areas. The pathogenesis of asthma is poorly understood due to the complex relationship between genetic susceptibility and modulating environmental factors. The Mechanistic Indicators of Childhood Asthma study (MICA) has collected

multiple types of clinical, demographic, exposure, and gene expression data in order to examine the interplay between environmental and genetic factors affecting asthma in a case/control cohort of children (aged 9–12 years). Oligonucleotide microarrays were used to measure gene expression from blood samples. Here, we hypothesize that asthmatic subtypes can be identified by considering gene expression data in the context of clinical measures of asthma severity/symptomology and biomarkers of environmental exposure.

**Methods:** As a first step toward identifying subtypes, we applied an unbiased (i.e. without knowledge of asthma status) analysis to assess the association between gene expression data and information on clinical, demographic, and environmental exposure indicators gathered for 195 children. For subsequent analyses, we select only gene expression probe sets that are significantly correlated with at least one of the demographic, clinical, or exposure indicators. This filtering method prevents us from selecting only genes whose expression is associated with broadly-defined, imperfect asthma diagnoses. Statistical techniques amenable to handling disease outcome subtypes are then used to model the association of gene expression biomarkers with various definitions of asthma. Examination of the genes differentiating asthma subtypes in the context of demographic, clinical, and environmental exposures highlights mechanistic genomic etiologies underlying the disease. These include subtypes of asthma characterized by patterns of gene expression associated with immune over-stimulation and household allergy exposures, as well as combinations of genomic biomarkers with demographic factors such as gender.

**Discussion:** It is hoped that studies such as this may shed light on genes contributing to asthma pathology and environmental factors modulating the expression of those genes. Better understanding of the mechanistic underpinnings of varied asthma subtypes may lead to more personalized diagnosis, management, and treatment of the disease.

*This work was reviewed by EPA and approved for publication but does not necessarily reflect official Agency policy.*

#### ISEE-1517

#### Determination of the Population at Risk of Heavy Metal Exposure Associated with a Former Zinc Smelter

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**Background:** We evaluated heavy metal abundance in the vicinity of a former zinc smelter to determine the population at potential risk of residual exposure to arsenic, cadmium, and lead following closure of the facility in 2001. Production of elemental zinc slabs and zinc oxide dust for approximately ninety years was estimated to release approximately 1,500 tons of Cd, 5,000 tons of Pb, and 100,000 tons of Zn to the atmosphere through stack and fugitive emissions from the smelter. Insufficient data on emission factors were available to estimate emissions of As to air. Residue from the smelting process was accumulated on-site in a pile approximately 1 km long, 150 meters wide, and 30 meters high. The residue pile contained unfired briquettes composed of coal and processed zinc ore and other materials that frequently burned and smoldered. Analyses of surface soil samples from plant property and residue pile revealed substantially enriched levels of As, Cd, Pb, and Zn (means of 272, 44, 2798, and 35320, respectively). Field campaigns conducted in 2003–2007 yielded environmental samples from multiple environmental exposure media in communities surrounding the former smelter that were analyzed for As, Cd, Pb, and Zn. Surface soil samples were obtained from 1,068 locations within approximately 16 kilometers of the smelter. Interior dust samples were collected from occupied areas and attics of 100 residential and commercial buildings in the area as well. Heavy metal levels were also determined in 8-hour integrated particulate matter samples obtained at 6 locations proximate to the facility prior to

and after cessation of secondary smelting operations. Finally, heavy metal emissions, transport, and deposition were predicted for each soil and dust sample location in the domain using the CALPUFF modeling system.

**Results:** Concentrations of As, Cd, Pb, and Zn in soil, interior dust, attic dust, and ambient air of the study area were substantially and significantly higher (medians up to 8-fold greater,  $P < 0.0001$ ) than the corresponding concentrations in comparable reference areas. Concentrations of the four metals in soil and dust decreased significantly ( $P < 0.05$ ) with increasing distance from the smelter. The geographic pattern of heavy metal deposition predicted for emissions from the former smelter explained 74% to 98% of the variability of community-average Cd, Pb, and Zn levels in soil and 25% to 50% of the variability of As, Cd, Pb, and Zn in attic dust of individual homes. Multivariate logistic regression of lead and arsenic enrichment in soil as a function of predicted heavy metal deposition was used to define the geographic domain of the population at risk of elevated exposure to smelter-related heavy metals. The approximately 23 km<sup>2</sup> domain centered on the former smelter includes approximately 10,000 people distributed among 7 towns and intermediate areas.

**Conclusion:** This community-based evaluation demonstrates the utility of an integrated multi-media measurement and modeling approach for determination of populations at risk of specific source-related exposures.

#### ISEE-1519

#### Geographic-Based Prediction of Agricultural Pesticides in Household Carpet Dust in the Central Valley of California

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**Background:** Epidemiologic studies have used residential proximity to agricultural pesticide applications to estimate ambient pesticide exposure. Little is known about the relationship between the proximity to agricultural pesticide applications and the resulting pesticide levels in the home.

**Methods:** We collected carpet dust samples from 60 residences in Central California and mapped agricultural land use within 0.8 mile (1.25 km) of each location. Dust samples were analyzed using gas chromatography-mass spectrometry to determine concentrations (nanograms per gram of dust) of six pesticides with extensive agricultural use in California: chlorpyrifos, dicofol, iprodione, simazine and trifluralin. California has a mandatory Pesticide Use Reporting (PUR) system that provides the active ingredient, pounds applied, crop treated, date and geographic location to approximately one-mile resolution for all commercial pesticide applications. We used a geographic information system (GIS) to estimate agricultural pesticide use near each residence from PUR data alone and by combining the PUR data with land use maps to estimate pesticide use at a finer spatial scale. Each metric was tested for its ability to discriminate homes exposed using logistic regression and predict concentration using linear regression for pesticide applications within 300, 500, 750, 1000, and 1250 meters of residence locations and during time periods of six months, one, two, and three years prior to the residence sampling date. We considered a ROC C-statistic value of greater than 80% to be a good predictor of pesticide occurrence. ROC is a measure of a model's predictive ability in a range of 0 to 100%, with 50% being random chance.

**Results:** The six pesticides were detected in 13% (dicofol) to 95% (chlorpyrifos) of carpet dust samples. The land use metrics were not good predictors of pesticide detections of dicofol, iprodione, phosmet, or trifluralin in homes either using PUR alone (ROC C-statistics 61.7%, 66.3%, 67.8%, respectively) or using PUR with landuse (ROC C-statistics 61.3%, 59.7%, 64.4%, respectively). However, both metrics

predicted pesticide concentrations of iprodione, phosmet, simazine, and trifluralin in homes in which these pesticides were detected (PUR alone  $P < 0.05$ ;  $R^2$  21.9%, 28.5%, 21.6%, 13.7% respectively) and using PUR with landuse ( $P < 0.05$ ;  $R^2$  29.9%, 27.8%, 20.9%, 14.9% respectively). Only the land use metric significantly predicted chlorpyrifos concentrations ( $P < 0.05$ ;  $R^2 = 9.7\%$ ). We augmented these metrics with soil and meteorological data. Wind speed and direction were found to be the most important variables, improving prediction of pesticide detection of dicofol, iprodione, phosmet, or trifluralin in homes (ROC C-statistics 73.8%, 70.3%, 70.3%, respectively) and were significant predictors of pesticide concentrations in house dust samples with detected pesticide ( $P < 0.001$ ;  $R^2$  18.6%, 58.4%, 48.4%, 40.9%, 29.2% respectively). Soil information was not a significant predictor of pesticide detection or concentration.

**Conclusions:** Pesticide use proximate to residences was not a good predictor of pesticide occurrence in house carpet dust. Both PUR and land use metrics significantly predicted concentrations of five of the six pesticides in homes with detections. Including wind information improved the predictive power of metrics.

#### ISEE-1520

#### Indoor Residential Exposure Assessment for Pesticides Using Calendex™

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**Background and Discussion:** This poster is associated with the symposium, "State-of-the-Science Probabilistic Aggregate and Cumulative Residential Exposure Models and Recent Residential Exposure Measurement Studies: How the Data and Models Compare." The purpose of the symposium is to understand the relationships between environmental and biological concentrations of pesticides and also to compare predictive model results to measured biological concentrations in exposed individuals. Calendex™ was developed to facilitate probabilistic estimates of human exposure to chemicals via different pathways and routes (dermal, inhalation and oral). Calendex™ is a calendar-based model that tracks source terms and models resulting exposures over time. Calendex™ is a platform in which the user specifies all equations, data and assumptions to estimate exposure. The U.S. EPA default residential SOPs are often used as a starting point, but there is no restriction on the algorithms which may be specified by the user. The U.S. EPA has used Calendex™ in assessing aggregate and cumulative exposures to the organophosphate and n-methyl carbamate classes of pesticides. Developing an understanding of the relationship between model results and measured biological concentrations is therefore important to inform regulatory decision making. To that end, a hypothetical case study based on a typical indoor residential application of foggers in a household was developed as a common basis for model comparison. The underlying model algorithms, predictive exposure equations, and assumptions for specific input parameters utilized in the case study are reviewed. Model outputs showing the range of estimated exposures for specific populations are summarized and key determinants of the predicted exposures are identified. The case study results using Calendex™ and those for other residential exposure models will be reviewed and discussed in the related symposium session.

#### ISEE-1521

#### Comparison of Immunoassay and High Performance Liquid Chromatography for Measuring Urinary Metabolites of Atrazine, Metolachlor, and Chlorpyrifos from Farmers

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**Methods:** Urine samples were collected from 50 participants in a study investigating pesticide exposure among farm families in Iowa. Aliquots from the samples were sent to two different labs and analyzed for

metabolites of atrazine (atrazine mercapturate), metolachlor (metolachlor mercapturate) and chlorpyrifos (TCP) by two different analytical methods: immunoassay and high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). HPLC-MS/MS methods tend to be highly specific, but are costly and time consuming. Immunoassay methods are cheaper and faster, but can be less sensitive due to cross reactivity and matrix effects. Three statistical methods were employed to compare the two analytical methods. Each statistical method differed in how the samples that had results below the limit of detection (LOD) were treated. The first two methods involved an imputation procedure and the third method used maximum likelihood estimation (MLE).

**Results:** The immunoassay and HPLC-MS/MS methods were moderately correlated (correlation 0.40–0.49), but the immunoassay methods consistently had significantly higher geometric mean (GM) estimates for each pesticide metabolite. The GM estimates for atrazine mercapturate, metolachlor mercapturate, and TCP by immunoassay ranged from 0.16–0.98 µg/L, 0.24–0.45 µg/L and 13.94–14.13 µg/L, respectively and by HPLC-MS/MS ranged from 0.0015–0.0039 µg/L, 0.12–0.16 µg/L, and 2.91–2.99 µg/L, respectively.

**Conclusion:** For this comparison between two analytical methods with censored data, MLE provided the most meaningful estimates.

#### ISEE-1522

#### Kitchen CO and PM Measurements from Biomass Smoke in Highland Guatemala

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**Background:** The Chronic Respiratory Effects of Early Childhood Exposure to Respirable Particulate Matter (CRECER) study is following a cohort of children previously enrolled in RESPIRE, a randomized stove intervention trial.

**Methods:** The RESPIRE-Guatemala trial (Randomized Exposure Study of Pollution Indoors and Respiratory Effects) enrolled 534 households of Mam-speaking indigenous Mayans residing in 23 communities in the Western Highlands to participate in a study of the impact of indoor air pollution (IAP) on acute lower respiratory infection (ALRI) incidence among children 18 months<sup>[1]</sup>. The households were allocated randomly to control and intervention groups, with the control households continuing to cook over open fires (receiving an improved chimney stove referred to as the *plancha* at the end of the study period) and the intervention group receiving a *plancha* upon enrollment into the study. The CRECER study, currently in its third year, is monitoring the same cohort of children longitudinally for an additional 5 years to elicit the chronic effects of inhaled PM during the critical time window of infant lung development on respiratory health. The primary hypothesis is that early life (first 18 months) exposure to biomass smoke, which contains high levels of particulate matter (PM), will negatively affect respiratory health later in childhood by causing increased symptoms of cough, phlegm production, and wheeze; a decreased rate of growth of lung function; increased risk of sensitization to aeroallergens; and decreased anthropometric growth. Personal CO concentrations are being measured over the duration of the study for the entire cohort of children as an indicator of wood smoke. Intensive monitoring of CO and PM concentrations are being collected in a subset of households including continuous and measurements as well as personal and area air pollution concentrations.

**Results:** In the first six months of the CRECER study (months) CO was found to highly correlate with PM measurements. Comparison of the kitchen measurements for CO and PM for the cumulative measurements produce a correlation coefficient (R) of 0.83 with  $P < 0.001$ . The maximum concentration CO and particulate concentrations were 25.3 ppm/hr and 3.04 mg/m<sup>3</sup> respectively. Minimum concentrations were 0.4

ppm/hr for CO and 0.041 mg/m<sup>3</sup> for PM and the mean concentrations were 5.2 ppm/hr and 0.58 mg/m<sup>3</sup>. The significant correlation over a large range of concentrations supports use of CO as an indicator for wood smoke in the CRECER study. Cumulative CO and PM results for the entire to date study period will be presented.

[1] For more information about the ALRI study, please visit the Guatemala Stove Intervention Trial web site at: <http://ehs.sph.berkeley.edu/guat/admin/admin/fso.asp>.

#### ISEE-1523

#### Variability of Phthalate Metabolites Determined in Spot Urine and Fractionated 24-Hour Urine Samples

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**Background:** The general population is exposed to phthalates through nutrition, consumer products and medical devices. In respective studies measurable concentrations of phthalate metabolites are usually determined in spot urine samples. Little is known about total daily excretion of phthalate metabolites and their correlation with concentrations in spot urine samples. Aim of the presented analyses was to explore possible correlations of phthalate metabolites determined in two fractions of 24-hour urine samples and in spot urine samples in a group of volunteers of German general population.

**Methods:** We recruited 35 volunteers among university students and a music class of an adult education centre to participate in the study. They were asked to complete a questionnaire concerning nutrition and lifestyle factors as well as self-reported health status and environmental worry. In addition, single spot and 24-hour urine samples were collected to determine phthalate exposure. The 24-hour sampling period started in the morning directly after the morning spot urine (SA) was collected and was divided into two 12-hour collection periods (A1 and A2). Six weeks later additional morning spot urine (SB) was sampled. We analysed the sum ( $\Sigma$ DEHP4) of one primary and three secondary metabolites of Di(2-ethylhexyl)phthalate (DEHP) MEHP, 5OH-MEHP, 5oxo-MEHP, 5cxMEHP in each sample. Wilcoxon singed-rank test was used to analyse similarities between the related samples of different fractions (SA vs. A1; A2 vs. A1, SA vs. SB) for raw concentrations and calculated 12-hour-excretion (concentration of  $\Sigma$ DEHP4 [µg/l] in each 12-h-fraction multiplied with volume/of the related fraction) of  $\Sigma$ DEHP4.

**Results:** Concentrations of phthalate metabolites of the entire study group (n = 35, age: median = 26 ys, 63% women) entered analysis. For the raw concentration of  $\Sigma$ DEHP4 median concentration [25th-; 75th-percentile] was 14.4 µg/l [9.7; 29.6] in SA, 28.4 µg/l [13.8; 66.7] in A1, and 48.3 µg/l [30.0; 85.8] in A2. Differences of raw concentrations were identified between the daytime fractions A1 and the spot urine samples SA ( $P = 0.021$ ) taken on the same morning, and between the day and night samples ( $P = 0.031$ ) of the same 24-hour collection period. The spot urine sample after six weeks (SB) differed highly ( $P = 0.001$ ) also with a median concentration for  $\Sigma$ DEHP4 = 65.8 µg/l [41.9; 89.4]. Median excretion for  $\Sigma$ DEHP4 was 32.9 µg/12h [19.8; 58.4] during daytime, and 34.2 µg/12h [26.9; 74.3] at night and no differences could be found between these fractions ( $P = 0.499$ ).

**Discussion:** Calculated excretion of DEHP metabolites showed rather constant values in this study while raw concentrations led to differences between night and day fractions and spot urine. These results give further

indication that spot urine samples are least appropriate to assess phthalate exposure, while 12-hour urine samples and determination of excretion of metabolites seem more reliable. Long-term phthalate exposure is necessary to be assessed in epidemiological studies and seems to be determined more accurately this way.

#### ISEE-1524

#### Updated Meta-Analyses of Benzene and NHL and of Formaldehyde and Leukemia

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**Background:** Previous meta-analyses and reviews of benzene and non-Hodgkin lymphoma (NHL) and of formaldehyde and leukemia have concluded that no clear association exists between these outcomes and exposures. We performed updated meta-analyses of these topics that include more recent studies and incorporate the impact of exposure misclassification, outcome misclassification, and the healthy worker effect. **Methods:** Following a thorough literature review, meta-analyses of the current epidemiologic literature on benzene and NHL and on formaldehyde and leukemia were performed using the inverse-variance weighting method with adjustments of variance for heterogeneity. A meta-analysis of refinery work and NHL was also performed since benzene exposure has been historically associated with this industry. Several studies on these topics presented relative risks (RR) for different exposure groups. For example, one RR would be presented for "all exposed" subjects and a separate RR would be presented for only those subjects with very high exposures (i.e. >16 ppm-years). Previous meta-analyses on these topics typically selected the RR for the "all exposed" group. However, this category can include some people with very low exposures and thus limit the ability to identify causal associations. In our meta-analyses, we chose the group with the highest exposure. For formaldehyde, previous meta-analyses used data for all leukemia types combined. In our meta-analysis we chose data specifically for myeloid leukemia when available. Including cancer cell types not associated with the exposure can also limit the ability of studies or meta-analyses to identify true effects.

**Results:** In the meta-analysis of benzene and NHL, the summary RR was 1.22 (95%CI, 1.02–1.47, n = 22 studies). When only high exposure studies were included, the summary RR increased to 1.49 (1.12–1.97, n = 13). When studies basing exposure solely on self reported data were excluded, the summary RR rose to 2.12 (1.11–4.02, n = 6). For refinery work and NHL, summary RRs for all studies and for only high exposure studies were 1.21 (1.00–1.46, n = 21) and 1.30 (0.90–1.88, n = 14), respectively. Adjusted for the healthy worker effect, the high exposure RR for refinery studies increased to 1.51 (1.07–2.14). The summary RR for studies of formaldehyde and leukemia was 1.46 (1.19–1.79, n = 16). When only studies of myeloid leukemia were included, the summary RR increased to 2.09 (1.25–3.51, n = 5). All five myeloid studies had RRs above 1.0.

**Conclusions:** These findings suggest that benzene and refinery work result in increased risks of NHL, and formaldehyde results in increased risk of myeloid leukemia. These findings also suggest that associations could be missed if biases from exposure misclassification, including unrelated cancers or cell-types, and the healthy worker effect are not considered when evaluating these effects.

#### ISEE-1525

#### Spatio-Temporal Modeling to Predict Intra-Urban Variation in Air Pollution Levels

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**Background:** Chronic air pollution epidemiology studies are improved by accurate estimation of intra-urban variation in individual concentrations. These estimates are typically limited, however, by sparse existing measurements since the EPA's Air Quality System (AQS) only supports a few sites in any given city. To further enhance spatial resolution in pollution concentrations, the EPA-funded Multiethnic Study of Atherosclerosis and Air Pollution (MESA Air) has collected supplemental measurements. Since these measures were collected on several platforms at incongruent times, synthesis is required to estimate residential concentrations for individual cohort members.

**Objective:** We consider the problem of estimating residential concentrations of gaseous nitrogen oxides ( $\text{NO}_x$ ) as a marker for air pollution generated by automobile traffic using several methods in a unified conceptual framework.

**Methodology:** Supplemental measurements include a series of three two-week averaged  $\text{NO}_x$  concentration "snapshots" in different seasons at monitors predominantly arranged in clusters covering distances from 50–300 meters from major roadways. To further characterize spatial variation and validate exposure estimates, two-week average concentrations are measured twice in the course of twelve months at about 100 subject homes, 4 at a time. Finally, ongoing two-week average measurements are being collected at a small number of fixed sites in each city to supplement daily observations from the AQS network. We estimate  $\text{NO}_x$  concentrations using a spatio-temporal "land use" regression model, supplemented by physics-based plume modeling to account for meteorology in the spatial regression. We incorporate the spatial regression structure in a Bayesian hierarchical spatio-temporal model implemented using an optimized Markov Chain Monte Carlo (MCMC) sampling algorithm.

**Results:** Analyses of real and simulated data validate the appropriateness and predictive power of our modeling approach. On a spatial subset of measured data, we find that including physics-based plume modeling for traffic in the "land use" regression results in improved cross-validated predictions ( $R^2 = 0.60$ ), compared to using simpler traffic-related covariates ( $R^2 = 0.51$ ). This regression model also results in an interpretable spatial correlation pattern that can be exploited by universal kriging to further improve the prediction accuracy ( $R^2 = 0.71$ ). In a simulation study with representative spatio-temporal data, we find that our MCMC estimation procedure for the Bayesian hierarchical model is successful and can be used to obtain accurate predictions of long-term average residential concentrations ( $R^2 = 0.91$ ) along with appropriate uncertainty estimates for each simulated cohort member.

**Conclusions:** We have described a statistical modeling approach for environmental epidemiology that incorporates "land use" regression, physics-based plume modeling, and a flexible spatio-temporal correlation structure in a computationally feasible Bayesian framework. Our results demonstrate that this approach is accurate and appropriate for predicting residential concentrations based on incongruent space-time data.

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#### ISEE-1526

#### Improved Estimates of Global Transport of DDT and Their Implications Using Sensitivity and Bayesian Analyses

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**Background:** Dichlorodiphenyltrichloroethane (DDT) is an insecticide that has been used worldwide since the 1940s for controlling agricultural pests and to combat vectors of insect-borne diseases, such as typhus or malaria. DDT is hydrophobic and resistant to biotic and abiotic

degradation, causing it to be very persistent in the environment. Although the use of this pesticide has been curtailed significantly, it continues to be applied in some regions. It is, consequently, important to continue to study the global fate and transport of DDT. In a recent paper, comparing model estimates to field measurements for DDT, the authors report model results that correspond well, in general, with field data. They also report, however, that atmospheric concentrations of DDT in the Arctic were appreciably under-predicted, and that the cause of this discrepancy is owing to poor estimates of specific model parameters, such as octanol-water partition coefficients.

**Discussion:** In this presentation, we describe a project in which we revisit this earlier work using a Bayesian statistical approach. We conduct refined uncertainty and sensitivity analyses using global measurements from 1940 to the present. We present revised estimates of the most influential model parameters, identify inputs for which model results are the most sensitive, and update predictions of future DDT migration patterns. The results provide new insight into important processes that appear to be controlling the global fate and persistence of DDT. We also discuss the implications to future ecological exposures as a result of these refined estimates.

#### ISEE-1527

#### The Utility of Common Household Objects as Markers of Home Hygiene in the Context of Access to Improved Sanitation

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**Background:** Lack of access to improved sanitation is known to impact human health via fecal contamination of hands and household drinking water. We examined whether lack of access to improved sanitation is associated with poor home hygiene, as measured by contamination of common household objects, such as a child's toy or a cleaning item used to clean the kitchen.

**Methods:** In rural Bangladesh, we observed sanitation facilities and collected demographic data in households with children <2 years old. The improved sanitation group had access to improved toilet facilities, such as a pour flush latrine. The unimproved sanitation group defecated in fields or open pit latrines. The sentinel toy, a plastic ball, was provided to each household and was collected four days later and washed in a 200 ml sterile bag containing ringer's solution. Respondents were asked to provide the material used to clean their kitchens. A 4 × 4 inch square of the material was placed in 200 ml of ringer's solution. For each household object, quantitative counts of fecal coliforms and *Escherichia coli* were performed on membrane fecal coliform (mFC) and mTEC media and ten-fold dilutions were performed as required. We used the Wilcoxon Rank Sums test to assess for statistically significant differences in contamination of sentinel objects between the groups with and without access to improved sanitation.

**Results:** We had information about the sentinel toy for 49 households and about the kitchen cleaning item for 59 households. For the sentinel toy, the geometric means for fecal coliforms were 8 CFU/100 ml for the improved sanitation group and 57 CFU/100 ml for the unimproved sanitation group ( $P = .06$ ). The geometric means for *E. coli* were 2 CFU/100 ml for the improved sanitation group and 7 CFU/100 ml for the unimproved sanitation group ( $P = .10$ ). The geometric means for fecal coliforms for the kitchen cleaning item were 23,936 CFU/100 ml for the improved sanitation group and 36,527 CFU/100 ml for the unimproved sanitation group ( $P = .56$ ). The geometric means for *E. coli* were 16 CFU/100 ml for the improved sanitation group and 67 CFU/100 ml for the unimproved sanitation group ( $P = .14$ ). Contamination of the toy was directly correlated with the age of the child <2 years old (fecal coliforms  $R = 0.53$ ,  $P < 0.0001$ ; *E. coli*  $R = 0.44$ ,  $P = 0.002$ ).

**Conclusions:** Access to sanitation in this study population was not significantly associated with the degree of contamination of household objects. A small sample size may have hampered our ability to detect an association since the sentinel toy and kitchen cleaning item had higher mean fecal bacteria levels in the unimproved group than in the improved group. Future study in a larger sample may further elucidate the utility of sentinel toy contamination as a marker of home hygiene. Kitchen cleaning items may remain moist for prolonged periods, thereby promoting local proliferation of fecal coliforms. Variability in local growth may obscure the contribution of lack of sanitation to kitchen cleaning item contamination and, thus, such cleaning items may not be useful markers of home hygiene related to sanitation.

#### ISEE-1528

#### The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits

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**Background:** Severe heat waves have resulted in substantial mortality in US and European cities. Global climate models project an increase in heat wave frequency, duration and severity in the future, presenting an ongoing challenge to health worldwide. While a large epidemiological literature exists on the mortality impacts of heat waves, there have been very few studies of their impacts on morbidity.

**Methods:** The California Department of Public Health, in conjunction with the Natural Resources Defense Council, conducted an analysis of increased hospitalizations and Emergency Department (ED) visits across the state of California during a severe heat wave in the summer of 2006. County-level hospitalizations and ED visits for all causes and for 11 cause groups were aggregated into six geographic regions. Excess morbidity and rate ratios (RRs) during the heat wave (July 15–August 1, 2006) were calculated and compared to a summer 2006 referent period by cause, age grouping, and racial/ethnic category.

**Results:** During the heat wave, 16,166 excess ED visits and 1,182 excess hospitalizations occurred statewide. ED visits for heat-related causes increased across the state (RR 6.30; 95%CL = 5.67–7.01), especially in the cooler Central Coast region which includes San Francisco (RR 23.05; 95%CL = 15.05–37.10). Children (ages 0–4 years) and the elderly (ages ≥65 years) were at greatest risk. ED visits also showed significant increases for acute renal failure, cardiovascular diseases, diabetes, electrolyte imbalance and nephritis. Significantly elevated RRs for hospitalizations were observed for heat-related illnesses (RR 10.15; 95%CL = 7.79–13.43), acute renal failure, electrolyte imbalance and nephritis.

**Conclusions:** The 2006 California heat wave had a substantial effect on morbidity, including in regions with relatively modest absolute temperatures during the heat wave period. This suggests population acclimatization and adaptive capacity influenced risk. This study provides insight into those populations most vulnerable to heat, demonstrates the value of analyzing ED visits and hospitalizations, and suggests possible preventive strategies to avoid heat-related deaths in the future and in other geographic areas. This presentation will discuss the findings of the study and the implications for global health in a warming future.

**ISEE-1529****The Cost of Health and Productivity Impacts of Indoor Air Pollution in California**

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**Background and Discussion:** The health and productivity impacts of common indoor air pollutants were estimated for California, based on results from field studies, coroners' studies, and epidemiological studies. The annual impacts of residential indoor pollutants on premature mortality for the year 2000 are estimated to be 115 cases from volatile organic compounds, 1,500 cases from radon, and about 4,000 cases from environmental tobacco smoke. In addition, indoor carbon monoxide is estimated to result in 23 fatal poisonings per year. Using the value of a statistical life of \$8.9 million (2007 dollars), these mortality impacts are estimated to cost \$50 billion per year. In addition, the impacts of mold and moisture-related problems on asthma-related mortality are estimated to cost \$44 million per year. The impacts of these pollutant exposures on hospitalization and other medical treatment are estimated to be \$850 million. In addition, the impacts of indoor air pollution and poor ventilation are estimated conservatively, based on chamber and field studies, to produce a 2% reduction in worker productivity in office and school settings. The productivity impact, including salaries and benefits, is estimated to cost \$8.5 billion per year. The total cost impact of indoor air pollution on health and productivity in California is estimated to be at least \$60 billion per year in 2007 dollars. Additional health impacts and costs due to indoor exposures to ozone emissions from air cleaners, particles from indoor combustion sources besides tobacco smoking, lead and other metals, and some other known exposures are not included in this estimate; thus, the actual costs are likely much greater than \$60 billion per year. Most of these impacts on health and cost can be avoided, as shown by intervention studies and the upcoming limits on emissions of ozone from air cleaners and on formaldehyde from composite wood in California.

**ISEE-1531****Development of Baseline Environmental and Occupational Exposure Measurement Strategies for the Population-Based Ontario Cancer Cohort: Recommendations Resulting from an International Workshop**

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**Background:** At Cancer Care Ontario (CCO), we are planning the Ontario Cancer Cohort (OCC), a prospective research project designed to improve our understanding of cancer risk factors, and to build more effective prevention and early detection strategies. The OCC will follow a large cohort of adult Ontarians for approximately 20 years and assess cancer and other chronic disease outcomes. Evaluation of the health risks associated with environmental and occupational exposures and gene-environment interactions is a priority. As part of the planning efforts, Cancer Care Ontario teamed with the Canadian Network of Toxicology Centres to host a workshop March 26th and 27th, 2008, for a multidisciplinary group of approximately 50 scientists with expertise in cancer epidemiology, occupational and environmental epidemiology, toxicology, risk assessment, exposure assessment, measurement error, industrial hygiene and analytical method development. The purpose of the workshop was to identify priority contaminants and propose cost-effective data collection and measurement strategies to access exposures in a large cohort of adults ( $n \sim 150,000$ ), aged 35 to 69 years that will be followed for cancer outcomes for approximately 20 years.

**S324**

**Methods:** Participants were grouped into five exposures source themes: air, water, food, consumer and personal care products, and work and home (soil, dust, other). Each group was asked to answer three questions: 1) what are the priority exposures or contaminants that should be measured?; 2) what methods or techniques are suitable for measurement of the identified priority contaminants (considering different levels of measurement including community, neighbourhood, occupational, residential, individual exposures)?; and 3) what biological specimens should be collected?

**Results:** More than 50 contaminants were identified by workshop participants, including arsenic, ozone, radon, nanomaterials, and pharmaceuticals in personal care products. Summary recommendations from the workshop included: 1) develop and apply criteria to prioritize contaminants and exposures for measurement; 2) conduct comprehensive reviews of existing measurement methods for priority exposures; 3) initiate validation studies to access the relationship between potential exposures and absorbed dose in subjects, and evaluate repeated measures within individuals over time; 4) focus on the collection and long-term storage of biological samples including blood, urine, hair and toenails; 5) consider the creation of an "EnviroBank" for the collection and storage of household level samples, such as house dust. These summary recommendations, together with a description of the OCC design and current questionnaire development efforts will be presented.

**ISEE-1532****Variants in Iron Metabolism Genes and Metals Concentrations in Infant Hair**

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**Objective:** Iron deficiency has been shown to increase both manganese and cadmium intestinal absorption. Genetic factors that regulate iron absorption, such as polymorphisms in iron metabolism genes, may therefore also regulate absorption of manganese and cadmium. No previous studies of which we are aware have explored genetic polymorphisms as predictors of internal manganese and cadmium levels. We examined the association of common missense variants in iron metabolism genes with hair manganese and cadmium levels among infants. We also assessed whether gene variants among mothers affect placental transfer of manganese and cadmium.

**Materials and Methods:** As part of the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) study, biological samples from mother-infant pairs in Mexico City were collected between 1994 and 1996. Venous blood samples from mothers and umbilical cord blood samples from infants were genotyped for HFE (H63D and C282Y) and TF (P570S) variants. Hair samples from 179 infants, collected at 1-month, 4-months, and/or 7-months of age, were analyzed for manganese and cadmium using a dynamic reaction cell-inductively coupled plasma mass spectrometer. Mixed effects models were used to examine the association of maternal and infant genotype (HFE, TF, and combined HFE+TF) with repeated measures of hair manganese and cadmium. Covariates included infant sex, gestational age, maternal age, maternal hemoglobin, and maternal smoking during pregnancy.

**Results:** Mean hair manganese concentration across all three time points was  $2.4 \pm 3.4$  (range 0.2–34.8)  $\mu\text{g/g}$ . Mean hair cadmium concentration was  $0.5 \pm 0.4$  (range 0.03–2.6)  $\mu\text{g/g}$ . Among children, 16.6%, 2.3%, and 17.1% carried the HFE H63D, HFE C282Y, and TF P570S variants, respectively. Among mothers, 17.5%, 1.3%, and 22.1% carried the HFE H63D, HFE C282Y, and TF P570S variants, respectively. 3.8% of mothers and 2.2% of infants had variants for both HFE and TF genes. No

significant associations were observed between infant or maternal genotype and infant hair metals concentrations, and adjustment for covariates did not substantially change results.

**Conclusions:** In this population, we observed no evidence that genetic polymorphisms in iron metabolism genes alter internal levels of manganese or cadmium, as measured in infant hair. Further study is needed to validate these results.

#### ISEE-1533

#### The Effect of Ozone on All Cause Mortality in the Elderly: Modification by Sex, Race, and Previous Heart, Lung, and Diabetes Related Hospital Admissions in a U.S. National Multicity Study

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**Background:** Ozone exposure has been associated with mortality in the warm season, but the nature of the susceptible population is still being explored. We conducted a case-crossover study in 89 US cities during the warm season during a 9-year period to evaluate the effect of ozone on mortality in a potentially susceptible population (persons 65 or older with at least one Medicare covered hospital admission), and examined further effect modification by the causes of the previous hospital admissions, race, age, and gender.

**Methods:** Cause specific hospital admissions and air pollution data for ozone were obtained from the Centre for Medicare and Medicaid Services for 1992–2000. Survival status as of 2000 and date of death were obtained from the same source. We fit city specific case-crossover analyses using time stratified approach such that exposures on the case day were compared to exposures occurring every third day of the same month and year as the case day; effect modification was examined by interaction terms for subject specific covariates. Results were combined across cities using a random effects meta-analysis.

**Results:** During the warm season, the lag zero effect of a 10 ppb increase in 8-h ozone was a 0.33% (95% confidence interval (C.I.): 0.21, 0.44) increase in all cause mortality. No significant effect modification was seen for prior admission for heart or lung disease, or diabetes. The effect of being black for all admissions increased the percentage of mortality significantly to 0.72% and this was three times the effect seen for whites or other races.

**Conclusions:** The results of this large multi-city study confirmed that exposure to ozone is associated with higher mortality and that the effect is modified by race and other personal characteristics.

**Funding:** EPA PM Center grant: R827353 and R83241601, NIEHS: ES00002.

#### ISEE-1534

#### Pesticide Use in California Homes with Small Children

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**Background:** To understand children's overall exposure to pesticides, research is needed on the exposure resulting from contact with surfaces and hand to mouth activity in the home environment. This exposure, in turn, depends on the frequency of applications, how much pesticide is applied during a given application, the method of application, the number and types of rooms pesticides are applied in, and the extent of cleaning following an application. Finally, there is interest in being able to determine patterns of co-use between various products.

**Objectives:** The SUPERB Study (Study of Use of Products and Exposure-Related Behaviors) seeks to understand the best methods for collection of behavioral data related to environmental exposures through food, daily activities, and household products. In particular, we are evaluating alternative platforms for collecting the relevant longitudinal data in different age groups. Pesticides are a major focus of the SUPERB Study and a computer-assisted telephone interview (CATI) is one platform we are using. A total of 524 families with a child between the ages of 18 months and 3 years have been enrolled.

**Methods:** The CATI asks about frequency of use for indoor spray and fogger products, as well as for outdoor spray products, across both the warm and cold months over the previous year. We additionally ask about professional applications and pet product use. For the indoor products, we ask for the number of containers and brands purchased over the last year. Finally, for the most recent application in each product type, we ask for the rooms in which the pesticide was applied, the relative size of the application, and room cleaning practices following the application. We report on the results from the first 448 families.

**Results:** Sixty percent of the families reported applying at least one of the product categories (indoor spray, outdoor spray, and indoor foggers) in the last year, of which, 30% reported applying at least two of the product categories. The mean frequency of use of indoor spray pesticide among users was greater in the warm months, (7.1 applications per 6-month season, SD = 19.0), as compared with the cold months (4.2 applications per 6-month season, SD = 14.6). The frequency of indoor spray use was correlated between the warm and cold months: correlation coefficient = 0.67. On average, families purchased 1.5 containers of indoor spray pesticide over the last year. The number of containers purchased was correlated with the self reported total number of applications (correlation coefficient = 0.50). The spray was applied in an average of 1.6 rooms, the most common being the kitchen (61% of applications) and the bathroom (32% of applications). Similar analyses are being conducted on outdoor spray use and indoor fogger use. Analysis of pet products, brand loyalty, cleaning habits after use, and correlations between frequency of use across multiple types of products will be reported, and data limitations will be discussed. Follow up interviews are being conducted a year after the first interview, which will allow us to look at longitudinal trends.

#### ISEE-1535

#### Effect Modification of Glutathione-S-transferases M1 Polymorphism on the Association Between Traffic Exposed Jobs and Inflammatory Response

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**Objective:** There is growing evidence that exposure to traffic-related particulate matter (PM) may be associated with increased morbidity and mortality from cardiovascular disease. Experimental evidence in animals and humans suggests that exposure to traffic-related PM results in reactive oxygen species (ROS) and systemic inflammation. Further, recent literature has suggested that the relationship between cardiovascular risk and systemic inflammation might be modified by genetic polymorphisms of glutathione-S-transferases M1 (GSTM1) gene, which regulates enzymes involved in the metabolism of ROS. In this pilot study we examined effect modification by GSTM1 polymorphism on the association of job related exposure with inflammatory markers among employees in the

United States unionized trucking industry, a population that we have previously reported an association between traffic exposed jobs and ischemic heart disease mortality.

**Material and Methods:** We visited two large trucking terminals and collected blood samples from 360 current workers, including long haul drivers, P&D (pick up/delivery) drivers, dock workers, hostlers, and clerks. Workers were also asked to complete a 4-page health questionnaire. Plasma C-reactive protein (CRP), soluble intercellular adhesion molecule-1 (sICAM-1), and interleukin-6 (IL-6) levels were assessed for these blood samples. To conduct a pilot study of possible effect modification by GSTM1 polymorphism, we selected 100 of these workers representing a variety of job titles. GSTM1 analyses were conducted at the Channing Laboratory using the Applied Biosystems 7900HT system.

**Results:** There were 97 blood samples with sufficient aliquots for GSTM1 analyses, 50 of them were GSTM1-null. The median CRP was 1.15 mg/L (IQR 0.50–2.09), sICAM-1 was 231.06 ng/mL (IQR 197.83–273.50), and IL-6 was 1.66 pg/mL (IQR 1.05–2.91). All the inflammatory markers were elevated among long haul drivers and clerks. Wilcoxon rank-sum tests showed that CRP levels were statistically significantly higher in the GSTM1-null group for P&D drivers and hostlers, and sICAM-1 levels were significantly higher in the GSTM1-null group for hostlers, compared to the non-null group. Adjusting for age, BMI, high blood pressure, and trucking terminal in a multiple regression analysis using robust variances, we found a suggestion of effect modification by GSTM1 polymorphisms on the association between some job titles and inflammatory markers.

**Conclusions:** In this pilot study of a group of trucking industry employees, there is a suggestion that job title, a proxy for particulate exposures, is associated with variation in markers of systemic inflammation. Further, this association may be modified by genetic polymorphisms of GSTM1.

#### ISEE-1536

#### Biological Monitoring and Surveillance Results of Human Exposure to Naturally-Occurring Uranium in New Mexico

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**Background and Objectives:** Biomonitoring is an emerging approach to quantify exposure (i.e. via blood and urine samples) to potential environmental toxicants rather than inferring exposure from environmental media concentrations such as in air or drinking water. The goals of the Rocky Mountain Biomonitoring Consortium (RMBC), as part of a Centers for Disease Control (CDC) biomonitoring grant, are to assess human exposures to environmental toxicants, including estimates of background exposure to naturally-occurring chemicals that have potential to cause harm. The New Mexico Department of Health, a member of the RMBC, has conducted exposure assessments to quantify concentrations of heavy metals in drinking water and urine samples from residents of New Mexico. Elevated uranium levels are associated with local uranium geological deposits and regional groundwater.

**Methods:** In this study we quantified uranium in urine and household drinking water and compared these data with national levels and drinking water standards and determined potential geographic regions of clustering.

**Results:** Approximately 10% of the biomonitoring participants' household water contained uranium concentrations that exceeded the EPA drinking water standard of 30 µg/L. Participant urine uranium levels have a geometric mean of 0.026 µg/L (95<sup>th</sup> percentile = 0.31 µg/L)—almost 3 times greater than the 2001–2002 National Health and Nutrition Examination Survey (NHANES) age group equivalent mean of 0.009 µg/L (95<sup>th</sup> percentile = 0.046 µg/L). For Rio Arriba County in particular, the urine uranium geometric mean is 0.081 µg/L—approximately 9 times

greater than the NHANES mean. Among the 764 geocoded cases collected during the biomonitoring surveillance, we identified statistically significant clusters of co-located urine and water uranium levels, as determined using Kulldorff's spatial scan statistic. The most likely cluster ( $P < 0.002$ ) comprised 22% of the total biomonitoring participants residing within a 14.7 km radius centroid encompassing two adjacent counties (Santa Fe and Rio Arriba), and the spatially-aggregated water and urine uranium geometric means are 8.2 µg/L and 0.089 µg/L, respectively. Additionally, data collected from 78% (97/124) of Rio Arriba County participants were in this cluster as were 61% (62/101) of Santa Fe county participants.

**Conclusions:** Our findings indicated that not all highly elevated urine levels were associated with elevated uranium in drinking water. These results have directed further study as part of our CDC Environmental Public Health Tracking Program to link these exposure data with health outcome data. This involves determining uranium exposures other than drinking water and plans to correlate elevated urine uranium levels with biomarkers of renal function in blood and urine. The results of this investigation are noteworthy in that these are the first biomonitoring uranium data to be quantified for the state of New Mexico, and the resulting elevated levels led to mitigation of the exposure in several high-risk communities.

#### ISEE-1537

#### Estimating Individual-Level Exposure to Airborne Polycyclic Aromatic Hydrocarbons throughout Gestational Period Based on Personal, Indoor and Outdoor Monitoring

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**Objectives:** Current understanding on health effects of the long-term PAH exposure is limited by lack of data on time-varying nature of the pollutants at an individual level. In a cohort of pregnant women in Krakow, we (1) examine the contribution of temporal, spatial and behavioral factors to prenatal exposure to airborne PAHs within each trimester; and (2) develop a predictive model of PAH exposure over the entire gestational period.

**Methods:** Pregnant women ( $n = 344$ ) were monitored for their personal exposure to the airborne benz(a)anthracene, chrysene/isochorysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, pyrene and benzo(g,h,i)perylene late second trimester for a consecutive 48 hour period. In a subset ( $n = 78$ ), indoor and outdoor levels of the nine PAHs were additionally monitored during the same period using an identical tool. In the same subset, repeated personal exposure measurements were taken during first and third trimester. In-depth health, lifestyle and environment questionnaire were administered to the pregnant women during the second trimester air monitoring.

**Results:** Mean personal exposure to  $\Sigma 8$  c-PAHs (ng/m<sup>3</sup>) during the heating months is 40 ng/m<sup>3</sup> higher than the similar level during April–September ( $P$ -value < 0.001). However, spatial difference in personal exposure is smaller. The mean personal  $\Sigma 8$  c-PAHs level (ng/m<sup>3</sup>) for outer city residents is 9 ng/m<sup>3</sup> lower than that for the city center ( $P$ -value = 0.012). The women who reported that they spent > 3 hours/day outdoors had significantly lower personal exposure than those who reported  $\leq 3$  hrs/day ( $P$ -value = 0.011). A one ln-unit increase in the outdoor concentration of the individual PAHs and  $\Sigma 8$  c-PAHs, respectively, are associated with 91–100% increase in personal exposure during the heating season. During the non-heating season, a one ln-unit increase in the outdoor concentration is associated with 58–89% increase in personal exposure to the eight carcinogenic PAHs, despite higher

frequency of window opening. An hour increase in ETS exposure is associated with 10–16% increase in personal exposure to the nine PAHs. One degree Celsius decrease in ambient temperature is associated with 3–5% increase in exposure for benz(a)anthracene, benzo(k)fluoranthene, and dibenz(a,h)anthracene, after accounting for the outdoor concentration. Based on random effects model, mean personal exposure at given gestational period depends on the season at given gestational age. Although the efficiency of the outdoor PAH concentration precludes the importance of other behavior/environmental information, ETS exposure remains an important source of personal exposure to PAHs.

**Conclusion:** Direct personal monitoring for 48-hour period, supplemented with the questionnaire data and meteorological data estimates the 9-month personal exposure with greater accuracy and precision, compared to our naïve predictive model based on outdoor monitoring only. The result of cross-validation analysis demonstrates that our current mixed model estimates the mean individual level of exposure at a given gestational month with validity and precision.

#### ISEE-1539

##### Mixed Modeling for Land Use Regression with Traffic-Related Pollutants

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**Background:** Exposure assessment for large-scale, panel-based epidemiology studies can be challenging even in a data-rich study. Typically, data are highly diverse both spatially and temporally. In order to take advantage of these data to predict exposures, models accounting for changes in both scales must be incorporated. A ten year epidemiologic study of the progression of asthma in young children in relation to air pollution has enrolled 302 children who have quarterly health and exposure evaluations which include semiannual spirometry in the field office; each child also participates in three two-week panels each year, during which daily symptoms, medication use, and exposure-related activities are recorded and pulmonary function tested twice daily. The study is evaluating acute effects associated with daily exposure to air pollutants (e.g., PM, elemental carbon, ozone) and bioaerosols (fungal spores, pollen grains, endotoxin).

**Methods:** The importance of both spatial and temporal aspects of a rich data set is illustrated for representative pollutants from the class of polycyclic aromatic hydrocarbons (PAHs), a class of compounds often used as a surrogate for diesel exhaust. PAH data were collected daily by the PAS2000 monitor for a year at three fixed locations, an EPA Supersite and two trailer sites at elementary schools. The PAS2000 provides realtime measurements of total particle-bound PAH. During the same year, intensive air pollution sampling took place at 84 homes including five to ten 24-hr PAH filter measurements. However, since the measurements were not made at all 84 homes on the same day, the between-home and within-home variability must be disentangled. Therefore, the data were used to formulate a land use regression model that utilizes the mixed modeling approach to account for both longitudinal and cross-sectional variability in the samples. The PAH filter concentrations at participant homes were the dependent variable; the independent variable included the particle-bound PAH concentrations at the fixed sites, meteorological data (wind direction, wind speed, relative humidity (%), temperature and precipitation), source data (traffic and land use), and other temporal and spatial variables (agricultural burning, season, etc) were. Highly predictive variables in the models were PAS2000 measurements, wind direction, wind speed, season and road type closest to home. LUR allows for extraction of spatial relationships in a more deterministic fashion than purely stochastic methods such as kriging or co-kriging.

**Results:** One of the important PAHs for this study is benzo[a]pyrene. The overall mean of benzo[a]pyrene is  $0.41 \mu\text{g}/\text{m}^3$ , with a standard deviation

of  $0.88 \mu\text{g}/\text{m}^3$ . The highest seasonal levels are in the winter (November through February) with an average of  $0.79 \mu\text{g}/\text{m}^3$ , and a range of 0.00 to  $8.13 \mu\text{g}/\text{m}^3$ . The average daily range for benzo[a]pyrene is  $0.60 \mu\text{g}/\text{m}^3$ , reflecting the degree of spatial variability. The daily range is higher, on average, in the winter than in the remainder of the year.

**Conclusion:** Important variables for predicting benzo[a]pyrene are the PAS2000 measurements, season of sampling, average daily temperature, direction of sampling site from the EPA Supersite, and amount of agricultural burning on the day of sampling.

#### ISEE-1542

##### Spatial and Temporal Profiles of Personal PM Exposure in Urban Childhood Asthma

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**Background:** Childhood asthma is a complex disease with both environmental and genetic risk factors. Elucidation of the environmental risk factors is confounded by difficulties associated with monitoring and distinguishing children's exposure patterns across varying micro-environments. The goal of this research was to track children's movement and associated particulate matter exposure through distinct micro-environments across the course of a day and to then visualize and analyze their exposure patterns within each micro-environment. We report findings on exposure to fine particulate matter here, however, our method is adaptable to any stressor or contaminant that can be monitored by a portable sensor in real-time.

**Methods:** This method integrates real-time monitors, global positioning system (GPS) receivers, and a geographical information system (GIS). The sampling apparatus consists of a backpack containing a portable GPS receiver, an ambient temperature sensor, a aerosol monitor (pDR-1200 with cyclone) with attached filter, and a pump. Thirty-two elementary school-age children wore the backpack for four consecutive days (Mon–Thur) during two distinct weeks throughout the school year resulting in over 200 daily samples. The time-referenced signals for fine particulate matter concentration, ambient temperature, and location were synchronized and merged within a GIS to analyze and visualize the children's exposures. We developed and applied algorithms to apportion exposure data into four micro-environments: school, home, morning transit and afternoon transit.

**Results:** Incremental improvements to the method after a pilot study included higher-sensitivity GPS receivers and an ambient temperature monitor. The new GPS receivers decreased lost and aberrant signals to less than 5%. Analysis of variance indicated that PM concentrations measured within the four micro-environment categories were significantly different from each other ( $P < 0.001$ ). Rank estimates for average exposure, from lowest to highest, were: school, morning transit, afternoon transit and home. Personal breathing-zone concentrations within the home were more than three times greater than at school. Interestingly, PM concentrations measured during afternoon transit were nearly twice that of morning transit, on average. Ambient temperature data provided insight into indoor vs. outdoor exposures and also allowed for the association of PM concentration flux with forced-air heating cycles indoors. Use of a GIS allowed data to be projected onto a map of the study area for visual interpretation of exposure across distinct micro-environments.

**Conclusions:** A high resolution, space and time-referenced sampling method for PM exposure assessment for asthmatic children was developed. With a 10-second temporal resolution and a  $<3 \text{ m}$  spatial resolution outdoors ( $\sim 10 \text{ m}$  indoors), the method allows examination of exposure patterns that were previously impossible with traditional exposure assessment techniques (i.e., time-integrated filter measurements). This method collects and automatically apportions over 8600 personal exposure data points per day with both high resolution and accuracy. The

method has lead to more reliable representation of exposures in these micro-environments and allows preparation of a more detailed 'exposure budget' for each child. Further research using this methodology will support analysis of health outcomes associated with micro-environmental exposures and towards assessment of interventional techniques to reduce exposure.

**ISEE-1543****An Evaluation of Time-Location Data: The Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air)**

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**Introduction:** To best assess human exposures, researchers and risk assessors often weight chemical concentrations in a given location by the time spent in that location. In air pollution studies, accurate estimates of time and location are critical, since concentrations can vary greatly within proximal environments (e.g., indoors, outdoors, and within vehicles). Although a number of resources provide information on typical time-location factors (e.g., US Environmental Protection Agency's Exposure Factors Handbook; Consolidated Human Activity Database), there remains an overall lack of data relevant to ethnically diverse older populations, who represent a growing part of the aging US population.

**Methods:** The MESA Air study includes a multi-ethnic cohort of 6,226 participants, aged 40 to 90 years, from 6 American cities. A questionnaire was administered to participants upon entry into the study, and included detailed information regarding typical time-location patterns during different seasons and days of the week. Data collected included time spent indoors, outdoors, in transit, at home, and at work. Additional questions were focused on transportation type and typical traffic conditions while in transit. To explore differences in activity patterns by age, we employed univariate linear regression models. Univariate *t*-tests were conducted to evaluate differences by race/ethnicity, socioeconomic status, and occupation.

**Results:** Ninety-five percent (95%) of study participants ( $n = 5,934$ ) provided complete time-location data. Of these, 38% were Caucasian, 28% were African-American, 24% were Hispanic and 11% were Chinese. This multi-ethnic cohort represents a unique adult population: at the time the questionnaire was administered, 2% were aged 40–49, 32% were aged 50–59, 30% were 60–69, 27% were 70–79, and 10% were aged 80–90 years. We found strong associations between age, ethnicity and reported time-location patterns. With increasing age, participants spent significantly ( $P < 0.001$ ) more time at home, less time outdoors, and less time in transit. Younger participants (40–59 years) spent, on average, the least amount of time in homes (15.6 hours/day) and the largest amount of time in transit (1.3 hours/day). In contrast, participants aged 60 to 79 years reported spending 17.9 hours at home and 1.0 hours in transit per day. The oldest participants (80–90 years) spent 20.2 hours at home and just 0.7 hours/day in transit. These findings were robust to season, ethnicity, and city. Activity patterns also differed by ethnic group. Caucasian and African American participants spent similar amounts of time inside their homes (17.2 hours/day), while Hispanics reported slightly more time at home (17.7 hours/day). At 18.8 hours/day, Chinese participants spent significantly more time inside their homes than all other groups combined ( $P < 0.001$ ). This trend was not due to differences in site as these findings remained in an analysis restricted to those cities with Chinese participants (Chicago and LA), although this population was only statistically different in Chicago.

**Conclusions:** We found behavior patterns to vary significantly with age and ethnicity within our large, multi-city cohort. This dataset provides a valuable opportunity to explore time-location patterns within a unique cohort of multi-ethnic adults.

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**ISEE-1544****Urinary Pesticide Concentrations and Their Relationship to Air and Dust Concentrations and Household Predictors**

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**Methods:** Biomonitoring data provide critical information about pesticide exposures, and combined with measurements in environmental media provide insight into exposure sources and pathways. We collected urine samples from 120 women living in Cape Cod, Massachusetts, a semi-rural coastal area; and US CDC analyzed the samples for 13 pesticides or pesticide metabolites. In addition, we measured concentrations of 40 pesticides in air and 39 pesticides in dust and collected self-reported information about pesticide use. We detected 12 pesticides in urine, 26 in air, and 28 in dust in at least one sample. Data tended to be left censored due to detection limits from the laboratory analysis. With high levels of censoring Pearson and Spearman correlation coefficients calculated with substitution of arbitrary values (DL/2 or DL/sqrt(2)) for censored data have been shown to be poor measures of actual correlation. Instead, either maximum likelihood estimates or Kendall's tau rank correlations with adjustment for ties have been shown to be more accurate, although, in general, Kendall's tau estimates tend to be lower in magnitude than corresponding Pearson or Spearman correlations. In this study, Kendall's tau rank correlation coefficients, adjusted for censored data, were calculated to explore within and between media relationships, with  $P$ -values obtained from 10,000 bootstrap replications.

**Results:** Urine compounds with the strongest positive correlation include 3,5,6-trichloro-2-pyridinol and 2,4,6-trichlorophenol ( $\tau = 0.72$ ), a relationship also observed in the NHANES dataset; and 3,5,6-trichloro-2-pyridinol and 4-nitrophenol ( $\tau = 0.20$ ). These relationships have not been reported before and are not predicted based on known common sources or metabolic pathways for these compounds. Pesticides with the strongest, significant ( $P < 0.05$ ) positive correlations within air include gamma-chlordane and alpha-chlordane with heptachlor ( $\tau = 0.69$  and 0.66, respectively), which were formerly used together in a technical chlordane mix, followed by pentachlorophenol with o-phenylphenol ( $\tau = 0.37$ ). Pesticides with the strongest positive correlation within dust include methoxychlor and DDT ( $\tau = 0.38$ ), both previously used organochlorines, followed by propoxur and piperonyl butoxide ( $\tau = 0.33$ ), both used currently in insecticide formulations. In contrast to the urinary phthalate metabolites in this population, the urinary pesticide metabolites did not show strong and significant correlations with their known parent pesticides in air and dust and were not strongly correlated with any other pesticides in air and dust. Potential relationships between urinary pesticides and self-reported pesticide use were determined using Wilcoxon tests with binary predictors. Urinary concentrations of 2,5-dichlorophenol were marginally significantly higher ( $P = 0.094$ ) in women living in homes treated for insects in the past year. Urinary concentrations of 1-naphthol, a metabolite of carbaryl, were marginally significantly higher ( $P = 0.10$ ) in women whose lawns were treated in the past year. Urinary concentrations of 2,4,6-trichlorophenol were significantly higher ( $P = 0.03$ ) in women with pets and marginally significantly higher ( $P = 0.06$ ) for women with pets treated for fleas.

**Conclusions:** While we observed some expected correlations within media and some relationships between urinary metabolites and self-

reported pesticide use within the residence, we did not observe correlations between urinary pesticide metabolites and pesticides in indoor air and house dust for this set of pesticides.

#### ISEE-1545

#### Synoptic Circulation Patterns Associated with Air Pollution and Asthma/Myocardial Infarction Hospital Admissions

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**Background:** Synoptic circulation patterns (large-scale tropospheric motion systems) are likely to affect air pollution and morbidity associations, particularly with increased global warming and changing climactic patterns. We examined how synoptic circulation patterns (air masses) may affect the association of air pollution and asthma/myocardial infarction (MI) hospital admissions among adults in North Carolina.

**Methods:** Daily surface meteorology data (including precipitation, wind speed, dew point) for five selected cities in North Carolina were obtained from the Climate Data Center of the National Oceanic Atmospheric and Oceanic Administration. We used a spatial synoptic classification (SCC) system (Sheridan, 2002) to classify each day over the ten year period with one of eight different climatic patterns (dry polar, moist tropical, etc.). Daily 24 hour ambient concentrations of  $PM_{10}$  and  $O_3$ , were obtained from the U.S. EPA AQS (Air Quality System.) Asthma and MI hospital admissions data from a ten year period, 1996–2005, were obtained from the NC Department of Health and Human Services (NC DHHS). Generalized linear models (GLMs) were used to assess the association of asthma and MI hospitalizations with  $PM_{10}$  and  $O_3$  concentrations with specific air mass types with a zero to five day lag. In all models we adjusted for relative humidity, pressure, dew point, temperature, wind speed, and day of the week effects.

**Results:** Three synoptic circulation patterns (dry moderate, dry tropical, and moist tropical), in conjunction with ambient air pollutant levels, were associated with increased asthma and myocardial infarction hospital admissions. In Charlotte, under the dry moderate circulation pattern, an increase in  $PM_{10}$  was associated with increased asthma hospital admissions with a zero lag ( $\beta = 0.013, P = 0.024$ ), but not lags 1–5. These same effects were also found under a moist tropical plus circulation pattern ( $P = .039$ ). Ozone was associated with asthma admissions with a 1 day lag under a dry tropical circulation pattern ( $P = .05$ ). In Asheville, ozone was associated with asthma admissions in a two day lag ( $P = .07$ ) under the dry tropical circulation pattern.  $PM_{10}$  was associated with MI admissions for a zero to 3 day lag under the moist tropical circulation pattern ( $P$ -values = 0.002, 0.001, 0.02, 0.05 respectively). Overall, we found that circulation patterns had different effects in different cities.

**Conclusions:** Certain synoptic circulation patterns, in conjunction with ambient  $PM_{10}$  and ozone concentrations, are associated with increased asthma and MI hospital admissions.

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#### ISEE-1546

#### Predictors of Self-Reported Chronic Respiratory Symptoms in an Occupational Cohort

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**Objective:** Predictors of self-reported chronic respiratory symptoms (chronic cough, chronic phlegm and persistent wheeze) were explored in a group of US trucking industry workers. Factors such as job title, smoking status, body mass index (BMI), and diet patterns have been shown to be associated with these symptoms in adult populations.

**Materials and Methods:** With the assistance of the International Brotherhood of Teamsters, we included a short questionnaire in a newsletter sent to all active Teamsters in the United States. We received surveys from a total of 3,103 individuals, 98% of whom provided contact information for future surveys. A second, more detailed survey was mailed to participants, including questions on chronic cough, chronic phlegm, and persistent wheeze based on the ATS questionnaire. We used logistic regression models to assess predictors of self reported chronic respiratory symptoms in this single occupational group.

**Results:** The response rate to the follow-up questionnaire was 43.6% (n = 1331). Responders were similar to non-responders by age, gender, race, job title, smoking and region of the country. One hundred thirty nine participants reported chronic cough, 160 reported chronic phlegm, and 561 reported persistent wheeze. In multivariate logistic regression models, all jobs with exposures to vehicle exhaust had increased risk of chronic cough and decreased risk of chronic phlegm compared to office workers. The models for persistent wheeze showed no clear pattern with work in exposed jobs. As expected, the models indicated that current smoking status was positively associated with chronic cough (OR = 4.58, 95%CI 2.50–8.39), chronic phlegm (OR = 3.99, 95%CI 2.25–7.07), and persistent wheeze (OR = 3.39, 95%CI 2.12–5.43). The average number of cigarettes smoked per day was associated with chronic cough (OR = 1.01, 95%CI 1.00–1.03), chronic phlegm (OR = 1.01, 95%CI 1.00–1.03), and persistent wheeze (OR = 1.01, 95%CI 1.00–1.03). BMI was only statistically significantly associated with persistent wheeze, (OR = 1.05, 95%CI 1.02–1.07), for each  $kg/m^2$  increase, although it was also elevated for chronic cough (OR = 1.03, 95%CI 0.99–1.06). We also examined the associations of respiratory symptoms with consumption of “junk food” and “fast food.” Eating more than three servings per week of “junk food” was statistically significantly associated with chronic cough (OR = 8.05, 95%CI 1.74–37.15) and chronic phlegm (OR = 3.29, 95%CI 1.05–10.24). Eating more than three servings per week of “fast food” was only statistically significantly associated with persistent wheeze (OR = 1.71, 95%CI 1.01–2.88).

**Conclusions:** In this occupational group, job titles with exposure to vehicle exhaust and indicators of an unhealthy lifestyle were predictors of chronic respiratory symptoms. These results may provide important targets of public health prevention in this industry.

#### ISEE-1547

#### Development of a High Performance Liquid Chromatography Method to Analyse *p*-Nitrophenol and *p*-Nitrocresol in Urine of Farmworkers Exposed to Parathion, Methyl Parathion and Fenitrothion

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**Background:** In Latin America and specifically in Brazil organophosphates represents almost 30% of total pesticide consumption. Among them, parathion (PT), methyl parathion (MPT) and fenitrothion (FT) are often present in many pesticide formulations. Biotransformation of these pesticides gives as ending products *p*-nitrophenol (PNP) from PT and MPT, and *p*-nitrocresol (PNC) from FT.

**Objective:** The main purpose of this work was to standardize an HPLC method to analyze urinary levels of PNP and PNC.

**Methods:** We have investigated several analytical parameters and procedures and the final standardized method is described as follows: 1-Reversed phase (5 µm–200 mm × 4.6 mm i.d. column); 2- Mobile phase constituted of 10 mM Tris-HCl buffer, pH 7.8 and methanol. Elution profile was obtained by using a linear gradient. 3- Diode array detection using a variable wavelength timetable (286 and 400 nm). Under these conditions retention times for PNP, 2-PNP (internal standard) and PNC were, respectively, 6.9; 10.5 and 12 minutes. Recovery studies were performed using spiked urine samples. Concentrations varied from 0.05 µg/ml up to 0.8 µg/ml. Standard curves were run simultaneously. In this part of the study 2 ml of spiked urine samples were submitted to a partial clean-up procedure and extracted once with ethyl acetate: ether. Quality control measures such as sample stability under storage, intra and inter assay variation were also performed.

**Results:** Our results demonstrated that analytical detection limits were 45 ng/ml and 49 ng/ml of urine, for p-nitrophenol and p-nitrocresol, respectively. These results were also corrected by creatinine content, giving detection limits of 0.042 mg/g and 0.045 mg/g of creatinine, for PNP and PNC respectively. It is worth of note that ACGIH has established 0.5 mg of PNP/g creatinine as a BEI for parathion and methyl parathion. Urinary conjugated forms of PNP were also analysed using this method and they could be detected in retention times equivalent to 2.9 and 4.2 minutes. Therefore, total PNP analysis is possible after acid or enzymatic hydrolysis of PNP conjugates. We have also analysed 8 samples from farmworkers exposed to parathion and methyl parathion. Results showed detection of p-nitrophenol ranging from not detected (2 samples) up to 421 micrograms/g of creatinine. We conclude that this method can be used as a sensitive biomarker to assess exposure to mentioned pesticides in samples obtained in occupational settings, as another tool to be used in biological monitoring, and therefore, giving support for risk assessment studies, in order to evaluate relationships between excessive exposure and health effects in occupationally exposed groups.

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#### ISEE-1549

#### Brominated Flame Retardant Levels in Human Milk and Serum from MAMA Study Participants: Preliminary Findings from Correlations over Time and Matrix, and with Questionnaire Results

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**Background:** Brominated flame retardants (BFRs) are synthetic, lipophilic, and bioaccumulative compounds used to prevent the combustion of a variety of items including electronics and furniture. There are 75 classes of BFRs, two of which are the polybrominated biphenyls (PBB) and the polybrominated biphenyl diethers (PBDE). The 209 PBDE congeners are classified based on bromination number and position. PBDEs are applied commercially as mixtures. Mixtures containing pentabrominated PBDE congeners are more readily absorbed into the body and are of interest for their reported health effects in animals. While penta- and octa-BDEs are no longer produced, deca-BDEs continue to be used.

The US EPA study, Methods Advancement for Milk Analysis (MAMA), recruited 34 lactating NC women who donated milk and serum at two time points (2–7 weeks and 3–4 months postpartum) between December 2004 and July 2005 for analysis of environmental and biological endpoints, including BFRs. All analyses were based on lipid-adjusted concentrations.

**Methods:** Seven PBDEs were measured and detected in the majority of the milk and serum samples (from lowest to highest concentration): BDE183, BDE154, BDE85, BDE100, BDE153, BDE99, and BDE47; three BFRs were measured in serum only (BDE17, BDE28, BDE66). Also

measured was one persistent organic pollutant BB153, which has not been used since the 1970s. Analysis of the deca-BFR BDE 209 was not performed in this study. Analysis of samples was performed using gas chromatography isotope dilution high resolution mass spectrometry. We anticipated that lactation would result in a decrease in BFRs between visits (average interval 8.4 weeks) due to depuration, but none of the milk or serum congeners were significantly different comparing levels at visit one to visit two.

**Results:** Nearly all of the milk and serum concentrations of individual BFRs were significantly correlated between visits, with the exception being BB153 and BDE183 in milk and BDE66 in serum. Comparing milk to serum levels for individual congeners within visit, only BDE 183 was not significantly correlated across matrices. BDE47 had the highest concentration in milk and serum at both visits. Maternal age was inversely correlated with most serum and milk BFR concentrations, with the exception of BB153. The age of the participant's home was inversely correlated with milk and serum levels of BDE47 and BDE100. Positive correlations were seen between the age of the primary motor vehicle and the concentrations of most congeners in serum and milk.

**Conclusion:** The participant's BMI, number of prior births, years in NC, and years at the current address yielded few, if any interesting correlations. These results begin to suggest possible routes of exposure for the reported blood and milk BFR concentrations in this study.

(This abstract does not necessarily reflect EPA, CDC, or NCHS policy).

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#### ISEE-1550

#### Characterizing the Spatial Distribution of Ambient PAHs Using Vegetation Biomonitoring

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**Background:** The use of Jeffrey pine needles as passive monitors to evaluate the spatial variability of polycyclic aromatic hydrocarbon (PAH) concentrations in ambient air in Fresno, California is an innovative approach to collecting large numbers (approximately 100) of samples from all areas of a city in less than one day to characterize spatial variability. Air sampling for PAHs is a labor-, equipment-, and time-intensive task which has yet to be achieved on a large scale. Using a biomonitor is a less intensive approach to characterizing the spatial variability. PAHs exist in ambient air as vapors (gas-phase) and adsorbed to particulate matter (particle-phase). Once emitted, they are deposited onto or absorbed into soil, vegetation, or surface water. Upon deposition to plants, PAHs partition into lipid-containing compartments of plants, such as leaves or needles. This partitioning behavior allows certain types of vegetation to be utilized as passive samplers for PAH, including pine needles. In order to quantify the PAH in pine needles, they are analyzed in a multi-step extraction and clean-up procedure. Samples are extracted in heptane, under 1500 PSI and at 120 degrees Celsius with an Accelerated Solvent Extractor. Then the extract is fractionated using a gel permeation column, in order to separate the organic matter from the PAHs. Last, the fraction is analyzed using GC/MS.

**Methods:** Using a stratified random sampling approach, 158 pine tree locations were identified in Fresno. The sample size was reduced in two ways. First, trees closer than 10 meters to another tree were eliminated. Second, the traffic and housing characteristics were graded on a scale of density and proximity. The sample was reduced to 100 by eliminating and equalizing the numbers in each traffic and housing category. We attempted to collect samples at these 100 locations, but at 9 locations the tree was inaccessible due to recent tree trimming or locked gates. These data were used to design a spatial model of PAH distribution in Fresno, CA. This was done in two ways. First, a land use regression approach was taken. The dependent variable was the individual PAH values at each sampling location; the independent variables were topography, traffic

density and proximity, and land use patterns. The second approach was to use kriging, a stochastic modeling approach, to interpolate values at non-sampled locations. These two outcomes are compared.

**Results:** In the example of pyrene, the range of samples was from 6.4 ng/gram fresh needle weight to 20.4 ng/gram fresh needle weight. The average was 12.7 ng/gram fresh weight, and the standard deviation was 4.4 ng/gram fresh weight. Samples collected closer to the highways had higher levels, as well as samples collected along major arterials. Maps of both sampling and modeling outcomes will be presented.

#### ISEE-1553

#### Building Tribal Capacity to Assess Health Effects from Contaminants in Their Food Supply Using a Case Study Approach

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**Abstract:** An existing software tool used by EPA, called LifeLine™, was enhanced so that it could be used by Tribal groups to evaluate potentially unique exposure that might occur as they practiced their own cultural traditions. With this new Tribal LifeLine™ software, the decision makers at federal, Tribal, and state levels, and the communities themselves have the capacity to determine: exposure levels if a contaminant is found in water or foods of that community; what foods and dietary profiles make significant contributions to that exposure; the impact of risk reduction strategies; and where more data and additional research could provide meaningful improvements and confidence in the assessments.

When introducing new approaches, particularly those involving the launching of new software, it is critical that those who will use it and those who will be called upon to respond to the users understand what the software can do and how the results should be interpreted. One way to help build a self-selecting Tribe's capacity to use the software and assess environmental threats from contaminants in their traditional food is to have a Tribally-trusted, technical expert (the Tribal Assessor) work closely with a Tribal community to produce a dietary health effects assessment. As part of the overall project done for OPPTS, EPA, an implementation study was undertaken in which training sessions were conducted for federal, state and university scientists who work with Tribal groups, as well as for Tribal Councils, to familiarize them with the principles of the exposure and risk assessment in the software. These sessions were well received and various groups are planning strategies for how they will interact with Tribal groups on the use of the software. A case study using customized dietary intake data, nutritional data and contaminant monitoring relevant to the community was also performed. The Tribal Assessor discussed with the Tribal representative which subsistence food should be considered in the case study, and confirmed the dietary intake for infants and children. The material to be presented at the meetings in the community was also discussed with the representative to assure that it would help the community understand how the Tribal LifeLine™ software was used and how to interpret the results from the assessment. The lessons learned from this approach reinforce the value of openness with all levels of government including Tribal Councils, involving the community in deciding which food is most important to them, what issues concern them and obtaining their input in selecting parameters for inclusion in the case study.

#### ISEE-1555

#### Neuropsychological Function in School-Age Children with Concurrent Mercury Exposures

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USA; ‡University of Northern Colorado, Greeley, CO, USA; and §Sahlgrenska University Hospital and Academy, Göteborg, Sweden.

**Background:** The EPA reference dose for methyl mercury was established using data from populations with greater exposures than those typical of the US. Few data are available on potential adverse health effects at lower levels.

**Objectives:** We examined relationships between hair mercury levels and concurrent neuropsychological outcomes in a population of US children.

**Methods:** This study included data from 355 children ages 6–10 enrolled in the New England Children's Amalgam Trial. Data on total hair mercury levels, sociodemographic information and neuropsychological function were collected. Using analysis of covariance, we evaluated associations between hair mercury and neuropsychological test scores. We also used generalized additive models to determine the shape of associations that departed from linearity. Models controlled for relevant covariates, including the potential beneficial effects of consuming fish.

**Results:** In adjusted models, we observed no significant linear relationships between hair mercury level and any test score. Significant departures from linearity were identified for WIAT Math Reasoning and WRAMVA Visual-Motor Composite scores. The association was positive for hair mercury levels below 0.5 µg/g and negative for levels between 0.5 and 1.5 µg/g. Test scores of children with hair mercury levels ≥ 1.0 µg/g appeared to be lower than those of children with levels < 1.0 µg/g, but few children had levels in this range.

**Conclusions:** Hair mercury levels below 1.0 µg/g in US school-age children were not adversely related to neuropsychological function.

#### ISEE-1556

#### Combined Effects of Prenatal Exposure to Traffic-Related Air Pollution and Inhaled Allergens on Maternal and Cord Blood IgE Expression: Project ACCESS

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**Background:** Sensitization to inhalant indoor allergens may be enhanced through simultaneous exposure to traffic-related air pollutants although these associations have not been explored in the prenatal environment. Traffic-related air pollutants are thought to modulate the immune response by increasing immunoglobulin E synthesis thus facilitating allergic sensitization. We examined the combined influence of prenatal exposure to traffic-related air pollutants and inhaled indoor allergens on IgE expression among a subset of mothers in mid-pregnancy and their newborns ( $N = 437$ ) enrolled in the Asthma Coalition on Community, Environment, and Social Stress (ACCESS) project, a prospective study of prenatal and early life environmental exposures and urban childhood asthma.

**Methods:** Local black carbon levels were estimated using a validated spatio-temporal land use regression model derived using ambient and indoor monitoring data [mean (SD) predicted annual black carbon 0.43 (0.31) µg/m<sup>3</sup>] over the gestational period. Exposure to dust mite was quantified in settled dust sampled from pregnant mothers' bedrooms; Der f 1 (range < 0.02 to 12.8 µg/g) and Der p 1 (10 µg/g) vs. low (< 10 µg/g) for the analysis. Tobit linear regressions were run stratifying by high vs. low dust mite exposure adjusting for maternal age, race, education, atopic history, socioeconomic strain, and prenatal smoking as well as the child's gender and season of birth. Separate models were run predicting maternal and cord blood IgE.

**Results:** Increased black carbon (IQR change) predicted increased maternal IgE in the high allergen strata ( $\beta = 0.58, P = 0.04$ ) and decreased levels of maternal IgE among those with low allergen exposure ( $\beta = -0.26, P = 0.006$ ). Similarly, increased black carbon was significantly associated with elevated cord blood IgE among those with high allergen exposure ( $\beta = 0.62, P = 0.01$ ) and not significantly associated with cord blood total IgE in those with low allergen exposure ( $\beta = -0.08, P = 0.23$ ). The difference between the strata was also significant (interaction term p value  $< 0.02$  for cord blood and  $< 0.006$  for maternal models). Living in an environment with increased air pollution as well as higher exposure to dust mite was most significantly associated with elevated levels of maternal total IgE in utero and cord blood IgE.

**Conclusion:** Given that elevated prenatal maternal IgE and elevated cord blood IgE have also been associated with Aeroallergen sensitization and later asthma development in childhood, these findings may have implications for atopic risk in these children.

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#### ISEE-1557

##### Correlations Between Urinary Phthalate Metabolites and Phthalates, Estrogenic Compounds 4-Butyl phenol and o-Phenyl phenol, and Some Pesticides in Home Indoor Air and House Dust

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**Background:** Biomonitoring data provide critical information about chemical exposures, and combining biomonitoring with measurements in environmental media provides insight into sources and pathways of exposure.

**Methods:** In a study of 120 Cape Cod, MA, homes (CCHES), we collected 24-hour indoor air samples and house dust samples and analyzed them for 89 different chemicals thought to be hormonally active, including phthalates, alkylphenols, o-phenyl phenol, bisphenol A, parabens, pesticides, PBDEs, PCBs, and PAHs. First-morning void urine samples were collected from a female resident of each home and analyzed by US CDC for urinary phthalate metabolites. Creatinine-adjusted urinary monoethyl phthalate (MEP), monobutyl phthalate (MBuP), monobenzylphthalate (MBzP) and mono(2-ethylhexyl) phthalate (MEHP) concentrations in the Cape Study were generally comparable to a subset of the NHANES 1999–2000 study population similar in gender, age, and ethnicity; and to the overall NHANES 1999–2000 study population (years selected to match Cape Cod sample collection period). Kendall's tau rank correlation estimates (adjusted for censoring) were used to characterize the relationships within and between urine, air and dust values since the data are subject to multiple censoring levels. In general, Kendall's tau estimates of correlation tend to be lower in magnitude than the corresponding Pearson or Spearman correlation estimates.

**Results:** Within the Cape Study population, levels of the four phthalate metabolites were correlated (taus ranging from 0.22–0.39,  $P < 0.001$  for all pairs); and significant correlations were also observed in the NHANES full sample and the subgroup comparable to the Cape Study population for both 1999–2000 and 2001–2002. Generally, strongest correlations were for MBuP with MBzP, MBuP with MEP and for MEHP with MBzP. Significant correlations were also observed between the parent phthalate in air and dust and the corresponding metabolite(s) in urine for MEP, and MBuP, but not MEHP and MBzP and air ( $\tau = 0.13–0.27, P < 0.05$ ). In addition, several ubiquitous air and dust contaminants that have been shown to be weakly estrogenic were also significantly correlated with urinary phthalate metabolites, including o-phenyl phenol and 4-t-butylphenol; and some urinary phthalate metabolites were correlated with air or dust levels of phthalates other than their parent compound ( $\tau$

= 0.12–0.17,  $P < 0.05$ ). The pesticides propoxur and permethrin and the synergist piperonyl butoxide in air or dust were also weakly correlated with urinary phthalate metabolites. This finding may reflect the use of phthalates as an inert ingredient in pesticide formulations.

**Conclusions:** Overall, these data show that concentrations of many EDCs in biological samples and indoor air and dust co-vary, suggesting that some EDC mixtures may originate from common exposure sources and highlighting potential confounding by other EDCs in health effect studies of phthalates. Future work will utilize factor analysis to identify source profiles of EDC mixtures that are associated with urinary phthalate levels.

#### ISEE-1558

##### Spatial Modeling of Air Pollution 1985–2000 in the Continental U.S.

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**Background:** Chronic epidemiologic studies of air pollution have demonstrated a link between long-term air pollution exposures and mortality. However, in these studies exposure assessment has mostly been limited to city-specific average pollution measures or spatial or land-use regression exposure models in small geographic areas.

**Objectives:** The purpose of this analysis is to develop nationwide models of annual exposure to four criteria pollutants ( $PM_{10}$ ,  $NO_2$ ,  $SO_2$ ,  $CO$ ) using spatial smoothing and Geographic Information System (GIS)-derived covariates. These models will be used to assign annual exposures 1985–2000 in a cohort of US men.

**Methods:** We used generalized additive models (GAMs) to predict annual outdoor levels of the pollutants using smooth spatial surfaces of available monitoring data and GIS derived covariates (e.g. distance to road, population density, elevation, surrounding land use, and power plant emissions). Model performance was determined using a cross validation procedure with 10% of the data. We assessed the potential bias of each model by calculating the prediction error, the difference between the observed and predicted values at each cross-validation location. We also assessed bias in the models by examining the intercept and slopes from linear regression of the predicted values on the measured values. Precision was estimated by taking the square root of the mean of the squared prediction errors (RMSPE).

**Results:** For  $PM_{10}$ , distance to road, elevation, proportion of low intensity residential, high intensity residential, and industrial, commercial, or industrial landuse within 1 km were all statistically significant predictors of measured  $PM_{10}$  concentrations (model  $R^2 = 0.57$ ). The median (and interquartile range (IQR)) prediction error of the model was  $-0.58$  ( $7.0$ )  $\mu\text{g}/\text{m}^3$ , the intercept and slope of the regression of observed and predicted measurements were  $1.28$  and  $0.93$ , and RMSPE was  $9.9 \mu\text{g}/\text{m}^3$ . Distance to all three Census classes of road, block group population density, surrounding land use, distance to the nearest  $SO_2$ -emitting power plant and the level of emissions from that power plant were all statistically significant predictors of measured  $SO_2$  concentrations (model  $R^2 = 0.70$ ). The median (IQR) prediction error was  $-0.14$  ( $2.2$ ) ppb, the intercept and slope were  $0.00$  and  $0.98$ , and the RMSPE was  $2.7$  ppb. Distance to road, population density, elevation, and land use within 1 km were all

statistically significant predictors of measured CO concentrations (model  $R^2 = 0.69$ ). The median (IQR) prediction error was  $-0.04$  (0.3) ppm, the intercept and slope were 0.05 and 0.94, and the RMSPE was 0.3 ppm. Distance to road, population density, elevation, surrounding land use, and distance to nearest NO<sub>x</sub>-emitting power plant were all statistically significant predictors of measured NO<sub>2</sub> concentrations (model  $R^2 = 0.88$ ). The median (IQR) prediction error was 0.05 (6.5) ppb, the intercept and slope were 0.00 and 0.88, and the RMSPE was 6.0 ppb.

**Conclusions:** GAMs using a combination of spatial smoothing and GIS derived covariates provide reasonably accurate and unbiased estimates of annual exposures for four of the criteria pollutants. These models can be informative for epidemiologic studies of chronic exposures.

#### ISEE-1559

#### Associations Between Arrhythmia Episodes and Air Pollution in Elderly Patients

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**Background:** Ambient air pollution has been associated with sudden deaths, some of which are likely from arrhythmias. Defibrillator discharge studies have examined the association of air pollution with arrhythmias in sensitive populations but less is known for the general population.

**Methods:** In the Normative Aging Study, a longitudinal study of aging established in 1963 in Boston, we investigated the association between ambient air pollution and change in arrhythmia episodes measured as counts of ventricular ectopy (VE) by 7 minutes Holter electrocardiogram monitoring in 635 patients, during the years 2000 to 2007. We used a zero-inflated Poisson model, controlling for seasonality, weather, day of the week, medication use, heart rate, non-HDL-cholesterol, smoking, having diabetes and having hypertension.

**Results:** We found significant increases in VE in association with PM<sub>2.5</sub>, BC, NO<sub>2</sub> and CO for the same hour of measurements, the four hour average and up to the 24-h average of pollution. For the same hour we found an OR of 1.33 (95%CI:1.26–1.41) for an increase of 1  $\mu\text{g}/\text{m}^3$  in BC, an OR of 1.25 (95%CI:1.2–1.3) for an increase of 10  $\mu\text{g}/\text{m}^3$  in PM<sub>2.5</sub>, an OR of 1.9 (95%CI:1.8–2.1) for an increase of 0.01 ppm in NO<sub>2</sub>, and an OR of 1.7 (95%CI:1.6–1.8) for an increase of 0.3 ppm in CO.

**Conclusion:** Increased levels of traffic related pollutants may increase the risk of ventricular arrhythmia in elderly subjects.

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#### ISEE-1560

#### Long-Term Ambient Multipollutant Exposures and Mortality

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**Background:** Population based studies have demonstrated associations between ambient air pollution exposures and mortality. Using information on occupation from questionnaire or expert review, a few studies have observed higher risks in individuals with occupational exposures to dust, gases, or fumes.

**Objectives:** The purpose of this analysis is to examine the association of ambient residential exposure 1985–2000 to four criteria pollutants (PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO) and mortality in a cohort of US men employed in the trucking industry.

**Methods:** Annual and long-term exposures for each cohort member' residential address were assigned using a GIS-based model. Cox proportional hazard models were used to examine the association of an interquartile range change in each pollutant ( $6 \mu\text{g}/\text{m}^3$  for PM<sub>10</sub>, 0.6 ppm for CO, 4 ppb for SO<sub>2</sub>, and 10 ppb for NO<sub>2</sub>) and the risk of all cause, respiratory, cardiovascular, and lung cancer mortality. Models adjusted and unadjusted for years of work in each of the major cohort job titles were compared to determine if there was confounding by job title. Multipollutant models were also considered.

**Results:** An IQR change in ambient residential exposures to PM<sub>10</sub> in the current calendar year was associated with a 3.27% (95%CI: 0.58–6.02%) increased risk of all cause mortality. The increase for an IQR change in SO<sub>2</sub> was 0.23% (95%CI: -1.37–1.85%), and NO<sub>2</sub> was 5.46% (95%CI: 1.77–9.29%). Associations with cause-specific mortality were seen for CO and COPD mortality (4.02%, 95%CI: 0.17–8.02%), and SO<sub>2</sub> and cardiovascular mortality in general (0.71%, 95%CI: -0.84–2.27%) and ischemic heart disease specifically (0.82%, 95%CI: -0.55–2.20%). Fewer significant associations were seen with long-term (1985–2000) average pollution levels. Of all of the exposures examined, none appeared to be confounded or modified by occupational exposures measured by job title. In multipollutant models the conclusions were unchanged.

**Conclusions:** In this population of US men, ambient air pollution exposures were associated with mortality. These associations were stable in models adjusted for occupational (trucking related) exposures and multiple pollutants.

#### ISEE-1561

#### Protecting Patient Confidentiality when Mapping Health Data: An Analysis of Geomasking Algorithms

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**Background:** A major challenge in mapping health data, especially for spatial surveillance, is protecting patient confidentiality while maintaining the spatial resolution necessary for in-depth analyses such as outbreak and cluster detection. Reporting the address locations of individuals may violate patient privacy while aggregating to politically defined regions causes a loss in the resolution of the data, thereby masking spatial details needed to identify, analyze, and monitor health problems at the community level. In response, a variety of geomasking methods have been proposed that displace point health data from their original locations. Here, we examine a geomasking technique, which we refer to as the donut geomasking method, that extends current methods of random displacement by ensuring that an address is not randomly assigned on or too near its original location. In donut geomasking, each geocoded address is relocated in a random direction by at least a minimum distance, but less than a maximum distance, while retaining the address in its original census block group.

**Methods:** We assessed the effectiveness of the donut geomasking method by simulating a disease field and injecting spatial case clusters over a four county region in North Carolina. The simulated data was then geomasked using both the donut method and random displacement. We examined the mean k-anonymity, defined as the number of people by which a de-identified case is displaced geographically and cannot be reversely identified, as a measure of patient privacy. We also quantified cluster detection using the SATScan Spatial Bernoulli Model scanning algorithm and calculated sensitivity and specificity for identified case clusters. This

simulation was repeated for a range of privacy protection levels and multiple times at each protection level.

**Results:** On average, the donut geomasking method resulted in a mean k-anonymity 10 to 40 per cent greater than random displacement with no significant decrease in sensitivity and specificity of cluster detection. In other words, the donut geomasking method provided a consistently higher level of privacy protection with minimal decrease in cluster detection performance. Additional simulations will be used to confirm this result and explore its validity using different geomasking parameters.

#### ISEE-1562

#### The Woodstove Exchange STudy (WEST): Mapping Residential Woodsmoke in the Skeena-Bulkley Valley Lakes District

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**Background:** The Woodstove Exchange Study (WEST) is evaluating air quality and health impacts from the implementation of a woodstove exchange program and wood burning bylaws within the Skeena Region and Bulkley Valley Lakes District (BVLD) (north western British Columbia, Canada).

**Objectives:** The objectives of the 2007/2008 research program were to i) establish baseline ambient concentrations and exposure gradients of residential woodsmoke, ii) identify persistent woodsmoke 'hot spots' at the neighborhood level, and iii) assess the utility of measurements at central monitoring stations for use in health studies within five communities.

**Methods:** Woodsmoke PM<sub>2.5</sub> was measured for ten nights in each community via mobile monitoring with an integrating nephelometer on cold, calm nights. PM<sub>2.5</sub> filter samples were also collected at one fixed-site in each community and analyzed for PM<sub>2.5</sub> mass, light absorbing carbon, and the woodsmoke tracer, levoglucosan.

**Results:** Mobile monitoring results indicate that the 90<sup>th</sup> percentile of PM<sub>2.5</sub> concentrations in two communities (Terrace: 33.2 µg m<sup>-3</sup>; Smithers: 25.4 µg m<sup>-3</sup>) exceeded the proposed provincial ambient air quality criteria for PM<sub>2.5</sub> (25 µg m<sup>-3</sup>, 24-hour average). Concentrations in the three other communities (Telkwa: 23.6 µg m<sup>-3</sup>; Houston: 23.8 µg m<sup>-3</sup>; Burns Lake: 11.1 µg m<sup>-3</sup>) were below the criteria. PM<sub>2.5</sub> concentrations were spatially variable within communities where the range between the 10<sup>th</sup> and 90<sup>th</sup> percentiles was as large as 42 µg m<sup>-3</sup> in a single evening. Elevated particle concentrations were commonly found in close proximity to older homes, in trailer parks, and in low lying areas. Central monitoring stations appear to be located in moderate to high pollution areas as the median PM<sub>2.5</sub> concentrations at these stations were comparable to the 50<sup>th</sup>–75<sup>th</sup> percentile range of the mobile measurements.

**Conclusions:** These results indicate that central monitors may be used to represent community average PM<sub>2.5</sub> concentrations and to compare concentrations between communities. Spatially resolved mobile measurements offer an improved estimation of woodsmoke PM<sub>2.5</sub> concentrations and help to identify potential focus areas for health studies, interventions and additional monitoring.

#### ISEE-1563

#### Daily Incremental Exposure: A Method for Comparing Exposures to Fine Particles from Everyday Sources

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**Background:** Although we encounter a great many sources of fine particles (PM<sub>2.5</sub>) in our daily lives, a methodology is needed to compare the exposures caused by these sources on a common basis.

**Methods:** This paper presents a systematic method for converting exposure measurements from a single source into a common 24-h average exposure. The methodology is illustrated using measurements of exposure from a variety of different sources (a cigarette in a car, smoking at home, a cigar, cooking, incense, Hookah smoking, candles), illustrating how these diverse sources can be compared by converting the experimental data to a common 24-h average concentration, the incremental 24-h exposure ( $IE_{24}$ ).

**Results:** New data are presented on measurements in California bars and restaurants, showing the  $IE_{24}$  exposures prior to the State's initial smoking ban, compared with  $IE_{24}$  measurements after smoking was restricted. Measurements in the passenger compartment of a 2005 Ford Taurus with a smoker present gives an average concentration of 1,113 µg/m<sup>3</sup> with an averaging time of 27.2 min. Using the integrated exposure methodology, this event corresponds to a 24-h average PM<sub>2.5</sub> exposure of  $IE_{24} = 21$  µg/m<sup>3</sup>. Similarly, smoking a single cigarette in a 283 m<sup>3</sup> home gave  $IE_{24} = 2.64$  µg/m<sup>3</sup>, and therefore smoking 11.8 cigarettes based on NHANES data gives an average exposure level in a home of 31.1 µg/m<sup>3</sup>, roughly equal to the 24-h mean concentration of 30 µg/m<sup>3</sup> reported in the particle TEAM study (Özkaynak *et al.*, 1996).

**Discussion:** An important advantage of the  $IE_{24}$  methodology is that it follows the laws of *linear superposition*. That is, since the results are on a common averaging time, the  $IE_{24}$  values from individual sources during the day can be added directly together, providing an estimate of the fine particle exposures that a person encounters during the day from all sources. To get the 24-h average exposure for a person simultaneously exposed to two different sources, we merely add the  $IE_{24}$  values for each source. The National Ambient Air Quality Standard for fine particles provides a convenient benchmark with which to compare integrated 24-h exposures. This paper presents considerable unpublished measurement data from California, showing how some sources can create very high integrated exposures while other sources create relatively small integrated exposures. Implications for policies for protecting public health are discussed.

#### ISEE-1565

#### An Approach for Evaluating the Operational Locations of Portable Combustion Devices and Mechanical Grinders to Obviate the Potential for Residential Impacts When Used to Process Waste in the Aftermath of Destructive Storms and Other Natural Disasters

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**Background and Discussion:** The devastation caused by severe hurricanes, other storms, and earthquakes leaves tons of debris in need of removal and disposal. A case in point is Hurricane Katrina. Katrina made landfall as a Category 2 storm along the Central Gulf Coast near Buras-Triumph, Louisiana on August 29, 2005. The ferocity of the 125 miles per hour winds combined with a strong tidal surge caused three large breaches in the levee system separating Lake Pontchartrain from New Orleans, resulting in the flooding of about 80% of the land area of the city. The wind and water severely damaged homes, businesses and industries. The storm generated millions of cubic meters and millions of metric tons of demolition waste, downed trees, and other debris in need of disposal. Given the shear magnitude of waste produced by severe storms, how can local and state authorities begin to deal with the magnitude of the situation? The storm-related waste will ultimately be landfilled. However, unless the volume of waste is somehow reduced, there is a real potential for adversely impacting the regional capacity of landfills. Recently it has been proposed that portable waste burners and mechanical grinders can be quickly employed to significantly reduce the volume of waste in need of disposal. These devices are likely to produce pollutant air emissions while processing the waste. The question becomes where can these devices be located so as to obviate impacts to residential areas? This paper presents a structured approach to producing information necessary to address this

issue through the application of several hypothetical but realistic scenarios involving the operation of portable waste burners and grinders during emergency situations.

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**ISEE-1566**
**Nicotine Contamination in Particulate Matter Sampling**

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**Objective:** A potential problem in occupational studies where particulate matter (PM) is used as the marker of exposure to industrial and traffic sources is the possibility of adsorption of vapor phase cigarette constituents onto the sample filter. This contamination can result in an over-estimation of PM exposures determined gravimetrically. In this study of US trucking industry drivers who are allowed to smoke while driving, we assessed potential contamination by nicotine, a marker of cigarette smoking, on PM<sub>2.5</sub> (less than 2.5 microns in diameter) samples intended to measure occupational exposures to vehicle related exhausts.

**Material and Methods:** We measured PM<sub>2.5</sub> and nicotine using active samplers in the truck cabs during the work shift of 16 truck drivers who smoked. PM<sub>2.5</sub> was collected on pre-weighed Teflon filters after the larger particles were removed by a cyclone separator. We placed a 37 mm Teflon-coated glass fiber filter treated with sodium bisulfate behind ("in-line" nicotine filter) the PM<sub>2.5</sub> filter to collect vapor phase nicotine (PM-nicotine sampler). Simultaneously, a "stand-alone" sodium bisulfate treated filter was placed in parallel with the PM-nicotine sampler. To assess vapor phase nicotine that became adsorbed to the PM<sub>2.5</sub> filter, we examined the difference of the nicotine concentrations collected from the "in-line" and "stand-alone" filters using paired-T tests, and the correlation between PM<sub>2.5</sub> and nicotine concentrations.

**Results:** The mean (SD) of the "stand-alone" nicotine concentrations was 8.20 (7.29) µg/m<sup>3</sup> and that of the "in-line" nicotine concentrations was 7.10 (7.03) µg/m<sup>3</sup>. PM<sub>2.5</sub> was bimodally distributed around 50 µg/m<sup>3</sup>, and nicotine levels were higher in samples with higher PM<sub>2.5</sub> concentrations. The overall correlation between the two nicotine filter levels was 0.98 (regression slope = 1.03, intercept = 0.9), and the correlation with PM<sub>2.5</sub> was 0.92 for "stand-alone" nicotine and 0.93 for "in-line" nicotine. However, there was a small but significant difference between the two nicotine measurements, mean = 1.10 µg/m<sup>3</sup> ( $P = 0.0003$ ), but this difference was only statistically significant in filters with lower levels of PM<sub>2.5</sub> (less than or equal to 50 µg/m<sup>3</sup>) when stratifying by PM<sub>2.5</sub> levels.

**Conclusions:** The extent of the difference between the "stand-alone" and "in-line" nicotine levels was systematic but relatively small. They suggest that it is important to account for cigarette smoke exposure while assessing occupational and environmental PM, particularly when PM concentrations are low. Additionally, measurements of nicotine are potentially useful for adjusting for PM<sub>2.5</sub> contamination from cigarette smoke, and further study with a larger sample size is required for quantifying the influence of vapor phase nicotine concentration on the PM filters.

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**ISEE-1568**
**A High-Resolution Gas Chromatography Mass Spectrometric Method for Measuring Pesticides and PCBs in Human Milk**

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**Background:** The benefits of breastfeeding for mother and child are well-documented; however, numerous studies have shown that pesticides and other environmental chemicals are present in measurable quantities in breast milk and may pose a potential risk to the developing infant. In particular, contemporary-use organophosphorus (OP) pesticides have been associated with neurodevelopmental deficits and bioaccumulating endocrine-disrupting organochlorines (OC) have been associated with abnormal reproductive endpoints. Chemical levels measured in human milk can be used to assess exposures to both the mother and nursing infant; thus, the analysis of this matrix is invaluable for longitudinal birth cohort studies of environmental exposures and maternal and infant health.

**Methods:** We have developed a new multi-analyte extraction and analysis method to simultaneously measure 1) contemporary-use pesticides including OP, pyrethroids, and carbamate insecticides; 2) bioaccumulating pesticides including DDT and its degradate/metabolite DDE, hexachlorobenzene, β-hexachlorocyclohexane and methoxychlor; and 3) several biologically relevant polychlorinated biphenyls (PCBs). Extraction of these compounds was achieved by dispersing 1 mL of milk over hydromatrix and using pressurized fluid extraction technology to pass approximately 40 mL of 1:1 hexane:dichloromethane through the extraction cells at 70 °C and 1500 psi. Extracts were then concentrated to 0.5 mL and purified using automated solid phase extraction (SPE) with an SPE cartridge filled with 500 mg neutral alumina and 750 mg primary and secondary amine bonded silica (PSA). The cartridges were eluted with 3 mL of acetonitrile, and the concentrated extracts were analyzed using high resolution gas chromatography-mass spectrometry with isotope dilution quantification.

**Results:** Extraction recoveries for the analytes were as follows: 55–96% for OP insecticides, 34–56% for OC insecticides, and 28–31% for PCBs with accurate quantification within 10% of the expected concentrations. The analyte-specific limits of detection were in the 50 pg/g range. The relative standard deviations of the measurements were less than 35%.

**Conclusion:** With this new method we have overcome the challenges of measuring many chemicals with different chemical properties and a potentially wide dynamic range in a matrix with high lipid content. This method will be applied to human milk samples collected in two different populations in California.

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**ISEE-1569**
**Human Health Risk Assessment from Air Pollution Caused by Stationary Sources in Industrial Cities of Ukraine**

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**Introduction:** Modern industrial activity of Ukraine is beleaguered by a substantial amount of hazardous factors that pose danger to health and safety. These days, the public clearly understands the need to seek approaches to choose strategies to prevent and mitigate threats to people's health. Only the systematic approach that comprises the identification of potentially dangerous factors, defining their impact, multi-sided comparative analysis of medical, social, and economic significance of the consequences of their impacts, and analysis of the expenditures and benefits from different management actions, is capable of solving complicated tasks in the field of medical ecology. These days, such a

systematic approach is being implemented through the methodology of Human Health Risk Assessment (HHRA) and is widely used by international organizations and in many countries of the world.

**Objective:** An objective of this study was assessment of human health risk attributed to air pollution in Zaporozhie and Kyiv based only on existing information that is likely to be available in other Ukrainian cities.

**Materials and Method:** This study is based only on legitimate statistical data concerning emissions of industrial enterprises in Zaporizhia and Kyiv. Available information was processed by means of GIS using high quality data (Quick Bird namely) in accordance with demands of the stages of human health risk assessment methodology. Average exposition levels were calculated by program complex ICS-Aermod taking into consideration meteorological, topographic, land use and demographic data.

**Results:** The carried out research gave the possibility to conduct human health risk attributed to industrial air pollution assessment studies on the territory of Ukraine. As a result cancer and non-cancer human health risks were estimated. In Zaporizhia city individual risk from air pollution formed by industrial enterprises is at relatively high level that equals  $10^{-2}$ – $10^{-3}$ . These are high enough values even for as highly industrialized city as Zaporizhia. Risk levels for Kyiv reach  $10^{-3}$ – $10^{-4}$  meaning. Under such conditions urgent sanitary measures and deeper study of existing problems is demanded. This is posed by the need of their prioritization in relation to other hygienic, ecological, social and economic questions on the studied territory.

**Conclusion:** The completed work allowed identifying the areas of the highest risk levels attributed to air pollution for the territories of Zaporizhia and Kyiv. It is planned that on these areas nature-conservative measures will be founded and implemented during the risk management stage.

#### ISEE-1570

#### Chronic Fine and Coarse Particulate Exposure, Mortality and Coronary Heart Disease in the Nurses' Health Study

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**Background:** Relationships between acute fine particulate exposures and increased risk of mortality and cardiovascular events have been well-documented. However less is known about chronic fine and coarse particulate exposures and these outcomes.

**Methods:** Using GIS-based spatial smoothing models to predict long-term exposures to fine and coarse particulates for each study participant at each residential location during the follow-up period, we examined the relationship of estimated monthly PM exposures with all cause mortality, and fatal and incident nonfatal coronary heart disease (CHD) in the Nurses' Health Study, a prospective study of US women. Participants in the current study were restricted to women living in metropolitan areas of the northeastern region of the US with follow-up 1992–2002. CHD outcomes were confirmed through medical record review, and covariates were updated biannually from mailed questionnaires.

**Results:** In the final sample of 66,250 women, there were 3,785 deaths, 1,348 first incident MIs, 494 fatal CHD events and 854 nonfatal MIs. The overall mean predicted  $\text{PM}_{2.5}\mu\text{g}/\text{m}^3$  (SD) was 13.9(2.4) and 7.7(2.6) for  $\text{PM}_{10-2.5}\mu\text{g}/\text{m}^3$ . In single pollutant Cox proportional hazards models, adjusted for Census tract-level median house value and household income, hypertension, family history of MI, hypercholesterolemia, BMI, physical activity, smoking, diabetes, calendar time, age and state of residence, each  $10\ \mu\text{g}/\text{m}^3$  elevation in  $\text{PM}_{2.5}$  exposure in the 12 months prior to death was associated with a hazard ratio (HR) of 1.26 increase in all cause mortality (95%CI: 1.02, 1.54). The HR's for fatal CHD, first incident MI and nonfatal MI were 2.19 (95%CI: 1.26 to 3.80), 1.11 (95%CI: 0.79, 1.55),

and 0.73 (95%CI: 0.48, 1.12), respectively. In similar models for  $\text{PM}_{10-2.5}$  exposures, the HR for all cause mortality was 1.03 (95%CI: 0.89, 1.18), HR = 1.18 (95%CI: 0.80, 1.74) for fatal CHD, HR = 1.04 (95%CI: 0.82, 1.32) for first incident MI, and HR = 0.96 (95%CI: 0.71, 1.30) for nonfatal MI. The associations with  $\text{PM}_{2.5}$  exposure were stable in fully-adjusted multipollutant models. There was a stronger association of nonfatal MIs with  $\text{PM}_{10-2.5}$ , with adjustment for  $\text{PM}_{2.5}$ . There was evidence of effect modification by family history of MI, hypercholesterolemia, hypertension and smoking. Women who had never smoked were at highest risk, followed by former smokers and current smokers. Strong associations of all cause mortality and CHD outcomes with chronic  $\text{PM}_{2.5}$  exposure were observed in this cohort of US women. Chronic exposure to  $\text{PM}_{10-2.5}$  showed less of an effect, except for nonfatal MI, when adjusting for  $\text{PM}_{2.5}$ .

#### ISEE-1571

#### Environmental and Biological Levels for PBDEs and Other Organic Compounds

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**Background:** The SUPERB Study (Study of Use of Products and Exposure-Related Behaviors) is an evaluation of alternative platforms for collecting longitudinal data related to non-occupational environmental exposures through food, daily activities, and household products. We are currently conducting a sub-study that includes environmental sampling and an internal measure of exposure as determined through biological samples.

**Objectives:** The purposes of this sub-study are two-fold. First, we are including a comprehensive set of home environmental samples to determine which, if any, environmental media are predictors of exposure, by comparing these environmental media to biological samples for PBDEs. Second, we are using data collected on exposure related behavior in conjunction with the biological measures of exposure to enhance our ability to interpret and evaluate the data being collected in the longitudinal study.

**Methods:** We are enrolling one-hundred and fifty households in California in this biomonitoring study. One-hundred of the households will involve the participation of both a parent and a child between the age of 18 months and 8 years, while 50 of the households in this study will involve the participation of an older adult. We will collect blood and urine samples from each study participant. The home walkthrough and environmental sampling protocol has been designed to focus on sources of and exposure to PBDEs. Environmental samples from the home include two types of dust samples (vacuum bag and HVA3), passive indoor air samples, as well as wipe samples from both the floor and windows for a subset of participants. The home walkthrough focuses on the age and use of potential sources of PBDEs, specifically furniture and electronics. The questionnaire and both dust collection methods have been piloted on 15 homes, with the questionnaire and HVA3 sampling completed on a total of 30 homes.

**Results:** As seen in previous studies, the concentrations were highly skewed and the concentrations found in California were slightly elevated at the median relative to concentrations found in other regions of the country. From the 30 homes, the median concentration of BDE 47 was 1051 ng/g dust, with a mean of 1426 and a maximum of 7051 ng/g. For BDE 99 and 209, the median concentrations were 1173 ng/g and 1242 ng/g, respectively.

**Discussion:** For our second aim, we will use data collected from questionnaires on exposure related behavior and consumer product use to determine if questionnaire-based data on exposure-related behavior (diet, time activity, consumer product use, etc.) are correlated with levels of exposure as determined through biological samples for phthalates, BPA,

non-persistent pesticides, cotinine, acrylamide, and PAHs (1-hydroxypyrene). Through this study we will also determine if changes in exposure-related behaviors over time are reflected in the levels of internal exposure and if differences in biological levels between three age cohorts (young children, their parents, and older adults) can be explained, in part, by differences in exposure-related behavior.

#### ISEE-1574

#### Characterizing the Spatial Accuracy of Geocoding for Exposure Assessment: The Multiethnic Study of Atherosclerosis and Air Pollution (MESA Air)

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**Introduction:** Residential proximity to roadways has been repeatedly linked to cardiovascular morbidity and mortality. Given the small-scale spatial variation of air pollution around roadways, identifying participant locations with minimal error is critical. Past research has demonstrated that a common method of positional assignment (street geocoding) can systematically overestimate the number of individuals living close to major roadways. In this investigation we compare estimates of roadway proximity between five different location assignment methods for individuals in California and Minnesota.

**Methods:** Spatial locations were assigned for a subset of the Multiethnic Study of Atherosclerosis and Air Pollution cohort who were visited for residential air pollution sampling in the Los Angeles/Riverside and St. Paul metropolitan areas. Five different approaches were used: (1) identifying locations using aerial photographs and positional information from field notes, (2) matching participants to parcel data, (3) collecting GPS measurements at subject homes, (4) street address geocoding with a 30 foot offset, and (5) street address geocoding with manual offsets (accounting for roadway widths and residential setbacks from the curb). All geocoding was conducted using Tele Atlas Dynamap 2000. Since we assumed that aerial photography was the best representation of a home's true location, only individuals who were identified by this method were included in this evaluation ( $n = 95$  in California and  $n = 63$  in Minnesota). We calculated distances from each location to interstate highways (FCC A1), state highways (FCC A2), and major arterial roads (FCC A3) for each spatial positioning technique. We also explored differences across methods in a binary proximity metric defined as <100 meters of an A1 or A2 or <50 meters of an A3. Euclidean distances were also calculated between each location and the coordinates from aerial photography to quantify the positional error by method.

**Results:** The five spatial assignment methods produced similar proximity estimates for participants living greater than 100 meters from any major roadway. However, differences were observed between methods for participants living within 100 meters of A3 roadways. Calculated proximities to A3s were systematically lowest for street geocoding with a 30 foot offset and highest for aerial photography and parcel data. These differences were limited to those individuals living directly on an A3 (25 of 50). The remaining individuals living on smaller roads (FCC A4s) within the immediate vicinity of A3s did not demonstrate the same bias. Persons living on A3s were also the primary contributors to the discordance (3 to 8%) between aerial photography and other methods for our binary proximity metric. No large differences were observed between methods for the limited number of individuals within close proximity of A1 or A2 roadways.

**Conclusions:** Assignment of residential proximity to roadways is sensitive to spatial assignment methodology within short distances, predominantly for individuals that live on major arterial roadways. This result did not

hold for interstate and state highways, on which people cannot generally reside.

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#### ISEE-1575

#### Air Pollution, Airway Inflammation and Lung Function in Schoolchildren from Mexico City, the EVA Cohort Study

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**Background:** The biological mechanisms involved in inflammatory response to air pollution are not clearly understood. This study assesses the association of short-term air pollutant exposure with inflammatory markers and lung function.

**Materials and Methods:** We studied a cohort of 158 asthmatic school-age children and 50 non-asthmatic children, followed an average of 22 weeks. Spirometric tests, measurements of FeNO, IL8 in nasal lavage and pH of EBC were conducted every 15 days during follow-up. Data were analyzed using linear mixed effects models.

**Results:** An increase of  $17.5 \mu\text{g}/\text{m}^3$  in the 8-hour moving average of  $\text{PM}_{2.5}$  levels (interquartile range) was associated with an 1.08 ppb increase (CI 95%: 1.0% to 17%) of FeNO in asthmatic children, and a 1% increase (CI 95%: 0.05% to 5%) in IL8 in asthmatic children and a 16% increase (CI 95%: 1.0% to 31.0%) in IL8 in healthy children. The 5-day accumulated average of  $\text{PM}_{2.5}$  exposure was significantly inversely associated with FEV<sub>1</sub> and FVC in both groups. FeNO and lung function were inversely associated ( $P < 0.05$ ) in asthmatic children.

**Conclusion:** Exposure to  $\text{PM}_{2.5}$  resulted in acute airway inflammation and decrease in lung function in both asthmatic and healthy children.

#### ISEE-1576

#### Long-Term Exposures to Air Pollution and Retinal Micro-Vascular Caliber: The Multi-Ethnic Study of Atherosclerosis (MESA)

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**Introduction:** Long-term exposures to ambient and traffic-related air pollution have been linked to cardiovascular morbidity and mortality. One hypothesized mechanism for these effects involves a chronic impact on the microvasculature and adjacent tissues. Retinal photography provides a unique, non-invasive method to explore links between air pollution and the microvasculature in humans.

**Methods:** Cross-sectional associations between long-term exposures to air pollution and average retinal vessel diameters were examined. The diameters were assessed using digital retinal images taken in MESA participants between 2002 and 2003 and expressed by the central retinal arteriolar equivalent (CRAE) and central retinal venular equivalent

(CRVE). Study participants were 46 to 87 years of age, and were without clinical cardiovascular disease in 2000. Regional-level air pollution exposures were assigned for each participant using annual average PM<sub>2.5</sub> and NO<sub>2</sub> concentrations from the regulatory monitor nearest to their home in 2000. Residential proximity to major roadways was also estimated as an individual-level indicator of long-term traffic exposures. All associations were examined using linear regression models adjusted for age, sex, race/ethnicity, education, income, smoking status, alcohol use, physical activity, body mass index, and family history of cardiovascular disease. We also examined the influence of other covariates including diabetes, cholesterol, glucose, blood pressure, emphysema, inflammatory markers, and medication use.

**Results:** CRAE was negatively associated with PM<sub>2.5</sub>, NO<sub>2</sub>, and residential proximity to major roadways among the 4,408 participants with complete information, with associations for residential proximity to major roadways and NO<sub>2</sub> meeting statistical significance. Living within 100 meters of an interstate or state highway or within 50 meters of a major road was associated with a 1.1 µm (95%CI: 0.2 to 2.0) decrease in CRAE in fully adjusted models. Similarly, NO<sub>2</sub> levels were associated with a 0.9 µm (95%CI: 0.2 to 0.7) decrease in CRAE per 10 ppb increase after controlling for all covariates. Associations with CRVE were less consistent.

**Conclusions:** Close residential proximity to major roadways and regional concentrations of NO<sub>2</sub> were significantly associated with smaller retinal arteriolar diameter. Associations with PM<sub>2.5</sub> were in the same direction although not statistically significant. These findings suggest that traffic-related air pollution exposures may impact the human microvasculature.

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#### ISEE-1578

##### Prenatal Exposure of p,p'-DDE and Infant Neurodevelopment at 24 Months of Age. Preliminary Report

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**Background:** p,p'-DDE (DDE) is an antiandrogenic compound, which has shown adverse effects on early infant neurodevelopment; however the persistence of its long-term effect is controversial. The objective of this study was to evaluate the effect of prenatal DDE exposure on infant neurodevelopment at 24 mo, according to the sex of the child.

**Methods:** As part of a perinatal cohort study conducted in Morelos, Mexico, we assessed the first 166 infants (58.4% male) with the Bayley Scales of Infant Neurodevelopment (BSID-II) at 24 mo of age. Maternal DDE levels (ng/ml) were measured during each trimester of pregnancy. The HOME Scale and family composition were considered as potential confounders.

**Results:** A marginal negative effect of DDE exposure at the third trimester of pregnancy on infant neurodevelopment at 24 mo of age was detected among male infants ( $Beta = -1.8$ ;  $P = 0.07$ ) but not among females ( $Beta = 1.6$ ;  $P = 0.20$ ).

**Discussion and Conclusions:** Our results suggest that due to its antiandrogenic activity, the effect of DDE exposure on infant neurodevelopment is modified by gender. A further analysis will include a larger sample size of this population.

#### ISEE-1579

##### Evaluation of PM<sub>2.5</sub> Levels in Louisiana Restaurants and Bars Before and After the Implementation of a Statewide Smoking Ban

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**Background:** Exposure to environmental tobacco smoke (ETS) is a well recognized public health problem responsible for the same adverse health effects as cigarette smoking. In spring 2006 the Louisiana Legislature passed Act 815, a statewide ban on smoking in most public places and workplaces including all restaurants with or without attached bars. Stand-alone bars and casinos are exempt from the law. This law began to be enforced on January 1, 2007.

**Methods:** To evaluate the effectiveness of Act 815, we conducted a statewide study of PM<sub>2.5</sub> levels in smoking restaurants, non-smoking restaurants, and bars before and after implementation of the smoking ban. Air samples were taken using TSI SidePak AM510 personal aerosol monitors calibrated to measure PM<sub>2.5</sub>. PM<sub>2.5</sub> is a suitable surrogate for measuring relative concentrations of environmental tobacco smoke. In 2006, before the law went into effect, we sampled 85 bars and 123 restaurants. After passage of the smoking ban in 2007, 85 bars and 124 restaurants were sampled.

**Results:** Mean PM<sub>2.5</sub> concentrations in restaurants before and after the ban were 121.4 and 17.2 µg/m<sup>3</sup> respectively ( $P < 0.0001$ ). There was no appreciable difference between bars before and after passage of the law.

**Conclusions:** These results demonstrate a substantial decrease in indoor air pollution with the passage of a statewide ban on smoking in public places. Places exempt from this legislation did not have a significant change in air quality.

#### ISEE-1580

##### Perfluoroalkyl Acids in the Serum and Milk of Breastfeeding North Carolina Women

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**Background:** Perfluoroalkyl acids (PFAAs) comprise a group of man-made persistent environmental compounds. They are widely used in consumer products such as food packaging material, non-stick cookware and cleaning agents, and have been detected in drinking water. Certain PFAAs tend to bioaccumulate and have been shown to be widespread in wildlife and humans although exposure data are limited. High doses of two of the most widely distributed PFAAs—perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA)—have shown developmental toxicity in laboratory animals when used at doses 100 to 500 times that in human serum. NHANES 2003–2004 serum data, which looks at the US population, shows that mean PFOS and PFOA levels are 20.7 and 3.9 ng/mL, respectively. Human biomonitoring and laboratory animal experiments indicate that certain PFAAs have the ability to transfer to milk although concentrations are thought to be lower in milk than in serum.

**Methods:** The US EPA conducted a pilot study entitled Methods Advancement in Milk Analysis (MAMA) including 34 breastfeeding North Carolina women between 18 and 38 years of age. The women donated milk and serum samples at 2–7 weeks and 3–4 months postpartum. Automated solid-phase extraction coupled to reversed-phase high performance liquid chromatography-tandem mass spectrometry was used to determine serum and milk concentrations of seven PFAAs: perfluorooctane sulfonamide, 2-(N-ethyl-perfluorooctane sulfonamido) acetate, 2-(N-methyl-perfluorooctane sulfonamido) acetate, perfluorohexane sulfonate, perfluorononanoate, PFOS, and PFOA. During the first

visit, a questionnaire was administered asking about potential dietary and other exposure routes as well as socio-demographic characteristics, including the duration of residence in North Carolina.

**Results:** Of the 7 PFAA compounds, all except one were detected in a majority of women's sera with PFOS and PFOA detected in greater than 98% of samples. Mean concentrations (ng/mL) at the two visits were 21.9 (SD: 8.3); 18.8 (8.3) for PFOS, and 3.9 (2.0); 3.0 (1.2) for PFOA, respectively. Neither PFOA nor PFOS were detected in milk. Women who had lived in North Carolina for 10 years or more had significantly higher serum concentrations (ng/mL) compared to those living in North Carolina less than 10 years at 2–7 weeks postpartum for PFOS: 26.6 (SD: 12.3) vs. 16.7 (6.7), *P*-value 0.007, and for PFOA: 4.7 (2.2) vs. 3.0 (1.4), *P*-value 0.01(t-test). Similar significant differences were seen at 3–4 months postpartum.

**Conclusions:** In this pilot study, concentrations of PFOS and PFOA were below the limit of detection in breastmilk, although they were detectable in nearly all serum samples collected. Although the number of participants in this pilot study is small ( $n = 34$  and  $n = 30$ , visits 1 and 2, respectively), there is an indication that living in North Carolina for a prolonged time period might be related to increased serum concentrations of certain PFAAs. PFAA exposure in lactating North Carolina women will be further explored in the upcoming National Children's Study, which provided partial funding for this pilot project.

*This abstract does not necessarily reflect CDC, EPA or NIH policy.*

#### ISEE-1582

#### Diesel Air Pollution and Asthma Exacerbations in a Group of Children with Asthma

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**Background:** Previous studies have found relationships between adverse health outcomes and proximity to traffic. Diesel emissions, a major source of elemental carbon (EC) soot in urban areas, are suspected as being responsible for these associations.

**Methods:** Forty five grade school children (10–12 years old) with asthma from four South Bronx schools (10 children per school) were followed for one month each, 24 hours a day, using a rolling backpack containing air pollution monitoring equipment. 24-hr personal filter samples were collected for Particulate Matter < 2.5 microns ( $PM_{2.5}$ ) mass and analyzed for Elemental Carbon (EC) concentration (via reflectance). Spirometry (via portable AM1) and symptom scores were recorded three times daily.

**Results:** Mixed model results showed a decline in PEF of  $-7.73$  liters/min ( $-16.02, 0.56, 95\%CI$ ), while cough score increased by 20% (0, 45 95% CI), wheeze score by 49% (11, 99 95%CI), and total symptom score by 28% (6, 54 95%CI). Associations with shortness of breath were positive, but not statistically significant. No associations were found with personal  $PM_{2.5}$ . Of the mixed model analysis using ambient exposure data, significant associations were only found with one day lag EC and cough and total symptoms.

**Conclusions:** We found significant associations of personal elemental carbon soot exposure with several asthma-related symptoms and one lung function metric in a cohort of inner-city elementary school children with asthma.

#### ISEE-1583

#### Urinary Biomarkers of Diesel Exhaust Exposure

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NJ, USA; ‡Environmental and Occupational Health Sciences Institute, Piscataway, NJ, USA.

**Background:** Nitro-PAHs are considered specific markers of diesel combustion emissions. After inhalation, nitro-PAHs can be metabolized into amino-PAHs that are excreted in human urine. Therefore, urinary amino-PAHs may serve as biomarkers of diesel exhaust exposure. The present study is designed to examine whether short-term exposure to diesel exhaust leads to increases in urinary concentrations of several amino-PAHs that are metabolites of the nitro-PAHs abundant in diesel exhaust.

**Methods:** The study was carried out in 55 healthy men and women. Each study subject underwent two 1-hour climate-controlled exposure conditions: one was a clean air atmosphere and the other was a diluted fresh diesel exhaust normalized to and maintained at  $300 \mu\text{g}/\text{m}^3$  as  $PM_{10}$ . One urine sample prior to the start of each exposure session and all urine voids within 24 hours following the session were collected for analysis of amino-PAHs. The HPLC-fluorescence method used to analyze amino-PAHs was sensitive enough to detect 1-aminopyrene, 1-aminonaphthalene, 2-aminonaphthalene, and 3-aminobenzanthrone, in more than 75% of all the urine samples collected.

**Results:** Results show that urinary concentrations of all four amino-PAHs increased by 2 to 3 fold following the diesel exhaust exposure, relative to following the clean air exposure, in the majority of the subjects. Results also show that average 24-hour post-exposure urinary amino-PAH concentrations were higher after exposure to diesel exhaust, but large inter-individual variation in the time courses may limit the utility of spot samples for quantifying exposure to nitro-PAHs as a marker of diesel exhaust exposure.

**Conclusion:** The variable response to a standardized diesel exhaust exposure suggests the need to further explore subject variables, such as genetic polymorphisms, that may affect the profile of nitro-PAH metabolism.

#### ISEE-1585

#### Association of Childhood Asthma with School Commuting Time

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**Background:** Several previous studies indicate that living near major roadways increases risk of asthma, but the association between risk of asthma and the exposure to on-road commuting exposure to air pollution has not been explored.

**Methods:** We used time and distance from school to home as an indicator of commuting exposure in a cohort of 4737 kindergarten and first grade children participating in the southern California Children's Health Study. Time and distance from school to home was obtained by using a PERL program employing the routines of MAPQUEST. We examined the relationships between prevalent asthma, lifetime asthma, late onset asthma [diagnosed age 5 or later], early [before age 4] and late onset wheeze [age 4 or later], and commuting time at the time of study entry in 2003.

**Results:** Compared with children in the lower quartile of commuting time, those in the upper quartile were more likely to have lifetime asthma (OR 1.31; 95%CI 1.01–1.71), prevalent asthma (OR 1.29; 95%CI 0.98–1.70), late onset asthma (OR 1.94; 95%CI 1.01–3.74), and late onset wheeze (OR 1.44; 95%CI 1.00–2.10), but not early onset wheeze or asthma. These associations were robust to confounding by socio-demographic and household characteristics and by traffic-related exposure modeled at the home of the child (which was independently associated with asthma). Similar associations were obtained between asthma and commuting distance to school.

**Conclusions:** These results suggest that commuting may increase the risk of asthma. However, the latency from entry to school was short, range of commuting time was modest (upper quartile range from 5 to 44 minutes)

and exposure would have been misclassified by this crude index. (Information about actual commuting route, other on-road travel, and traffic volume was not available). Therefore, it is possible that (1) these results could be explained by other unmeasured confounders, (2) school commuting time may have been a proxy for on-road travel elsewhere, or (3) effects of even modest on-road exposure were substantial.

#### ISEE-1586

#### Variability in Activity Levels as Measured with Actical Monitors Between Individuals, Days, and Seasons

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**Background:** The SUPERB Study (Study of Use of Products and Exposure-Related Behaviors) is an evaluation of alternative platforms for collecting longitudinal data related to non-occupational environmental exposures through food, daily activities, and household products.

**Methods:** As part of this effort, forty-seven households in California were enrolled in a study to investigate passive measures of exposure for use in epidemiology and exposure monitoring studies. Of the 47 households, 17 had one older adult participating and 30 had young children where both an adult and a child were enrolled. To capture activity level, each adult participant was asked to wear an Actical motion detector attached to their waist for one week. For comparison, a second one was placed on their wrist. Children only wore wrist devices. For the adults, data from the Actical was converted into METs using a set of equations presented by Klippel and Heil as well as the Actical 2-regression model presented by Crouter and Bassett, with results from the latter presented in this abstract. Activity was classified as sedentary/resting (MET<1.0), minimal (1.0 < MET ≤ 2.0), light (2.0 < MET ≤ 3.0), moderate (3.0 < MET ≤ 6.0) and vigorous (6.0 < MET) based on the average calculated MET score per six minute period. Each household was recruited to participate for a one-week stint 4 times over the course of 16 months, allowing us to look at seasonal variability as well as year to year variability.

**Results and Discussion:** At present, data for 133 weeks have been collected and processed, with data collection ongoing. We have noted days the participant potentially did not wear their Actical as days where there were less than 10 six-minute periods with activity over the sedentary/resting level. This occurred for approximately 20% of the days. These days will be further evaluated to determine if the participant truly had limited activity on that day or if they were not wearing the monitor. Data indicate that days where the participant potentially did not wear the Actical were lowest during the first week the participant was enrolled in the study, and increased over time. Using only the days where we are confident the participants wore the Actical device, the older population spent more time in sedentary/resting and minimal activity levels than did population with young children. The population with young children spent, on average, 18.3 (SD = 4.7) hours per day in sedentary/resting, 2.1 (SD = 1.4) h/d in minimal activities, 2.0 (SD = 3.2) h/d in light activities, 1.5 (SD = 2.1) h/d in moderate activities, and 1.2 (SD = 0.1) min/d in vigorous activities. Comparing across seasons, at the median, this population was most active in Spring. Similar evaluations for the older adult population will be presented. Mixed models will be used to compare seasonal variability by individual once more data becomes available. In addition, we will determine how effectively a single week predicts activity over multiple seasons of monitoring. Finally, differences between weekdays and weekend days will be evaluated.

#### ISEE-1588

#### A Case Study of Cumulative and Background Risk in an Urban Environment

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**Abstract:** A biomass incinerator proposed to be built in an urban setting in Minneapolis, Minnesota, has raised numerous questions about the assessment of health risks from cumulative effects, the role of background air pollution in making emissions permit decisions, and the conflicting ethical and environmental stewardship issues wherein one environmental objective (e.g., reduced CO<sub>2</sub> emissions) may be pursued at the expense of another (e.g., potential adverse health effects among residents living near the facility.) Analysis of the expected emissions from the proposed facility yields a hazard index (HI) well below the threshold of concern (1.0). However, data from a nearby monitoring station indicate that the ambient air carries a HI greater than 1.0, largely due to mobile and area sources. The status of the locality as an economically disadvantaged area has simultaneously attracted the facility (through tax incentives) and raised concerns about environmental justice. Community interest in the project has been high, with some groups changing their opinion of the project during the permit process. The facility is perceived by local residents as bringing an unacceptable increase to a pollution burden that is already potentially at an unhealthy level due to other sources and media. This case has forced state regulators to confront several emerging issues in exposure and risk assessment. State agencies foresee increased attention to background air quality when evaluating new emissions sources, and are seeking a coherent and consistent policy that will protect public health. Consideration of background hazards when evaluating permit applications may be desirable, but could have the effect of prohibiting any new facilities within a wide swath of territory, including most urban areas in the state. Such assessments may also be limited by the availability of a nearby monitoring station, the range of pollutants being sampled, and the availability of health standards or toxicity data for pollutants of concern. Comparisons between monitored ambient air and modeled facility emissions have also been limited by a lack of overlap between the monitored contaminants and those emitted from the proposed facility; most of the hazard from the facility is derived from chemicals not measured by the ambient air monitoring station. The facility also presents a risk communication challenge, as concepts of relative risk and the use of a range of exposure scenarios and pathways (some of which may not be relevant to the case in question) are often misunderstood or ignored within the community. Also, by using local tree debris as its principal source of fuel, this facility compares favorably with existing sources of energy (coal, oil) from a CO<sub>2</sub> emissions standpoint, causing a potential conflict between minimizing effects on local air quality and meeting state goals for renewable energy. As they address these issues in the present case, state regulators remain mindful that their actions may set a precedent for future evaluation of cumulative and background risk at other sites.

#### ISEE-1589

#### Evaluation of Infant Exposure to Persistent Organic Pollutants Using Physiologically-Based Pharmacokinetic Modeling

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**Background and Objective:** Exposure to persistent organic pollutants (POP) in infants has been shown to induce several health effects, such as impaired neurodevelopment. While repeated measurements of POP levels would efficiently assess exposure in infants, such method is costly and might not capture some key events in the toxicokinetics of these compounds (e.g. drop in blood levels after the breastfeeding period). Therefore, we aimed to build a physiologically-based pharmacokinetic

(PBPK) modeling framework for POP to assess male and female infant internal exposure to these chemicals through lactation.

**Methods:** The PBPK model equations and parameters for the mother and infants were taken from the literature. Intake of POP by infants through lactation was described as a direct input in the liver compartment and the dose was calculated from both the daily ingested breast milk volume and its predicted POP concentration. Preliminary validation of PBPK model was attempted using data from a previous follow-up study on mothers and infants from the northern Quebec Inuit population. PCB-153 was used as a surrogate chemical. Only subjects with available data on mother/infant physiology (e.g. body weight, body height) and blood concentration were kept for predictions of PCB-153 levels in infants at 6 months of age ( $n = 40$ ).

**Results:** Strong correlations were obtained between predicted and measured values for cord blood (Spearman's  $r = 0.671$ ) and breast milk concentrations (Spearman's  $r = 0.891$ ) with 92.6% and 81.3% of predicted values falling within a 2-fold range of measured levels, respectively. While a high correlation was observed between simulated and measured PCB-153 blood concentration in infants (Spearman's  $r = 0.648$ ), the model was unable to predict PCB-153 measured levels within a 2-fold range for 37.5% of individuals.

**Discussion:** Further work with a larger dataset and other compounds is planned in order to assess parameter variability and investigate the sources of discrepancy between specific measured and simulated values. This study showed the potential of using PBPK modeling in epidemiological studies for the assessment of POP exposure in infants during hypothesized windows of susceptibility.

#### ISEE-1590

#### Temperature Stove Use Monitors (SUMs) to Improve Exposure Estimates of Indoor Air Pollution from Biomass Cookstoves

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**Background:** Indoor air pollution (IAP) is a global health concern, causing an estimated 1.6 million premature deaths each year. We work in Guatemala highland in an area of about 23 villages comprising principally an indigenous (Mayan) population, all initially using wood for cooking in open indoor cookfires. In the course of our CRECER study, some households have been provided with an improved chimney cookstove called the *Plancha*. Levels of exposure to indoor air pollutants from biomass burning are assessed for each study child periodically. In a sub-sample of the study population we conducted more detailed measurements on the personal and indoor levels of PM and CO, as well as time-activity. From this monitoring we have demonstrated the importance of measuring other parameters such as stove use to accurately quantify IAP exposure during the open fire to stove transition. There is need for new methods to systematically collect stove use data without household surveys, which are resource intensive, must rely on householder memory, and are subject to bias because householders may respond according to how they believe they should. In addition, other than having someone in the kitchen throughout the day, which is extremely resource-intensives and disrupts normal household routine, there has not been a way to determine the details of use by meal, day or week, type of food, or other parameters. We present here the use of simple electronic temperature dataloggers that can reliably provide estimates of stove use to avoid the need for survey information. Because it gives precise and unbiased measurements of a simple physical parameter, it can provide statistically reliable information with smaller sample sizes than surveys.

**Methods:** We pilot tested the use of temperature loggers as stove use monitors (SUMs) in our CRECER study. Using the SUMs, we report here on stove use in the days and weeks after they started to use their *Planchas*. We placed the monitors on the surface of the *Plancha* stoves

and record temperature readings every 20 minutes. Fifty stoves were monitored, including 40 newly built and 10 older stoves that had been in use for 4–6 years. In the new homes, the SUMs were placed before the very first usage for each new stove. In a subsample of households, we also placed a HOBO datalogging CO monitor on the wall of the kitchen, using protocols developed for our projects.

**Results and Discussion:** Separating the monitoring periods by weeks, we found a significant increase in median hours of stove use from week one to week two followed by a period of greater stability during weeks two to three. Comparing the average hours of stove use for the newly built and the old stoves suggests that although many, if not most, of the new stove users will adopt using the stove quickly after training, there may be a more gradual transition for some users that extends beyond our measurements. Here we demonstrate the utility of SUMs as an indicator of stove use, an important parameter multiple assessments, including a novel approach to time-activity data collection.

#### ISEE-1591

#### Cumulative Exposure to Lead and Risk of Parkinson's Disease

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**Background:** Lead is an environmental toxin that is known to induce oxidative stress and affect dopaminergic neurotransmission, systems known to be involved in Parkinson's disease (PD). Several epidemiologic studies have suggested an association between exposure to heavy metals, including lead, and PD using subjective exposure measurements. Biological markers of cumulative exposure to lead, however, have been used in only one study and that was in an occupational setting. That study suggested an association between cumulative exposure to lead and greater risk of PD. **Methods:** To investigate the association between cumulative exposure to lead among typical PD patients seen at movement disorders clinics and the odds of PD, we enrolled 330 PD patients (216 men and 114 women) from five different sites and 166 controls (126 men and 40 women) frequency-matched on age and sex. We measured tibia and patella bone lead concentrations, biological markers of cumulative exposure to lead, using 109 Cadmium excited K-shell X-ray fluorescence (KXRF). We calculated odds ratios (OR) for PD using logistic regression adjusting for age, age squared, sex, pack-years of smoking, education, race, and indicators for the different recruitment sites.

**Results:** PD cases were on average 66.5 (standard deviation [sd] = 9.5) years of age at the time of bone lead measurement and had been diagnosed with PD at an average age of 59.2 (sd = 10.8) years. Compared with the lowest quartile of tibia lead exposure the OR for PD in the second, third, and fourth quartiles were 1.04 (95% confidence interval [CI]: 0.50–2.17), 1.56 (95%CI: 0.73–3.38), and 1.90 (95%CI: 0.87–4.18), respectively. When tibia lead concentration was modeled as a continuous variable the OR for PD for each 10 microg/g bone mineral increase in tibia lead concentration was 1.26 (95%CI: 0.95–1.67). We did not find an association between patella bone lead concentration and the odds of PD.

**Conclusions:** These findings, using an objective biological marker of cumulative lead exposure among typical PD patients seen in movement disorders centers, strengthen the evidence that cumulative exposure to lead increases the risk of PD.

**ISEE-1592****Determinants of Human Exposure to Pet Pest Products: Fipronil**

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**Background:** Fipronil (5-Amino-1-(2,6-dichloro-4-(trifluoromethyl)phenyl)-4-(1,R,S-trifluoromethyl) sulfinyl)-1H-pyrazole-3-carbonitrile; CAS 120068-37-3), is active ingredient in Frontline®, the leading topical flea and tick treatment. Fipronil is also registered in 47 products for indoor ant and roach baits and for structural pest control. It is remarkable that pet owners apply products (up to 9.8% w/v) more than 150-times more concentrated than sprays used by licensed pest control operators. There is considerable potential for human dermal exposure to fipronil (Jennings et al. 2002), but a comprehensive exposure assessment including possible photoproducts is lacking. More than half (56.8%; AVMA 2007) of California households own companion animals. The climate dictates that photoproducts may be important. Fipronil is photolabile and is transformed to at least 4 photoproducts. The sulfone and desulfanyl fipronil derivatives, are likely more toxic than the parent compound.

**Methods:** This study uses common analytical methods and exposure assessment techniques to study the environmental fate and levels of fipronil resulting from use on dogs and cats. This first phase of this study has two parts. First, five different types of gloves (latex, nitrile, lightweight cotton, mediumweight cotton, and heavyweight cotton) were assessed through the use of fortified samples to investigate the differences between these gloves as a dosimeter of personal exposure. Cotton textiles as well as small pieces (coupons) of other materials such as wood, vinyl, ceramic, and carpet flooring will be fortified with  $\mu\text{g}/\text{cm}^2$  levels of fipronil to determine stability and performance of the analytical method. Analytical methods used were dislodgeable residue, total surface residue and transferable surface residue. Transferable surface residue was measured using an Atlas AATCC CM-5 Crockmeter™ (ASW) (Atlas Electric Devices Co., Chicago IL) that was modified to simulate finger and hand transferability. In the second phase, direct contact with pets is measured using gloves selected from phase one (modified after Jennings et al. 2002) and indirect contact using ASW and hand-press methodology to estimate exposure potential. Next, cotton textiles and flooring coupons were placed in areas where pets sleep and play in homes of pet owners who routinely use fipronil. In homes, textiles were analyzed for dislodgeable residue, total surface residue and transferable surface residue as well. The potential for inhalation exposure was surveyed using an electrostatic air filtration device (Oreck, New Orleans, LA).

**Results and Discussion:** Preliminary results indicate nitrile and lightweight cotton gloves as the best dosimeter for this study based on transferability, recovery rates, expense and ease of use. Cotton gloves showed time-dependent levels of fipronil and other fipronil products (ranging from < 66  $\mu\text{g}/\text{pair}$  to 2714  $\mu\text{g}/\text{pair}$ ). Other textiles, such as flooring and bedding, also show time dependent accumulation of fipronil and products (ranging from 0.05  $\mu\text{g}/\text{cm}^2$  to 120  $\mu\text{g}/\text{cm}^2$ ). Preliminary data do not indicate inhalation as a major source of exposure at levels of (ranging from  $9.5 \times 10^{-8} \mu\text{g}/\text{cm}^3\text{-day}$  to  $15 \times 10^{-8} \mu\text{g}/\text{cm}^3\text{-day}$ ). Future studies will characterize indoor exposure to fipronil and its products, as well as investigate three potential urine biomarkers.

**ISEE-1594****A Panel Study on Lung Function Among Children Living in a Polluted Area in Sardinia (Italy)**

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**Objectives:** To study change in lung function in all children attending primary school living in an area with high levels of air pollution.

**Materials and Methods:** A panel study on 233 children aged 8–14 years attending primary school has been conducted in Sarroch (Sardinia, Italy), a small municipality (5234 inhabitants) where oil refinery and petrochemical plants are located. A baseline modified ISAAC (International Study on Asthma and Allergies in Childhood) questionnaire was administered at the beginning of the study on January 2007. Spirometric examinations were performed once a month from the end of January 2007 till the beginning of 2007 for a total of 909 exams. Air pollution was assessed by passive dosimeters on a grid of 21 locations on every week preceding the examinations and by three fixed monitors on a daily basis during the whole study period.

**Results:** The mean values for the whole period was 5.14  $\text{mcg}/\text{mc}$  for  $\text{SO}_2$  with 19 episodes of hourly concentrations above 125  $\text{mcg}/\text{mc}$ , 6 lasting more than 3 hours and one episode with weekly average above 60  $\text{mcg}/\text{mc}$ . We found in the entire population of children a reduction in lung function ( $\text{FEV}_1$ , Forced expiratory volume in 1 second) of 4.1% (90% Confidence Interval 1.9–6.3,  $P$ -value = 0.003) for 10  $\text{mcg}/\text{mc}$  increments of  $\text{SO}_2$  measured as two-days average before spirometric examination. If we consider only children without respiratory symptoms in the last 12 months (149 children) we found a reduction in  $\text{FEV}_1$  of 3.2% (90%CI 0.9–5.5%,  $P$ -value = 0.024) for 10  $\text{mcg}/\text{mc}$  increments of  $\text{SO}_2$  measured as two-days average before spirometric examination. The pollutant effects were adjusted for a series of confounding factors: sex, height and weight, day of the week, meteorological conditions (temperature and humidity), other pollutants ( $\text{PM}_{10}$ ,  $\text{SO}_2$ , and  $\text{NO}_2$ ), traffic, socio economic status, passive smoking, house conditions (damp and mould), respiratory infections in the days preceding the examinations.

**Conclusion:** Short term effects of exposure to  $\text{SO}_2$  is associated to a reduction of lung function among children attending primary school.

**ISEE-1595****Identifying Fish Consumption Patterns and Exposure to Mercury in Washington State Using a Population-Based Telephone Survey**

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**Abstract:** In Washington State, efforts to reduce exposure to mercury and other contaminants in fish focus on education and outreach to consumers and physicians to increase awareness and change behaviors. Planning and evaluating these efforts requires state-specific data on knowledge, attitudes and exposure behaviors among susceptible populations, as well as the general population. The Washington State Department of Health has used the Behavioral Risk Factor Surveillance System (BRFSS), a probability-based telephone survey of non-institutionalized adults, as a means of collecting such data through time. A variety of fish consumption questions were incorporated into this survey in 2002, 2004 and 2005. Weighted analyses accounting for the probability of selection and post-stratification were used to generate estimates for the underlying population.

In 2004, just over half of adults (57%) had eaten canned tuna in the last month. People who ate canned tuna ate it just over three times per month. Just under half of those who ate canned tuna usually ate albacore or "white" tuna, about a quarter ate light tuna, and about a quarter had no preference. Testing of canned tuna shows that levels of mercury are about three times higher in albacore tuna (mean 364 ppb) compared to light or "chunk" tuna (mean 127 ppb).

In 2002 and 2004, 78% and 74%, respectively, of adults reported eating fresh or frozen store-bought fish in the past month. Among people who reported eating store-bought fish in the past month, the average number of meals per month increased from 3.3 meals per month in 2002 to 4.6 meals per month in 2004 ( $P < 0.05$ ). In 2005, 57% of adults reported

eating fresh fish bought at a grocery store or fish market (excludes frozen fish). Among people who ate fresh fish in the past month, salmon was the type of fish most frequently eaten (44%), followed by halibut (20%), cod (13%) and tuna (6%). Levels of mercury and other contaminants tend to be low in salmon compared to other types of fish.

Fishing is a popular recreational activity in Washington State. In 2004, 17% of adults reported eating sport-caught fish in the previous month and 35% reported eating sport-caught fish in the past year. A higher proportion of men (19%) than women (14%) reported eating sport fish in the past month. People ate an average of 2.9 meals of sport fish in the past month.

Other results will also be presented including differences in fish consumption among different racial and ethnic groups, differences in fish consumption for different geographic areas and seasons, as well as results on knowledge about contaminants in fish, sources of information about consuming fish, and estimates of the proportion of women of child-bearing age and children whose intake of mercury from fish consumption would be expected to exceed health guidelines. These results have been used to help guide fish consumption advisory programs. Using an established survey such as the BRFSS will allow us to consistently track changes in these behaviors and assess the potential impacts of our fish consumption advisory efforts.

#### ISEE-1596

#### Spatial and Temporal Variation of Ambient Hexavalent Chromium in Urban Communities in Paterson, New Jersey

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**Background:** Hexavalent chromium (Cr-VI) is classified as a human inhalation carcinogen and Cr-VI compounds have been listed as one of the core hazardous air pollutants by the US EPA. Thus, information on Cr-VI concentration and its spatial and temporal variations are very important to health risk reduction strategies in urban communities. However, limited data is available due to the lack of accurate sampling and analysis methods for the measurement of Cr-VI in ambient air.

**Methods:** The concentrations of Cr-VI in ambient PM<sub>10</sub> were measured one in every six days over the course of one year at three different locations in urban communities in Paterson, New Jersey. The Cr-VI levels in Chester background site were also simultaneously monitored. The concentration of Cr-VI in ambient PM<sub>10</sub> was measured by a newly developed sampling and speciated isotope dilution method, which includes collection of samples on cellulose filters pre-treated with sodium bicarbonate, extraction of the sample filters with nitric acid solution (pH = 4), separation by Ion Chromatography, and detection by Inductively Coupled Plasma Mass Spectrometry.

**Results:** It was found that the Cr-VI concentrations were 0.26 ± 0.21 ng/m<sup>3</sup>, 0.23 ± 0.23 ng/m<sup>3</sup>, and 0.25 ± 0.22 ng/m<sup>3</sup> at commercial, industrial, and mobile sites, respectively in Paterson. The maximum Cr-VI concentration was reported to be 1.13 ng/m<sup>3</sup> in Paterson. The concentrations for background site were measured to be from 0.01 to 1.15 (0.23 ± 0.25) ng/m<sup>3</sup> in Chester. The Cr-VI concentrations observed at different site were compared using the non-parametric test (Wilcoxon two-sample test and Kruskal-Wallis test, respectively) to examine the spatial and temporal variability. The summer Cr-VI was found to be significantly higher than the other 3 seasons ( $P < 0.0001$ ), suggesting that photochemical reactions contribute significantly to ambient Cr-VI in Paterson. However, we did not observe statistically significant differences among the 4 sites ( $P = 0.4705$ ) or between weekday vs. weekend ( $P = 0.2702$ ). These observations suggested that the impact of local emission on Cr-VI is not significant. Spearman correlations were calculated between Cr-VI and other elements in the PM<sub>10</sub> samples. Total chromium had no significant association ( $P = 0.5304$ ) with hexavalent

chromium for the paired data ( $N = 80$ ), however, statistically significant associations between Cr-VI and other elements, i.e. As, Br, Cu, Fe, Pb, Ni, K, Se, Na, Sr, S, V, Zn and Zr were observed ( $N = 144\sim168$ ).

#### ISEE-1597

#### Nitrogen Dioxide a Factor in Increasing Availability of Lead from Lead-Based Paints

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**Background:** It has been well established that low-level exposure to lead is associated with measurable changes in mental development and behavior in children. Although lead based paint in older homes has historically been a major source of exposure, little is known about the role of traffic based air pollutants in increasing availability of lead from lead based paints through oxidant driven degradation of the pigment and binders. Building on previous work showing that exposure of test surfaces painted with lead based paints to ozone increased lead availability, here we demonstrate the potential role of nitrogen dioxide in the degradation process of lead-based paint.

**Methods:** Stainless steel surfaces painted with historically representative formulations of low gloss solvent lead based paint were exposed in stainless steel chambers to nitrogen dioxide equivalent to approximately 4.6 years of exposure at historical 1970s Los Angeles indoor concentrations. Lead availability from surfaces was assessed using lead wipes (NIOSH method 9100) with GFAAS analysis (NIOSH method 7105). Furthermore, changes in surface morphology were assessed using surface reflectance (BYK Gardner spectrophotometer) and scanning electron microscopy (Zeiss EVO).

**Results:** Preliminary results indicate that NO<sub>2</sub> exposure resulted in a 3 fold increase in surface lead availability, corresponding to a consistent reduction of 2 ppm in NO<sub>2</sub> concentrations between the inlet and outlet of the chamber.

**Conclusions:** Differences in reflectometry of surfaces after ozone and NO<sub>2</sub> exposure suggest that a different mechanism may be responsible for increased lead availability. We present results of current studies to elucidate the mechanisms of paint degradation and potential synergistic effects of the combination of traffic derived air oxidants.

#### ISEE-1598

#### Dietary Organophosphorus Pesticide Intake and Urinary Dialkylphosphate Levels in Adult Volunteers

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**Methods:** We are investigating the validity of using urinary biomarkers to estimate dietary intake of organophosphorus (OP) pesticides in a pilot sample of adult volunteers ( $n = 11$ ) from Atlanta, USA. We collected 4 consecutive days of duplicate diet samples and 10 spot urine samples (first morning and before bedtime samples) from each subject. Daily diet samples were composited in 9 categories: above ground vegetables, below ground vegetables, fruits and fruit juices, grains, dairy, meat/fish/eggs, fats and oils, beans/nuts/legumes/ miscellaneous, and non-dairy beverages. The categories were developed to group foods with similar likelihoods of pesticide detection and with similar aqueous or lipid content. Detailed diet information, including food description, organic versus conventional, preparation details (raw vs. cooked, peeled vs. unpeeled) and weight (in grams), was also collected for each item composited. The sampling

protocol was conducted once in summer 2005 and once in winter 2006 for each subject. We measured chlorpyrifos, diazinon, and malathion in each composite type except for fats and oils. A total of 511 food composites were analyzed. Analytical detection limits were 0.88 ng/g for chlorpyrifos, 0.66 ng/g for diazinon, and 0.76 ng/g for malathion. Six dialkylphosphate (DAPs) OP pesticide metabolites were measured in the urine samples ( $n = 235$ ). We calculated daily volume weighted average urine concentrations for each DAP by summing the mass of the bedtime and next morning urines and dividing by the combined volume of the two samples.

**Results and Discussion:** Among the food composites, chlorpyrifos was most frequently detected in beans/nuts/legumes samples (29%), although the highest measured concentration (400 ng/g) was found in a dairy sample consisting of chocolate ice cream. Diazinon was most frequently detected in grains samples (35%), with the highest concentration (6,564 ng/g) found in a composite sample of whole wheat bread, whole grain chips, rice noodles, and a multigrain bar. Malathion was most frequently detected in beans/nuts/legumes samples (14%), though the highest measured concentration (388 ng/g) was found in a dairy sample of milk and yogurt. The most frequently detected DAP was the malathion metabolite dimethylthiophosphate, which we measured in 87% of urine samples at median and 95<sup>th</sup> percentile blank corrected concentrations of 0.06 and 5.70  $\mu\text{g/L}$ , respectively. Spearman correlation analyses of the daily dietary pesticide intakes with their corresponding daily volume weighted average DAP concentrations showed no statistically significant relationship between daily intakes of chlorpyrifos, diazinon and malathion and their corresponding DAPs. In this presentation we describe results from a more detailed mixed model regression analyses of the OP residues in food and urinary DAP levels in this pilot sample.

#### ISEE-1600

#### Patterns of Ultrafine Particle (UFP) Deposition in Human Lung Alveolar Space and Exposure Related Physiological Responses of a Respiratory System on Healthy Individuals During Indoor Cooking

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**Background:** Harmful health effects have been linked to exposure to various particulate matters (PM) including ultrafine particles (UFP same as PM<sub>0.1</sub>). In indoor settings, the levels of exposure to UFP are influenced by various types of indoor sources. In non-smoking indoor environments, cooking activities have been known to influence the PM exposure levels. Consequently the PM, especially UFP, generated during daily cooking activities has been speculated as a potential contributing factor for harmful health effects. Few studies, however, have demonstrated characteristic UFP deposition patterns in the lung alveolar surfaces in conjunction with pulmonary physiological responses.

**Methods:** In this study, three UFP and nano-particle monitors from TSI, Inc in addition to a portable device for pulmonary function testing (PFT), SBG Spirometer, were utilized in a residential kitchen area during one evening with two healthy adult volunteers. The participants with no known history of lung diseases had completed their annual physical examinations days before the measurement started. The PFT was performed twice before and after the cooking period. Among the three PM monitors, the Nano Surface Area Monitor (model 3550, detection range between 10 and 1000 nm) was used to measure the lung deposited surface area corresponding to alveolar regions. A water-based Condensation Particle Counter (model 3782 with a detection limit down to 10 nm) was attached to an Electrostatic Classifier (model 3080) with a Differential Mobility Analyzer to collect information about UFP size distribution and particle counts.

**Results and Discussion:** The preliminary data showed 1) the UFP surface area concentration deposited in the lung alveolar areas increased to 26

times ( $1.3 \mu\text{m}^2/\text{cm}^3$ ) of the baseline concentration ( $0.05 \mu\text{m}^2/\text{cm}^3$ ) within a minute in a space with  $13,500\text{ft}^3$  size, 2) the deposited levels of the UFP in the lung alveolar spaced were steadily maintained with less than  $0.008 \mu\text{m}^2/\text{cm}^3/\text{min}$  clearance rate during the meal time when there was no air ventilation or filtration, 3) the deposition levels of the UFP in the lung alveolar were reduced at 3 times faster rate ( $0.026 \mu\text{m}^2/\text{cm}^3/\text{min}$ ) with an operation of a central air filtration system equipped with a commercially available air filter, 4) the overall count concentration of the observed UFP (between 10 and 414 nm) showed the highest value nearby 100 nm (ranging between 10 and 414 nm) although the UFP size distribution patterns varied constantly during the entire period of the measurement, 5) three dependent variable parameters including the volume, the mass, and the surface area of the UFP were positively correlated with the increasing sizes of the particle diameters detected by the monitors, 6) the PFT results showed that the alveolar exposure to the UFP and nano PMs at the detected levels in this study ( $1.3 \mu\text{m}^2/\text{cm}^3$  for 30 minutes) was not significantly high enough to cause any observable acute physiological variations (less than 5% variation of FEV<sub>1</sub> for one with 8% variation of FEV<sub>1</sub> for another participant) in the respiratory systems. This study demonstrated the possibility of a better understanding on the pathophysiological events in respiratory systems by combining data from real time UFP and PFT devices.

#### ISEE-1602

#### Nitrogen Dioxide (NO<sub>2</sub>) Exposure Assessment in Support of U.S. EPA's NAAQS Review: Application of AERMOD and APEX to Philadelphia County

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**Abstract:** The US Environmental Protection Agency (EPA) is conducting a review of the national ambient air quality standards (NAAQS) for nitrogen dioxide (NO<sub>2</sub>). A critical component of this review process is risk and exposure assessment, where the metric of interest is exposure to exceedances of various threshold hourly concentrations that are associated with potential health risk. This presentation discusses results of the assessment, including evaluations of current ambient NO<sub>2</sub> concentrations, ambient levels that just meet the current NO<sub>2</sub> NAAQS, and ambient levels that just meet possible alternative NAAQS. Several US metropolitan statistical areas (MSAs) are being studied for this assessment. This presentation discusses the technical approach used for all the MSAs and presents exposure estimates for Philadelphia County, Pennsylvania, USA.

Many studies have found that indoor, outdoor, and personal exposure concentrations of NO<sub>2</sub> are strongly associated with proximity to vehicle traffic. Other studies have found that indoor and personal exposure concentrations are associated with gas cooking. The exposure assessment described here considers both of these emission sources along with major stationary emission sources.

The steep gradient of NO<sub>2</sub> concentrations near roadways requires characterization with fine spatial resolution in order to generate accurate estimates of exposure concentrations from vehicle traffic. The density of US Census blocks is high in metropolitan areas and provides the needed fine spatial resolution of concentrations. Thus, air dispersion modeling was conducted with AERMOD—the US EPA's recommended steady-state, Gaussian plume model for regulatory applications—using receptors located at Census blocks to estimate ambient air quality impacts from major point source, and area emission sources. Onroad emissions for input to AERMOD were estimated with predictions from the US EPA's MOBILE6 emission factor model and a traffic demand model (TDM).

Major stationary source emissions were derived from the 2002 National Emissions Inventory (NEI) and the Clean Air Markets Division (CAMD) Emissions Database.

US EPA's Air Pollutants Exposure Model (APEX) is a probabilistic model that simulates the movement of individuals through time and space and estimates their exposure to a given pollutant in indoor, outdoor, and in-vehicle microenvironments. The air quality estimates from AERMOD were input to APEX to provide estimates of population exposure. The APEX simulations also included the impacts of gas cooking. Relevant results include the relative contributions of the various emission source categories to predicted exceedances of the various concentration thresholds of concern within Philadelphia County.

*Any opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of ICF International or the US EPA. This work has been supported by EPA under Contract No. EP-D-06-115.*

#### ISEE-1603

##### Occupational Exposure to Methomyl in California

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**Abstract:** Methomyl, S-Methyl-N-(methylcarbamoyloxy)thioacetimidate, is a broad-spectrum N-methyl carbamate insecticide with anti-cholinesterase activity. It is used for pest control in field, fruit and vegetable crops; turf; livestock quarters; commercial premises and refuse containers. There are no homeowner uses of methomyl. EPA classifies methomyl as Restricted Use Pesticide because of its high acute oral toxicity to humans (Toxicity Category I). Methomyl is Category II inhalation toxicity, and Category III dermal toxicity. Methomyl is highly toxic via ocular exposure (Category I eye irritant). Methomyl is a subject to reregistration and part of a cumulative risk assessment processes for N-methyl carbamate pesticides ongoing at US EPA. Pesticide products containing methomyl are being evaluated on the basis of its widespread agricultural use, high acute toxicity, the steepness of its acute dose-response curve, its low NOELs for both neurotoxic and hematological effects, and the consistency of the hematological effects in different species and study types. Representative occupational exposure scenarios were identified according to uses allowed on product labels. Chemical-specific exposure monitoring data were available for some scenarios. In the absence of chemical-specific data, handler exposures were estimated using surrogate data from the Pesticide Handler Exposure Database. Field worker exposure estimates took into accounts the timing of pesticide applications, foliar residue dissipation, and frequency and timing of agricultural activities.

This occupational exposure assessment is part of the risk characterization document prepared in California Department of Pesticide Regulation.

#### ISEE-1604

##### Geographic-Based Prediction of Agricultural Pesticide Exposure and Concentrations in Windowsill Dust

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**Background:** Populations living in highly agricultural areas are exposed to pesticides due to the proximity of their residences to treated crops. We developed a method for identifying residences with probable exposure from agricultural pesticide drift making use of land cover data and a Geographic Information System (GIS) to determine specific crops grown in the vicinity of residences. Recently, this approach has been applied in

two California studies to provide a more precise estimate of residential proximity to pesticide applications reported by the California Pesticide Use Reporting database. In this study we examined the correlation between pesticides detected in windowsill dust and residential proximity to reported agricultural pesticide applications as determined using these GIS-based agricultural metrics.

**Methods:** We collected windowsill wipe samples from 57 residences in Northern and Central California. Residences with agricultural land use within a mile of the residence were eligible for the sampling of household dust. The GIS-based agricultural metrics were used to estimate agricultural pesticide use near each residence. The applications of pesticides were assessed for buffers ranging in size from 200–500 m for up to two years prior to the date of household dust sample collection. We calculated the sensitivity, specificity and positive predictive value for the agricultural metrics.

**Results:** For pesticide applications within 500m of the residence, 90 days prior to the collection of windowsill dust, there were seventeen pesticides reported near the participants' homes; the frequency of use ranged from 1 to 162 applications and 3.9 to 3975 pounds of active ingredient. Eight of the 17 pesticides applied and measured in the wipe samples were detected (phosmet, chlorpyrifos, simazine, diazinon, trifluralin, cyfluthrin, carbaryl, permethrin) with detection rates ranging from 25% (phosmet) to 98% (chlorpyrifos and diazinon). Using the wipe samples as a "gold standard", the sensitivity and specificity of the agricultural metric ranged from 50% (cyfluthrin, permethrin) to 100% (phosmet) and 95% (cyfluthrin) to 100% (chlorpyrifos, diazinon, trifluralin, permethrin)%, respectively, for the 8 pesticides while the positive predictive values ranged from 25% (cyfluthrin) to 100% (chlorpyrifos, diazinon, trifluralin, permethrin).

**Conclusions:** We observed only modest correlations between the GIS-based agricultural metrics and pesticide concentrations in windowsill dust. However, these results may be a reflection of the high limit of detection for some pesticides in the windowsill wipe samples and the difficulty in obtaining a sample of sufficient quantity with the windowsill wipe method. Additional analyses will examine whether the correlation between pesticide exposure predicted by agricultural metrics and windowsill dust varies by household characteristics (e.g., agricultural workers in the home), length of time from application to dust sampling, and buffer size.

#### ISEE-1605

##### Effects of Organophosphorus Pesticide Exposure on Birth Outcome Among Pregnant Women with Differing PON1 Status

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**Background:** We have previously shown organophosphorus (OP) pesticide exposure during pregnancy to be associated with shorter gestational duration. However, individuals' susceptibility to adverse effects of OPs exposure may differ according to their genetic expression of enzymes that detoxify these pesticides. Single nucleotide polymorphisms (SNPs) at positions 192 and -108 along the PON1 gene affect the catalytic efficiency and expression of the enzyme paraoxonase (PON1), which is involved in OP pesticide detoxification. This present study investigates whether the association of prenatal OP pesticide exposure with birth outcome differs by PON1 genotype and/or enzyme activity among a population of pregnant women.

**Methods:** Study participants were 436 low-income women living in a farm-working community in Northern California and participating in the CHAMACOS birth cohort study. Infant birth weight, length, and head circumference were measured at delivery by hospital staff. Gestational age at birth was calculated by the mother's recall of her last menstrual period or by first trimester ultrasound, if maternal recall was not available. Dialkylphosphate (DAP) metabolites of OP pesticides were measured in urine collected at two points during pregnancy. PON1 enzyme activity towards four

substrates (paraoxon (PO), phenyl acetate (ARY), chlorpyrifos-oxon (CPO), and diazoxon (DZO)) was measured using spectrophotometric methods. Maternal PON1 enzyme activity was measured in plasma samples collected during pregnancy and at delivery; infant PON1 activity was measured in umbilical cord plasma. PON1 192 and -108 genotypes for mothers and infants were determined using high-throughput genotyping.

**Results and Discussion:** Previously, we reported that the PON1<sub>192</sub> QQ genotype was associated with significantly lower PON1 CPOase and POase activity as compared to the RR genotype in both mothers and children, suggesting a greater OP susceptibility among those with the QQ genotype. Additionally, for the promoter SNP PON1<sub>-108</sub>, the TT genotype was associated with significantly lower PON1 levels as measured by ARYase activity. In this study, infant PON1<sub>-108</sub> TT genotype was associated with shorter gestational duration compared to CC ( $\beta = -0.5$  weeks,  $P$ -value = 0.04). No significant effect was seen with infant PON<sub>192</sub> genotype alone, although the shortest gestational duration was seen among infants with a combination of both susceptible genotypes (QQ/TT). In infant cord blood, lower PON1 levels as measured by ARYase activity and lower CPOase enzyme activity were associated with shorter gestational duration and lower birth weight. Neither maternal genotype nor enzyme activity was associated with birth outcomes. Significant interaction was seen between DAPs and infant 192 and -108 genotypes for gestational duration. When the data were stratified by genotype, the negative association of DAPs and gestational duration was strongest among the infants with the most susceptible genotypes (PON1<sub>-108</sub> TT vs CC, or PON1<sub>192</sub> QQ vs RR), although the associations were not statistically significant. These findings suggest that fetal PON1 genotype and enzyme activity are associated with birth outcome, and may render some pregnancies more susceptible to effects of OP pesticides on gestational duration.

#### ISEE-1606

##### A Stochastic Model of Viral Transmission Via Fomites

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**Abstract:** Existing microbial risk assessment models do not incorporate detailed descriptions of human interaction with fomites. We develop a novel stochastic-mechanistic model of risk from exposure to non-dietary ingestion of rotavirus iterated by simulated intermittent fomes-mouth, hand-mouth, and hand-fomes contacts typical of a child under two years of age. Through laboratory experiments we quantified the mean rate of inactivation for ms2 phage on glass (0.0052 s<sup>-1</sup>) and mean transfer between fingertips and glass (36%). Simulations using these parameters demonstrated that a child's median ingested dose from a rotavirus contaminated ball ranges from 0–1000 virus over a period of one hour, with a median value of 42 virus. This corresponds to a risk of infection range of 0–87% with a median value of 70%. These results were heavily influenced by selected values of model parameters, most notably concentration of rotavirus on fomes, frequency of fomes-mouth contacts, frequency of hand-mouth contacts, and virus transferred from fomes to mouth. The model demonstrated that mouthing of fomes is the primary source of risk, with hand mouthing contributions accounting for less than 1/5th of the child's dose over the first ten minutes of interaction.

#### ISEE-1607

##### Secondhand Tobacco Smoke Exposure in Motor Vehicles

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**Background:** Motor vehicles, including cars and trucks, represent important microenvironments for pollutant exposure. Of particular importance, due to the confined space with the cabins of cars and trucks,

is exposure the secondhand tobacco smoke. A number of countries, states and municipalities have banned smoking in cars with children present. Limited amount of data on secondhand smoke exposure levels in cars exists. More data are needed to inform policy practices aimed at eliminating smoking in cars where children are present.

**Objective:** The objective of this study was to assess levels of exposure to secondhand tobacco smoke within the cabin of cars with a smoking driver using passive airborne nicotine samplers.

**Methods:** A convenience sample of individuals ( $N = 5$ ) who smoked and commute to and from work in their own vehicle were recruited to participate. Two air nicotine samplers were placed in each vehicle for a period of 5 days. To evaluate levels of secondhand smoke exposure expected for actual passengers, one monitor was placed at the base of the passenger front seat headrest and the other was placed on the left lateral hanger of the passenger back seat. Air nicotine samplers were analyzed by gas chromatography with a nitrogen phosphorous detector.

**Results:** The mean age of the drivers was 43 years (standard deviation, 10 years). Three of them were men and two were women. In four vehicles, at least one adult passenger usually occupied the vehicle (two of them were also smokers) and in one vehicle usually 4 children occupied the car. The median (range) commuting time was 52 (10, 225) minutes and the median (range) number of cigarettes smoked by all passengers in the car was during the commute was 2 (0, 18). The median (range) air nicotine concentrations in the study cars were 22.6 (3.6, 286)  $\mu\text{g}/\text{m}^3$ , with little difference between the monitors placed in the back and the front seats.

**Conclusions:** Air nicotine concentrations in motor vehicles in this study were much higher than air nicotine concentrations generally measured in public or private indoor places, and even higher than concentrations measured in restaurants and bars. These high levels of exposure to secondhand tobacco smoke support the need for legislations that ban smoking in motor vehicles when passengers are present, including children.

#### ISEE-1609

##### Analysis of Exposure to Benzene from a Mineral Spirit Solvent Used During Parts Washing and Degreasing Operations

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**Background:** Historically, the primary focus of benzene exposure assessment was on workers in industries that produced or used substantial quantities of benzene; however, questions have been raised regarding workers exposed to products generally containing low levels of benzene. Mineral spirit solvents are one type of benzene-containing product that has drawn attention because of widespread use in cleaning and degreasing applications, such as parts washing, but few exposure data exist.

**Methods:** This study summarizes previously unpublished benzene data for parts-washing activities and provides an evaluation of potential daily and lifetime cumulative exposures of workers, typically mechanics, to benzene associated with the use of historical and current formulations of a recycled mineral spirit solvent in manual parts washers. The distributions of the potential total doses from inhalation and dermal uptake of benzene from the use of parts washers were calculated using probabilistic methods.

**Results:** The 50th and 95th percentiles of the potential daily inhalation doses for workers performing parts washing are 0.42 and 2.9 mg (0.013 and 0.091 ppmv equivalents) for the historical solvent and 0.11 and 0.99 mg (0.0033 and 0.031 ppmv equivalents) for the current solvent formulation, respectively. The estimated 50<sup>th</sup> and 95<sup>th</sup> percentiles of total internal daily dose from both inhalation and dermal exposure are 0.32 and 2.1 mg and 0.076 and 0.70 mg benzene for historical and current solvent formulations, respectively. The results which take into account both inhalation and daily dermal contact with the solvent, indicate that inhalation constitutes approximately 93 and 99% of the total 50<sup>th</sup>

percentile benzene dose for workers using historical and current solvent formulations, respectively. The 8-hour ppmv-equivalent value for the 95<sup>th</sup> percentile daily mechanic exposures from parts washing using the historical solvent, 0.091 ppmv, is well below the current Occupational Safety and Health Administration permissible exposure limit of 1.0 ppmv for benzene. Additionally, the estimated 50th and 95th percentiles of the distribution of occupational lifetime cumulative dose via inhalation for mechanics working in facilities with parts-washing units using the historical solvent are 0.029 and 0.53 ppmv-years, respectively.

#### ISEE-1610

##### Leprosy, Social Conditions and Deforestation at the Brazilian Amazon

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**Objective:** To compare the detection rate of leprosy with the social and environmental indicators of geographical regions of the Brazilian Amazon. **Methods:** Ecological study using socio-environmental indicators as: deforested areas calculated until 2006; proportion of the residences without basic sewer and proportion of residences with water without treatment, and the correlation with detection rate of leprosy of 2006 after flattening using the spatial data by local empiric Bayesian method. The analyses were carried out by correlation and average differences (ANOVA) with significance level in 5%. The data distribution of Kernel method was applied to show "hot areas" to every indicator analyzed.

**Results:** Positive correlation in the detection rate of leprosy was verified with the total area deforested ( $r = 0.501$ ;  $P < 0.000$ ), and with the proportion of the residences without basic sewer ( $r = 0.494$ ;  $P < 0.000$ ). The proportion of the residence with water without treatment was not associated with the detection rate coefficient when analyzed to the entire region. The spatial analyses showed that "hot areas" for the studied indicators, are concentrated near the region known as "area of deforestation" that is located at the border of the Brazilian Amazon.

**Conclusion:** The coefficient of the detection rate of leprosy that represents the magnitude of the disease is associated with the indicators of the conditions of life and way of territorial occupation at the Amazon.

#### ISEE-1611

##### The Impact of Exposure Measurement Error in a Time-Series Analysis of Air Pollution and Emergency Department Visits in Atlanta, Georgia

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**Background:** Uncertainties exist as to how well central site ambient air pollution concentrations represent true personal exposures to different pollutants and how resulting exposure measurement error may impact health risk estimates in epidemiologic analyses. One component of this uncertainty is the spatial variability in ambient air pollution that is not captured by a central monitor alone. The spatial variability of ambient air pollution varies widely between pollutants; therefore, the impacts on health risk estimates are expected to vary.

**Objectives:** We present a method for examining the impacts of exposure measurement error (due to spatiotemporal variability in ambient air pollutant concentrations) on air pollution health risk estimates in a daily time-series analysis of emergency department visits in Atlanta, Georgia.

**Methods:** Data for this analysis included daily ambient criteria pollutant concentrations obtained from several urban and rural monitoring stations and daily emergency department visit counts for the 1998–2004 time period. We used Poisson generalized linear models to examine associations between current day air pollution concentrations and cardiorespiratory emergency department visits for the whole population

and for several geographic subpopulations. We estimated associations of health with air pollutants, using data from monitoring sites located at differing distances from each subpopulation as alternative measures of exposure. This approach allowed us to assess the impact of the distance between each monitoring site and a subpopulation on the estimated associations.

**Results:** In both whole population and geographic subpopulation analyses, associations observed using urban site data for spatially variable primary pollutants (e.g., CO and NO<sub>2</sub>) were not observed when using data from the most rural site (located 38 miles from the urban center) as the measure of exposure. For example, for circulatory visits in a specific urban geographic subpopulation, relative risks were 1.030–1.036 ( $P \leq 0.02$ ) per interquartile range increase in CO concentrations when using data from each of three urban monitoring sites, located on average within 5 to 10 miles of the population. In comparison, the relative risk was 0.980 ( $P = 0.19$ ) when using CO data from the most rural monitoring site, at a distance of 48 miles from the population. In contrast, associations observed for spatially homogeneous pollutants (e.g., O<sub>3</sub> and PM<sub>2.5</sub>) were more similar regardless of monitoring site location. For example, for circulatory visits in another urban geographic subpopulation, relative risks were 1.019–1.030 ( $P = 0.03$ –0.17) per interquartile range increase in PM<sub>2.5</sub> concentrations when using data from each of four urban and rural monitoring sites, located between 5 and 38 miles from the population.

**Conclusions:** For spatially heterogeneous primary air pollutants, our findings suggest that the distance of an air monitoring site to a population of interest can impact epidemiologic model results. This impact is likely due to exposure measurement error. However, for the spatially heterogeneous pollutants examined in this analysis, distance was only important when using data from sites located far (e.g., at a distance of >30 miles) from a subpopulation. Within the urban Atlanta area, ambient data from several central monitors yielded comparable results, even for spatially variable pollutants.

#### ISEE-1613

##### Estimating Subsistence Farm Family and Gardener Multi-Pathway Exposure to Uranium from Well Water

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**Background:** Naturally-occurring uranium above the U.S. EPA Maximum Contaminant Level (MCL) of 30 µg/L exists in groundwater throughout many areas of the American West. Uranium is a potential kidney toxicant, with children being more susceptible due to their higher intake/body weight ratio. Two rural drinking water systems in Idaho (one up north near the Canadian border, the other in the southwest region) were evaluated for health concerns. Water was sampled 2–3 times/year from 2004 through 2007. Samples were analyzed using EPA Method 200.8 (ICP-MS). Total uranium levels ranged from 63–72 µg/L (median 68 µg/L) at the northern system and 51–108 µg/L (median 80 µg/L) at the southwestern system. Home-grown foods raised using uranium-containing water are staples of many residents' diets in these two communities. This study evaluated the relative contribution of home-grown produce, meat and eggs to residents' total uranium exposure compared to water ingestion alone.

**Methods:** Using formulae generated by Los Alamos National Lab (Hayes et al. 2000), uranium soil loading from water and uranium uptake into produce were estimated for the two systems' communities. Watering with system water was predicted to increase soil uranium concentration by approximately 6–12% over a growing season. Root vegetables and leafy greens irrigated with system water were predicted to uptake 15–30 times more uranium than crops irrigated with water containing <1 µg/L uranium. Both of these crop types concentrate more uranium in their

edible tissues than other types. Ingestion rates for produce were estimated using EPA Exposure Factors values. A serving of root vegetables and leafy greens eaten by a child in the same meal can contribute as much as the ATSDR Minimal Risk Level (0.002 mg/kg/day) beyond what might be ingested from drinking water. Median child uranium dose from water ingestion alone was 0.004 mg/kg/day for the northern system and 0.005 mg/kg/day for the southwestern system based on intake of 1 L/day. Soil ingestion was not considered but could also be a significant pathway for children.

**Results:** Uptake of uranium into meat and eggs was estimated using guidance from U.S. Department of Energy (1999, 2003), and ingestion rates were estimated using EPA Exposure Factors values. Meat and eggs were not found to significantly contribute to total aggregate exposure. Outreach to encourage well testing and water treatment or alternative sources is a priority in Idaho.

#### ISEE-1615

##### Prenatal Exposure to PBDEs and Neurodevelopment

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**Background:** Polybrominated diphenyl ethers (PBDEs) are widely-used flame retardant compounds that are persistent and bioaccumulative and therefore, have become ubiquitous environment contaminants. Animal studies suggest that prenatal exposure to PBDEs may result in adverse neurodevelopmental outcomes. A longitudinal cohort study initiated by the Columbia Center for Children's Environmental Health examined the impact of prenatal exposures to toxicants, including PBDEs, which may have been emitted from the World Trade Center (WTC) buildings in New York City following the September 11, 2001 terrorist attack.

**Objective:** We explored the relationship between prenatal PBDE exposure and indicators of neurodevelopment at ages 1–4 years.

**Methods:** Between December 2001 and June 2002, cord blood specimens were collected from 329 non-smoking women delivering singletons at three hospitals located near the WTC site, of which 210 samples were measured for selected PBDE congeners. Demographic, health, and exposure information was abstracted from medical records and a questionnaire administered after delivery. Neurodevelopmental effects were assessed using the Bayley Scales of Infant Development (MDI and PDI) at ages 1, 2 and 3 years and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) at 4 years. There were 118, 117, 114, and 97 children with available cord PBDE measurements who were assessed at 1, 2, 3 and 4 years, respectively. Multiple variable regression analyses were used to evaluate associations between concentrations of PBDE congeners 47, 99, 100, and 153 and neurodevelopmental indices. Generalized estimating equations (GEE) were used to evaluate the effect size for PBDE on neurodevelopment over time (through 48 months). PBDE concentrations were log-adjusted and the limit of detection (LOD) divided by the square-root of two was used for values below the LOD. Multivariate models were adjusted for: gestational age at birth, child's exact age at testing, sex, ethnicity, maternal education, IQ and marital status, environmental tobacco smoke exposure during pregnancy, material hardship, and whether the child was breast-fed.

**Results:** Median cord concentrations of PBDE congeners 47, 99, 100, and 153 were 11.2, 3.2, 1.4, and 1.0 ng/g lipid and 79.9%, 58.4%, 62.2%, and 46.7% were above the LOD, respectively. In general, children who had higher cord blood concentrations of BDE 47, 99, and 100 scored lower on tests of mental and physical development. These associations were significant for year 2 MDI, and for year 4 scales of verbal and performance IQ. Using GEE, children who were in the highest quintile of cord blood concentrations of PBDEs 47, 99, and 100 had significantly lower developmental scores as compared to children who were in the

lower 80% of the exposure distributions for these chemicals. At 4 years, however, differences in full IQ score were detectable but not significant. Cord concentrations of BDE-153 did not appear to significantly influence neurodevelopmental scores.

**Conclusions:** Levels of cord blood PBDEs in our population are consistent with those reported among other U.S. populations. To our knowledge, this is the first study to suggest neurodevelopmental effects in relation to cord blood concentrations of PBDE 47, 99, and 100. Confirmation is needed in other longitudinal studies.

#### ISEE-1616

##### Validation of Hair Nicotine Against Salivary Cotinine as a Biomarker of Self-Reported Tobacco Exposure

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**Background:** Cotinine, the most widely used biomarker of tobacco exposure, can be measured in several body fluids. However, the need for the collection, storage, and transportation of blood, urine, or saliva limits its use in large monitoring studies. During the past decade, hair nicotine has been used increasingly because it is easier to handle than body fluids. However, limited studies have shown the utility of hair nicotine against salivary cotinine as a biomarker of self-reported tobacco exposure.

**Objectives:** The purposes of this study are 1) to evaluate the association between hair nicotine and saliva cotinine concentrations, and 2) to evaluate the utility of hair nicotine measurements as a biomarker of tobacco exposure.

**Methods:** This study was conducted with 296 study participants (106 smokers, 79 never smokers, 111 passive smokers) in Baltimore, MD, USA. Hair nicotine and salivary cotinine were measured using gas chromatography with mass spectrometry (GC/MS). Self-reported subjects' demographic characteristics, smoking status, and smoking behaviors were also collected.

**Results:** According to our preliminary results, the medians (IQR) of hair concentrations for never, passive, and active smokers were 0.23 (0.08, 0.44), 0.35 (0.17, 3.03) and 16.8 ng/mg (4.2, 39.8 ng/mg), respectively. The Spearman correlation coefficient between hair nicotine and salivary cotinine concentrations was 0.4 among active smokers.

**Conclusion:** The current study provides basic information supporting the utility of hair nicotine. We are currently conducting further analyses to determine cutoff values of salivary cotinine and hair nicotine that minimizes misclassification of self-reported smoking status.

#### ISEE-1618

##### Occupational Behaviors and Farmworkers' Pesticide Exposure: Findings from a Study in Monterey County, California

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**Background:** Pesticide exposure is a significant occupational risk facing the nearly three million farmworkers employed in U.S. agriculture. The largest intervention to date to reduce farmworkers' occupational pesticide exposure is the U.S. EPA Worker Protection Standard (WPS). Although WPS is mandated nationwide its effect on reducing farmworker pesticide exposure is not known. Despite the widespread promotion of behaviors such as glove use and handwashing by WPS and other programs, there is

limited field-based evidence of their effectiveness, especially among U.S. fieldworkers (i.e., farmworkers who are not pesticide handlers). We studied the relationship between WPS-recommended behaviors, and fieldworkers' organophosphorus (OP) pesticide exposure, as measured by urinary metabolite levels, among farmworkers ( $n = 73$ ) employed in Monterey County, California. We focused on OP pesticides because of their extensive agricultural use and their possible effects on adult neurobehavioral function and potential adverse effects on neurodevelopment in children who may be exposed to pesticides carried home on workers' skin and clothing.

**Methods:** Farmworkers' behaviors such as wearing a long-sleeved shirt, pants, closed-toe shoes, and a hat; wearing clean work clothes; using gloves; and handwashing with and without soap were assessed via self-report. Organophosphorus (OP) pesticide exposure was measured using total dimethyl alkylphosphate (DMAP) and malathion dicarboxylic acid (MDA) urinary metabolite levels. To determine the potential for fieldworker exposure, malathion was measured in DFR samples collected from a field that participants worked in and had been sprayed with malathion ( $n = 12$ ) and a field that had not been sprayed ( $n = 4$ ).

**Results:** Wearing the four items of recommended clothing (long-sleeved shirt, pants, closed-toe shoes, and a hat), wearing clean work clothes, and the combination of both using gloves and handwashing with soap were associated with lower DMAP and MDA urinary metabolite levels. The levels of malathion dislodgable foliar residues (DFRs) we observed were an order of magnitude higher in the sprayed field after expiration of the pre-harvest interval compared to the unsprayed field and are consistent with levels reported in other studies.

**Conclusions:** Our findings suggest that wearing all four clothing items recommended by the WPS, wearing clean work clothing, and the combination of both using gloves and handwashing with soap reduced exposures from these DFRs. Interventions that facilitate compliance with these behaviors may be effective in decreasing fieldworkers' pesticide exposures. Despite these protective behaviors, however, farmworkers in this study had significantly higher levels of exposure as compared with a national reference sample. Further efforts are needed to reduce exposure disparities and the potential for "take home" exposures to fieldworkers' families.

#### ISEE-1619

##### Urban Pesticide Sampling Procedures: Washington, DC, Pest Project

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**Background:** The Washington, DC, Pesticide Project is an attempt to survey 100 residents from each of eight wards by investigators from the George Washington University (GWU). We believe this is the largest urban pesticide survey ever undertaken in the U.S. The questionnaire (approved by GWU's IRB) is designed to elicit attitudes towards residential pests, including insects and rodents and garden pests as well. The survey asks what pesticide products are applied by the respondent and by their landlord or licensed pesticide applicator. We seek to know the numbers and ages of all other residents, with particular focus on children and those with ailments such as asthma. And we seek to know their knowledge of safe pesticide application practices, such as reading the label and wearing protective clothes.

**Methods:** Because of wide differences in literacy, we designed the survey to be guided with approximately 5 to 8 subjects responding to one trained interviewer. A monetary incentive of \$20 voucher will be offered to participating subjects. Our original approach was to seek the assistance of Area Neighborhood Commissioners (ANCs) to help staff find and interview subjects. We found that most ANC—though interested in the survey—could not assist the project by providing access to residents. We turned to Washington, DC, voter registration lists, which are accessible for survey purposes. We thought the timing between a mayoral (in 2007) and a presidential election (in 2008) would also mean a relatively good

random selection of subjects throughout the city. However, we also intend to include volunteers in our survey, who may be friends or relatives of the selected respondents, as well as Washington, DC, health fair attendees. In addition we seek participation of groups such as students and non-English speakers (many Spanish speakers reside in certain neighborhoods) whom we believe will not be registered to vote. When completed results are tabulated we will ask ANCs to assist us with outreach. We intend to compare those residents chosen via voter registration with others with regard to both demographics as well as pest concerns and pesticide use. In this way, we can demonstrate if respondents not from voter registration present a potential bias and in what direction they may skew our overall sample. Ultimately, this survey will enable us to suggest what community-based pesticide education, including integrated pest management (IPM) will be needed and relevant to residents of Washington, DC, and other major cities.

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#### ISEE-1620

##### Traffic Related Air Pollution and Perinatal Mortality

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**Introduction:** There is some evidence that maternal exposure to air pollution is linked to a variety of pregnancy outcomes ranging from low birth weight, prematurity, and congenital anomalies to death at different periods (fetal, neonatal, post-neonatal and infant deaths). This study aimed to examine the association between perinatal deaths and exposure to traffic related air pollution in São Paulo, Brazil.

**Methods:** A population-based case-control study was carried out from August 2000 to January 2001. Cases were 164 antepartum fetal deaths and 146 neonatal deaths. Controls consisted of a random sample of 313 births surviving at least 28 days. Information was collected from birth and death certificates, hospital records and home interviews. We mapped each case and control home locations at birth and estimated exposure to traffic-related air pollution using a distance-weighted traffic density (DWTD) measure. This measure takes into account residential proximity to and level of traffic on roadways surrounding homes.

**Results:** Statistically significant factors associated with fetal and neonatal deaths included marital status, mothers' education, history of previous low birth weight infant; hypertension, diabetes, lack of antenatal care, and intrauterine growth restriction. An increasing risk of neonatal death according to exposure to traffic was observed. Mothers exposed to the highest quartile of DWTD presented an OR = 2.76 (95%CI 1.12–6.80) compared to those in the lowest quartile. Although a similar trend was observed for fetal deaths, no significant association was found in the multivariate logistic models.

**Conclusion:** These results are consistent with the emerging literature on effects of air pollution on pregnancy outcomes. It suggests that exposure to traffic-related pollutants may be an important risk factor for neonatal deaths but not for fetal deaths.

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#### ISEE-1622

##### Chronic Arsenic Toxicity: Clinical Features, Epidemiology, and Treatment: Experience in Indo-Nepal Border

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**Background:** Chronic arsenic toxicity due to drinking arsenic-contaminated water has been one of the worst environmental health hazards, affecting eight districts of Nepal and India since the early eighties.

**Methods:** Detailed clinical examination and investigation of 248 such patients revealed protean clinical manifestations of such toxicity. Over and above hyperpigmentation and keratosis, weakness, anaemia, burning sensation of eyes, solid swelling of legs, liver fibrosis, chronic lung disease, gangrene of toes, neuropathy, and skin cancer are some of the other manifestations. A cross-sectional survey involving 7683 participants of all ages was conducted in an arsenic-affected region between April 2006 and March 2007.

**Results:** Out of a population of 7683 surveyed, 3467 and 4216 people consumed water containing As below and above 0.05 mg/L, respectively. Except for abdominal pain, the prevalence of all other clinical manifestations tested (e.g., pigmentation, keratosis, hepatomegaly, weakness, nausea, lung disease and neuropathy) were found to be significantly higher in As exposed people (water As >0.05 mg/L) compared to control population (water As level <0.05 mg/L). The prevalence of pigmentation and keratosis, hepatomegaly, chronic respiratory disease and weakness rose significantly with increasing arsenic concentrations in drinking water. The respiratory effects were most pronounced in individuals with high arsenic water concentrations who also had skin lesion. Therapy with chelating agent DMSA was not found to be superior to placebo effect. However, therapy with DMPS caused significant improvement of clinical condition of chronic arsenicosis patients as evidenced by significant reduction of total clinical scores from  $8.90 \pm 2.84$  to  $3.27 \pm 1.73$ ;  $P < 0.0001$ . Efficacy of specific chelation therapy for patients suffering from chronic As toxicity has further need to be fully substantiated. However, supportive treatment could help in reducing many symptoms of the patients.

**Conclusions:** Treatment in hospital with good nutritious diet has been found to reduce symptom score in a subset of placebo treated patients during the course of DMSA and DMPS trial. People should be advised to stop drinking As contaminated water or avoid As exposure from any other source. The various clinical manifestations should be treated symptomatically.

#### ISEE-1624

#### The Impact of Smoke-Free Legislation in Ontario on Levels of Second Hand Smoke in Enclosed Public Places

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**Objective:** To evaluate the impact of the Smoke-Free Ontario Act (SFOA) by comparing levels of second hand smoke (SHS) in separately ventilated designated smoking rooms (DSRs) of bars and coffee shops before and after the implementation of the Act, which prohibited smoking in all enclosed workplaces and public places in Ontario.

**Methods:** A sample of 46 bars and coffee-shops was drawn. Air particulate matter (PM), and carcinogenic particulate polycyclic aromatic hydrocarbons (PPAH) were measured inside and outside DSRs in Toronto, Ontario, venues, which allowed smoking only in DSRs, and in venues in a control community, Windsor, Ontario, where smoking was allowed in shared spaces before the ban. Measurements were repeated two months post-ban on the same day of the week and at approximately the same time of the day as before the ban. Mixed model analysis was used to compare levels of markers for SHS before and after the ban.

**Results:** Before the ban, the median PM and PPAH levels were  $438 \text{ mm}^2/\text{m}^3$  (square millimeters per cubic meter) and  $162 \text{ ng}/\text{m}^3$  (nanograms per cubic meter) inside DSRs,  $100 \text{ mm}^2/\text{m}^3$  and  $18 \text{ ng}/\text{m}^3$  outside DSRs in Toronto venues, and  $349 \text{ mm}^2/\text{m}^3$  and  $77 \text{ ng}/\text{m}^3$  in Windsor venues, respectively. Post- ban, the median PM and PPAH levels were reduced by

88% (to  $53 \text{ mm}^2/\text{m}^3$ ) and 93% (to  $11 \text{ ng}/\text{m}^3$ ) inside DSRs and by 47% (to  $53 \text{ mm}^2/\text{m}^3$ ) and 60% (to  $7 \text{ ng}/\text{m}^3$ ) outside DSRs in Toronto, and by 87% (to  $46 \text{ mm}^2/\text{m}^3$ ) and 87% (to  $10 \text{ ng}/\text{m}^3$ ) in Windsor venues, respectively. All reductions were statistically significant ( $P < 0.001$ ).

**Conclusions:** DSRs did not provide adequate protection from SHS for nonsmoking workers and patrons. The total ban on smoking implemented as part of the SFOA, produced a significant and substantial reduction in both particulates and carcinogens in bars and coffee shops with DSRs and in those with no separately enclosed areas.

#### ISEE-1625

#### Malondialdehyde (MDA)-dG Adducts Among Schoolchildren Resident in a Petrochemical Site in Respect to Those Living in a Rural Area (Sardinia, Italy)

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**Objectives:** To evaluate if a biomarker of oxidative stress (MDA-dG) is associated to different level of air pollution. MDA is a natural product of lipid peroxidation of cellular membrane. MDA is capable to interact with DNA, forming exocyclic DNA adducts, including 3-(2-deoxy- $\beta$ -D-erythropentafuranosyl)pyrimido[1,2- $\alpha$ ]purin-10(3H)-one, the adduct generated by reaction of MDA with deoxyguanosine. MDA-dG adducts are also formed via site-specific free radical attack on the DNA, through base propenal intermediates. MDA DNA adducts have been implicated in the induction of G→T transversions and A→G transitions. MDA-dG adducts have been found in humans and is considered to be a promising biomarkers for estimating oxidative stress and lipid peroxidation induced DNA damage.

**Materials and Methods:** In May–June 2007 a survey was planned in 6–14 yrs old children in Sarroch and in a non-polluted area (Burcei), with parental questionnaires, lung function tests (spirometry), fractional exhaled nitric oxide (FeNO) measurements and malondialdehyde (MDA)-dG adducts analysis performed in brushing samples of nasal mucosa. Assessment of MDA-dG adduct in schoolchildren living in Sarroch and Burcei was studied using a modified 32P-postlabelling version. This protocol was developed to ensure an efficient 3'-dephosphorylation and to obtain an improved chromatography resolution. A multidirectional chromatography system based on urea solvents was applied for MDA-dG adduct analysis. Improvements were tested analysing 1,1,3-tetraethoxypropane (TEP) modified DNA standards for qualitative and quantitative comparison.

**Results:** Median SO<sub>2</sub> was  $10.4 \text{ mcg}/\text{m}^3$  in Sarroch and  $3.4 \text{ in Burcei}$ . Last 12 mo wheezing symptoms were 11.6 % (8.1–16.0) and 6.6% (3.6–10.8). Mean FEV<sub>1</sub> and FeNO ( $\pm SD$ ) in 27 children with asthma or last 12 mo wheezing symptoms in Sarroch and in 24 children in Burcei were  $2.1 \text{ ml}$  (0.6),  $31.7 \text{ ppb}$  (34.7) and  $2.4 \text{ ml}$  (0.8),  $25.3 \text{ ppb}$  (22.7), respectively. Mean FEV<sub>1</sub> and FeNO ( $\pm SD$ ) in 8 children without asthma or asthmatic symptoms in Sarroch and in 55 children in Burcei were  $2.3 \text{ ml}$  (0.8),  $13.3 \text{ ppb}$  (14.3) and  $2.5 \text{ ml}$  (0.6),  $9.8 \text{ ppb}$  (8.5), respectively. Adjusting for age, height, weight, gender, socio economic status of the family, passive smoking, housing condition (damp or mould), traffic exposure, concurrent respiratory infections and steroid therapy, FEV<sub>1</sub> was reduced of 10.3% among children living in Sarroch vs those living in the not-exposed town of Burcei (90% confidence interval 5.8–14.6%  $P < 0.001$ ) and an increase of 34.96% of FeNO (90% CI 1.11–80.13 %  $P = 0.088$ ). The levels of MDA-dG adducts were higher in children residents near the petrochemical complex in respect to those living in the rural area. The adjusted effect estimate was a frequency of MDA-dG greater than 61.4% (90% CI 9.5–137.8%  $P = 0.043$ ; on average  $5.54 \text{ RAL } 10^7$  in Sarroch vs  $3.70 \text{ RAL } 10^8$  in Burcei).

**Conclusions:** Our present study suggests that children living in Sarroch can experiment an increased MDA-dG adduct formation. The emissions from the petrochemical complex are the main source of air pollution in this area and can be the cause of such increment in the levels of DNA damage.

#### ISEE-1627

#### Spatial Analysis of Kidney, Pancreatic, and Bladder Cancer on Upper Cape Cod using Generalized Additive Modeling

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**Background:** Population-based case-control and cohort studies provide a strong foundation for spatial epidemiology because potential confounders and disease latency can be addressed, a weakness of many registry-based analyses. In 1982, elevated cancer incidence in the upper Cape Cod region of Massachusetts (USA) prompted a large epidemiological study to investigate possible environmental risk factors. Positive associations were observed, but the environmental exposures explained only a portion of the excess cancer incidence. The upper Cape case-control study provides detailed information on individual-level covariates and residential history, and geocoding of this information produces a rich, point-based data set that can be spatially analyzed with the help of geographical information systems (GIS).

**Methods:** Here, we investigate the association between geographic location and kidney, pancreatic, and bladder cancer. The cases were incident cancers diagnosed from 1983 through 1986 among permanent residents of the five upper Cape towns (Barnstable, Bourne, Falmouth, Mashpee, and Sandwich) and reported to the Massachusetts Cancer Registry. The controls were from the same source population as the cases: permanent residents of the five upper Cape towns during 1983–1986. Interviews provided extensive individual-level information-age, vital status, smoking, family history of cancer, forty year residential history and other covariates. We generated maps using generalized additive models, smoothing on longitude and latitude while adjusting for covariates. The resulting continuous surface estimates disease rates relative to the whole study area. We used permutation tests to examine the overall importance of location in the model and identify areas of increased and decreased risk.

**Results and Discussion:** Maps of all bladder cancer are essentially flat based on the global statistic for location. However, when we consider a 15 year latency, we observe slightly elevated odds ratios in the east. The resulting map for kidney cancer shows a sloped surface with significantly increased odds ratios in the south of the study area and decreased odds ratios in the north. The spatial analysis for pancreatic cancer indicates a hot spot in the center of the study area located near known groundwater plumes and the Massachusetts Military Reservation. The numbers of cases for kidney and pancreatic cancer were too small to restrict the analysis for latency assumptions. Spatial epidemiology of population-based case-control studies addresses many methodological criticisms of cluster studies and generates new exposure hypotheses. Our results provide evidence for spatial clustering of pancreatic cancer on upper Cape Cod. The analysis suggests further investigation of the potential association between pancreatic cancer and pollution plumes using detailed exposure modeling.

#### ISEE-1628

#### Brazilian Amazon: Priority Areas to Monitoring the Effects of the Air Pollution to the Human Health

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**Objective:** To identify priority areas of the Brazilian Amazon to monitoring the effects of the air pollution to the human health to vulnerable groups for Respiratory diseases.

**Method:** Ecological study using spatial analyses of exposure indicator of the proportion of critical hours of  $PM_{2.5}$  as limit of violation in  $80\mu g$  (in aerodynamic diameter). The estimation for the level of pollutants was calculated according to coupled the CATT-BRAMS Model by CPTEC/INPE, and hospitalization and mortality rates due to respiratory diseases (RD), among individuals of age groups younger than five years old, and 65 years and older flattening by Bayesian local empiric method. The data was plotted by Kernel technical to show up the “hot areas” of indicators analyzed. The database was applied to the 807 municipalities, and compared with 107 geographical micro region that aggregate many municipalities of the Brazilian Amazon. The database was regarding the year of 2005 that presented a long dry season.

**Results:** It was verified that the associations between the indicator of hospitalization rates and of mortality by RD are important when the analyses take for unit the geographical micro region, even after flattening by Bayesian local empiric method. The biggest rates of hospitalization and mortality by RD occurred in areas in direction to the southeast from those with the biggest percentages of critical hours of  $PM_{2.5}$ , in  $80\mu g$  for the States of Mato Grosso, Rondônia and Acre. This behavior was not observed to the States of Pará and Maranhão at the east border of the Amazon.

**Conclusion:** The priority areas to establishment sentinel monitoring the RD by atmospheric pollution is mainly at the states of Mato Grosso and Rondônia. It looks like coherent with the direction to dispersion the smoke of the deforestation.

#### ISEE-1629

#### Knowledge about Universal Precautions in Medical Interns of Nepal and How They Response the Occupational Accidents

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**Background and Aim:** Medical students are vulnerable to occupational accidents with body fluids, droplets, needles and other cutting devices because of their inexperience and lack of training despite their desire to do a lot. There is some information in our country regarding the frequency of such accidents in medical interns. The aim of the present study was to study the frequency and type of occupational accidents suffered by medical interns and their knowledge about the universal precautions.

**Methods:** A cross-sectional study of all the medical interns working in healthcare centers around the country during 2006 Jan and 2007 Dec was performed. A randomized sample of 631 was selected (power 95%, error 5%) to this population as guided survey was applied. The survey consisted of 20 structured questions, most closed and three open, enquiring about the number of occupational accidents, types, what done at the moment and the knowledge of universal precautions.

**Results:** Of all the participants, 99% had been working at least 1-year rotation as medical interns (last year medical career), including medical, surgery, gyn & obst., pediatrics, and emergency unit. The sample included the community health camp by interns also. Only 83% of interns surveyed had received anti-HBV vaccination. 54% of them admitted, They had suffered at least one occupational accident with patient's exposure: 12% of these admitted had suffered occupational accidents with needles, 48% did nothing after accidents because they didn't know what should be done. Of total sample, 93% of the interns knew little or nothing about the universal precautions.

**Conclusion:** A very high proportion of medical interns in Nepal suffer risky occupational accidents including tuberculosis, eye infections and other incidents in their medical practices. Most of these young doctors do nothing to prevent themselves from occupational transmitted diseases,

mainly due to lack of knowledge. Their knowledge regarding universal precaution is poor, and their comment is that there should be training of safety management to all the medical professionals to prevent the chance of further infectious diseases (HIV, HepB, HepC, etc.) which is very urgent for poor developing countries like Nepal.

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**ISEE-1630****Accuracy of Automated and E911 Geocoding Methods for Rural Addresses**

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**Background:** Exposure assessment methods often involve the use of geocoded addresses. Automated geocoding methods are inexpensive and convenient, but they are often very inaccurate in U.S. rural areas. Another geocoding option relies on information from county-level E911 programs. In an effort to improve 911 emergency response times, readdressing projects have been completed throughout many rural areas to assign a valid physical street address to all residents that were previously only identified by post office/rural route boxes. This often results in the renumbering of entire streets to accommodate the influx of these new street assignments. The availability of E911 geocodes for exposure assessment will continue to increase as more rural communities undertake readdressing projects. This paper assesses the feasibility of applying E911 methods as a supplement to automated geocoding in a rural community study.

**Methods:** We compared automated and E911 geocoded addresses to GPS measurements to determine their accuracy. Our automated method matched addresses to street centerline files from the U.S. Census Bureau and a private commercial firm. The E911 geocodes were based on information provided by county officials. Residents are participants of a longitudinal rural community study with a valid GPS longitude and latitude measurement. We first applied automated methods to geocode the addresses. Any addresses that did not successfully geocode were then geocoded using E911 information provided by county officials for our rural study area. We measured accuracy by measuring distance between geocoded and GPS coordinates and by determining if the geocoded coordinate was in the correct census block.

**Results:** Of the 179 participants, we geocoded 70% using automated methods and 27% with E911 data, leaving only 3% that could not be geocoded. Automated geocoded addresses had a mean error of 855 meters and E911 geocoded addresses had a mean error of 47 meters when compared to the GPS coordinates. In addition, a higher proportion of E911 geocoded addresses were located in the correct census block compared to automated geocodes. However, the E911 geocoding took twice as much total person-time as the automated methods for far fewer addresses. Supplementing automated geocoding with E911 information increased our percent of successful geocodes from 70% to 97%.

**Conclusions:** Our analysis indicates E911 geocodes in this rural study area are very accurate. The accuracy of the automated geocodes is similar to what has been observed in other rural studies. One source of error is that GPS measurements were taken at the residence, while the geocoded data is for the location where the public road meets the private road. This results in higher errors for participants with long private driveways. Another source of error is that reference street files have outdated street information. The street addresses provided by the participants included both new and old addresses. Participants who reported their pre-E911 addresses are more likely to be geocoded using automated methods than participants who reported their new E911 addresses. Although E911 geocodes take longer, their accuracy suggests that all addresses should be geocoded with the E911 data rather than using it only as a supplement to automated geocoding.

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**ISEE-1632****A Simplified Steady State Modeling Approach for Estimating Benzo(A)Pyrene and Lead in Human Milk Resulting from Long Term Chronic Exposure to the Mother**

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**Background:** The Office of Environmental Health Hazard Assessment is currently revising the risk assessment guidance for estimating risks from airborne contaminants from stationary facilities in California under the Hot Spots program. Non-inhalation as well inhalation pathways are evaluated for some chemicals. A subset of these chemicals can potentially result in significant exposure via the mother's milk pathway. For example, PAHs and lead have been measured in breast milk. Models for estimating PAH and lead concentrations in breast milk after long term low level environmental exposures to the mother has not been available. Infants have an increased sensitivity to these toxicants relative to adults.

**Discussion:** A PAH model was derived from recent studies of individual PAHs measured in the breast milk of both nonsmoking and smoking women, the number of cigarettes smoked by smokers, the dose of individual PAHs per cigarette and the partitioning of PAHs from lungs to blood. Benzo(a)pyrene (BaP) was chosen as the PAH compound to model. The BaP model predicts that a chronic maternal dose of 1.0 mg/kg-body weight (BW)/day will result in 1 mg/kg-milk. Inorganic lead is known to accumulate in the bone, reach a steady state and then mobilize during pregnancy and lactation. A lead model was derived from measures of the absorption, tissue distribution, elimination and bone mobilization from both human and animal studies. The lead model predicts a concentration of 0.15 mg/kg-milk resulting from a 1.0 mg/kg-BW/day maternal dose. Each model assumes that steady state conditions exist from long term low level environmental exposures modeled in the Hot Spots program. This approach is similar to the approach used to measure cow's milk toxicant concentrations from feeding studies, although it is not clear in some studies that steady state has been reached. We are currently investigating the applicability of this approach to other chemicals.

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**ISEE-1633****Comparison of BTEX Concentrations from TCEQ Fixed Monitoring Sites and RIOPA-TX**

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**Background:** The US EPA regulates outdoor emissions of hazardous air pollutants (HAPs) because of their association with cancer or other deleterious health effects. These regulations have been based on data that are mostly collected at fixed monitoring sites. Concentrations of HAPs from these sites have been used as surrogates of personal concentrations to evaluate exposure and health risks. This method to assess exposure may not be a good indicator of population risk for several reasons, including the fact that people spend most of their time indoors, and building environments can change human exposure to HAPs.

**Methods:** We compared concentrations of HAPs that were collected at fixed monitoring sites and a personal assessment study in Houston, Texas. We used data from the Texas Commission on Environmental Quality (TCEQ) monitoring sites, which were generally located in close proximity to the Houston Ship Channel. We also utilized data from the Texas component of the Relationship of Indoor, Outdoor, and Personal Air (RIOPA-TX) study; where outdoor, indoor, and personal air samples were collected from 106 non-smoking residences that were mostly located in the vicinity of petrochemical facilities. We examined a subset of the HAPs from TCEQ and RIOPA-TX that tend to originate from vehicle

emissions and volatilization from gasoline: benzene, toluene, ethylbenzene, and xylenes (BTEX).

**Results and Discussion:** Results suggest that personal, indoor, and outdoor concentrations for BTEX were higher than those from the monitoring sites, but only personal and indoor measurements showed statistically significant differences ( $P < 0.05$ ). These discrepancies may be due to BTEX sources such as parked motor vehicles in residential garages and carports. These results indicate that regulations that aim to decrease human exposure to HAPs that only consider data from fixed monitoring sites are insufficient, and that these efforts could be improved with information on the immediate sources that influence personal exposure.

#### ISEE-1634

#### Integrated and Real-time PM<sub>2.5</sub> Concentrations in Kitchens, Bedrooms, and Outdoors in Highland Guatemala Using both Gravimetric and UCB Particle Monitor

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**Background:** Though indoor air pollution from solid fuel use is responsible for 2.6% of the total global burden of disease (DALYs) and causes between 1.5–2 million deaths each year, the exposure-response curve for particulate matter at high levels has yet to be characterized within a single population.

**Methods:** The Randomized Exposure Study of Pollution Indoors and Respiratory Effects (RESPIRE)—with a study population of 534 households from rural Highland Guatemala—provides a unique opportunity to study the long-term effects of high exposure to biomass smoke. We report in here fine particle results in three household microenvironments (kitchens, bedrooms, and outdoors) taken during our RESPIRE study spanning over a period of two years. 48-hr integrated particulate matters (both PM<sub>2.5</sub> and PM<sub>1.0</sub>) were measured using a portable battery operated SKC pump with a Triplex BGI cyclone and filter in all three microenvironments. Co-located with the gravimetric sampler in the kitchens, two continuous UCB Particle Monitors were utilized to measure real-time minute-by-minute fine particulate matter. These households were part of a randomized trial in which half of the households had been given improved woodstoves with chimneys and the other half continued to use open woodfires for cooking.

**Results:** For PM<sub>2.5</sub>, kitchen concentrations were  $1093 \pm 906 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 87$ ) in the open fire homes and  $81 \pm 181 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 57$ ) in the improved stove homes constituting a 93% reduction of particles in the improved stove homes ( $P = 8.53 \times 10^{-23}$ , 95%CI); bedroom concentrations were  $73 \pm 350 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 54$ ) in the open fire homes and  $26 \pm 48 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 45$ ) in the improved stove homes constituting a 64% reduction of particles in the improved stove homes ( $P = 0.296$ , 95%CI); and outdoor concentrations were  $44 \pm 31 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 4$ ) in the open fire homes and  $14 \pm 3 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 2$ ) in the improved stove homes constituting a 69% reduction of particles in the improved stove homes ( $P = 0.147$ , CI=95%). On the other hand, for PM<sub>1.0</sub>, kitchen concentrations were  $931 \pm 1490 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 121$ ) in the open fire homes and  $75 \pm 93 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 121$ ) in the improved stove homes constituting a 91% reduction of particles in the improved stove homes ( $P = 9.50 \times 10^{-7}$ , 95% CI); bedroom and outdoor concentrations did not show significant reduction of PM at the 95% confidence interval. Likewise, the UCB Particle Monitor showed mean 48-hr concentrations of  $107 \pm 90 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 55$ ) and  $855 \pm 754 \mu\text{g}\cdot\text{m}^{-3}$  ( $N = 59$ ) for improved-stove and open-fire kitchens, respectively.

**Conclusion:** The results demonstrate the potential reduction of particles by installing improved stoves in rural areas where solid fuel is being used for cooking.

#### ISEE-1635

#### Inhalation Exposure and Accessibility of Source in the Vicinity of Human Body

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**Background:** Inhalation exposure to indoor pollutant sources has been associated with public health problems. Specific health hazards related to the inhalation exposure include sick building syndrome symptoms, respiratory and cardiovascular diseases, and spread of infectious disease. Inhaled air quality for an indoor occupant depends on pollutant source position and distribution of airflow in a space. Accordingly, with the airflow in the space stabilized, pollutant source characteristics dominate level of human exposure. This study investigates the effect of source location in the vicinity of a human body on inhalation exposure. By applying source accessibility, a parameter describing how easily a contaminant reaches to a specific region, the study quantifies effect of source position on inhaled air quality.

**Methods:** Numerical experiments were conducted to examine contributions of seven different source locations around a human body to inhaled pollutant concentration. Computational Fluid Dynamics model simulated airflow and pollutant transports around a virtual manikin, which generates 70W of heat flux. To simulate a residential room, in which the mechanical ventilation system is off and only infiltration is present, cold supply air with low speed was used as a boundary condition. Under this circumstance, the airflow in the space was driven primarily by buoyancy from the manikin's heat. Using a steady-state injection of gaseous and particulate pollutants, non-uniform pollutant distributions around the manikin were monitored for each source location. Based on the inhaled concentration data, source accessibility to the breathing zone of the manikin was calculated.

**Results and Discussion:** The results show that for inhalation exposure source accessibility is larger with sources close to floor than with those in upper level. The high contribution of floor source to exposure is likely due to the buoyant airflow around the manikin transporting pollutant close to floor to upper breathing zone. This result implies that floor sources such as particles re-suspended from floor or off-gassing from carpet materials can contribute to high levels of inhalation exposure in residential environments. The results also showed that airflow direction with respect to an occupant also affects the source accessibility. However, given that a stratified flow associated with buoyancy was dominant throughout the simulations, the impact of airflow direction was generally smaller than that of source position.

#### ISEE-1636

#### Biomarkers of Inflammation and Antioxidant Activity, and Exposure to Indoor and Outdoor Home Air Pollution in Elderly People with Coronary Artery Disease

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**Background:** Ambient measurements of air pollution have been associated with hospitalization and mortality from cardiovascular causes. Mechanisms involving oxidative stress and inflammation have been proposed. Circulating biomarkers of inflammation and thrombosis have

been associated with ambient air pollutants, but here is less data on antioxidant enzymes. Particles with potentially the greatest impact on systemic cardiovascular responses are in the ultrafine range <0.1  $\mu\text{m}$  in diameter, found in high concentration near sources of fossil fuel combustion.

**Hypothesis:** Biomarkers of systemic inflammation will be positively associated with quasi-ultrafine particulate matter <0.25  $\mu\text{m}$  in diameter ( $\text{PM}_{0.25}$ ), total particle number (PN) concentration, and markers of combustion-related pollutants, including elemental carbon (EC). Furthermore, associations for predicted indoor exposure to particles of outdoor origin will be stronger than associations for unadjusted indoor exposures.

**Methods:** We conducted a study involving 12 repeated measurements of air pollutant exposures and circulating biomarkers in 61 subjects ages  $\geq 65$  years with a history of coronary artery disease living in four retirement communities within the Los Angeles air basin. Biomarkers of inflammation from blood samples included plasma interleukin-6 (IL-6), tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) and its receptor (TNF-RII), platelet selectin, C-reactive protein (CRP); biomarkers of erythrocyte antioxidant activity included glutathione peroxidase-1 (GPx-1) and copper, zinc-superoxide dismutase (Cu,Zn-SOD). Exposures included indoor and outdoor home daily size-fractionated particle mass ( $\text{PM}_{0.25}$ ,  $\text{PM}_{0.25-2.5}$  and  $\text{PM}_{2.5-10}$ ), and hourly EC, black carbon (BC), PN, CO, and  $\text{NO}_x$ - $\text{NO}_2$ . We used estimated air exchange rates, infiltration factors, and hourly pollutants in a single compartment mass balance model to assess contributions of indoor and outdoor sources to measured indoor EC and PN. We analyzed data with linear mixed effects models with subject random effects nested within study period and community, and adjusted for temperature, community and season.

**Results:** We found positive associations of IL-6, sTNF-RII, and CRP with lag 0 and multi-day averages of outdoor and indoor concentrations of EC, BC, PN, CO and  $\text{NO}_x$ - $\text{NO}_2$ , and with outdoor  $\text{PM}_{0.25}$ . There were weaker or no associations for  $\text{PM}_{0.25-2.5}$  and  $\text{PM}_{2.5-10}$ . We found decreases in Cu,Zn-SOD and GPx-1 and increases in platelet selectin (if not taking Clopidogrel) for the same exposures plus  $\text{PM}_{0.25-2.5}$  and  $\text{PM}_{2.5-10}$ . For most biomarkers, we found stronger associations for indoor EC or PN of outdoor origin than for unadjusted indoor exposures. For an interquartile increase in 7-day average unadjusted indoor EC (0.68  $\mu\text{g}/\text{m}^3$ ) and 3-day average unadjusted indoor PN (8349 particles/cm $^3$ ), IL-6 increased by 0.34 pg/mL (95% CI: -0.04, 0.74) and by 0.29 pg/mL (95% CI: 0.03, 0.56), respectively. In comparison, for indoor EC of outdoor origin (0.50  $\mu\text{g}/\text{m}^3$ ) and indoor PN of outdoor origin (6407 particles/cm $^3$ ), IL-6 increased by 0.58 pg/mL (95% CI: 0.16, 1.01) and 0.56 pg/mL (95% CI: 0.04, 1.07), respectively.

**Conclusions:** Outdoor traffic emission sources of air pollution including quasi-ultrafine particles and related PN lead to increased biomarkers of inflammation in plasma and decreased erythrocyte antioxidant enzyme activity in elderly people with coronary artery disease. Stronger associations for indoor exposures of outdoor origin support the view that personal exposures to outdoor source particles are responsible for associations.

#### ISEE-1637

##### VOCs in Indoor Air of New California Homes, Garages, and Vehicles

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**Background:** Exposure to volatile organic compounds (VOCs) in indoor environments is a major concern because newer California homes are built tighter in order to conserve energy. Thus, they experience less leakage, which can lead to lower indoor-outdoor air exchange rates. New cars also are built tighter and have shown reduced air exchange rates.

**Methods:** To examine the implications of tighter homes, ARB obtained measurements of 60 VOCs in 24 homes as part of a larger study that aims

to characterize ventilation and indoor air quality (IAQ) in 108 new California homes. The VOC study placed a special emphasis on acrylonitrile (ACN), a potent carcinogen, which ARB has identified in California's ambient air. In order to obtain 24-hour integrated measurements of the 60 VOCs, 6-L Summa canisters were deployed in the living spaces and garages of the homes and in 14 outdoor locations near the homes. In addition, canisters were placed in five ARB employees' newer automobiles and in two of their garages. The canister samples were all analyzed by GC/MS, and an additional sample was taken from each canister and was analyzed for ACN by GC/MS using MS SIM (Single Ion Monitoring).

**Results:** The results showed that concentrations of benzene and toluene met or exceeded their respective Chronic Reference Exposure Levels (CRELs; guideline levels for avoiding health impacts from long-term exposures) in two garages. Several compounds were present in sufficient concentrations to exceed the Proposition 65 No Significant Risk Level (NSRL; one excess cancer in 100,000 people exposed for a lifetime) in some or all of the homes. These were 1,4-dichlorobenzene, acrylonitrile, benzene, bromo(dichloro)methane, chloroform, methylene chloride, tetrachloroethene, and toluene. With the exception of bromo(dichloro)methane, all of these chemicals, along with trichloroethene, were also present in sufficient concentrations to exceed the NSRL in some or all of the garages. ACN was detected in six of the new homes, one garage, and one vehicle at concentrations below the reporting limit. ACN concentrations exceeded the reporting limit in one garage (0.86 ppbv) and in four of the five vehicles where concentrations ranged from 0.50 to 1.4 ppbv.

**Conclusions:** These results indicate that individuals living in new California homes may be exposed to some VOCs at concentrations that may pose a health risk from long-term exposure. Furthermore, vehicles appear to be a significant source of ACN emissions, and may be the primary source of most people's exposure to ACN. However, due to the small sample size of this study, the results should be interpreted with caution, and further sampling is warranted.

#### ISEE-1638

##### Age of Air as an Indicator of Exposure to Particles

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**Background:** Recent studies have indicated association between particulate air pollution and respiratory and cardiovascular diseases. Since people spend most of their time in building environments, indoor particle sources could contribute to elevated human exposure to particles. In order to design healthy indoor environments and minimize occupant exposure to particles, architects and engineers need to understand how particulate pollutants distribute in an occupied space and in the vicinity of a human body.

**Objective:** The objective of this study is to investigate whether age of air (the time elapsed from the moment air enters a space to when it reaches a specific location) can be used as an indicator of human exposure to indoor particulate matter.

**Methods:** Experiments and Computational Fluid Dynamics (CFD) modeling were used to correlate age of air and indoor particle concentration through a three-phase approach. In the first phase, experiments were conducted to monitor airflow and size-resolved particle concentrations in a test house with partition walls. During the experiments, heat sources were distributed in the house to produce airflows typical of indoor environments. In the second phase, the experimental conditions were simulated with CFD. In this phase the results from the experiments were used to adjust the CFD parameters that affect the accuracy of the CFD results. In the third phase, the validated CFD model was used to produce data to correlate age of air and indoor particle concentration.

**Results and Discussion:** Preliminary experimental results showed spatial variation of particle concentration associated with non-uniform airflow

velocity. Age of air and particle concentrations vary with the location of heat sources, configuration of supply diffuser and exhaust, flow rate, and particle size. Generally, results indicate strong correlations between age of air and fine particles, and weaker correlations between age of air and coarse particles. The uncertainty of particle concentrations is relatively large in the vicinity of heat sources, which may be due to turbulence caused by thermal plume. These results imply that using age of air as an indicator of exposure to particles appears to be more applicable to mechanically ventilated spaces rather than in naturally ventilated environments. The results also suggest that ventilation effectiveness, which is calculated based on distribution of age of air, can help predict occupant exposure to particles during the building design phase.

#### ISEE-1639

##### Gene Expression-Based Biomarkers of Air Pollution Mixtures

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**Background:** The deciphering of the human genome gave birth to genomics technologies with widespread applications in medicine and public health. Whole genome toxicogenomics allows us to detect the cellular and biological processes modulated by exposure to xenobiotics and thus, infer potential health-related phenotypic responses and identify potential early biomarkers of health effects. The added value of the methodology rests on the possibility to explore all biological functions that can be modified by the toxicological insult. This capability enlarges the scope of health effect research to endpoints beyond the ones addressed by conventional epidemiology and toxicology. It is also a valuable tool for enhancing our understanding of the biological mechanisms underlying pathologic responses to chemical exposure.

**Methods:** In this study, whole DNA gene expression micro-array technology was used to investigate the definition of biomarkers of early biological events associated to chronic exposure to indoor and outdoor air mixtures and to their individual components following a toxicogenomics approach. Two types of mixture were selected including both polycyclic aromatic hydrocarbons (PAHs) characteristic of the ambient air in urban settings and VOCs commonly found in the ambient and indoor air across Europe. The volatile monoaromatic hydrocarbons benzene, toluene, ethylbenzene, and xylene (BTEX) comprised the VOC mixture studied. Environmental monitoring studies demonstrate significant differences in the mean exposure of the general population. Although exposure to PAHs and VOCs has been associated with health risks very little is known about the modulation of toxic responses by the exposure levels of BTEX and the variation in its composition. In this study we investigate the modulation of gene expression in vitro on human bronchoepithelial cells A549 and in vivo in the lungs of mice exposed intra tracheally to a PAH mixture and to two BTEX mixtures representative of European cities.

**Results:** Results from the in vitro studies demonstrated dose-response relationships for sub-toxic concentrations ranging from 10 ng to 10 µg/l. The most significant biological processes that characterize the cells treated with PAHs were processes related to cell motility and signal transduction between cells using extra cellular matrix proteins as the signal. Twenty modulated genes are involved in cell proliferation and differentiation. Two biological processes were significantly modulated by both the indoor air mixture and PAHs treatment: protein targeting and localization and cell structure. Overall, results show that there is much more biochemical activity regulated by indoor air chemicals than by PAHs.

**Discussion and Conclusions:** The gene expression pattern correlates to different ratios of benzene/toluene in the BTEX mixtures. Similar results were obtained from in vivo studies on mice at 24 hours following intra tracheal exposure. Increasing concentration of toluene was a major factor in modulating the expression of genes related to apoptosis, cell cycle control and proliferation, detoxification and inflammation. These results were confirmed by Quantitative PCR assays. On the basis of the

experimental results and bioinformatics data analysis, useful conclusions can be drawn on the appropriate methodological steps for using whole genome microarrays for the discovery of biomarkers of exposure to actual ambient and indoor air pollution mixtures.

#### ISEE-1640

##### Exposure Characterization and Health Risk of Volatile Organic Chemicals in the Indoor Air in Europe

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**Background:** Increasing worldwide concerns about climate change and security of energy supplies have heightened the need for energy conservation in dwellings and public buildings over the last ten years. At the same time, the scientific community progressively improves on its understanding of the link between indoor air quality and human health as more and more evidence on adverse health effects of indoor air toxicants is found. The WHO is considering the derivation of guidelines for indoor air pollution similar to the ones set for ambient air.

**Objectives:** The work presented in this paper provides a comprehensive collection of data on indoor air pollutant concentrations across Europe. This knowledge base comprises results obtained both from several years (2003–2008) of experimental campaigns across several European cities of variable size, topography and climatic features, and from a very comprehensive literature survey of all published information related to indoor air pollution in the continent. Our work had four distinct objectives as follows:

- 1) to identify and quantify the main air pollutants present in public buildings, including indoor environments where children frequently stay, like schools and kindergartens,
- 2) to identify the main sources of these pollutants applying source apportionment analyses,
- 3) to estimate people's exposure to these pollutants while working and/or remaining in these areas and combined with micro-environmental activity patterns during the day and
- 4) to evaluate possible health risks due to (chronic) exposure to air pollutants, in particular, for children.

The pollution values reported in this paper focus on volatile organic compounds (VOCs), carbonyls and particulate matter in the indoor and ambient air. In addition to environmental measurements, personal exposure concentrations of VOCs and carbonyls are reported based on measurement campaigns performed with the help of volunteers in several European countries.

**Results:** A review of health effects associated with indoor air contaminants was undertaken and its results are reported here. In addition to that, a case study on the health risk from indoor exposure to VOCs was completed using a biologically-based dose-response model to estimate the biologically effective dose of benzene and its metabolites in the presence of realistic mixtures of VOCs and the corresponding cancer and neurotoxicity risk after life-long exposure to the measured levels of VOCs for each city included in the study. Hierarchical modeling and Markov chain Monte Carlo based on priori distributions of key exposure and physiological parameters have been used to manage the uncertainties typically associated with these kinds of studies. This allowed us to estimate the health risk distribution curves for the population in each of the participating cities without an undue increase in uncertainty in the final risk estimate.

**Conclusions:** The results indicate that consistently indoor air pollution values are higher than the respective outdoor ones for the chemical families this study focused on. Differences attributable to variation in consumer behaviour, climate and type of building materials used, have been identified in the indoor:outdoor ratio of primary pollutants across

Europe. These differences account for small, yet significant, variance in the corresponding health risk to the local population across the EU.

#### ISEE-1641

#### Repeated Hospital Encounters for Children with Asthma and Traffic-Related Air Pollution in Orange County, California

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**Background:** A number of studies have indicated that repeated exacerbations of asthma in children are associated with short-term exposure to ambient air pollution. Hospital encounters for asthma (admissions or emergency department visits) have also been associated with short-term exposure to ambient air pollution in time series studies. There is less data on the relationship between repeated hospital encounters (admissions or emergency department visits) and traffic-related ambient air pollution near the homes of children. This is important because of the considerable spatial heterogeneity of potentially toxic pollutant components and ultrafine particles that are not represented by data from regional ambient monitoring sites.

**Objectives:** We aimed to estimate the association of individual exposures to local traffic-generated air pollution with repeated hospital encounters for children seen with a primary diagnosis of asthma or other lower respiratory illness (mainly acute bronchitis or pneumonia) with a secondary diagnosis of asthma.

**Methods:** Hospital records data for children ages 0–18 years were obtained from a retrospective hospital surveillance study for 2000–2003. Subjects lived in the catchment area of the two hospitals studied in metropolitan North Orange County, California. Subjects' residential addresses were geocoded using Tele Atlas geocoding service. We used a line source dispersion model (CALINE4) to estimate individual average exposures to local traffic-generated pollutants ( $\text{NO}_2$  and CO) longitudinally for each 6-month season (warm and cool) beginning with the first hospital encounter. Recurrent proportional hazard analysis was used to estimate the hazard ratio of exposure to traffic-related ambient air pollution adjusting for sex, age, health insurance, race-ethnicity, and season. Census block group socioeconomic variables were also tested (poverty and median family income), but did not affect estimates. We also tested differences in association by age group (0, 1–5, 6–18 years) and by sex.

**Results:** There were 3297 children with encounter data, of which 2489 children had one encounter and 817 had at least two encounters during the study period. Preschool children < 6 years old were 59% of the study population. Proportional hazards ratios for interquartile range increases of local traffic-related  $\text{NO}_2$  (2.2 ppb) and CO (96 ppb) were 1.26 (95% confidence interval (CI): 1.15, 1.38) and 1.55 (95% CI: 1.40, 1.71), respectively. We found a nominally stronger impact of traffic-related  $\text{NO}_2$  on hospital encounters for girls than for boys (product term  $P = 0.18$ ). Associations were generally similar and most significant across the age groups, including infants, pre-school children, and school children in whom the diagnosis of asthma is clearer.

**Conclusions:** Traffic-related  $\text{NO}_2$  and CO were associated with repeated hospital encounters for children with asthma, suggesting that locally-generated air pollution near the home affects asthma severity. We have some evidence that girls are more sensitive to traffic-related pollutants than boys are. The diagnosis of asthma before the age of 6 can be difficult. Therefore, our findings require confirmation with clinical follow-up of these subjects. Nevertheless, results suggest that in this younger group, traffic-related air pollution near the home is related to repeated

hospital encounters for respiratory illnesses that can increase risk for asthma in later childhood.

#### ISEE-1643

#### An Integrated Exposure and Risk Model for Benzene in the Ambient Air

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**Background and Methods:** The scope of the present study was the development of an integrated model of exposure to ambient air benzene, going from emissions up to estimation of the associated health risk. A set of modeling modules was developed and implemented, including traffic emission models, dispersion models, multiple regression exposure models and finally a biology based dose-response model. The environmental data required for model development and evaluation were collected from a medium-sized Southeastern European city. The field campaign included ambient air monitoring and personal exposure measurements to general population and the occupational groups of traffic policemen gasoline station employees and taxi drivers with both passive and active sampling in several microenvironments, as well as meteorological and traffic data.

**Results:** The results indicated that ambient benzene concentrations vary from 6 to  $21 \mu\text{g}/\text{m}^3$ , with an average value of  $9.2 \mu\text{g}/\text{m}^3$ . Benzene concentrations depend strongly on traffic congestion, street canyons, and calm wind conditions. The importance of these parameters was further evaluated by measurements and computational models. Personal exposure values for the general population ranged from 4.3 to  $19.7 \mu\text{g}/\text{m}^3$ . The importance of the parameters that control the exposure levels to the general population were accessed through statistical analysis of detailed daily activity-time diaries and active sampling measurements. Indoor exposure to benzene is in general lower to outdoor, indicating that traffic is the dominant source of benzene emissions in the area, compounded by environmental tobacco smoke in indoor environments. A regression model for population exposure based on active sampling results was applied on passive sampling with very good agreement. The occupational groups were exposed to benzene during the work shift 2 to 3 times more than the general population. Risk evaluation due to benzene exposure was assessed by a physiology-based toxicokinetic-based risk assessment model, indicating that non-smoking population runs a leukemia risk equal to  $2.8 \times 10^{-5}$ , which increases by up to 2 times under specific activity patterns, compared to  $5.7 \times 10^{-5}$  for smokers. The estimated lifetime risk of leukemia for the occupational groups was increased by 10–20%. Active smoking constitutes a dominant parameter for leukemia risk due to benzene exposure, much stronger than any related activity, occupational or not. Bayesian statistics and Monte Carlo simulation are used to estimate and manage the associated uncertainty. Finally, due to the dominant contribution of traffic emissions to the exposure pattern, several "what if" scenarios were tested in order to estimate the effects of traffic fleet changes to the corresponding health implications. In the best-case scenario, a factor of 55–72% risk elimination was calculated for the non-smoking population compared to 8% for smokers.

**Conclusions:** This paper highlights the different methodological steps necessary for reliable exposure and health risk estimation for ambient air benzene in urban settings. The build-up and use of exposure scenarios allowed us to develop exposure and health risk management options and identify the most effective risk reduction strategies. The methodology described in the paper can be readily applied to any urban setting where a minimal set of environmental benzene measurements is available.

**ISEE-1645****Why Peaks Matter: Linking Asthma Attacks to Exposure Distributions**

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**Background:** Asthmatic responses are an acute narrowing of the airways in response to deposition of an airborne allergen or irritant in the airways. High intensity, short duration exposures are suspected of being most important for causing attacks. Attacks develop rapidly, within approximately minutes. Thus, it presents the exposure assessor with the very difficult problem of measuring the precipitating exposure. Requiring each subject to wear a personal, real-time monitor for particles or gases could provide the temporal resolution, but how sharply do asthmatics notice the onset of an attack? However, for an epidemiologic study that type of monitoring is not practical. Alternatively, average exposures of groups may be measured and compared to the average response rates. This can give us useful information about group risk, but interpretation is unclear because two groups can have the same mean with very different levels of high intensity exposures because their exposure distributions are very different.

**Objectives:** We propose an alternative approach using exposure distributions and hypotheses about logistic exposure relationships to formulate a dose metric. If we know the probability of an attack for a given exposure during a time interval and we know the probability of the exposure, then the product of those probabilities summed over the full range of exposures is the joint overall probability of an attack during that time period given the exposure distribution. This can be extended to a longer time period and probability relationships used to calculate the likelihood of at least one or more attacks.

**Methods:** Simulations have been conducted to determine how exposure distributions affect the probability of attacks. These were run using variations in measured ozone exposure distributions and observed logistic relationships for asthma in 12 communities in Los Angeles.

**Results:** We found that the overall attack risk is a strong function of the upper tail of the lognormal exposure distribution. We also explored the use of a community's observed ozone exposure distribution and its overall rate of attacks to develop a dose metric for a community that reflects its full exposure distribution. A community's annual asthma attack rate, mean exposure, and regional baseline rate of asthma attacks can be used to define a provisional logistic relationship. Then, this can be used with the measured exposure distribution obtained during a study period to calculate a joint probability for attacks during the same time period. This probability can be used as a dose metric, which is a number that is proportional to the true risk given the exposure. However, since this dose metric is not calculated from the true logistic relationship it is not a direct estimate of the exposure risk relationship, but is expected to be proportional. The dose metric can be regressed against the observed number of attacks during the period to determine the strength of the relationship. An example of this application shows that this approach can be used for analysis and that it is sensitive to changes in the upper tail of the exposure distribution.

**ISEE-1649****Association of Indoor Smoking and PM<sub>2.5</sub> Level in Public Places, Seoul Korea**

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**Background:** Secondhand smoke (SHS) is a major source of indoor air pollution. SHS contains a complex mixture of more than 4,000 chemicals and 50 cancer-causing agents. There is no safe level of exposure to SHS. Korea does not have comprehensive indoor smoke-free policy, although hospitals, day-care centers, kindergartens as well as elementary, middle

and high schools are designated as "smoke-free buildings". Limited information of the extent of SHS exposure in Seoul public places is available.

**Objectives:** The purpose of this study was to assess the impact of SHS in public places in Seoul, Korea, on indoor particulate matter with 2.5 μm aerodynamic diameter or smaller (PM<sub>2.5</sub>).

**Methods:** Indoor PM<sub>2.5</sub> level was measured using an aerosol spectrometer (Sidepak Model AM510, TSI Inc). Purposive sampling was used to identify the venues that allowed smoking. Indoor air quality was measured in 40 public places, including 8 restaurants, 10 cafes, 6 pub/bars, 10 billiard halls and 6 PC rooms. A central location of the venue was chosen and the direct puffs of smokers were avoided. The monitoring was continued for at least 40 minutes each place in the busiest business hours in Friday and Saturday, from December 2007 to March 2008. Outdoor level was measured to confirm no significant outdoor sources. Information on room size, number of person and number of burning cigarettes was collected.

**Results:** Average size of the public places was 231.2 m<sup>3</sup>. Average number of people was 19 and average burning cigarette was 2.9. The mean of PM<sub>2.5</sub> concentrations in the 40 places was 165 μg/m<sup>3</sup>, which was more than 4 times higher than the US National Ambient Air Quality Standard for 24 hours (35 μg/m<sup>3</sup>). The average indoor PM<sub>2.5</sub> concentration in 3 venues with no smoking was 24 μg/m<sup>3</sup>. When indoor smoking was observed in 37 places, indoor PM<sub>2.5</sub> concentrations ranged from 33 to 881 μg/m<sup>3</sup>, with a mean of 177 μg/m<sup>3</sup>. Among the 37 smoking places, indoor PM<sub>2.5</sub> concentrations were 84 μg/m<sup>3</sup> in 6 restaurants, 144 μg/m<sup>3</sup> in 9 cafes, 108 μg/m<sup>3</sup> in 6 pub/bars, 173 μg/m<sup>3</sup> in 10 billiard halls, and 392 μg/m<sup>3</sup> in 6 PC rooms. Smoking density was calculated by average number of burning cigarettes (bc) per 100 m<sup>3</sup> of indoor volume. Average smoking density in the 40 venues was 3.4 #bc/100 m<sup>3</sup>, ranging from 0 to 39.5 #bc/100 m<sup>3</sup>. Indoor PM<sub>2.5</sub> level was significantly associated with smoking density. When smoking density was less than 1 #bc/100 m<sup>3</sup>, indoor PM<sub>2.5</sub> concentration was 92 μg/m<sup>3</sup>. Indoor PM<sub>2.5</sub> concentrations were 147 μg/m<sup>3</sup> and 241 μg/m<sup>3</sup> when smoking densities were 1–2 #bc/100 m<sup>3</sup> and greater than 2 #bc/100 m<sup>3</sup>, respectively.

**Conclusions:** SHS can cause significantly higher indoor fine particle concentrations in Seoul public places. Reduction of exposure to SHS in public places is important for public health. The findings support the need for indoor smoke-free laws in Korea to improve indoor air quality in all public places.

**ISEE-1653****Between-Community Comparisons of Housing Characteristics and Location-Time-Activity Patterns of Elderly Participants in the Cardiovascular Health Study**

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**Background:** The National Heart, Lung, Blood Institutes' Cardiovascular Health Study (CHS), initiated in 1989, is a population-based longitudinal (prospective) study of coronary heart disease and stroke among elderly residents of four U.S. counties. In an CHS ancillary study to assess the impacts of air pollution and other environmental exposures on clinical measures of cardiovascular and respiratory health, an exposure assessment questionnaire (EAQ) was administered to participants in three Field Centers (FC).

**Objective:** To define between-community differences in potential exposure modifiers and confounders, and to enhance retrospective assessment of individual-level long-term (years) exposures to air pollution (particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and sulfur dioxide (SO<sub>2</sub>)).

**Methods:** The main EAQ was developed for CHS participants to self-administer at home and complete within 30 minutes. Questions ascertained residence information, housing characteristics, and patterns of usual activities. In 2000, with the exception of those who were known by local CHS FC staff to be too ill, or who had declined participation in ancillary studies, all active participants in Sacramento County, California, Forsyth County (Winston-Salem area), North Carolina, and Allegheny County (Pittsburgh), Pennsylvania were invited to participate. The questionnaire, a cover letter from the CHS FC principal investigator, and a postage-paid return envelope was mailed to each current participant ( $n \sim 3000$ ) in each of two seasonal periods (winter/spring, summer/fall). Non-respondents were contacted by telephone and at that time asked a subset of the questions contained in the main questionnaire.

**Results:** Although not optimum, a reasonably good response rate was achieved with the winter administration: 54% ( $n = 574$ ) in Forsyth, 52% ( $n = 658$ ) in Sacramento, and 47% ( $n = 509$ ) in Allegheny. An additional 10% from each County completed the telephone-administered questionnaire. Approximately 80% of winter respondents also completed the summer questionnaire. Statistically significant between-community differences in a number of exposure-modifying factors were observed. For example, distance of primary residence to a roadway differed ( $P < 0.01$ ): In Pittsburgh, Forsyth and Sacramento Counties, 54%, 30%, and 22% of the respondents, respectively, indicated their residence was either in immediate proximity to a busy street or within a block of a busy street. Proximity to a busy street was not related to income bracket. The proportion of homes with gas appliances, which are an indoor source of both  $\text{NO}_2$  and PM, differed ( $P < 0.01$ ) among the three communities: the proportion of participants with a gas stove or oven was greatest in Allegheny (46%), while Forsyth had the lowest (11%). The total amount of time a gas stove was used, and frequency of use, did not differ by gender within a given community. Relatively few respondents (<8%) reported that they, someone living with them, or someone who visited them regularly, smoked inside their residence. Activity patterns, including the type, time of day and location of activities also varied by community, by gender and income bracket.

**Discussion & Conclusion:** The observed between-community and within-community differences in factors that can modify exposures to pollutants have important implications for both analytic strategies and interpretation of results from studies involving multiple communities.

#### ISEE-1655

#### A Situational Residential Chlorpyrifos Biomonitoring Study: Excessive Exposure Triggered by Intensive Activity and Previously Unstudied Floor Coverings

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#### Study A

**Methods:** Six total release chlorpyrifos foggers were used by residents of a wood frame residence in Fresno, CA in June 1997. A situational (opportunistic) urine biomonitoring of the family of four including two children aged 6 and 8 years-of-age produced remarkably greater TCPy equivalents excreted in urine than in previous studies. No adverse effects or signs of toxicity were reported or revealed during follow-up medical examination. Prefogging urine specimens from each family member 5 times during a 4 week period contained 0.06 to 1.6  $\mu\text{g}$  equivalents chlorpyrifos/kg-day based upon 3,4,5-trichloro-2-pyridinol (TCPy; uncorrected). The residence was fogged on 6/28 and the family left for the day (Saturday). Morning urine specimens were provided the next 4 days.

**Results:** Elevated TCPy levels were seen in each family member within one day. The father excreted 3-times more than his wife (2.0 to 30  $\mu\text{g}$  eq./kg-d). The children excreted more than 20 times more than their mother, who resided indoors for the same time as the children. The 8-

year-old excreted 32, 142, 158, and 262  $\mu\text{g}$  eq./kg-d on days the 4 successive mornings after fogging. The children were extremely active and their play was restricted to indoor activities due to extreme heat most of the day. Indoor surfaces that included wood, tile, and berber carpet were also thought to have contributed to greater exposure than nylon carpeting present in all previous homes where our fogging research had been conducted.

#### Study B

**Methods:** Subsequent studies using an ACE Indoor Fogger (EPA Reg. No. 9688-63, contains 0.50% chlorpyrifos) that was discharged following label instructions in a 6 m  $\times$  4.7 m  $\times$  2.5 m room. The fogger was placed in the middle of the room. The total chlorpyrifos applied in this room was 0.84 gram. Five types of floor covering including nylon carpet, berber carpet, linoleum, tile and wood were laid out as a circle with a radius of 1.2 m. Foil coupons were placed at 0.4, 1.2 and 2.1 m from the fogger. Transferable residues for each flooring were measured after 2, 24, 48 and 192 h using an Automated Surface Wipe (ASW). (ASW is a new transferable residue measurement developed by PCEP). Flooring coupons were simultaneously collected for total surface residue measurement. California roller measurements of transferable residue were used for nylon and berber carpet. More chlorpyrifos was deposited close to the fogger as observed in other studies.

**Results:** The transferability of surface chlorpyrifos residues over the total study period was as follows: tile  $\approx$  wood  $>$  linoleum  $>$  nylon carpet  $\approx$  berber carpet. The transferability of chlorpyrifos residues from other flooring in addition to nylon and the intensity of children's indoor activity at Fresno likely contributed to their excessive absorption and excretion of chlorpyrifos equivalents in this unusual 1997 study.

**Discussion:** The results of the chlorpyrifos monitoring were reported to the USEPA and to Dow Agro Sciences as an Adverse Effects Report FIFRA 6(a) (2) in August 1997 and remained unexplained until similar findings were made in support of recent pyrethroid monitoring (Keenan and Krieger, in manuscript).

#### ISEE-1656

#### The Relationship Between Ambient Air Pollutants and Early Children's Neurobehavioral Development

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**Background:** It is widely acclaimed that air pollution can cause adverse health effects. However, the impact of air pollution exposure on neurobehavioral development in children remains unclear. This study was aimed to investigate the relationship between the ambient air pollution during prenatal and postnatal stages and early childhood neurobehavioral development.

**Methods:** We recruited 533 mother-infant pairs from 11 towns in Taiwan from November to December, 2003. All study mothers were requested to complete the childhood neurobehavioral development scales when their children were at the ages of 6 months and 18 months, respectively. The nearby stations of the Taiwan air quality monitoring network provided the hourly ambient concentrations of sulfur dioxide, carbon monoxide, ozone, particulate matter  $\leq 10 \mu\text{m}$  in aerodynamic diameter, nitrogen dioxide, and total and nonmethane hydrocarbons. We used multilevel analysis to assess the association between early childhood neurobehavioral development and average exposure levels of air pollutants at three trimesters during pregnancy and children at the ages of 0 to 6, 7 to 12, and 13 to 18 months, respectively.

**Results:** We found that lower gross motor score at the age of six months was associated with the average level of nonmethane hydrocarbons at the

second and third trimesters ( $\beta = -8.74$ , SE = 3.51). In addition, lower fine motor scores at the age of 18 months were associated with the average levels of exposure to sulfur dioxide during pregnancy ( $\beta = -0.08$ , SE = 0.03 for the first trimester;  $\beta = -0.11$ , SE = 0.05 for the second and third trimesters) and children from birth to the age before 12 months ( $\beta = -0.09$ , SE = 0.03).

**Conclusions:** This study provides evidence that ambient air pollution may be associated with poor neurobehavioral development in the early childhood. It warrants further research to elucidate the causal relationship.

#### ISSE-1657

#### Lifetime Environmental Exposure to Tobacco Smoke and Primary Lung Cancer of Non-Smoking Women in Developing Country

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**Background:** For a female population with a high lung cancer mortality rate, such as Nepalese women, who smoke relatively rarely but live in an environment with high male smoking prevalence, the risk and population burden of lung cancer due to environmental tobacco smoke (ETS) are relatively important.

**Methods:** An age-matched case-control study was designed to investigate the effects of cumulative environmental exposure to tobacco smoke during childhood and adult life on lung cancer risk among non-smoking women. Information on passive smoking from all possible sources and life periods were obtained from interviews with 268 and 445 lifetime non-smoking cases and controls. Conditional logistic regression and synergism 'S' index were applied to the data to assess the independent and joint effects of passive smoking in different life stages while controlling for possible confounding variables.

**Results:** Risks of contracting lung cancer among women near-distantly exposed to the highest level of ETS in childhood (>20 smoker-years) and in adult life (>40 smoker-years) were 1.8-fold (95% CI: 1.2–2.9) and 2.2-fold (95% CI: 1.4–3.7) higher than that among women never exposed to ETS, and the two variables accounted for about 37% of tumours in this non-smoking female population. Children were found to be more susceptible to ETS than adults, and such early exposure was found to modify the effect of subsequent tobacco smoke exposure in adult life based on an additive interaction model.

**Conclusions:** Environmental tobacco smoke exposure occurring in childhood potentiates the effect of high doses of exposure in adult life in determining the development of lung cancer. Smoking prohibition would be expected to protect about 37% of non-smoking women against lung cancer.

#### ISSE-1658

#### Possible Differences in Metabolism, Sources of Exposure, and Timing of Exposure for DDT-Related Compounds in Breast Cancer Cases Compared to Controls in the Child Health and Development Studies Cohort

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**Background:** We recently reported that women exposed to higher levels of *p,p'*-DDT at a young age (mean age of 26 years) had an increased risk of premenopausal breast cancer in a prospective nested case-control investigation (N = 129 case-control pairs, in the Child Health and Development Studies cohort). One feature of this study population is that DDT-related compounds were measured in serum samples collected in the 1960's before DDT was banned, and when women were actively acquiring their body burden of DDT.

**Methods:** Here, we explore differences in *p,p'*-DDT, *p,p'*-DDE and *o,p'*-DDT levels that may indicate differences in metabolism, exposure sources or exposure timing for cases compared to controls. During periods of

active exposure to commercial DDT, a higher ratio of serum *p,p'*-DDT to its primary metabolite, *p,p'*-DDE is a marker of recent exposure to the insecticide and/or a marker of delayed metabolism of past exposure. Serum levels of a third DDT-related compound, *o,p'*-DDT, can help distinguish between these two alternative explanations of variations in the *p,p'*-DDT to *p,p'*-DDE ratio in serum. *o,p'*-DDT is a low level contaminant of commercial DDT that is eliminated most rapidly, followed by *p,p'*-DDT and then *p,p'*-DDE.

**Results:** We found that women who remained free of breast cancer appeared to maintain a stable ratio of *p,p'*-DDT to its metabolite, *p,p'*-DDE, even when *o,p'*-DDT levels were high. In contrast, compared to controls, breast cancer cases showed an increasing proportion of *p,p'*-DDT as serum *o,p'*-DDT levels increased ( $P < 0.01$  for interaction).

**Discussion:** This result suggests that cases did not eliminate *p,p'*-DDT as fast as the controls, or that the sources of DDT exposure in the cases differed from sources for controls. Controls may have acquired more of their *p,p'*-DDE directly from foods high in animal fat where it accumulates. Wolff and colleagues have suggested that over time, accumulated of DDT-related compounds would be eliminated more slowly among those with higher body mass. Thus, the expected negative correlation between body mass and DDT concentration observed during periods of active accumulation could reverse as accumulation declines. Interestingly, the relation of *o,p'*-DDE or *p,p'*-DDT to body mass index differed significantly for breast cancer cases and controls; Only controls showed the expected inverse relation with body mass ( $P < 0.05$  for interactions). This result might indicate that the cases acquired a greater proportion of their body burden of DDT compounds in the past. This hypothesis is consistent with the higher levels of *o,p'*-DDT previously reported in controls, than in cases, in this population and would provide further support for the hypothesis that women who were exposed when young are at greatest risk. Our findings suggest that measurement of metabolites and their joint consideration in analyses, despite expected substantial correlations, is an essential feature of studying human effects of environmental chemical exposures.

#### ISSE-1659

#### Effectiveness of a CBPR Worksite Intervention to Reduce Occupational and Take-home Pesticide Exposures to Farmworkers and their Children

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**Background:** Occupational pesticide exposure can have health implications for both farmworkers and their children who may be exposed through "take home" of pesticides. To decrease pesticide exposures to farmworkers and their children, the Center for Children's Environmental Health Research at the University of California Berkeley and community partners in the Salinas Valley developed a multi-component worksite intervention including a system for supplying warm water and soap to field-based handwashing facilities and the provision of coveralls, gloves, and field-based education. We conducted a randomized controlled trial to assess the effectiveness of this intervention with 130 farmworkers at two strawberry farms in Monterey County, California. We measured the intervention's effect on changing farmworkers' exposure-related behaviors at and after work.

**Methods:** Farmworkers were randomized by work crew into either a group that received the intervention program or a control group that received a similar program after the trial. Farmworkers' behaviors were assessed before the worksite intervention commenced and after two months of the program via an interviewer-administered questionnaire. We

conducted field observations throughout implementation to assess worker behavior. Focus group discussions and interviews were carried out with farmworkers and farm staff to obtain in-depth feedback about the worksite program, barriers and facilitators of behaviors, and possibilities for sustainability.

**Results:** Farmworkers who received the worksite intervention demonstrated significantly greater improvements in glove and coverall use, wearing clean work clothes, and handwashing behaviors than those in the control group ( $P < 0.05$ ). Observed behavior concurred with self-report. The worksite program, however, was not successful in achieving statistically significant changes in all desired behaviors. For example, although the warm water system used in this intervention reduced cultural barriers to handwashing (i.e., the belief that the interaction of cold water and warm skin will result in illness), other barriers persisted. Using feedback from farmworkers, farm staff, and community partners, we will discuss some of these barriers and make recommendations for future intervention.

**Conclusions:** This worksite program offers a promising intervention for reducing both worker and take-home pesticide exposures. Additional efforts are needed, however, to test potential variations in the worksite program that may reduce barriers, to measure the intervention's impact on workers' and take-home pesticide exposures, and determine the best way to scale-up and sustain an effective program.

#### ISEE-1661

##### Avoiding Measurement Errors When Monitoring Fine and Ultrafine PM for Exposure and Epidemiology Studies

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**Background:** Recent attention has been focused on the association of fine and ultrafine PM and cardiovascular disease and premature mortality. These pollutants are now monitored in a growing number of epidemiology and personal exposure assessment studies in locations around the world. The monitors that are commonly employed are capable of displaying data on a real-time basis in many microenvironments and are easy to use. These include condensation particle counters (CPC) for ultrafine particle counts and nephelometers (Dustrak, Sidepak510, and DataRAM) for PM<sub>2.5</sub> mass data. Other portable monitors report number counts or mass derived from optical particle counters. However, each of these may report inaccurate data in common microenvironments of concern. Examples of instrument use that leads to inaccuracies include: 1) use of CPCs in high concentration locations such as traffic or combustion impacted situations where it is possible to under report particle counts by factors of 2-6, depending on equipment selected for monitoring; 2) use of nephelometers in urban settings to measure PM<sub>2.5</sub> mass may over report mass by factors of 2-3; 3) nephelometers operated in high humidity situations report values much in excess of PM mass from reference monitors; and 4) improper calibration and startup of nephelometers may lead to unpredictable errors in data quality.

**Discussion:** Failure to understand these instrument-specific and operational factors can result in data that grossly miss-estimates ambient concentration and exposure conditions. Exposure-response factors or effects estimates derived from such data will also be inaccurate, either over- or underestimating the risks these pollutants pose to human health. For the most part, it is not straightforward or even possible to correct data that has not been properly collected or collected by inappropriate monitors. In this talk the role of sampling practices and instrument selection will be shown to play key roles in producing quality data. Example data sets collected in problem microenvironments will be shown and discussed to demonstrate the factors that should be taken into account when selecting and using monitors. Actions that can be taken to avoid collection of inaccurate PM data will also be suggested.

#### ISEE-1662

##### LifeLine Aggregate and Cumulative Exposure Model: Advances in Predicting Residential Exposure from Multiple Pesticide Uses

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**Background and Discussion:** This poster accompanies the symposium: "State-of-the-Science Probabilistic Aggregate and Cumulative Residential Exposure Models and Recent Residential Exposure Measurement Studies: How the Data and Models Compare," This poster presents a detailed discussion regarding the underlying principles and approaches used in The LifeLine Exposure and Risk Assessment Software as it assesses non-dietary multiroute exposure resulting from the use of a pesticide in residential settings. The probabilistic estimate of the human exposure is compared to real-world monitoring data derived from these scenarios of pesticide use. The exposure model approaches are highlighted, including use of available data on human activity patterns, chemical concentrations in media contacted and the dynamics of interaction with those media, characteristics of the subject chemical and other exposure factors. The pesticide scenario is provided to multiple modelers and the results, as described in the poster will be compared and approaches considered in the oral presentations during the symposium.

#### ISEE-1664

##### The Asian Dust Events and Emergency Department Visits with Atopic Asthma in Seoul, Korea

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**Introduction:** The Korean peninsula has a long history of spring time dust clouds or storms blown from the arid deserts of Mongolia and China, and these are called Asian dust events. During the episode in 2002, daily average of PM<sub>10</sub> in Seoul exceeded 600 µg/m<sup>3</sup>. Accordingly, public concern about the possible adverse health effects of these dust events has increased, because the dust arrives in Korea after having flown over heavily industrialized eastern China. We investigated the association between the episodes of the Asian dust events and emergency department visits with atopic asthma in Seoul, Korea.

**Methods:** We obtained 671 emergency department visits due to atopic asthma (ICD-10 codes J45-J46) from the National Emergency Department Information System database in Seoul during the spring period of 2007. We used a generalized additive model analysis to assess the risk of emergency department visits in Asian dust events, controlling for time trends, meteorological variables (e.g. temperature, humidity), air pollutants (e.g. PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO, O<sub>3</sub>), pollen (e.g. trees, grasses, weeds, molds), and influenza epidemic.

**Results:** We found the estimated percentage increase in the rate of emergency department visits increased 9.4% (95% C.I. 4.7~25.5) for atopic asthma and 15.2% (95% C.I. -3.0~34.0) for visits of persons aged 65 years and older.

**Discussion:** We found that Asian dust events are associated with risk of emergency department visits due to atopic asthma. Moreover, the association between dust events and visits of persons aged 65 years and older was stronger. It suggests that persons with atopic asthma or aged may be susceptible to Asian dust events.

#### ISEE-1665

##### Childhood Asthma and Early Life Exposure to Air Pollution

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**Background:** Asthma prevalence has increased in recent decades, and environmental exposures are thought to be largely responsible, with early life exposures being especially important. Outdoor air pollution has consistently been identified as an asthma trigger, but it is unclear whether exposure influences incident of disease. Previous studies have not been conclusive but suggest that traffic-related pollutants in particular may increase risk of asthma. As part of the Border Air Quality Study, we investigated the effect of air pollution exposure in utero and during the first year of life on risk of asthma diagnosis in a population based birth-cohort.

**Methods:** The birth-cohort included all children born in Southwestern British Columbia in 1999 and 2000 (N = 37,401). Incidence of asthma diagnosis (defined as one hospital admission or two outpatient diagnoses of asthma) at age 3–4 years was assessed using hospitalization and outpatient records. We used a nested case-control design with each asthma case matched to five controls by sex and month of birth. Exposure to ambient air pollution was estimated using high-resolution pollution surfaces that were developed using measurements from government monitoring stations (CO, NO, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, O<sub>3</sub>, SO<sub>2</sub>) or land use regression models (NO, NO<sub>2</sub>, PM<sub>2.5</sub>, black carbon, wood smoke) adjusted for temporal variation. Logistic regression analyses were used to estimate effects of in utero and first year exposure to air pollutants and proximity to roads and point sources. Models were adjusted for birth weight, gestational period, socioeconomic status, breastfeeding, parity, and maternal age.

**Results:** Follow up data was available through 2003; during this time 3,482 children (9%) were classified as asthma cases. After matching to controls, a total of 20,892 children were included in the analysis. We found significantly increased asthma risks associated with exposure to CO, NO, NO<sub>2</sub>, PM<sub>10</sub>, SO<sub>2</sub>, black carbon and proximity to point sources. Traffic-related pollutants were associated with the highest risks: 1.08 (1.04–1.12) for a 10 µg/m<sup>3</sup> increase in NO, 1.12 (1.07–1.17) for a 10 µg/m<sup>3</sup> increase in NO<sub>2</sub>, and 1.10 (1.06–1.13) for a 100 µg/m<sup>3</sup> increase in CO. Effects were generally larger for first year exposures than in utero exposures and also larger for girls than boys. Sensitivity analyses showed that the results were robust to different administrative data definitions of asthma.

**Interpretation:** Despite relatively low levels of ambient air pollution in the study area, we observed an increase in risk of asthma diagnosis for children exposed to higher levels of air pollution in early life. First year exposures appear to be more important, but we cannot determine a specific sensitive period of exposure due to correlation of exposures and data limitations. As seen in previous studies, traffic-related pollutants appear to be the most important predictors. The results should be interpreted with some caution due to the difficulty of diagnosing asthma in young children.

#### ISEE-1666

#### The Effect of Maternal Lead Level on Fetal Growth and Pregnancy Outcome in MOCHE Study, Korea

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**Introduction:** A multi-center birth cohort study, the Mothers' and Children's Health and Environment (MOCHE) program was initiated in 2006 and plans to continue enrolling participants up to the year 2010, for assessing environmental exposure and its effect of mothers and their babies. One of the hypotheses is that maternal lead exposure can affect fetal growth and birth weight. Lead is widely spread in the environment and affects mainly central nervous system. Several studies showed that fetal exposure to low level of lead decreased birth weight. In this study, we aim to assess the associations of maternal blood lead level and its effect of fetal growth and pregnancy outcome.

**Method:** Pregnant women in their first trimester of pregnancy and their spouses were recruited from three collaborating centers in Seoul (metropolitan area), Ulsan (industrial area), and Cheonan (medium-sized urban area). Each center is a community-based collaborative network composed of university hospitals, local clinics, and community public health centers. Trained nurses interviewed the participants to record the following information. The participants were followed up until delivery. For fetal growth, we measured biparietal diameter, abdominal diameter, and femur length by ultrasonography. The gestational age was estimated by last menstrual period and ultrasound assessment. We performed multiple linear regression analyses to assess the associations of maternal lead level and its effects of fetal growth and pregnancy outcome after adjusting for maternal age, BMI, educational level, drinking alcohol, number of previous parity, and infant's gender.

**Result:** A total of 440 babies were born between August 2006 and February 2008. The mean age of mother was 32 years ( $\pm 3$ ). Of those, 37.7% had a job and 66.4% had 13 or more years of education. Women having a history of active smoking were 7.6% and 47.0% smoked passively at home. The mean weight of babies was 3261 g ( $\pm 429.54$ ) and the mean gestational age was 39 ( $\pm 1$ ) weeks. In the ultrasound assessment of third trimester, mean biparietal diameter, abdominal circumference, and femur length were 9.0 cm, 31.9 cm, and 6.9 cm respectively. The mean concentrations of lead in maternal blood during the first trimester and in cord blood were 1.54 (µg/l) and 1.01 (µg/l). Fetal femur length was significantly decreased ( $\beta = -0.08$ ,  $P = 0.009$ ) and biparietal diameter was marginally decreased ( $\beta = -0.09$ ,  $P = 0.06$ ) by maternal lead level after adjustment for gestational age and maternal height and weight. Birth weight was decreased by maternal lead level during first trimester ( $\beta = -105.76$ ,  $SE = 46.63$ ), after adjusting for maternal age, infant's gender, and drinking.

**Conclusion:** This study suggests that lead level during early pregnancy may contribute to the risks for retarded fetal growth and reduce birth weight as well. Therefore, prenatal and environmental education for various possible sources of environmental lead exposure might be necessary for babies' good health.

#### ISEE-1667

#### The Association Between Blood Cadmium, Lead, and Mercury Levels in the U.S. Population and Various Demographic Factors

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**Background:** Of late, biomonitoring has become an essential tool in assessing human exposure to environmental contaminants. Although occupational exposures have diminished with the use of personal protective equipment and established government guidelines, concerns about environmental exposures have increased recently. Utilizing data from the National Health and Nutrition Examination Survey (NHANES), we characterized concentrations of lead (Pb), total mercury (THg), and cadmium (Cd) for use as reference points in evaluating biomonitoring data. Additionally, we evaluated which characteristics had the largest effects on levels of these metals.

**Methods:** Serum levels of Pb, THg, and Cd and demographic data from the 2001–2002 and 2003–2004 NHANES cycles were combined into a single dataset and utilized in these analyses. Reference concentrations for

each metal were characterized by region and age, gender, race/ethnicity, or tobacco smoke exposure. The adjusted associations between various characteristics and levels of metals were evaluated for each metal independently using linear regression. The natural log of each metal was used as the dependent variable in all models.

**Results:** The overall geometric mean (GM) blood lead level for the U.S. population was  $1.43 \mu\text{g}/\text{dL}$  (95%CI: 1.39–1.49) while GM concentrations of total mercury and cadmium were  $0.33 \mu\text{g}/\text{L}$  (95%CI: 0.32–0.35) and  $0.78 \mu\text{g}/\text{L}$  (95%CI: 0.70–0.86), respectively. In general, concentrations of cadmium varied little across geographic regions regardless of subgroup whereas greater variation was observed in levels of lead and total mercury for the different regions. GM levels of blood cadmium, adjusted for tobacco smoke exposure, age, gender and race/ethnicity, were the highest for other Hispanic/multi-racial female smokers aged 70 years and older living in the West region and were the lowest for non-Hispanic white male children living in the South. For lead, the highest levels were observed in Mexican-American and non-Hispanic black male smokers 70 years and older residing in the Northeast. GM lead levels were the lowest in non-Hispanic white females 12–19 years living in the West, South or Midwest. For THg, non-smoking males of multi-racial/other Hispanic descent between the ages of 50 and 59 who resided in the West region had the highest concentrations whereas young female smokers of Mexican-American descent who resided in the Midwest had some of the lowest.

**Discussion:** Biomonitoring has progressively been employed by numerous industries, as well as government bodies, to evaluate exposure of populations to a wide range of environmental contaminants. Nevertheless, the cost-benefit of biomonitoring is only maximized if the data can be interpreted. To that extent, the descriptive statistics provided here should prove useful when assessing concentrations of lead, cadmium and total mercury in individuals or populations potentially exposed to these compounds. Furthermore, our results illustrate the need to consider the effects of various demographic characteristics in determining reference levels of these metals for the general population and are also useful in ascertaining which populations are at an increased risk of having elevated blood levels of these metals.

#### ISEE-1668

#### Effect of Air Pollution on Lung Function in Schoolchildren in Alta Floresta, Mato Grosso, Brazil

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**Objective:** The aim of this study is to evaluate the effect of air pollution (biomass burn) on lung function in schoolchildren (6–15 years old) who live in the county of Alta Floresta, Mato Grosso, Brazil.

**Methods:** This was a panel study that collected during 112 days (08/14/2006 a 12/03/2006) daily measurements of levels of  $\text{PM}_{2.5}$ , temperature ( $^{\circ}\text{C}$ ), humidity (%), peak expiratory flow (PEF) and respiratory symptoms of 309 children from the public school Rui Barbosa who were random selected for the study. These children had been submitted to the PEF exams daily, except on weekends and holidays, at the time they were studying. Each child had their own portable device and daily, three measures were collected sequentially but just the maximums were considered for the present study. To complement the PEF, children weekly took home a card for daily evaluation of respiratory symptoms like cough, itch in the ear and throat, nose draining, tearing and visit to the hospital. In this card, the child or its responsible party were to mark an "X" in the corresponding cell for the day of the week and respiratory symptom presented. Individual characteristics such as weight, height, gender and age were collected using a questionnaire that also included questions to identify the asthmatic child based on the "International Study

of Asthma and Allergies in Childhood" (ISAAC) instrument. The data analysis was based on a multilevel model where the exposure variable ( $\text{PM}_{2.5}$ ) and the meteorological variables (humidity and temperature) were considered first level units and the individual characteristics as second level units. The final basic model considered the temporal trend of the PEF measures, temperature and humidity with 2-days lags, adjusted for quadratic parametric spline with random effect in the model's parameters. Beyond the basic model three other models had been structuralized. Model 1 incorporates the basic model and individual characteristics of the child. Model 2 includes the basic model and symptoms respiratory variables with random effect in the model's parameters. Model 3 includes the basic model, Model 2, age of the child and asthma (asthmatic and non-asthmatic). The air pollution effect was evaluated in the four models estimated and it used the current day, 1-day, 2-day and 3-day lags and accumulates effect of 2-days and 3-days of air pollution levels. Moreover, these models were adjusted in three different moments: 1) for all 309 schoolchildren; 2) only for asthmatics children according ISAAC; 3) and only for non-asthmatics children according ISAAC.

**Results:** The models adjusted for all children showed a significant effect between the exposure variable and the lung function of the schoolchildren. Every  $10 \mu\text{g}/\text{m}^3$  increase of  $\text{PM}_{2.5}$  the PEF average decrease. Between the four adjusted models the decrease varied from 0.31 to 0.34 l/min for current day level of  $\text{PM}_{2.5}$  and from 0.18 to 0.21 l/min for the 2-days accumulates levels. Among the asthmatic children, for every  $10 \mu\text{g}/\text{m}^3$  increase of  $\text{PM}_{2.5}$  the PEF average also increase. On the other hand, among non-asthmatic children, for every  $10 \mu\text{g}/\text{m}^3$  increase of  $\text{PM}_{2.5}$  the PEF average decreased.

#### ISEE-1670

#### Air Pollution and Preterm Birth in Mexico City, Mexico (1992–2002)

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**Background:** Infants born prematurely are at higher risk for adverse developmental and health outcomes than infants born at term. Although the causes of prematurity are not definitively known, environmental exposures such as air pollution, in addition to individual clinical, behavioral, and socio-economic factors, may contribute to this outcome and present an important opportunity for preventive interventions.

**Objective:** We examined the associations between exposures to outdoor air pollutants, including particulate matter less than ten microns in aerodynamic diameter ( $\text{PM}_{10}$ ), ozone ( $\text{O}_3$ ), sulfur dioxide ( $\text{SO}_2$ ), nitrogen dioxide ( $\text{NO}_2$ ), carbon monoxide (CO), and preterm birth in Mexico City.

**Methods:** Data from mother-infant pairs enrolled in the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) study from 1992–2002 were analyzed. Women were excluded from the study if they lacked complete information on the following covariates: mother's age, years of education, marital status, smoking status during pregnancy (yes or no), parity, calf circumference, or previous adverse birth outcomes (defined as any previous stillborn, miscarried, preterm, or low birth weight infants). Daily pollutant averages from the metropolitan Mexico City air quality monitoring network were used to assign trimester-specific and full pregnancy exposure levels to the 807 women who met the study inclusion criteria. Of these women, 53 (6.6%) delivered preterm. We used a logistic regression model to evaluate the effect of an interquartile range increase in the estimated exposure on the likelihood of preterm birth, adjusting for potential confounding variables (see covariates listed above).

**Results:** Preliminary results demonstrate a significant increased risk in the likelihood of preterm birth associated with  $\text{O}_3$  exposure over the entire pregnancy (adjusted OR = 2.01; 95%CI = 1.09, 3.71; IQR = 0.01 ppm). We also found associations with  $\text{PM}_{10}$  (adjusted OR = 1.49; 95%CI =

0.98, 2.27; IQR = 1.49  $\mu\text{g}/\text{m}^3$ ) and  $\text{SO}_2$  (adjusted OR = 1.56; 95%CI = 0.96, 2.55; IQR = 0.02 ppm) during the first trimester, which are consistent with previously published studies.

**Conclusions:** These preliminary results, which adjust for many individual risk factors, show an association between  $\text{O}_3$  and increased risk of preterm birth and suggest an effect from  $\text{PM}_{10}$  and  $\text{SO}_2$ . The  $\text{PM}_{10}$  and  $\text{SO}_2$  associations we observed are consistent with other birth outcomes literature, while the  $\text{O}_3$  results are notable in that few other studies have reported associations with this oxidant pollutant, which is found at high levels in Mexico City.

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#### ISEE-1671

#### Prenatal Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) and Neurodevelopment at 1 Year of Age

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**Background:** PAHs are widespread ambient and indoor air combustion products from coal burning power plants, heating, cooking, and cigarette smoke. Previous work linked transplacental exposure to PAHs or PAH-DNA adducts on the metabolic pathway of PAHs to decrements in head circumference and birth weight, and impaired cognitive and motor development in childhood in our longitudinal cohort study in New York City (NYC). We also previously showed that prenatal exposure to PAHs significantly impairs fetal growth and the neurodevelopment of 6-month-old infants in an inner-city cohort study in Krakow (Poland), and suspect that subsequent neurodevelopmental outcomes will also be adversely affected in this highly exposed Caucasian cohort.

**Objective:** We explored the relationship between prenatal PAH exposure and the Mental Development Index (MDI) score (assessed using the Bayley Scales of Infant Development (BSID-II)).

**Methods:** Between November 2000 and December 2003, 505 non-smoking and otherwise healthy pregnant women were enrolled in Krakow. The participants provided demographic, health, and exposure information and carried air monitors for 48 hours in their second and/or third trimesters of pregnancy to report personal PAH exposure. We collected cord and maternal blood at delivery to measure cotinine (marker of exposure to environmental tobacco smoke (ETS)), PAH-DNA adduct levels, and plasma lead (Pb) concentrations, and assessed the development of the children at 1 year of age with MDI. Regression models included total PAHs ( $\ln$ ) transformed continuous, or dichotomized as high/low), maternal education, and gender of newborns. We examined MDI both as the continuous score, and dichotomously (score <85 corresponding to moderate delay, vs. normal at  $\geq 85$ ). We restricted the analyses by quality of PAH monitoring data ( $\text{QC} < 3$ ), and cotinine levels  $<25 \text{ ng}/\text{m}^3$ . Finally, we included lead (Pb), a known developmental toxicant and potentially important confounder, in our model.

**Results:** We found a significant adverse effect of PAHs on MDI score at age 1 year ( $\beta = -1.03$ ,  $P$ -value = 0.03). When dichotomizing MDI scores into delayed vs. non-delayed, the results were borderline significant. Including cord adducts in the model (neither cord nor maternal adduct levels alone were predictive of MDI at 1 year) did not change the effect size or significance of the association between PAH and MDI score at 1 year ( $\beta = -1.04$ ,  $P$ -value = 0.04,  $n = 326$ ), suggesting that the adverse effect of PAHs is not directly mediated by adducts, but by other mechanisms exerted by these pollutants. Including cord Pb in the model appeared to significantly confound the association between PAH exposure and MDI score.

**Conclusions:** This study shows that prenatal exposure to PAHs is detrimental to child neurodevelopment at age 1, and may be exerting its

effect via a different mode of action than previously hypothesized. These results differ from NYC cohort results, where prenatal PAHs were not observed to affect neurodevelopment until the children were aged 3. Our findings also suggest that cord Pb may be the major pollutant affecting the health of children in this population.

#### ISEE-1672

#### 2006 California Heat Wave High Death Toll: Insights Gained from Coroner's Reports and Meteorological Characteristics of Event

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**Background:** In July 2006, California experienced a heat wave of unprecedented magnitude and geographic extent—impacting the entire State. Coroners attributed 140 deaths to hyperthermia, and it has been estimated from vital statistics data that in excess of 600 heat-related deaths may have occurred over a 17-day period (July 14–30). Global warming has and will continue to increase the frequency and magnitude of extreme heat events extending their geographic breadth and placing more populations at risk. Furthermore, there is evidence that the character of heat waves in California is changing: they are progressively more often humid, consequently tending to remain hot through the night and last longer overall.

**Objectives:** (1) To evaluate case data from coroners' reports of hyperthermia deaths that occurred July 14 to 30, 2006, inclusive, in the context of individual risk factors and daily meteorological parameters. (2) To optimize public health intervention strategies to prevent heat-related mortality and morbidity.

**Methods:** Working with county and local coroners, data was compiled on 140 hyperthermia deaths to ascertain case demographics, co-morbidities, and zip code of residence, among other information. Regional indices of both maximum and minimum temperatures evaluated at 95 stations over California and Nevada were used to define, relative to local climate, the period and spatial extent of the heat wave. Locally, a heat wave was defined to occur when the 99th temperature percentile was exceeded.

**Results:** Meteorologically, the 2006 heat wave over California as a whole was significant between July 14–30 with the greatest spatial extent and regional magnitude concentrated between July 21–26. Nineteen counties reported at least one death; 80% of the cases were in seven counties, most of which were in the Central Valley—a region characterized by high summertime temperatures (e.g. Sacramento, in the northern Central Valley, experiences average summertime maximum temperature of 33°C/91°F and minimum temperature of 15°C/59°F. The corresponding 99%-ile thresholds of 42.2°C/108°F and 22.8°C/73°F, were exceeded for 3 consecutive days and 7 nights, respectively, with a nighttime peak temperature of 29°C/84°F and high humidity throughout the event). Of the 140 deaths, 126 were classified as “classic heat-stroke” (CHS) and 14 as “exertional heat stroke”. 66% of cases were male. The age distribution for Hispanic cases tended to younger age groups, compared to non-Hispanic cases; this difference could not be accounted for by occupational activities. 99% of cases lived in zip codes where > 50% of residents live below the poverty guide line. The majority of CHS cases were older adults, living alone, and had at least one chronic health condition (e.g., cardiovascular (47%) or pulmonary (7%) disease; psychiatric condition (23%) or alcohol abuse/dependence (17%)). Heat exposure occurred indoors in most cases. 13% of the CHS cases were determined to have functional air conditioners that had not been used.

**Discussion and Conclusion:** Case risk factors and unusual meteorological conditions during this event appear to have jointly contributed to the high death toll. Insights from this study can be

translated to public health actions that diminish risk of heat-related morbidity/mortality.

#### ISEE-1674

#### **Urinary Levels of Occupational Contaminants in the General U.S. Population: Cobalt, Thallium, Tungsten, and Uranium**

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**Introduction:** Human exposure to cobalt (Co), thallium (Tl), tungsten (Tu), and uranium (Ur) is primarily occupational. Although a biological exposure index has been established for Co, current reference values for Tl, Tu, and Ur have not been previously characterized in detail. Using the 2001–2002 and 2003–2004 NHANES data, we calculated reference statistics for each of the four metals and evaluated the demographic characteristics that had the greatest impact on levels of these metals in urine.

**Methods:** Demographic information and urinary concentration data for creatinine, cobalt, thallium, tungsten and uranium from the 2001–2002 and 2003–2004 NHANES surveys were combined into a single dataset and utilized in these analyses. All concentrations of metals were adjusted for urinary creatinine. Reference concentrations, including the geometric mean and various percentiles, were characterized for each metal by region and age, gender, race/ethnicity, or tobacco smoke exposure. Adjusted associations between the various factors and levels of metals were evaluated for each metal independently using linear regression. The natural log of cobalt, thallium, tungsten or uranium concentrations were used as the dependent variable in all regression models. All analyses were completed using SAS and SUDAAN software.

**Results:** The overall geometric mean (GM) levels of creatinine-adjusted urinary cobalt, thallium, tungsten, and uranium for the general, U.S. population were  $0.35 \mu\text{g/g}$  (95% CI: 0.33–0.36),  $0.16 \mu\text{g/g}$  (95% CI: 0.15–0.17),  $0.076 \mu\text{g/g}$  (95% CI: 0.071–0.081), and  $0.0081 \mu\text{g/g}$  (95% CI: 0.0074–0.0088), respectively. Generally, concentrations of cobalt and thallium varied little across geographic regions. For tungsten, some variation was observed among the different regions, but only concentrations of uranium varied significantly by region. Interestingly, adjusted GM levels of all four metals were considerably higher in young children (one to five years of age) and slightly higher in females and individuals living in the West region. For cobalt, tungsten and uranium, adjusted geometric mean concentrations were higher for smokers. While non-Hispanic blacks had lower levels of cobalt, thallium and uranium than non-Hispanic whites, Mexican Americans had higher levels of all four metals than non-Hispanic whites.

**Conclusion:** The National Health and Nutrition Examination Surveys provide a rich source of data with which to determine reference values for various compounds that may be encountered through occupational exposure. Additionally, the data is useful in evaluating which populations are at greatest risk of having elevated urinary concentrations of these compounds. In utilizing the NHANES data to determine referent values of these metals, we have provided needed information with which to compare results from biological monitoring studies of cobalt, thallium, tungsten, and uranium in potentially exposed individuals and populations.

#### ISEE-1675

#### **Effect of Environmental Factors and Maternal Mercury Level on Birth Weight Using a Structural Equation Model (SEM)**

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**Background:** Previous studies have investigated that the relationship between maternal mercury level and birth weight. The aim of the study was to investigate the effect of maternal mercury level on birth weight. Also, we examined the relationship among environmental factors, mercury level, and birth weight using a structural equation model.

**Methods:** The collaborating multi-centers, Seoul (metropolitan area), Ulsan (industrial area), and Cheonan (medium-sized urban area), for a prospective cohort study of Mothers and Children's Health and Environment (MOCHE) have been built up in 2006, and we enrolled 770 women before their second trimester of their pregnancy along with their spouses in 2006–2007. A trained nurse interviewed participants to record general information on demographic and socioeconomic factors, medical history, complications of current gestation, health behaviors, and environmental factors. We collected blood and urine samples to measure biomarkers for environmental exposures including heavy metals. We used the atomic absorption spectrophotometer to measure mercury level in blood. Because of skewed data, we changed the maternal mercury level by log-transformation. A structural equation model described the sequential relationships among environmental factors, mercury level and birth weight. Model fitting was assessed by various indices, such as chi-square,  $\chi^2/\text{df}$ , Root mean square error of approximation (RMSEA), Tucker-Lewis index(TLI), and normed fit index(NFI). In these models, observed variables are considered manifestations of a limited number of causally related latent variables, so this approach is useful for analyzing multidimensional epidemiologic data. We used AMOS 6.0 (SPSS Inc.) for the SEM analysis. Mercury levels of 631 pregnant women was analyzed. In addition, the pregnancy outcome records of 440 individuals were collected for this study.

**Results:** The mean weight of babies was  $3261 \pm 429.54(\text{g})$ , and the mean concentration of mercury level in maternal blood during the first trimesters was  $4.45 \pm 3.78(\mu\text{g/l})$ . The path from fish consumption prior to pregnancy to maternal mercury level ran in a positive direction ( $0.27, P = 0.01$ ). The path in the model showed that mercury level directly acted on the birth weight reduction. Also, after considering environmental factors, we examined that fish consumption might cause increases of mercury levels. Birth weight was indirectly decreased by fish consumption through mercury level.

**Conclusion:** This study suggests that fish consumption prior to pregnancy was significantly associated with maternal mercury level. Our results are consistent with numerous studies of environmental factors and birth weight. The finding of this study using a structural equation model (SEM) supports the construction of national policy for environmental health management.

**Acknowledgment:** This study was supported by the Ministry of Environment, Republic of Korea.

#### ISEE-1676

#### **Impact of Biomass Combustion: Prevalence of Asthma Due to Indoor Air Pollution in Developing Country**

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**Methods:** In this study, we examined the effect of cooking smoke on the reported prevalence of asthma among elderly men and women 60 years of age or older. The analysis is based on 38,595 elderly persons' clinical reports (1997–2007). Effects of exposure to cooking smoke, ascertained by type of fuel used for cooking (biomass fuels, cleaner fuels, or a mix of biomass and cleaner fuels), on the reported prevalence of asthma were estimated using logistic regression. Because the effects of cooking smoke are likely to be confounded with effects of age, tobacco smoking,

education, living standard, and other such factors, the analysis was carried out after statistically controlling for such factors.

**Results:** Results indicate that elderly men and women living in households using biomass fuels have a significantly higher prevalence of asthma than do those living in households using cleaner fuels [odds ratio (OR) = 1.59; 95% confidence interval (95% CI), 1.30–1.94], even after controlling for the effects of a number of potentially confounding factors. Active tobacco smoking was also associated with higher asthma prevalence in the elderly, but not environmental tobacco smoke. Availability of a separate kitchen in the house and a higher living standard of the household were associated with lower asthma prevalence. The adjusted effect of cooking smoke on asthma was greater among women (OR = 1.83; 95% CI, 1.32–2.53) than among men (OR = 1.46; 95%CI, 1.14–1.88).

**Conclusions:** The findings have important program and policy implications for countries such as Nepal, where large proportions of the population rely on polluting biomass fuels for cooking and space heating.

#### ISEE-1677

##### Exposure to Bisphenol A in Pregnant Women and Early Fetal Growth

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**Objective:** Bisphenol A is well known as an endocrine disruptor having estrogen activity. Previous reports showed that high exposure to bisphenol A was associated with recurrent carriage. In this study, we aimed to assess the relation of maternal urinary bisphenol A with fetal biparietal diameter, abdominal diameter and femur length on fetal ultrasonography.

**Material and Methods:** A multi-center birth cohort study, Mothers and Children's Health and Environment (MOCHE) has been established in Korea since 2006 to evaluate the effects of the maternal environmental exposure on fetal growth and development. Participants were interviewed by trained nurses to collect information of residential factor, environmental exposure as well as of general characteristics. As indices for fetal growth, we measured the biparietal diameter, abdominal diameter, and femur length by ultrasonography during mid and late pregnancy. The gestational age was estimated by last menstrual period as well as ultrasound assessment. Blood and urine were sampled to measure biomarkers for environmental exposures. We measured the urinary concentrations of BPA for 125 pregnant women using isotope dilution-high-performance liquid chromatography-tandem mass spectrometry. We used linear regression analyses to assess the effect of bisphenol A on fetal growth.

**Results:** During the early pregnancy, the mean value for bisphenol A in pregnant women was  $0.28 \pm 0.37$  ( $\mu\text{g}/\text{dl}$ ). At the time of ultrasonographic measurement during the second and third trimester of pregnancy, the mean gestational age of the fetus was  $18.8 \pm 3.3$  weeks and  $36.2 \pm 2.3$  weeks, respectively. During the second trimester, mean biparietal diameter, abdominal diameter and femur length was  $4.52 \pm 1.28$  (cm),  $14.71 \pm 3.84$  (cm) and  $3.01 \pm 0.98$  (cm), respectively. On the other hand, mean biparietal diameter during the third trimester was  $9.0 \pm 0.49$  (cm) and abdominal diameter and femur length was,  $31.96 \pm 2.26$  (cm) and  $6.9 \pm 0.47$  (cm), respectively. In simple regression analysis, bisphenol A level was significantly associated with abdominal diameter, and femur length during the mid and late of pregnancy. Fetal head circumferences ( $\beta = -0.06$ ,  $P = 0.02$ ) and abdominal circumferences ( $\beta = -0.32$ ,  $P = 0.02$ ) during the late of pregnancy were significantly decreased by

maternal bisphenol A level after adjustment for gestational age and maternal height and weight. Bisphenol A level was significantly associated with fetal femur length during the mid of pregnancy ( $\beta = -0.04$ ,  $P = 0.04$ ).

**Conclusions:** This study suggests that maternal bisphenol A level during early pregnancy may contribute to the risks of retarded fetal growth.

#### ISEE-1678

##### The Relationship Between Indoor PM from Maternal Environment and Birth Outcomes Using Structural Equation Model

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**Objective:** Several studies have recently reported an association between air pollution and adverse birth outcome. Therefore, the aim of this study is to identify the relationship between indoor PM effects from maternal environmental factors and pregnancy outcomes.

**Material and Methods:** We collected the eligible data of 770 pregnant women from three collaborating centers in Seoul (metropolitan area), Ulsan (industrial area), and Cheonan (medium-sized urban area). Each center had a community-based collaborative network composed of university hospitals, local clinics, and community public health centers. The questionnaire was composed of residential factors and general characteristics. We measured indoor air pollution data such as  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  for every 171 houses. We performed separately multiple linear regression analysis among residential factors, measured  $\text{PM}_{10}$  concentrations, and pregnancy outcomes, adjusting for maternal age, education, infant gender, and maternal BMI. Also, we analyzed using Structural Equation Model (SEM) to evaluate the relationship between numerous estimated contribution of each confounding factors and pregnancy outcomes. SEM is a technique to assess the sequential relationship between environmental variables from questionnaire, measured PM concentrations, and birth outcomes during pregnancy. We applied the variables such as maternal age, maternal education, house age, factory, furniture, carpet, smoking, infant gender, infant birth weight, and gestational age for modeling. Model fitting was assessed by various indices, such as chi-square, comparative fit index(CFI), root mean square error of approximation(RMSEA), and expected cross-validation index (ECVI).

**Results:** Indoor  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  levels were  $66.09 \pm 33.55$  ( $\mu\text{g}/\text{m}^3$ ) and  $30.18 \pm 23.14$  ( $\mu\text{g}/\text{m}^3$ ), respectively. Infant birth weight and gestational age were  $3279.93 \pm 449.05$  (g) and  $39.07 \pm 1.18$  (weeks), respectively. In multiple linear regression model, the gestational age was significantly decreased by  $\text{PM}_{10}$  ( $\beta = -0.01$ ,  $SE = 0.00$ ) and  $\text{PM}_{2.5}$  ( $\beta = -0.01$ ,  $SE = 0.00$ ), respectively after adjusting for maternal age, education, baby gender, and maternal BMI. In SEM analysis, there were a number of paths between maternal environmental factors and pregnancy outcomes. The path from presence of factory to indoor  $\text{PM}_{10}$  ran in a positive direction (11.704,  $P = 0.043$ ) and the paths from indoor  $\text{PM}_{10}$  to gestational age ran in a negative direction ( $-0.009$ ,  $P = 0.007$ ). The path model shows that smoking directly acted on the indoor  $\text{PM}_{2.5}$  in a positive direction (14.122,  $P = 0.018$ ). Indoor  $\text{PM}_{2.5}$  directly acted on gestational age in a negative direction ( $-0.013$ ,  $P = 0.015$ ).

**Conclusions:** We found that PM exposure during pregnancy decreases gestational age, and there are sequential relationships between maternal environmental factors, indoor PM concentration, and pregnancy outcomes.

Therefore, this study suggests one of the possible mechanisms for risk factors during pregnancy.

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#### ISEE-1679

#### The Impact of Woodstove Technology Upgrades on Air Quality in British Columbia Homes

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**Background:** Residential wood burning is a major source of air pollution in many communities. Relative to other air pollution sources there is high potential for human exposure to woodsmoke because wood is burned in densely populated residential areas and woodsmoke can be emitted directly into the indoor environment. Exchanging “conventional” woodstoves for cleaner-burning, certified alternatives has the potential to improve indoor and outdoor air quality.

**Methods:** Eighteen homes in Smithers, British Columbia, are being monitored twice during the 2007/2008 heating season to evaluate the indoor air quality impacts of upgrading to a certified woodstove. Each home is monitored for six days before and six days after stove upgrade. PM<sub>2.5</sub> filter samples are collected with 10-lpm Harvard Impactors, and filters will be analyzed for levoglucosan, a woodsmoke tracer, as well as particulate metals and light absorbing carbon. In addition, continuous indoor and outdoor light scattering measurements are made with nephelometers. Residents complete a diary on stove use frequency, operating conditions, and wood characteristics during both the pre- and post-exchange monitoring sessions. Nephelometer data will be used in a recursive mass balance model to estimate PM<sub>2.5</sub> infiltration efficiencies ( $F_{inf}$ ), thus allowing a within-home comparison of pre- and post-exchange indoor concentrations of indoor- and outdoor-generated PM<sub>2.5</sub> and levoglucosan.

**Results:** Pre-exchange sampling has been completed in 11 homes. Mean ( $\pm$ SD) indoor and outdoor PM<sub>2.5</sub> concentrations were  $15.5 \pm 9.3 \mu\text{g}/\text{m}^3$  and  $15.4 \pm 7.1 \mu\text{g}/\text{m}^3$ , respectively. The average  $F_{inf}$  was  $0.28 \pm 0.14$ , and 8 of 11 homes had an indoor-outdoor PM<sub>2.5</sub> ratio  $> 2.5$  (mean:  $11.4 \pm 9.6 \mu\text{g}/\text{m}^3$ ) generally made a greater contribution to indoor concentrations than infiltrated outdoor PM<sub>2.5</sub> ( $4.2 \pm 2.4 \mu\text{g}/\text{m}^3$ ). On average, indoor-generated PM<sub>2.5</sub> accounted for 67% of the measured indoor PM<sub>2.5</sub> concentration. Levoglucosan concentrations will allow us to assess the role of woodsmoke as an indoor source.

**Conclusions:** These preliminary results suggest relatively high indoor and outdoor PM<sub>2.5</sub> concentrations at these residences operating non-certified woodstoves. The relatively low  $F_{inf}$  estimates are consistent with previous findings in the region. These tightly sealed homes attenuate the contribution of outdoor PM<sub>2.5</sub> to indoor air, but indoor concentrations remain elevated due primarily to the major contribution of indoor sources.

#### ISEE-1680

#### Nation-Wide Monitoring Mercury Residues in Freshwater and Estuarine Fish Tissue for Building the National Fish Contamination Survey System in Korea

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**Background:** Mercury residues in fish tissue collected in freshwater and estuarine waters were firstly nation-wide monitored in Korea to make a

nation mercury map. This study is the first step for developing the national fish contamination survey system.

**Methods:** Fish samples were collected from April of 2006 to December of 2007. A total of 45 species from 55 freshwater sites and a total of 22 estuarine species from 6 costal sites were identified and the edible parts of 5,687 fish samples were analyzed. A total of water ( $n = 324$ ) and sediment ( $n = 299$ ) samples were analyzed to determine total mercury levels. In addition, methyl mercury in a portion of the water, sediment and fish samples was measured. Total mercury (Hg) concentrations in the edible part of the fish samples were measured by cold vapor atomic fluorescence spectrometer (CVAFS) and calculated on wet weight base. Methylmercury (MeHg) concentration in the samples was analyzed by gas chromatography-CVAFS using distillation (water and sediment samples) or alkaline digestion (fish samples)-aqueous phase ethylation. A total 24 target species were selected from the above 45 species as a “biomonitor” species for their efficacy and representatives to identify mercury biological hot spots and to make a nation-wide mercury map. The metric used for the basis of the evaluation was the total Hg concentration, consumption rate, and geographical range.

**Results:** In descending order by mean concentration of mercury, mandarin fish (*Shiniperca scherzeri*)  $195.8 \pm 111.8 \mu\text{g}/\text{kg}$  ( $n = 90$ ), skygager (*Eryghroculeter erythropterus*)  $159.8 \pm 113.4 \mu\text{g}/\text{kg}$  ( $n = 108$ ), molgae (*Squalidus japonicus Koreanus*)  $157.5 \pm 46.2 \mu\text{g}/\text{kg}$  ( $n = 4$ ), bass (*Micropterus salmoides*)  $152.3 \pm 180.8 \mu\text{g}/\text{kg}$  ( $n = 134$ ), Korean piscivorous chub (*Opsariichthys bidens*)  $149.9 \pm 127.1 \mu\text{g}/\text{kg}$  ( $n = 100$ ), and catfish (*Silurus asotus*)  $145.6 \pm 168.7 \mu\text{g}/\text{kg}$  ( $n = 203$ ). All of species listed above are piscivorous fishes. The ratio of MeHg to total Hg in 67 fish samples of 12 species ranged from 81% to 96% (average  $\pm$  standard deviation,  $89 \pm 11\%$ ). There was the relationship between the total Hg concentration versus length within the same fish species collected from the same area, whereas there were significant differences of the length-normalized Hg concentration among different sampling areas. Among the freshwater species, bass, mandarin fish, skin carp, skygager, Korean bullhead, and blugill appeared to have elevated total Hg concentration versus length relationships, collected from large artificial lakes located in the upper reach of the major four watersheds in Korean peninsula, where are pristine areas far distant from the industrialized areas. In the case of estuarine species, goby and rock fish showed the elevated total Hg concentration versus length relationship near the Hadong coal-fired power plant and the mouth of Nakdong River, which is an intensively industrialized area. Mandarin fish showed the significant relationship between length-normalized total Hg concentration and MeHg in sediment.

**Conclusion:** In Korea, fish consumption is the major exposure pathway for mercury intake. Mercury intake by fish consumption was estimated to be  $0.035 \mu\text{g}/\text{kg}\cdot\text{d}$ , which is similar to estimated value ( $0.038 \mu\text{g}/\text{kg}\cdot\text{d}$ ) from total diet study (KFDA, 2006). Further plans for the national fish contamination survey include deriving target residue value and recommending a fish consumption advisory to the public, especially sport and subsistence fisherman.

#### ISEE-1681

#### Referent Levels of Urinary Antimony, Barium, Cesium, and Molybdenum Concentrations in the U.S. Population

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**Introduction:** Exposure to metals such as antimony (Sb), barium (Ba), cesium (Cs), and molybdenum (Mo) primarily occurs through dietary intake. However, exposure to barium and antimony can also occur from contact with environmental media such as air, water and soil. Given the increased interest in biomonitoring as a tool to evaluate environmental exposure, we calculated reference statistics for each of these four metals and evaluated which demographic characteristics had the greatest impact

on levels of these metals in urine using the 2001–2002 and 2003–2004 NHANES data.

**Methods:** We combined urinary concentration data for creatinine, antimony, barium, cesium and molybdenum and demographic information from the 2001–2002 and 2003–2004 NHANES surveys into a single dataset. All concentrations of metals were adjusted for urinary creatinine. Descriptive statistics, including the geometric mean and various percentiles, were characterized for each metal by region and age, gender, race/ethnicity, or tobacco smoke exposure. Linear regression models developed to evaluate the association between various characteristics and levels of metals adjusted for region, age, gender, race/ethnicity, tobacco smoke exposure and urinary creatinine. The natural log of each metal concentration was used as the dependent variable in all regression models. All analyses were completed using SAS and SUDAAN software.

**Results:** The overall geometric mean (GM) creatinine-adjusted urinary Sb, Ba, Cs, and Mo concentrations for the U.S. population were 0.104 µg/g (95%CI: 0.099–0.110), 1.46 µg/g (95%CI: 1.36–1.55), 4.57 µg/g (95%CI: 4.44–4.76), and 40.85 µg/g (95%CI: 39.25–42.52), respectively. Unadjusted urinary concentrations of antimony, barium, and cesium did not vary among the geographic regions while concentrations molybdenum varied slightly from region to region. After adjusting for tobacco smoke exposure, age, gender, race/ethnicity, and creatinine, urinary GM levels for all four metals were the highest in 1–5 year olds while the other subgroups varied by model. For antimony, female, other Hispanic/multi-racial smokers who resided in the South were observed to have the highest urinary level. Urinary GM concentrations of barium showed similar values to antimony except that the non-Hispanic white individuals were observed to have the highest levels. For cesium, the highest urinary GM levels were observed in female non-smokers of non-Hispanic white and other Hispanic/multi-racial descent who resided in the West. The highest urinary molybdenum levels were similar to cesium's urinary levels with the exception that only other Hispanics/multi-racial individuals had the highest concentrations.

**Conclusions:** The increasing use of biomonitoring as an exposure assessment tool has promoted the characterization of referent levels of numerous compounds in the general population. Here we developed reference levels of antimony, barium, cesium and molybdenum for use in interpreting biomonitoring data collected to evaluate occupational or environmental exposures of individuals or populations. Overall, these results demonstrate the need to consider the impact of demographic characteristics in determining reference levels of metals found in environmental media and food products.

#### ISEE-1682

#### Personal Exposures to Volatile Organic Compounds in Urban Environments of Tianjin, China

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**Background:** Popularity of home refurbishment/decoration since 1990 once resulted in high indoor concentrations of volatile organic compounds (VOCs), which brought wide health concerns. Subsequently, a series of indoor air quality (IAQ) related standards and compulsory national standards for limits of harmful substance contained in interior decorative materials (LHSCIDM) have been promulgated since 2000. At the same time, smoking has still been a serious public health concern because it was reported that there are 350 million smokers and over 540 million passive smokers in China as of 2007. Due to the rapid growth in economy and urbanization, vehicle population in many big Chinese cities has increased significantly. In response to those rapid changes in urban areas of China, a measurement campaign concerning personal VOCs exposure

in urban environments has been conducted in Tianjin, China, to better understand important factors of effecting population exposure.

**Methods:** 200 adults in two residential communities with different proximities to vehicle emission were randomly selected and asked to fill out a questionnaire concerning their time-activity, living habits and working environmental conditions. 86 agreed to participate in this exposure measurement study. Finally, 20 smokers and 20 non-smokers were selected to participate in the field measurement and personal monitoring campaign. Passive samplers (Tenax/Carbopack X) were employed for both environmental and personal monitoring in the spring and summer of 2008. Matched residential indoor, residential indoor, community central site, transit, indoor workplace, and personal measurements were made simultaneously. Average indoor air exchange rates (AERs) were monitored using continuous CO<sub>2</sub> sensor. All the VOCs samples were analyzed by thermal desorption/gas chromatography/mass spectroscopy (TD/GC/MS). A general linear model describing personal exposure to VOCs in different microenvironments was developed. To identify the factors that influence personal exposures to selected air toxics, regression analysis has been done for monitored exposure levels and modeled values.

**Results:** Preliminary analysis results indicate that smoking is an important contributor for both smokers and some passive smokers. Furniture in residence and office appear as an strong emerging source for indoor VOCs pollution and personal exposure. Household cleaning products have not become a common VOC source in Tianjin. Significant differences in exposures to traffic-related compounds, including ethylbenzene, m- and p-xylene and o-xylene, were found in relation to gender. Exposure occurred during transportation contribute to all BTEX compounds exposure significantly. More important results may be determined when all the field measurement and chemical analysis have been completed.

#### ISEE-1683

#### The Predictive Factors for Mercury Contamination in Fish Farming Areas in the North Region of Mato Grosso, Amazon Basin

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**Methods:** The present study addresses the long-term mercury contamination as a consequence of goldmining activities and the predictive factors in fish farming areas that may explain the mercury contamination in fish in the north region of the Mato Grosso State. The study involves the social and environmental characterization of the farming activity, such as: localization and identification of artesian gold mining areas in the region, fish-farming conditions, and degraded gold mining areas rehabilitated for fish farming. Geographic Information System techniques were used on the characterization of the rural population, with emphasis on the cultural and social habits. All the information was assessed by specific questionnaires and the field surveys. The fish sampling involved 254 fish from 19 species. Total mercury and methymercury were also determined.

**Results:** The results show that the Hg levels found in fish consumed by communities of the five municipalities (n = 254 samples)—three of them with past intensive gold mining activity (n = 184 samples)—show a significant difference in Hg levels between piscivorous and non-piscivorous fish ( $P < 0.001$ ). The average mercury concentration in piscivorous fish (n = 125 samples) was 0.58 mg/kg, with  $sd \pm 0.54$  and a range of 0.20 to 3.50 mg/kg. In non-piscivorous species (n = 129 samples) the average was 0.03 mg/kg, with  $sd \pm 0.03$  and a range from 0.01 to 0.21 mg/kg. From the multivariate analysis models developed for fish farming scenarios to predict factors in fish farming areas only one model (stepwise) showed a good correlation ( $r = 0.74$ ).

**Conclusions:** Previous local goldmining activity, the source of water for the fish-farming and the techniques for the adubation fish ponds showed a strong association with the mercury contamination fish farming.

#### ISEE-1684

#### Trends in Formaldehyde Concentrations and Exposures in California Residences

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**Background:** Data from a recent study of new California homes indicate that progress in reducing concentrations of formaldehyde in single family, conventional homes over the past 20 years has been minimal, and substantial risk remains. These results for new conventional homes are important because, despite the recent attention on the highly elevated formaldehyde levels in trailers provided to hurricane victims, over 90% of the population resides in conventional homes.

**Methods:** In a recent study of 108 new (1–3 year old) California single family, detached homes, formaldehyde concentrations ranged from 4.8 to 136  $\mu\text{g}/\text{m}^3$ , with a mean of 43 (SD 27  $\mu\text{g}/\text{m}^3$ ), a median of 36  $\mu\text{g}/\text{m}^3$ , and a 90th percentile value of 86  $\mu\text{g}/\text{m}^3$ . Samples were obtained over 24 hours in accordance with ASTM D5197-03 using a constant rate pump and solid sorbent cartridge with DNPH.

**Results:** Prior to this study, in 2005 ARB staff developed estimates for all ages of conventional California housing stock as of the early 2000s. Those estimates were based on a review of emissions studies and indoor air concentration data from two studies covering 259 homes of all ages; those results yielded a mean of about 17  $\mu\text{g}/\text{m}^3$  and a maximum of 290  $\mu\text{g}/\text{m}^3$ . A similar analysis conducted for manufactured homes in California estimated a mean of about 46  $\mu\text{g}/\text{m}^3$  and a maximum of 280  $\mu\text{g}/\text{m}^3$  for manufactured homes.

**Discussion:** The new California home mean concentration is more similar to the estimate for manufactured homes than to the mixed age stock of conventional homes, and the new homes show a mean several times higher than the older mixed stock. This is not unexpected, because a substantial portion of building materials in new homes in California are composite wood materials made with urea-formaldehyde resin, which can off-gas formaldehyde over a period of years. These results indicate little progress in reducing mean formaldehyde concentrations and exposures in residences. The large reduction in peak levels in new homes relative to the estimate for mixed stock conventional homes may indicate some progress in reducing peak concentrations, but is more likely attributable to missing the upper end of the distribution in new homes due to the limited sample size in the California new home study. Most importantly, the data show that nearly all new homes in California exceed health benchmarks for both carcinogenic risk (2  $\mu\text{g}/\text{m}^3$ , Proposition 65) and avoidance of irritant effects (3  $\mu\text{g}/\text{m}^3$  OEHHA Chronic Reference Exposure Level, 33  $\mu\text{g}/\text{m}^3$  ARB 8-hour indoor guideline level, 94  $\mu\text{g}/\text{m}^3$  OEHHA Acute Reference Exposure Level). Full implementation of Phase II of ARB's new regulation to reduce formaldehyde emissions from composite wood materials is estimated to reduce levels in new homes up to 44% by 2013, which would result in a new home average concentration of about 20–30  $\mu\text{g}/\text{m}^3$  and peak values of about 70  $\mu\text{g}/\text{m}^3$ . If achieved, this would represent a substantial reduction in exposure and risk in new California homes, but also indicates that further reductions in indoor concentrations of formaldehyde are needed.

#### ISEE-1685

#### Association of Hospital Admissions for Cardiovascular Causes and Air Pollution ( $\text{PM}_{10}$ , $\text{PM}_{25}$ and $\text{O}_3$ ) in Santiago, Chile

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**Objective:** To evaluate the association between hospital admissions from cardiovascular causes and the daily levels of air pollution from particulate matter and ozone, and to assess the differential effects according to age groups.

**Materials and Methods:** The data on daily number of hospital admissions in the Metropolitan Region of Santiago for the period of time between 2002 and 2005 were obtained from the Statistical Department of the Ministry of Health. Daily levels of air pollution were obtained from the MACAM monitoring network. The following group of causes were studied (codes for ICD10 Classification are given): *Heart Failure* (I50–I509), *Heart Rhythm Disturbances* (I44–45, I46–49, R001, R008, R0012), *Cerebrovascular Diseases* (G45–G468, I60–I698), *Ischaemic Heart Disease* (I20–I259, I51–I528, M219), *Peripheral Vascular Disease* (I70–I79, M30–M31), *Hypertension* (I10), *Acute Respiratory Infections* (J00–J06, J10–J118, J12–J18, R065), and *Chronic Obstructive Pulmonary Disease* (J209, J40–J43, J441–J449). The data were stratified in four age groups: less than 18 years old, 18 to 44, 45 to 65, and older than 65 years. The association between the daily number of admissions and both the 24 hr average and the 1 hr daily maximum was studied through Times-series using general linear model in R software, controlling for season, apparent temperature and day of week. Lags 0 to 7 were considered. Model selection was performed on the basis of minimum autocorrelation of model residuals.

**Results:** A significant association ( $P < 0.05$ ) was observed for several cardiovascular causes and a respiratory one. For adults between 45 and 65 years old, the increase in risk *Cerebrovascular Diseases* was 1.1 (95%CI: 0, 13–2.1)% for  $\text{PM}_{10}$ , lag 4, and 2.1(0.2–4.1)% for  $\text{PM}_{25}$ , lag 4. The same was observed for *Hypertension* (2.3 (0.2–4.5)% for  $\text{PM}_{10}$ , lag 4) and *Acute Respiratory Infections* (1.0 (0.0–2.1)% for  $\text{PM}_{10}$ , lag 7). For older than 65 years an association with *Cerebrovascular Diseases* was observed 0.68 (0.0–1.4)% for  $\text{PM}_{10}$ , lag 6, and *Heart Rhythm Disturbances* at 1.1(0.1–2.1)% for  $\text{PM}_{10}$ , lag 5, and 2.1(0.2–4.2)% for  $\text{PM}_{25}$ , lag 5 and for *Acute Respiratory Infections* was 2.2(0.0–4.6)% for  $\text{O}_3$ , lag 0. Less than 18 years old only was significant for *Acute Respiratory Infections* (1.6 (0.0–3.2)% for  $\text{O}_3$ , lag 0). All the figures are indicated as the change percentage in the hospital admission by the increase of 10  $\mu\text{g}/\text{m}^3$  of pollutant.

**Conclusion:** This analysis show an association of air pollution levels and cardiovascular morbidity in Santiago, Chile, expressed as the number of hospital admissions. The association depends on specific cause and age group, with the higher impacts for adults from 45 to 65 years old in *Cerebrovascular Diseases*, and for older than 65 for *Heart Rhythm Disturbances*. These results are consistent with the previous literature.

#### ISEE-1686

#### Level of Perfluorinated Chemicals in Maternal Blood, Cord Blood, and Breast Milk in Korea

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**Methods:** Fetal and maternal exposure levels of perfluorinated compounds (PFCs) in the fetus and the infant were first measured in Korea. One of the objectives of this study was to elucidate the relationship between maternal PFC serum levels and breast milk levels to better understand the lactational transfer of PFCs. For this purpose, matched individual milk and serum samples as well as cord blood samples from 20 Korean women living in Seoul Korea were collected in 2007. This is the first report on the relationship of PFCs in human maternal serum and milk and the first report on the fetal exposure levels of PFCs in Korea.

**Results and Discussion:** Eight PFCs (PFOS, PFOA, PFHxS, PFNA, PFDA, PFBS, PFDoDa, and PFHpA) were detected in the serum samples, and three PFCs (PFOS, PFOA, PFHxS) of them were also above the detection limit in the milk samples. The mean concentration of PFOS, PFOA, and PFHxS in blood was 3.77 (0.69 ~ 9.43) and 1.39 (0.50 ~

3.22) pg/ml. The mean concentration of PFOS and PFOA in milk was 60.79 (31.64 ~ 109.91) and 41.03 (21.23 ~ 77.43) pg/ml, respectively. In blood samples, more compounds, including long-chain PFDA and PFUnDA, were measured at two orders of magnitude greater than levels in milk. However, the observed levels were much lower than those in other countries. PFOS was dominant in the composition profile as shown in most human blood studies. Levels in blood samples were significantly higher than in cord blood. Good correlation was observed between milk and cord blood for all compounds (particularly, PFOA). Exposure level for perfluorinated compound to the fetus and maternal exposure level for perfluorinated compound to the neonatal infant were similar to other studies conducted in USA and EU. Further study plans exist to assess the relative importance among different exposure pathways for PFCs.

#### ISSE-1687

#### **Exposure to Persistent Organic Pollutants and Myocardial Infarction: Can Obesity Modify the Atherogenic Effect of Lipophilic Compounds?**

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**Background:** Traditional risk factors explain only up to 50–85% of coronary heart disease (CHD) cases in various populations. Recent studies indicate that exposure to persistent organic pollutants (POPs)—such as polychlorinated biphenyls, dioxins/furans, and persistent pesticides—is an emerging risk factor for atherosclerosis-related diseases, including CHD and its severest form—myocardial infarction (MI). Experimental studies indicate that the major mechanism responsible for the atherogenic effect of POPs is the ability of these lipophilic compounds to alter lipid metabolism in the liver causing atherogenic dyslipidemias. Since POPs are fat-soluble compounds able to bioaccumulate in the adipose tissue of the human body, an important question emerges: does the amount of body fat affect the atherogenic effect of POPs? We hypothesized that the atherogenic effect of POPs can be modified by obesity.

**Methods:** We conducted an ecologic study of environmental exposure to POPs and MI in obese and non-obese populations. To examine the effect of POPs exposure on MI hospitalization rates, we used the New York Statewide Panning and Research Cooperative System data on hospital discharges for MI in 25–74 year-old patients for a 12-year period (1993–2004). The ZIP codes of residence were classified as “POPs”, “other-than-POPs waste”, or “clean” according to whether they contained (or abutted) contaminated sites. Relative risks (RR) of MI hospitalization were estimated as MI hospitalization rate ratios. To control for potential confounders, adjusted RR and 95% confidence intervals (CI) were estimated by Poisson regression. To adjust for clustering of observations within ZIP codes, the generalized estimating equations (GEE) method was used.

**Results:** Both in obese and non-obese populations, MI hospitalization risk was significantly higher for POP-exposed residents compared to unexposed ones. For POP-exposed obese populations, adjusted RR of MI hospitalization was 1.115 (95% CI = 1.028–1.209). For POP-exposed non-obese populations, MI hospitalization risk was even higher than in obese populations (adjusted RR = 1.587; 95% CI = 1.298–1.941). Also, MI hospitalization risks were higher in males (adjusted RR = 2.641; 95% CI = 2.547–2.738), in obese populations compared to non-obese ones (adjusted RR = 15.532; 95% CI = 14.138–17.063), in African Americans compared to Caucasians (adjusted RR = 1.625; 95% CI = 1.434–1.841), and in older age groups (35–44 year-old, 45–54 year-old, 55–64 year-old, and 65–74 year-old groups) compared to 25–34 year-olds with adjusted RR (95% CI) of 4.975 (4.071–6.080), 18.690 (14.541–24.023), 38.271 (29.032–50.446), and 70.824 (52.520–95.517) respectively. These findings are consistent with existing knowledge of MI risk factors and prove the quality of our model.

**Conclusion:** Our results support the hypothesis that atherogenic effect of POPs is modified by the amount of body fat. Obesity can change the pattern of distribution of POPs in the human body; the higher accumulation of these lipophilic compounds in the adipose tissue and lesser accumulation in the liver can decrease ability of POPs to cause atherogenic dyslipidemias.

#### ISEE-1688

#### **Estimation of Skin Permeability Coefficients for Aqueous Chloroform from the Gordon et al. *in vivo* Human Trials: Impact on Estimated Relative Contribution of Dermal Exposure**

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**Background and Methods:** Published estimates of water-skin permeability coefficients of organic contaminants found in potable water can be highly variable. This reflects variation in both experimental conditions and mathematical approaches to estimation of permeability coefficients. Human *in vivo* experiments are potentially the most credible sources of estimates of descriptors of dermal absorption, but require relatively sophisticated mathematical models (e.g., PBPK models) to interpret resulting biomonitoring data such as breath measurements. Within those models alternative mathematical representations of skin can yield substantially different estimates of the permeability coefficient from the same data. Gordon et al. (1998) conducted experiments at three different water temperatures in which breath chloroform data were collected from human volunteers immersed in hydrotherapy tubs. Their data have been reevaluated using three PBPK models that differ only in the manner in which skin is represented and Markov chain Monte Carlo methods. Statistically significant differences in estimates of permeability coefficients have been found across both temperatures and models.

**Results:** Using a membrane model of skin, median permeability coefficients of 0.024 and 0.052 cm/hr were estimated at water temperatures of 35 °C and 40 °C, respectively. Corresponding values produced using a CSTR representation of skin were 0.015 and 0.043 cm/hr. For the six subjects exposed to both 35 °C and 40 °C water, estimated (membrane model) permeability coefficient values were 66% to 370% higher at 40 °C than at 35 °C.

**Discussion:** Lessons learned from this exercise are applicable to the larger question of the relative importance of ingestion and dermal exposures to water contaminants. The most extensive current US EPA guidance on dermal absorption of chemicals from water is found in Risk Assessment Guidance for Superfund (RAGS) Volume I Part E, which was published in 2004 by the EPA Office of Solid Waste and Emergency Response (OSWER). That document provides protocols for assessing dermal exposure to water contaminants and a screening level comparison of dermal to drinking water ingestion doses. For chloroform and other trihalomethanes (THMs), RAGS Part E guidance leads to the conclusion that the dermal contribution is small compared to ingestion. The EPA Office of Drinking Water has not produced comparable formal guidance, but has sponsored a monograph published in 2006 by the Office of Research and Development's National Center for Environmental Assessment (ORD/NCEA) that comes to a different conclusion, reporting that oral and dermal exposures to THMs are roughly equivalent. Disparate findings in these documents and prior publications are attributable to different modeling approaches and parameter assumptions. Factors that lead to underestimation of the contribution of dermal exposure include failure to incorporate temperature correction in permeability values, assumption of steady-state absorption when unwarranted, and lack of consideration of differences in quality of hot and cold water.

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#### ISEE-1689

##### **Childhood Asthma and Ambient Air Pollution in Warm and Cold Seasons**

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**Background:** Ambient air pollution has been associated with asthma outcomes in children in time series analyses that control for season. In this study, we examined the effects of air pollution on acute outpatient visits for childhood asthma separately for warm and cold months to assess whether the associations vary by season.

**Methods:** We gathered childhood (ages 18 and under) asthma visit data between 8/1/98 and 12/31/02 from electronic member utilization records of a managed care organization in Atlanta, Georgia. Air pollution data were collected as part of the Aerosol Research and Inhalation Epidemiology Study (ARIES). Measurements included in this analysis are the 24-hour averages of PM<sub>2.5</sub> and its components (sulfates, elemental carbon, organic carbon, and water-soluble transition metals), coarse PM (PM<sub>10-2.5</sub>), PM<sub>10</sub>, oxygenated VOC (OVOC), 8-hour maximum O<sub>3</sub>, and 1-hour maximum NO<sub>2</sub>, CO and SO<sub>2</sub>. We also examined, for both PM<sub>2.5</sub> and coarse PM, the 24-hour averages of total water-soluble (ws) metals, ws copper, ws iron and ws manganese, and total copper, manganese, and zinc. We conducted a time series analysis using Poisson general linear modeling (GLM) with control variables for temporal trends and meteorological variables, and a Poisson offset term of the log-transformed value of the total membership. The warm season months were defined as April through October, and the cold season months defined as November through March.

**Results:** There were 28,487 acute childhood asthma visits in the 53-month study time period, with a mean of 17.6 visits per day (11.4 std. dev.). Model results were notably different for cold and warm seasons. For the cold season, only PM<sub>2.5</sub> EC (RR = 1.053; lag 6–8) and O<sub>3</sub> (RR = 0.883; lag 6–8) were significant. On the other hand, there were five statistically significant findings for the warm season, all of which were positive effects. PM<sub>2.5</sub> EC was significant for all three lags, while PM<sub>2.5</sub> OC and PM<sub>2.5</sub> ws metals were significant only for lag 3–5. Compared to a full 53-month time period analyses that controlled for season, the effects for the warm season were larger, with RRs ranging from 1.045 for PM<sub>2.5</sub> EC (lag 0–2) to 1.091 for PM<sub>2.5</sub> EC (lag 3–5). For metals, there were no statistically significant findings during the cold season, but six significant findings for the warm season. All of the warm season findings were positive and for lag 3–5. Significant pollutants included PM<sub>2.5</sub> Mn, PM<sub>2.5</sub> ws metals, PM<sub>2.5</sub> ws Fe, PM<sub>2.5</sub> ws Mn, coarse Zn and coarse ws Mn. RRs ranged from 1.050 for PM<sub>2.5</sub> ws metals to 1.106 for coarse Zn.

**Conclusions:** These findings show seasonal variation in associations between childhood asthma and ambient air pollution. This suggests that separate models for warm and cold months may be more informative in some cases than the common approach of controlling for season in full-year models.

#### ISEE-1691

##### **Community Oriented Reuse and Refinement of Available Transportation, Air Quality and Public Health Data to Shape Regional Equity Discussions and Healthier Development Outcomes in Somerville, Massachusetts**

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Area Planning Council (formerly), Boston, MA, USA; and <sup>¶</sup>Metropolitan Area Planning Council, Boston, MA, USA.

**Background:** Residents and community organizations often lack the resources to conduct original research that might protect them from serious environmental impacts, support healthier land use patterns and provide clean transportation systems. Though highway emissions are dangerous to nearby populations, our current regulatory framework is regional and attention is moving to global climate issues. This raises a concern that primary pollution impacts upon vulnerable populations, especially low income and minority, may remain unmitigated. Low cost mining of underutilized data can help integrate growth policies and mitigation across temporal and spatial scales. Volunteers at MVT and STEP have used detailed public health data (from MassCHIP) and surface transportation and emissions data (from the MPO) to improve land use decisions and secure transportation projects. MAPC's GIS capacities have been tapped to show travel intensity and emissions at the roadway, intersection and Traffic Analysis Zone (TAZ) level. Somerville has 19,000 people per square mile. A majority of its public school students come from households where English is a second language. There are half as many jobs as workers and less than 2 acres of public open space for every 1000 residents. Overrun by 3 highways and 6 diesel commuter rail lines, vehicle miles traveled (VMT) in Somerville exceed 200,000 daily and diesel trains exceed 15,000 annually, both per square mile.

**Discussion:** After reviewing 5 years of age-adjusted lung cancer and acute myocardial infarction data, MVT and STEP showed that 14 of the 100 communities that surround Boston had 75% of the region's excess mortalities, yet only 25% of the population and 10% of the land area. From 1989 through 2003, Somerville had 292 excess deaths in these two categories, 23% more than expected. MVT and STEP have also analyzed MOBILE 6.2 data for 2727 TAZes. The TAZ data includes VMT, VHT, CO, VOCs and NOx. There is enormous heterogeneity. Average CO emissions per square mile in the most intense 5% of TAZes are 100× greater than in the least intense 5%. Minority population is twice as concentrated in the top 5% as in the region as a whole. The 60%, 80% and 100% of median income population segments are 50%, 40% and 20% more concentrated in the high TAZes. In Somerville, MVT has limited big boxes and promoted dense transit-oriented mixed use for a 145 acre riverfront development. Projected vehicle trips per day were cut from 100,000 to 50,000. Developers agreed to contribute \$15 million toward a new subway stop as well as to fund bike paths and a health study. Mixed income housing will be more than 500 feet from highways. MVT and STEP have also led a local fight to ensure state commitment to 2 new light rail branches, a \$700 million investment. The reuse and refinement of MassCHIP and MPO data has led to filing of health impact legislation and accelerated agency discussions. Based on MVT and STEP experience, it is likely others could utilize existing data to support growth patterns that more thoughtfully balance environment, health, land use and transportation.

#### ISEE-1692

##### **Health Impacts of Trade: Integration of Multimedia Multi-Continental Model and a Global Input-Output Trade Model**

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**Background and Objectives:** Globalization and the resulting increase in global trade can result in significant health impacts that are unequally distributed between producing and consuming nations. This occurs because pollutants affect human health both at the local point of emission and globally through long-range transport. In this project, we estimate the

emissions associated with global trade and estimate the resulting globally-distributed health impacts. We aim to estimate global health impacts of trade by linking three actors: the producers of goods, the consumers of the goods, and the population impacted by the pollution (producers, consumers or a third party). Exchanges through trade (embodied pollution content) and multi-media pollutant transfer are considered on a global scale.

**Methods:** To estimate the impacts due to pollution resulting from global trade, we integrate the following pieces of information: (i) pollutant emissions associated with a given region's consumption, (ii) global transport of the pollutant, (iii) human intake through ingestion and inhalation, and (iv) the impact of the ingested and inhaled pollution. The emissions are computed by incorporating life cycle assessment into a global economic model. The health impacts are estimated using a global multi-media model that simulates the fate, exposure and ultimate intake of pollutants emitted during the manufacturing, transport and use phases.

**Results and Discussion:** The global multimedia model consisting of 17 continental zones and 9 ocean zones has been created based on the IMPACT 2002 model to estimate pollutant transport and intake. We use this model to estimate the total intake fraction (iF) for an emission in each of the 17 zones and further sub-divided the intake into the exposed regions. The iF of particulate matter (PM), which is one of the most damaging air pollutants, is highest when emitted in regions with high population density. Thus, pollutants emitted in or near China and India have large iFs because of their high population density. By incorporating jet streams into a multi-continental model, we improve our estimate of long-range transport and of the subsequent inter-media transfers. We also discuss the influence of vertical exchange and jet streams on long-range transport and the eventual health impact. We estimate the emissions resulting from global trade with a newly-created economic Input-Output model describing the production, consumption and trade of goods between 19 regions and 24 economic sectors. These emissions are multiplied by the spatial intake fractions in order to estimate resulting health impacts. As an example, of the total amount of PM emissions associated with German textile consumption, about 35% of the emissions occur in Germany, and 40% occur in India and China. However, because of the high population densities in India and China, these populations experience more than 60% of the impact due to PM emissions from the German textile sector. Results are finally extended to the overall world good consumption.

#### ISEE-1693

#### Use of Intake Fractions and Blood Half-Lives in Combination with Toxic Equivalency Factors (TEFs) to Evaluate Multi-Compound Emissions and Blood Concentrations

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**Background:** It is common to use Toxic Equivalency Factors (TEFs) to compare emissions of various congeners of dioxin-like compounds or PAHs. Based on dose-response experiments, these TEFs are adequate to compare intake, but are also often used inappropriately to produce TEF-weighted emissions or to compare serum concentrations of various congeners. The present paper develops a method to consistently compare both emissions and serum concentrations and applies it to the 29 WHO dioxin-like compounds and the 16 U.S. EPA PAHs.

**Discussion:** To relate emissions to intake, a multi-scale multimedia fate and exposure model is being developed with high resolution in the Laurentian Great Lakes region to determine Intake Fractions—the fraction of an emission that is taken in by the overall population. For PAHs, it shows that 3% of the emissions correspond to 53% of the intake, which

account for 98–99% of the toxic impact. This demonstrates that it is essential to account for both toxic potential (i.e., TEFs) and environmental transport/exposure (i.e., intake fraction) to weight PAH emissions. For serum concentrations, it is important to relate intake to serum concentration, which is done by accounting for half-lives and pharmacokinetics in the body. This pharmacokinetic method is illustrated using the 29 dioxin-like compounds, resulting in a deviation of up to one order of magnitude from the TEF-only calculation. The result is a model and set of Emission Equivalency Factors combining iF and TEF that can be used to appropriately weigh emissions based on their potential fate, exposure and health impact. Similarly sets of Blood Equivalency Factors will be provided combining pharmacokinetics and TEF to appropriately weigh blood concentrations.

#### ISEE-1694

#### A Methodological Framework for Environmental Carcinogen Exposure Surveillance in Canada

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**Background:** Cancer prevention efforts targeting environmental carcinogens are limited, due primarily to a lack of information. The Canadian Partnership against Cancer (CPAC), funded by Health Canada, has recently created Carex Canada, a national occupational and environmental carcinogen surveillance Unit, which will create regionally based exposure estimates for a number of priority carcinogens present in workplaces and communities across Canada. Carex Canada's goal is to produce geographically based and population specific exposure estimates for priority environmental carcinogens using a variety of data sources and modeling methods. The methodological framework for calculating regional based exposure estimates for environmental carcinogens in Canada is presented here as well as preliminary results for 4 carcinogens.

**Methods:** Priority environmental carcinogens for surveillance in Canada have been determined through an extensive prioritization process. Preliminary results indicate approximately 53 substances for immediate surveillance efforts. Systematic reviews of the literature as well as consultation with experts were used to develop the methodological framework for determining exposures to environmental carcinogens in Canada. The methodological framework was applied to 4 environmental carcinogens with different sources and routes of exposure.

**Results:** A methodological framework has been created to guide surveillance efforts for priority environmental carcinogens in Canada. The framework has 5 stages. Stage 1 systematically reviews exposure circumstances and routes of exposure (air, water, soil, food and consumer products) for each carcinogen and the relative contribution of each route of exposure to total exposure. Specific attention is focused on exposure circumstances and routes that may vary geographically or by population characteristics. Stage 2 is an extensive data identification and collection process targeting federal, provincial and local agencies. Stage 3 assesses the current data gaps and surveillance opportunities for environmental carcinogens in Canada. Stage 4 identifies gaps that may be supplemented with expert opinion data and highlights gaps that cannot be addressed without further data collection. Stage 5 applies monitor and model based methods for each significant carcinogen route of exposure with available data and will make use of Geographic Information Systems (GIS). Stage 6 combines model outputs with Canadian census data to determine national and regional exposure estimates. In addition to describing the methodological framework, preliminary results for 4 environmental carcinogens with different sources and routes of exposure will be presented. These include PM<sub>2.5</sub> and radon (air), water disinfection byproducts (water), and Mercury (food).

**Summary:** Identifying the number of Canadians exposed to environmental carcinogens, the levels of exposure and the geographic variation in exposure levels will provide significant support for targeting

exposure reduction strategies and prevention programs. Currently there are no programs that provide this information in Canada, and only limited environmental carcinogen exposure programs exist elsewhere. The results presented here are valuable to environmental surveillance initiatives and individual researchers.

#### ISEE-1695

#### Nutrient Intakes May Lower Oxidative Stress Among Those with Low Blood Lead Concentration

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**Background:** Oxidative stress may be affected by lead exposure as well as nutritional status, yet little is known about the interaction between nutrient intakes and blood lead concentration on oxidative stress level.

**Method:** As part of the Biomarker Monitoring for Environmental Health study conducted in Seoul and Incheon, Korea, between April and December 2005, we analyzed data from 366 men (mean age = 51.8 ± 8.3 yr) and 327 women (mean age = 51.3 ± 8.4 yr) who had complete measures on blood lead level, nutrient intakes, oxidative stress marker (urinary 8-hydroxy-2'-deoxyguanosine [8-OHdG]), and background variables considered in the analytic model. Nutrient intakes were assessed by a validated semi-quantitative food frequency questionnaire, blood lead level using atomic absorption spectrophotometry, and 8-OHdG by ELISA. For the purpose of statistical analyses, subjects were divided into 2 groups (Low[Q1] vs High[Q2,3,4]) by blood lead concentrations using a cut-off point was 3.2 µg/dL and 3 groups based on nutrient intakes (Q1 vs Q2,3 vs Q4). Interactions between nutrients and lead were estimated by employing analyses of covariance after controlling for main effects of nutrient intakes and blood lead levels and potential confounders.

**Results:** Mean 8-OHdG level was 6.59 ± 4.82 µg/g creatinine (median 5.58). Blood lead level differed by gender (male [5.06 ± 1.96 µg/dL] > female [3.85 ± 1.71 µg/dL]) as well as smoking and alcohol drinking status. In the low lead group, there were linearly inverse relationships between 8-OHdG level and micronutrient intakes including fiber, potassium, niacin, folic acid, β-carotene, and vitamin A, B<sub>6</sub>, C, and E. No such associations were found in the high lead group.

**Conclusion:** These findings suggest that better dietary quality associated with high micronutrient intakes may be beneficial regarding oxidative stress in case of low lead exposure close to less than 3.0 µg/dL.

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#### ISEE-1696

#### Pharmacokinetic Modeling to Support the Statistical Analysis of Blood Dioxin Concentration

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**Methods:** We develop a method to convert historical intake of dioxin-like compounds of a given individual into a 2005 actualized intake value. Three successive correction factors need to be applied. 1) Present food intakes are corrected to account for the change of intake with age, as a child eats less than an adult. 2) The second factor accounts for historical

changes in dioxin concentration in the food chain, with a peak around 1968. 3) The half-life of each congener in the body is used to decay past intake over time. This approach is used as a pharmacokinetic (PK) pre-treatment of food intake variables—expressed in a 2005 actualized number of meals over lifetime—before performing the statistical regression analysis. It also provides insights on an adequate statistical model for predicting blood as a function of food intake and age. The method is applied to the University of Michigan Dioxin Exposure Study in Midland and Saginaw, involving more than 950 participants whose serum Dioxin concentration was sampled. Results of various linear and non linear models for the statistical analysis are systematically compared with a physiologically based pharmacokinetic model (PBPK).

**Results:** In a traditional multiplicative analysis, age is the dominant parameter explaining variability in Dioxin concentration in blood. Using the actualized number of meals over lifetime enables us to explain more than 60% of the variability in blood concentration, with neither age nor BMI having a significant influence. This PK corrected model is compared with a non-linear hybrid model, composed of an exponential term for factor affecting decay rate (age, BMI, breastfeeding, smoking status) that multiplies a multi-linear sum of diet intakes, leading to comparable R<sup>2</sup> higher, close to 60% or higher. This model can be applied for the 29 WHO congeners and demonstrate a strong correlation between the age coefficient and the congener half-life in blood connected in the literature.

**Conclusion:** The PBPK model enables us to better discuss the respective contributions of each food items considered in the food questionnaire to the population blood concentration.

#### ISEE-1697

#### Effect of the Temperature and Precipitation on the Incidence of Acute Respiratory Infections and Acute Diarrheic Disease in Veracruz, Mexico

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**Background:** The increases of temperatures and the changes in seasonal precipitation patterns have impacts on human health. The acute respiratory infections (ARI's) and acute diarrheic disease (ADD) are very important in Mexico in terms of public health. The incidence of these diseases shows a clear seasonality, suggesting that climatic variables play an important role in their epidemiology. For this reasons we evaluate the relationships between temperature and precipitation on the incidence of ARI's and ADD in Veracruz, Mexico.

**Objective:** To estimate the effects of temperature and precipitation on the incidence of acute respiratory infections and acute diarrheic diseases cases in municipalities of Mexico.

**Methods:** Weekly cases from 1995 to 2005 of acute respiratory infections, acute diarrheic diseases in children under 5 year, temperature and precipitation of three municipalities of Veracruz, Mexico (Acayucan, Coatzacoalcos and Las Choapas) were analysed by time-series regression. A negative binomial regression model was used to model the relationships, using sine and cosine functions for seasonal adjustment.

**Results:** Preliminary results show that the risk of having acute respiratory infections in Acayucan is 4% less in the children below 5 years age (CI: 0.94, 0.99%) for each Celsius degree increase in maximum temperature, adjusting by precipitation with a lag of one week in both temperature and precipitation. In Coatzacoalcos (CI: 0.95–1%) and Las Choapas (CI 0.96–1%) was not found a significant effect. However, maximum temperature was positive associated with weekly diarrhea cases in the three municipalities of study. For every Celsius degree increased in maximum temperature, adjusting by precipitation, the number of diarrhoeal cases per week increased by 19% (CI: 3–32%) in Acayucan with a lag of 3 weeks in temperature and precipitation of the same week; 2% (CI: 1–4%) in Coatzacoalcos with a lag of 1 week in temperature and

precipitation of the same week; and 13% (CI: 1–28%) in Las Choapas, 1-week lag of temperature and 5-weeks lag of precipitation.

**Conclusions:** The study shows that the acute diarrheic disease is sensitive to climate changes on municipalities of Mexico. However there is a need to evaluate the health impact of climate variability and acute respiratory infections considering different ecosystems as well as vulnerability conditions for both diseases.

#### ISEE-1698

#### Assessing Economic Costs of Health Impacts of Environmental Risk Factors: What's in It for Epidemiologists?

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**Background:** Assessing economic costs of health consequences of environmental health determinants is a discipline attracting growing interest. Countries in the European region of WHO, for example, have included the topic in the 2009 Ministerial Conference on Environment and Health. Economic assessment is an important tool for evidence-based decision making, and information on costs and benefits of certain policies carry a heavy political weight. Impressive developments have taken place in the field. Comprehensive assessments of air quality, for example, have estimated the cost of mortality due to particulate matter pollution in the European Union at figures of the order of hundreds of billions euros per year; similarly, current transport policies in Europe have external health-related costs in the region of 6–8% of GDP; or, inaction on climate change may eventually cost up to 20% of GDP (as opposed to a 1% cost of action).

**Discussion:** These and other examples provide compelling additional arguments for adopting health-friendly policies (which are not always adopted promptly), but in other cases the picture is less clear: environmental regulation is often challenged on the grounds of limited effectiveness or “little value for money”. Current methodology and applications, in fact, pose several important questions, under current discussion in several research and policy settings. Some critical aspects have been highlighted in recent work carried out by WHO, OECD, EEA and the European Commission. Major challenges include: 1) framing: who commissions the assessment, what model of health one considers, what spatial and temporal boundaries are assumed, etc; 2) discounting: are tomorrow's health or monetary benefits less valuable than today's? If so, how much?; 3) distributional issues: whose costs and whose benefits does the analysis consider, and how can equity issues be incorporated in these assessments?; and 4) can epidemiological evidence be “packed” in such a way that these assessments are improved? if so, how? These questions need to be addressed from a multidisciplinary perspective. It appears important, in any case, that economic assessments are accompanied by or part of more comprehensive evaluations and are used as part of a broader context of evidence, and not as a unique/ultimate tool for determining the most appropriate course of political action or identifying the optimal solution.

#### ISEE-1699

#### Effects of Pregnant Women's Exposure to Bisphenol A on Oxidative Stress

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of Korea, #Department of Family Medicine, Seoul National University Hospital, Seoul, Republic of Korea; and \*\*Graduate School of Public Health & Institute of Health and Environment, Seoul National University, Seoul, Republic of Korea.

**Objectives:** Effects of endocrine disruptors on human health remains to be unknown. The purpose of this study was to investigate the association between exposure of pregnant women to endocrine disruptors and maternal oxidative stress.

**Methods:** A total of 770 pregnancy women who had lived in Seoul, Cheonan, and Ulsan, Korea were enrolled from July 2006 through November 2008. We measured levels of urinary Bisphenol A(BPA), Mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHP), Mono-(2-ethyl-5-oxohexyl) phthalate(MEOHP), Mono-(2-ethyl-5-butyl) phthalate(MEBP) as endocrine disruptor markers. We measured urinary Malondialdehyde (MDA) concentrations for measurement of oxidative stress.

**Results:** Mean urinary levels of BPA, MEHP, MEOHP, MEBP in early pregnancy were  $0.46 \pm 0.82 \mu\text{g/g}$  cr ( $N = 192$ ),  $9.42 \pm 9.44 \mu\text{g/g}$  cr ( $N = 171$ ),  $11.66 \pm 11.08 \mu\text{g/g}$  cr ( $N = 171$ ),  $19.28 \pm 17.07 \mu\text{g/g}$  cr ( $N = 171$ ), respectively. Geometric mean urinary concentrations of MDA in early pregnancy were  $2.20 \pm 2.29 \mu\text{mol/g}$  creatinine ( $N = 586$ ) respectively. In univariate analysis, urinary concentrations of BPA, MEHP, MEOHP, MEBP were significantly associated with MDA levels in early pregnancy. But these effects, except BPA, disappeared after adjustment for age, alcohol consumption, exercise, urinary cotinine levels. Urinary concentrations of BPA were significantly associated with urinary MDA levels even after adjustment of confounders during early pregnancy period ( $\beta = 0.20$ ,  $P = 0.04$ ).

**Conclusions:** Bisphenol A may have adverse effect on reproductive function, fetal development and children's growth etc. Maternal exposure to oxidative stress during pregnancy may explain the adverse pregnancy outcomes such as PTD, low birth weight, IUGR etc. These results suggest that Bisphenol A induces lipid peroxidation in pregnant women, potentially causing various health outcomes of pregnant women and their babies.

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#### ISEE-1700

#### Allergenic Potential of *Broussonetia papyrifera* Pollens Prevalent in the Atmosphere of Southern Taiwan

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**Background:** Pollens are known as major allergens in the atmosphere while increasing prevalence and mortality of asthma and rhinitis has been observed around the world. *Broussonetia papyrifera* pollen, a suspected inhalant allergen by only a few published literatures, was found to be a major genus, about 40%, in the atmosphere of southern Taiwan. This study was therefore aimed to assess whether *Broussonetia papyrifera* pollen in atmosphere could be a seasonal allergen in Taiwan.

**Methods:** Fresh pollens of *Broussonetia papyrifera* were collected from trees during March to May, the flowering season, for extraction before identical analysis was conducted with commercial pollens (Allergen AB, Sweden) for comparison. Serum of 20 allergic asthmatics (median level of total IgE = 580.50 EU/L) and 20 healthy schoolchildren (median level of total IgE = 17.65 EU/L), altogether 40, with 21 males and 19 female aged between 7 ~ 12 years old, were analyzed for the specific IgE levels after challenged with *Broussonetia papyrifera* extract, both of fresh ones and commercial preparation. Furthermore, thirty volunteer subjects (12 males and 18 female; aged between 23 ~ 38 years old) were recruited for

skin prick test (SPT) and the specific IgE analysis to *Broussonetia papyrifera* by Enzyme-Linked ImmunoSorbent Assay (ELISA). Nonparametric statistics of Mann-Whitney U and Spearman correlation was performed with S-PLUS 7.0 (Insightful Co.).

**Results:** Morphologically, the diameter of collected *Broussonetia papyrifera* pollens were 10–12  $\mu\text{m}$ , smaller than that of many prevalent pollens, and might be easier for penetration into respiratory track after inhalation. Specific IgE levels measured in subjects when exposed to fresh pollen extract correlated well with those measured after exposure to commercial pollen extract (spearman correlation = 0.86,  $P < 0.001$ ). OD value of specific IgE levels in schoolchildren with allergic asthma was higher than that of healthy children (median value 0.035 vs 0.025,  $P < 0.05$ ). Moreover, twelve subjects (40%) with positive response to skin prick test (definition of wheal areas greater than positive-control areas after challenge of histamine-dihydrochloride) had higher total IgE concentrations (median value 129.00 vs 34.65 EU/L,  $P < 0.001$ ) and OD value of specific IgE levels (median value 0.062 vs 0.034,  $P < 0.05$ ) than those without.

**Conclusions:** The allergic characteristic of *Broussonetia papyrifera* pollens is supported by tests on both school-aged children as well as young adults based on not only the specific IgE analysis but also the skin prick test, and therefore suggested to be one important emerging allergen in Taiwan.

#### ISEE-1704

##### Drinking Water Safety and Diarrheal Diseases in Peri-Urban Area of Mongolia

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**Methods:** A prospective cohort study aimed to identify the association between diarrheal diseases and drinking water quality was conducted in Ulaanbaatar city, Mongolia in 2003. In total, 169 households were questioned on water supply and sanitation and diarrhea cases, and drinking water was tested.

**Results Water Supply:** Some 40.4% of peri-urban households used public water kiosks while the rest was dependent on spring water. Almost half of the peri-urban households lived more than 200 meters far from the water source. Regarding water handling, 21.1% of the households did not cover water containers. Behavior to drink non-boiled water is practiced in more than half of the peri-urban households when compared with only 6.7% of the urban residents.

**Drinking Water Quality:** The microbiological quality of water at the collection point was within the acceptable limits of the national standard for drinking water. But spring water had total bacteria, total coliforms, nitrite and nitrate in excess than the standard. Household stored water had high level of contamination that the parameters were much elevated than at the source and were in the range of: total bacteria  $5.86\text{--}6.36 \times 10^3$  CFU/ml, total coliforms  $100.8\text{--}110.2$  CFU/100 ml, ammonia 0.119–0.48 mg/l, nitrite 0.018–0.026 mg/l and nitrate 9.457–9.682 mg/l. Tap water had much better quality than household stored water. The household stored water taken from spring had significantly higher level of parameters than the water taken from public water kiosk.

**Diarrheal Diseases in the Households:** According to the data from health agencies, the prevalence of diarrheal diseases in the peri-urban area was higher than that in the urban area. Among the reported diseases, diarrhea was the leading disease, followed by dysentery and viral hepatitis. In regard to self-reported diarrhea, the incidence rate of diarrhea 0.3 case/household year in the peri-urban area was three times higher than the rate in the urban area, which was 0.1 case/household year.

**Association of Water Supply and Diarrheal Diseases:** The distance to water source, water quality score and drinking of raw water were found to

be associated with diarrhea. Households, located far from their water source ( $\text{RR} = 3.20$ , 95%CI = 2.09–4.89), using poor quality water ( $\text{RR} = 2.41$ , 95%CI = 1.32–4.39) and drink raw water ( $\text{RR} = 1.90$ , 95%CI = 1.21–2.99) were at increased risk compared to households, located near to a water source, using relatively good quality water and do not drink raw water.

**Conclusions and Recommendation:** In this study water supply is associated with diarrheal diseases and found to be one of the contributing factors for endemic diarrheal diseases in the peri-urban area. The inadequate access to water source and drinking water contaminated in home coupled with common behavior of drinking of water without boiling are the risk factors of diarrheal diseases. Improper handling and storage of drinking water in the home is deteriorating water quality in households. There is a need to improve the provision of water supply and sanitation in peri-urban area. Health education for the households in peri-urban area on water safety, sanitation and personal hygiene is recommended.

#### ISEE-1706

##### The Relationship between Ambient Air Pollution and Children's Respiratory Diseases and Symptoms in China

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**Objective:** To analyze the relationship between ambient air pollution and children's respiratory health in China.

**Material and Methods:** Published papers from 1980 to 2007 were selected from those on ambient air pollution and respiratory diseases or symptoms in children according to the following criteria: (1) children who are in primary schools or in kindergartens; (2) local annual average concentration of air pollutants from air monitoring station was reported; the ATS-DLD questionnaire was used to investigate children's respiratory diseases and symptoms, including cough, long-term cough, sputum, long-term sputum, wheeze, asthma, bronchitis, pneumonia, which are showed as the incidence. Finally the data from 9 documents were used to assess the relationship between ambient air pollution and children's health in China by Pearson correlation analysis.

**Results:** According to the documents, the average levels of ambient air TSP were in the range of  $0.096 \text{ mg/m}^3\text{--}1.067 \text{ mg/m}^3$ ,  $\text{SO}_2$  were  $0.014 \text{ mg/m}^3\text{--}0.6 \text{ mg/m}^3$ ,  $\text{NO}_x$  were  $0.018 \text{ mg/m}^3\text{--}0.2575 \text{ mg/m}^3$ . There was a significant positive correlation between the levels of TSP and children's respiratory symptoms. The reported incidences of cough, long-term cough, sputum, long-term sputum, bronchitis increased 0.51% ( $R = 0.892$ ,  $P < 0.001$ ), 0.12% ( $R = 0.615$ ,  $P < 0.001$ ), 0.46% ( $R = 0.807$ ,  $P < 0.001$ ), 0.09% ( $R = 0.806$ ,  $P = 0.001$ ) and 0.049% ( $R = 0.87$ ,  $P < 0.001$ ), respectively, with per  $10 \text{ }\mu\text{g/m}^3$  increase of TSP. Stronger correlations between the levels of TSP and the incidences of children's respiratory symptoms were observed in south China and North China compared with all of China. The incidence of those symptoms increased 0.051% ( $R = 0.951$ ,  $P < 0.001$ ), 0.037% ( $R = 0.930$ ,  $P < 0.001$ ), 0.052% ( $R = 0.924$ ,  $P < 0.001$ ), respectively with per  $10 \text{ }\mu\text{g/m}^3$  increase of TSP. However, there was no significant correlation appeared between  $\text{SO}_2$  and  $\text{NO}_x$  and children's health.

**Conclusions:** Compared with other ambient air pollution, the levels of TSP showed the significant correlation with the incidences of respiratory symptoms and diseases in children, China.

#### ISEE-1707

##### Determinants Characterizing Vulnerability for Island-Wide Cardiovascular and Respiratory Mortality at Extreme Temperatures in Taiwan

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**Background:** Events of extreme temperatures have long been implicated with increasing mortality of both cardiovascular and respiratory diseases. Socioeconomic and behavioral factors, also age and race, are identified as critical determinants, through within- or inter-city comparison, to characterize effectively the adaptive capability when encountering extreme temperature events. However, only limited research has reported on the variability or extremes of temperature related to mortality in tropical countries where physical adaptation can be distinctively different from that of temperate zone. Our study aimed to identify the vulnerable regions (higher mortality ratio) under the extreme temperature events, and also to further characterize the attributable determinants for developing the adaptation strategy at events of extreme temperature in Taiwan.

**Methods:** The mortality ratio of cardiovascular and respiratory diseases for 358 townships was estimated with the number of deaths due to one of the 2 disease categories in the 2-week period after the temperature event as the nominator, and the number of deaths before as the denominator. Empirical Bayes procedure, affecting particularly the value for sites with small population at risk, was used to map the mortality ratio of both diseases during 24 cold surge events (1993 to 2003) and 14 heat waves (1993–2004), through the metrological evaluation, for each township across the Island. Principle component analysis was used to summarize the pattern of inter-correlation among 11 factors for each township, including income, percentage of service and agriculture occupancy, home ownerships, household overcrowding, aborigine, elders, elders living alone, disability, numbers of medical center and numbers of clinics. Major factors accounting for most the variance were therefore extracted. Spatial regression was applied to examine the association between extracted major factors and various mortality ratios during extreme cold and heat events.

**Results:** When comparing mortality ratios, metropolitan regions had relatively lower mortality ratios in both diseases during cold and heat events than those in rural. Substantial impacts were observed for cardiovascular mortality ratio at events of both cold and heat. Events of extreme cold, compared to heat, had greater impacts in mortality ratio in most townships. Three exploratory factors, including urbanization and medical resources, elders and vulnerable subgroups, and aborigine, were found to account for 75.83% variance in the 11 variables. Statistically negative association was identified between factors of urbanization and medical resources and mortality ratios by spatial lag model, taking into account the spatial dependence in the model. On the contrary, higher percentage of elders, vulnerable subgroups, and aborigine appeared to increase the vulnerability of the townships during cold and heat events.

**Conclusions:** Our data, using an island-wide analysis, suggested urban areas are with greater adaptive capability than rural areas, plausibly due to higher socioeconomic status and more medical resource. Aborigine people and other vulnerable subgroups, especially the elders living alone with more underlying diseases and having less preventive response to the event, were also the determinants of adaptive capability. Social inequality across urban and rural townships is apparent, and developing adaptation programs in vulnerable regions at the events of extreme heat and cold should be prioritized.

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**Objective:** To describe the indoor air pollution and to explore the potential health impact of indoor air pollution to the residents in the rural North China.

**Methods:** Rural villages with different fuel source including biomass, coal and liquefied petroleum gas (LPG) from North Hebei province and the suburbs of Beijing city were selected to monitor the indoor air PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub> and CO in Summer and winter; to acknowledge the respiratory symptoms of women and children via questionnaires and to perform pulmonary function test.

**Results and Discussion:** Results showed that indoor air pollution in the study areas came mainly from usage of biomass and coal for cooking and heating; indoor air quality in the household with decentralized heating system in winter was significantly higher than that in summer, and the indoor air quality in the household with decentralized heating system was also higher than that with central heating system. The results also suggested that the indoor air pollution in rural north China has already impact the respiratory system health of women and children. Moreover, it is very necessary to carry out environment and health education in Chinese rural areas. Finally, the plan for further research projects will be discussed.

#### ISEE-1714

#### Drinking Water Regulation in New EU Accession States of Estonia and Lithuania: Policy Implications of Scientific Controversies

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**Objective:** The goal of the research was to explain the influence of scientific controversies on the functioning of drinking water safety regulations in Estonia and Lithuania since they joined the EU in May 2004. The scientific controversies behind the set standards (e.g. the relevance zero-surrogate levels), their inclusiveness (e.g. not all the hazardous substances found in Estonian drinking water sources, e.g. barium, are regulated in the drinking water regulation) had to be acted upon in adopting the European regulation in these accession countries. The improper addressing of the exposure to the hazards from drinking water can pose a great public health concern.

**Methods:** The risk regulation regime perspective (Hood et al 2004) was applied to disaggregate the functional parts of setting the goals, monitoring and enforcing the drinking water regulation, and to test the ways in which the scientific controversies influence these components. The research draws upon a wide array of documentary information (e.g. scientific reports and legal statutes) and 40 semi-structured elite interviews carried out with the key Estonian and Lithuanian regulatory actors and scientists.

**Results:** Among pressures from organised interest groups and influence of public preferences, the knowledge uncertainties are key external drivers of regulation. Three ways in which scientific uncertainties influence the risk regulation can be distinguished. Firstly, the uncertain evidence undermines the knowledge basis of regulation design. Rushed Drinking Water Directive implementation process left little room for proper analysis of the suitability of the regulation to natural and infrastructural conditions of Estonia and Lithuania. Secondly, in the information gathering stage of regulation, lack of risk-based analysis has not allowed for clear determination of the sources of hazardous substances, leading to stakeholder debates and blame shifting. For example it is problematical whether water suppliers and inspectors should track down obscure trace elements (e.g. arsenic, uranium and radon), where the provision of primarily microbiologically pure drinking water is problematic. Thirdly, the scientific uncertainties about the causes and effects of the water-related disease impede the enforcement of new regulatory standards as the

#### ISEE-1710

#### The Survey on the Indoor Air Quality and Its Health Impact in Rural North China

Zhang J,\* Zeng Y,† and Liu L,† \*Chinese Research Academy of Environmental Sciences (CRAES); School of Public Health, Peking

local implementers are left with the burden of proof to demonstrate that the potential health risk might not be as harmful as assumed. Scientific controversies obfuscate the credibility of the standards and understandings whether the existing safety levels are worth following at all.

**Conclusions:** The scientific controversies were backgrounded in the process of change of regulation in new EU member states. This negligence affects the overall effectiveness of drinking water regulation. In the process of EU Drinking Water Directive adoption, a clear tendency of scientific and policy emulation can be identified. The main reasons for this trend are underdeveloped environmental health policy and research domain, low credibility of local epidemiological research and general bureaucratic strive for EU allegiance in Estonia and Lithuania.

#### ISEE-1717

#### Exposure Assessment for the Chemical Hazards Among Photolithographic Workers in a Color Filter Company

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**Objectives:** The purpose of this study is to assess the chemical exposure among photolithographic workers at a color filter company.

**Materials and Methods:** The workplace information was collected by questionnaire. We employed FOXBORO® TVA-1000 portable flame ionization detector (FID) to screen the TVOCs (total volatile organic compounds) levels at a clean room. The concentration distribution of TVOC will provide the location of "hot spot" of TVOC in the study area. After mapping the "hot spot" of TVOC, US EPA's TO-14 method was applied on the "hot spot" area to collect VOCs samples. The VOCs samples were collected with 6 L Silonite SUMMA® Style Canister (ENTECH, USA) and analyzed using Gas Chromatograph/Mass Spectrometry (GC/MS) to qualify/quantify individual VOCs. The health risk ranking was generated based on the questionnaire, and then the personal sampling was conducted on the workers ranked high risks. Personal sampling method from IOSH standard methods was adopted to investigate personal exposure levels of pollutants specified by TO-14.

**Results:** According to the area sampling results on GC-MS, we found that the major VOCs include clean solvents (Acetone and Isopropyl alcohol) and photo resist thinners (PGMEA and Cyclohexanone) in the color filter clean room. In personal sampling, only Acetone and IPA samples exceeded 1% of the Occupational Exposure Limit. In 19 acetone samples, 18 samples were greater than the detention limit, 3 of which were greater than 1% of the Occupational Exposure Limit. In 14 IPA samples, 13 samples were greater than the detention limit, one of which was greater than 1% of the Occupational Exposure Limit. Therefore, only the emission of the clean solvents needs more attention in the workplace.

**Conclusion:** After investigating the air contamination in the color filter clean room, we completed the chemical hazard identification of color filter photolithographic task and established the exposure profile for the normal workers and the prevention maintenance workers. A strategy for the area/personal sampling and the analytic technology were also established in this study.

#### ISEE-1719

#### Assessing Traffic Meter Attendants' Exposures to Traffic Air Pollutants and Health Effect

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**Background:** By mid-July 2006, traffic meter attendants in Taipei city reached a number of 635. Eight hours working along the roadside and constantly exposing to traffic related pollution results in risks to these

attendants who have the following occupational characteristic: Long-period exposure to traffic pollutants, closed to vehicles' emission, and work duration that contains at least one rush hour.

**Objective:** We realize that traffic meter attendants might expose directly to air pollution for a long period. Therefore, we want to: 1) Assess traffic meter attendants' exposures to traffic air pollutants on ambient particles, CO and noise; and 2) Discuss the adverse effects of cardiovascular and pulmonary system caused by traffic related pollutants.

**Methods:** 24 female attendants were recruited in this research to complete six-days of air sampling and health monitoring. Monitoring data of TEPA were also compared to instant personal sampling results. Inspection data of CO and noise dose were also gathered at work time. Outcome of air sampling were linked to health effects to assess the impact of traffic related air pollution, which includes PEFR, HRV (Heart rate variability), PWV (pulse wave velocity,) and also biomarkers of inflammations (CRP, fibrinogen, tPA, PAI-1, glucose and lipid profile).

**Results and Discussion:** We found that in work time the average of particles: < 0.25  $\mu\text{m}$ , 0.25–0.5  $\mu\text{m}$ , 0.5–1.0  $\mu\text{m}$ , 1.0–2.5  $\mu\text{m}$ , >2.5  $\mu\text{m}$ , PM<sub>1</sub>, and PM<sub>2.5</sub> could reach  $26.4 \pm 8.7 \mu\text{g}/\text{m}^3$ ,  $18.2 \pm 9.7 \mu\text{g}/\text{m}^3$ ,  $7.1 \pm 5.2 \mu\text{g}/\text{m}^3$ ,  $9.7 \pm 4.7 \mu\text{g}/\text{m}^3$ ,  $23.2 \pm 11.7 \mu\text{g}/\text{m}^3$ ,  $55.1 \pm 19.7 \mu\text{g}/\text{m}^3$ , and  $61.3 \pm 20.0 \mu\text{g}/\text{m}^3$ . Exposure of CO and noise could reach to  $1.60 \pm 0.71 \text{ ppm}$  and  $73.4 \pm 8.0 \text{ dBA}$ . When it comes to monitoring data of TEPA, PM<sub>2.5</sub>, PM<sub>10</sub>, CO and O<sub>3</sub> were  $47.2 \pm 22.0 \mu\text{g}/\text{m}^3$ ,  $69.2 \pm 27.2 \mu\text{g}/\text{m}^3$ ,  $0.9 \pm 0.3 \text{ ppm}$  and  $37.1 \pm 23.6 \text{ ppb}$ . Health outcome were shown in table. No lag effect was examined after simulating by a linear mixed effect model in pulmonary analysis. But we found 3 days lag effect in PWV (Pulse Wave Velocity) caused by PM<sub>2.5</sub> and PM<sub>10</sub> which is a popular indicator to predict stiffness and artherosclerosis. Moreover, we also found CO plays an important role in the homeostatic of heart rate and blood pressure.

#### ISEE-1720

#### The Need for Speciation of Organometallic Contaminants in Biomonitoring aka It's Not Just the Metal, It's What It's Wearing

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**Background:** Developing effective tools for metals biomonitoring necessitates characterization of the chemical species of the metal. Arsenic for example come in many chemical forms, some very toxic and related to a drinking water source, others much less toxic and traced to dietary sources. Chromium is both a micronutrient and a lung carcinogen depending on its oxidation state. The chemical form of the metal is often more important than the total amount of a metal in a sample collected for biomonitoring. As more is understood about each metal's toxicity, metabolism and sources of environmental exposure, more will have to be done on characterizing the chemical species of the metal within both the biological sample and its environmental source. The science of organometallic speciation has begun to make significant inroads into the field of biomonitoring. More and more methods are being developed for identification and quantization of different organometallic species in samples such as hair, urine, blood, digestive fluids and tissue. All of these new methods will be utilized in characterizing the fate and transport of a metal from environmental contaminant to biological sample. New methods such as EPA 6800, the use of speciated stable isotope labels and new SRMs such as 2701 and 2669 will make methods development significantly easier in the future.

**Discussion:** We have developed three different speciation methods for both environmental and biological samples. Mercury, chromium and arsenic all present significant human health risks and all can be traced to one type of environmental contaminant pathway or another. The methods themselves utilize a chromatographic separation with ICPMS detection. The difficult part in speciation for biomonitoring is not the analysis but rather the isolation of the organometallic species from its biological or

environmental matrix. This presentation will focus on the methods developed for biomonitoring of metals and their application in human exposure and animal studies. The analytical procedures, including microwave extraction as well as the significance of their application will be presented. For example, in one subject for one time point, the amount of total arsenic in urine was 10 times higher than the non dietary arsenic concentration. Chromium can be reduced upon ingestion but can also be complex, and the inorganic species of mercury ( $Hg^{2+}$ ) was found in many regions of the brain in an animal study. These are just three of the examples that will be presented demonstrating the need for speciation in biomonitoring studies. The presentation will be an overview of the analytical methodology, a summary of the studies that used the techniques and a discussion on the future of elemental speciation for environmental monitoring.

**ISEE-1723****Human Health Risks Associated with Fish and Shellfish Consumption in an Industrialized Leasehold in a Southern California Bay**

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**Methods:** This study describes a human health risk assessment of anglers who catch and consume fish from an industrialized leasehold in a Southern California bay. Potential exposures to polychlorinated biphenyls (PCBs), inorganic arsenic, copper, mercury, and cadmium via ingestion of fish (spotted sand bass) and shellfish (lobster) were calculated using edible tissue samples collected from within the leasehold. Deterministic and probabilistic exposure assessment techniques were used to characterize cancer and non-cancer risks. Wherever possible, site-specific data were used, and due to the nearly complete lack of access at this particular site, a subsistence angler was not considered to be a realistic exposure scenario. The evaluation considered published fish consumption rates (FCR) from creel/angler surveys conducted in industrialized, limited access areas as well as accessible, recreational areas. The deterministic risk assessment used a FCR from a creel/angler survey conducted in a highly industrial area with relatively few access points for anglers. For purposes of comparison, the probabilistic assessment also used a fish consumption rate distribution that included values from other recreational areas in Southern California, as well as the FCR from the industrial site.

**Results:** Deterministic cancer risk estimates based on mean tissue concentrations (fish or shellfish) ranged from  $1.67 \times 10^{-8}$  to  $1.62 \times 10^{-6}$  for inorganic arsenic and from  $1.70 \times 10^{-8}$  to  $2.53 \times 10^{-7}$  for PCBs; deterministic cancer risks based on the 95% UCL tissue concentrations were below  $1 \times 10^{-6}$  for both chemicals. The probabilistic analysis for both fish and shellfish indicated that cancer risks for the 50<sup>th</sup> percentile were below  $10^{-11}$ ; even at the uppermost portion (99<sup>th</sup> percentile) of the population, cancer risks for both chemicals were below  $1 \times 10^{-6}$ . The low risk estimates for PCBs are consistent with the observation that fish and shellfish tissue concentrations reported in this study are statistically indistinguishable to what has been measured elsewhere in the bay, in other non-impacted waters in California, and at several "background" locations. The corresponding uncertainty analysis indicated that by and large, the fish consumption rate had the greatest contribution to total variance (approximately 86% and 90% for PCBs and arsenic, respectively). Other contributors included exposure duration and the Aroclor 1260 cancer slope factor (for PCB risk). For arsenic, the fraction of arsenic that was assumed to be inorganic contributed about 5% to the total variance. This value was assumed to range from 0–4% in the probabilistic assessment, as it was not specifically measured in the tissue samples used in this analysis. For the non-cancer risk assessment, all hazard indices were well below 1. Even using the 95% UCL tissue concentrations, the hazard indices did not exceed 0.013, 0.019, 0.04, 0.004,

and 0.0004 for inorganic arsenic, total PCBs, mercury, copper, and cadmium, respectively.

**Conclusion:** Taken together, this risk assessment indicates that consumption of fish caught at this particular site does not pose an increased cancer or non-cancer risk to anglers.

**ISEE-1724****Indoor Air Pollution and Child Health in a Rural Area in Egypt**

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**Background:** The Egyptian Demographic and Health Survey indicated that 10% of children under the age of 5 years complained of acute respiratory tract infection, and 19% suffered from diarrhea. The mortality rate for the under-five years old was 46 deaths per 1000 births and the results showed a strong negative association between household wealth and early childhood morbidity and mortality rates. Another study assessed home environment and its relation to child health in rural area in Alexandria revealed that 99% of the study subjects complained of cough, 40.9% had pneumonia 10.5% had bronchitis, and 6.2% complained of dyspnea. Generally, these complaints were related to environmental factors. To better understand the impact of indoor air pollution on child health, we conducted this study in a rural area in Egypt.

**Methods:** By using a multistage method, 70 homes were randomly selected; all children under five years of age, along with their mothers, in those houses were included in the study. General health assessment and anthropometric measurements were done for 84 children included in the study. A socio-demographic scale was used to identify the family's social class. An observational checklist was used to assess the indoor home environment for sources of indoor air pollution. Measurements of concentrations of indoor physical and biological air pollutants were carried out from the chosen houses. Finally, a structured interview was used to assess mothers' practices.

**Results:** Among the children under study, more than one quarter (28.6%) had low birth weight with 10.7% of them born pre-term; approximately one quarter of the children suffered eye inflammation, irritation and discharge (25%, 28.6%, 21.4%, respectively). More than half of the children (57.1%) suffered runny nose, 10.7% had discharge and flaring nose. 39.3% of the children had moist cough; 57% had dry cough; 42.9% had wheezes; 39.3% complained of difficulty in breathing; 39.3% suffered skin rash and itching; 35.7% were diagnosed for having asthma; and 10.7% were diagnosed for allergic rhinitis. Air pollution measurements show that Means of TSP, CO, SO<sub>2</sub> & NO<sub>2</sub> were 45.01, 2.27, 13.95, 4.69  $\mu\text{g}/\text{m}^3$ , respectively. Indoor air samples from the sampled homes show total number of microorganisms ranging from  $11 \times 10^6$  to  $30 \times 10^6$  cfu/m<sup>3</sup> and pathogenic microorganisms ranging from  $9 \times 10^6$  to  $24 \times 10^6$  cfu/m<sup>3</sup>. 85.7% of the sampled houses had domestic/farm animals and birds either inside or in the shed near the house. All rooms inside the houses had at least one window, but only 41.7% of which had separate kitchen. Although all the houses had a natural gas stove, the vast majority (95.2%) still relied on the traditional rural cook stoves that used dung, wood, animal and agricultural residue as a fuel (90.5, 71.4%, 85.7%, 95.2%, respectively). Questionnaire data indicated that 71.4% of the fathers smoked indoors and 65.5% of the houses have other relatives who smoked indoors. Prevalence rates for the presence of visible cockroaches, rodents, mold/mildew, flies/mosquitoes and water damage indoors were 48.8%, 61.9%, 81%, 100%, and 47.6%, respectively. Analyses are being undertaken to relate health outcomes with indoor air pollution concentrations and household characteristics.

**ISEE-1730****Incidence of Malignancies in Relation to Terrestrial Gamma Radiation in Two Swedish Counties 1973–2000**

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**Background:** Several epidemiological studies have investigated if the terrestrial gamma radiation is a risk factor for malignancies, but the results have not been consistent. In Sweden the mean gamma dose rate is 90 nGy/h and up to 1,700 nGy/h in areas with alum shale.

**Methods:** From the National Archives and the Statistics Sweden all individuals were retrieved from the counties of Kalmar and Östergötland in 1973 together with their annual dwelling coordinate (1 meter accuracy) up to year 2000. In all, 477,759 individuals were included in this retrospective cohort. Geographical Information System (GIS) technique was used to match the dwelling coordinates with their inhabitants to the terrestrial gamma radiation (TGR). TGR has been calculated in a 200 × 200 meter grid by the Geological Survey of Sweden after aerial measurements. A mean lifetime dose rate was calculated for each individual during follow up 1973–2000. Cases of malignancies and deaths were retrieved from the Swedish Cancer Register using the unique personal identification number. Cox-regression was used to analyze the incidence on malignancies both assuming a continuous relationship with radiation, but also in six exposure categories. The relative risk (RR) was calculated with the lowest gamma radiation category as reference (ref), and adjusted for age as a continuous variable.

**Results:** The incidence of total malignancies, and also in some specific sites showed a positive and statistically significant relationship using a linear model (ERR per 100 nGy/h). When analyzed in six exposure categories (0–60, 61–75, 76–83, 84–91, 92–95 and 96–366 nGy/h) there was a dip in RR in the first two categories followed by an increase in the highest category. Leukemia showed RR (95%CI) of 1.00 (ref), 0.86 (0.74–1.01), 0.97 (0.82–1.14), 1.19 (1.01–1.39), 1.18 (0.93–1.50) and 1.39 (1.10–1.75). The RR for total malignancies was 1.00 (ref), 0.92 (0.89–0.94), 0.94 (0.92–0.97), 1.05 (1.02–1.08), 1.14 (1.10–1.19), 1.25 (1.21–1.30).

**Conclusion:** Previous observations of increased incidence of some malignancies in relation to TGR were replicated. The interpretation of the results is complicated as the linear model might not be appropriate. In Sweden it is possible to link TGR on an individual level with high accuracy, hence enables large studies.

**ISEE-1731****The Respiratory Function Tests Among Domestic Waste Workers**

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**Introduction:** Domestic solid waste management is a relatively new field in this country as compared to others and usually not many are involved. Hence they are often left out from the field of research. Thus it is the objective of this study to investigate the status of respiratory functions of these workers and the factors that might influence it.

**Methodology:** The selected disposal sites are within Peninsular of Malaysia. The respondents are grouped into two categories; direct and indirect contact with the solid wastes. Each respondent answered a standard questionnaire which includes demography and health data. Ambient air concentration of PM<sub>10</sub> and personal air monitoring were done only on one particular landfill due to logistic limitation.

**Results:** Respiratory functions tests revealed that 21 (46%) workers showed abnormal readings. The PM<sub>10</sub> concentration in the landfill was 735 µg/m<sup>3</sup> which is hazardous and higher than USEPA standard for ambient air (500 µg/m<sup>3</sup>). The mean for personal air monitoring in that

particular landfill was 1299 ± 2678 µg/m<sup>3</sup>. Only the usage of personal protective equipments (PPE) has a significant relationship with level of workers' knowledge.

**Conclusion:** We demonstrated that solid waste workers are exposed to high PM<sub>10</sub>. The poor reading of respiratory functions tests was associated with exposure to the dust. It is suggested that the respiratory function tests should be a part of medical surveillance among domestic waste workers.

**ISEE-1733****Establishing a Dynamic Exposure Assessment with an Activity-based Modeling Approach: Methodology and Results for the Dutch Case Study**

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**Introduction:** In large-scale population exposure assessments, exposure monitoring studies are not applicable and air quality monitoring does not cover the entire study area. In these cases, air quality modeling approaches are often combined with residential information to perform indirect population exposure assessments. However, this static approach is often the subject of controversy since the exposure is likely to be underestimated in (urban) areas with a large concentration of work activities. Unfortunately, attempts at more advanced dynamic exposure assessments, certainly for large study areas or large time scales, are -to the best of our knowledge- very scarce.

**Research Goals:** The main objective of this research project is to develop a population exposure model for the Dutch population taking into account population and concentration dynamics in the entire study area, and using, for the first time, an activity-based modeling approach for this purpose. More specifically, this project also focuses on the evaluation of spatio-temporal differences between this new dynamic approach and the conventional static exposure assessment.

**Methodology & Results:** The first step in the exposure modeling procedure concerned the simulation of people's travel patterns in the Dutch study area. In this first step a comprehensive population dynamics model, the activity-based model ALBATROSS, was used to simulate activity-travel patterns for individuals within the population (approximately 10 million agents). The activity-based model relies on a set of decision rules to simulate activity-travel schedules and takes into account spatial and temporal interrelationships between simulated trips. This activity-based modeling step resulted in hourly population distributions over 4000 population zones. A validation of the predicted travel behavior displayed only slight differences with reported travel values (less than 10%). Next, hourly exposure concentrations were modeled with the AURORA Eulerian grid model, using meteorological, geographical and emission input data. By using a nested procedure the concentrations were simulated for the entire study area with grid cell sizes up to one square kilometer. Considering the size of the study area (± 40,000 km<sup>2</sup>) and the intended time scale (six months of modeling on 1-h time resolution), this modeling step was very time-consuming. In a last step, the exposure to atmospheric pollutants was estimated using GIS overlay techniques in ArcView. Due to the importance to health and/or traffic purposes, only the emissions from PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>x</sub> were considered for exposure analysis. Both hourly exposure estimates per population zone as integrated exposure indices were calculated for the Dutch population for the assigned time period. By comparing these results in a GIS environment to the exposure results from the static exposure method the differences between both approaches were evaluated.

**Conclusion:** The results of this study indicate the importance of using a dynamic exposure approach instead of a conventional static exposure method. Further, this research also demonstrates the possibility of using an activity-based model for exposure analyses. Considering the

characteristics of this population dynamics model, further research will allow for impact analyses of several traffic control and emission reduction measures on the exposure of people.

**ISEE-1734****Effect of Interaction Between Temperature and Air Pollution on Daily Mortality During Heat-waves**

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**Background:** In recent decades, the number of heat-waves occurring in the Netherlands increased. Severe heat waves in 2003 and 2006, probably caused tens of thousands excess deaths throughout Europe, and led to a number of publications on the effect of heat on mortality. Some of these suggest a modification of air pollution effects during heat waves. We assessed whether air pollution effects on mortality show an increase during heat waves in the Netherlands. In the Netherlands a heat wave is defined as a period of five or more consecutive days with a maximum temperature of at least 25 °C, of which three or more days show a maximum temperature of at least 30 °C, as measured in the centrally located town of De Bilt.

**Methods:** We present the analysis of covariate adjusted time series of daily mortality, air pollution and temperature in the Netherlands from 1986 up to 2006 using generalized additive models (GAM) with penalized splines to explore the effect of heat waves on the effect of air pollution on mortality. Additional covariates included relative humidity, ambient air pressure, influenza cases, pollen counts, national holidays, and day of the week. Daily air pollution data for particulate matter, ozone, nitrogen dioxide, nitric oxide, and black smoke were measured at the National Air Quality Measurement Network. Daily counts for total non-accidental, cardiovascular, respiratory, COPD, and pneumonia mortality were provided by Statistics Netherlands. Meteorological data were provided by the Royal Netherlands Meteorological Institute. We used the mgcv package in R for GAM modelling applying cubic regression splines.

**Results and Discussion:** Our results show increased effect estimates of the associations between air pollution and daily mortality during a heat wave period compared to non heat wave periods, suggesting that a substantial number of daily deaths attributed to high temperatures, could be attributed to the interaction between temperature and air pollution.

**ISEE-1736****Bisphenol A, Age, Ethnicity and Health Outcomes**

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**Background:** Bisphenol A (BPA) is a plasticizer widely used in food and drinks packaging. Evidence of effects in animals has generated concern over low-level chronic exposure in humans.

**Objective:** To examine associations between urinary BPA concentrations and health status in children and adults and across ethnic groups.

**Methods:** Cross-sectional analysis of the National Health and Nutrition Examination Survey (NHANES) 2003-04, representative of the general population of the United States. Outcomes studied included chronic disease diagnoses (in adults) plus blood markers of inflammation, lipids, liver function, and glucose homeostasis. Regression models were adjusted for age, sex, race/ethnicity, education, income, smoking, BMI, waist circumference, and urinary creatinine concentration.

**Results:** Higher urinary BPA concentrations were present in children. Higher levels were also present in non-Hispanic Black Americans compared to other groups.

In adults, higher urinary BPA concentrations were associated with cardiovascular diagnoses and diabetes but not with other studied common diseases (see JAMA, Sept 2008). In addition, higher BPA concentrations were associated with clinically abnormal levels of the liver enzymes gamma-glutamyl transferase 1.29 (95% CI 1.14 to 1.46,  $P < 0.001$ ) and alkaline phosphatase (OR per SD increase in BPA 1.48 (95% CI 1.18 to 1.85,  $P = 0.002$ ). Ethnic group differences were explored, but interaction terms were not significant.

In children (data available for those aged 10 to 17 yrs,  $n = 499$ ), models adjusted for age, sex and urinary creatinine, higher urinary BPA concentrations were associated with higher concentrations of lactate dehydrogenase ( $P$  for trend = 0.043). A ‘one sided’ association was also present for alkaline phosphatase concentration ( $P$  for trend = 0.069) but no association was found for  $\gamma$ -glutamyl transferase ( $P$  for trend = 0.446).

**Conclusion:** Cross sectional associations exist between higher BPA exposure, reflected in higher urinary concentrations of BPA, and diabetes, heart disease and liver enzyme increases in the community-dwelling adult population. The liver enzyme increases are also present in children aged 10 to 17 yrs. Given this consistency of findings, further work is urgently needed to clarify whether these associations are causal. Further work is also needed to explore ethnic and other disparities in BPA exposure and outcomes across the US population.