Environmental Determinants of Hypertension /High Blood Pressure

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Outline

- **Brief introduction on Hypertension worldwide**
- **Currently understood causes and solutions**
- **Environmental determinants: air pollution as an exemplar**
- **What can be done ?**

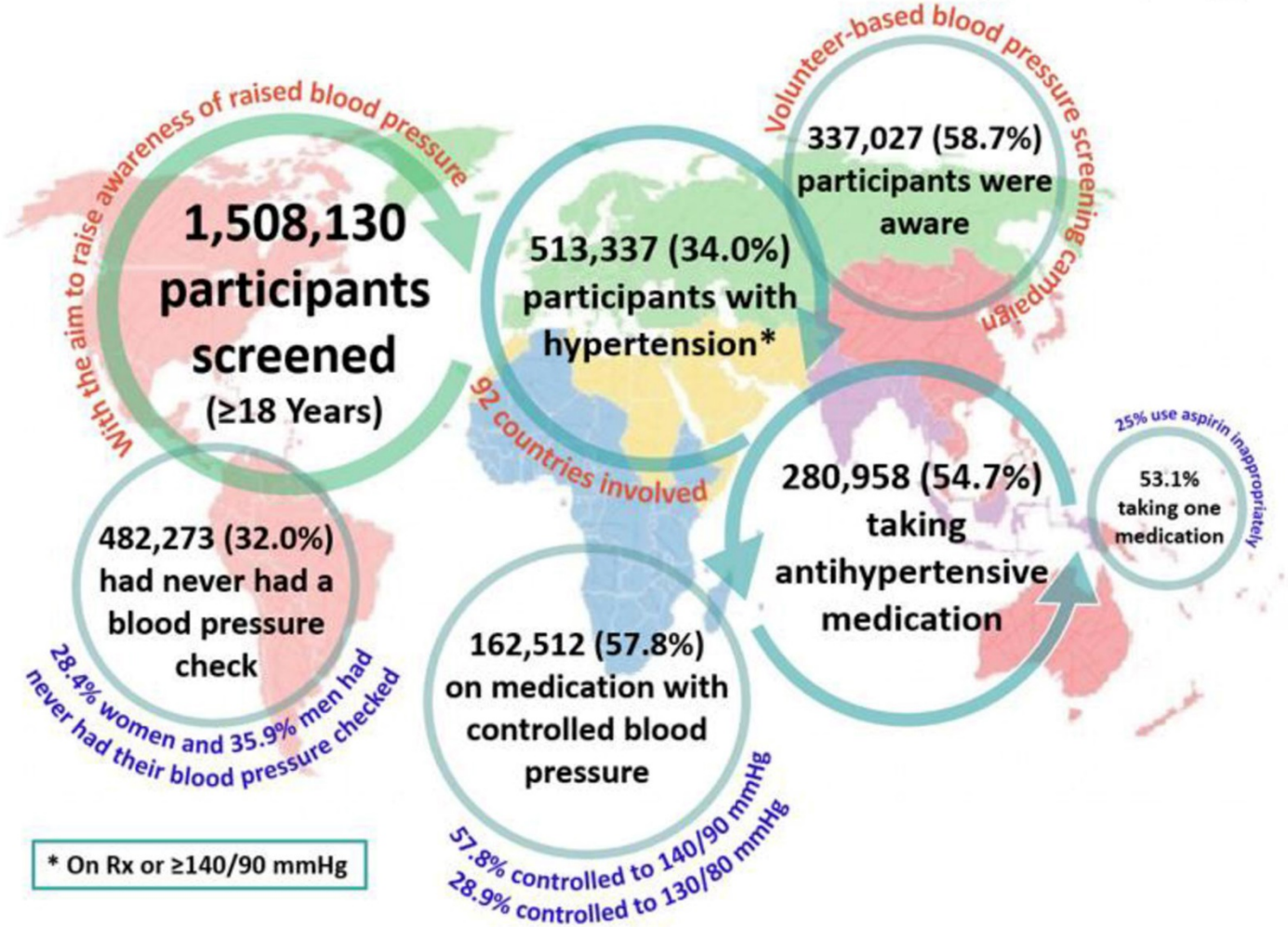
High blood pressure in some numbers (Global: 2017)

- 10.4 million deaths (136.5 deaths per 100,000 population)
- 18.7% of total deaths
- 21.5 million YLDs (280 YLDs per 100,000 population)
- 2.5% of total YLDs
- 218 million DALYs (2852 DALYs per 100,000 population)
- 8.7% of total DALYs
- Huge burden in LMICs

https://vizhub.healthdata.org/gbd-compare/

May Measurement Month 2019

The Annual Blood Pressure Screening Campaign



Beaney et al. Hypertension 2019

What is well known about hypertension in the world

A disease of THREE PARADOXES

- **Easy to detect but diagnosis rates are dismal**
- **Easy to treat but treatment rates are disappointing**
- **Several potent drugs are available, but control rates are abysmal**

Established Causes

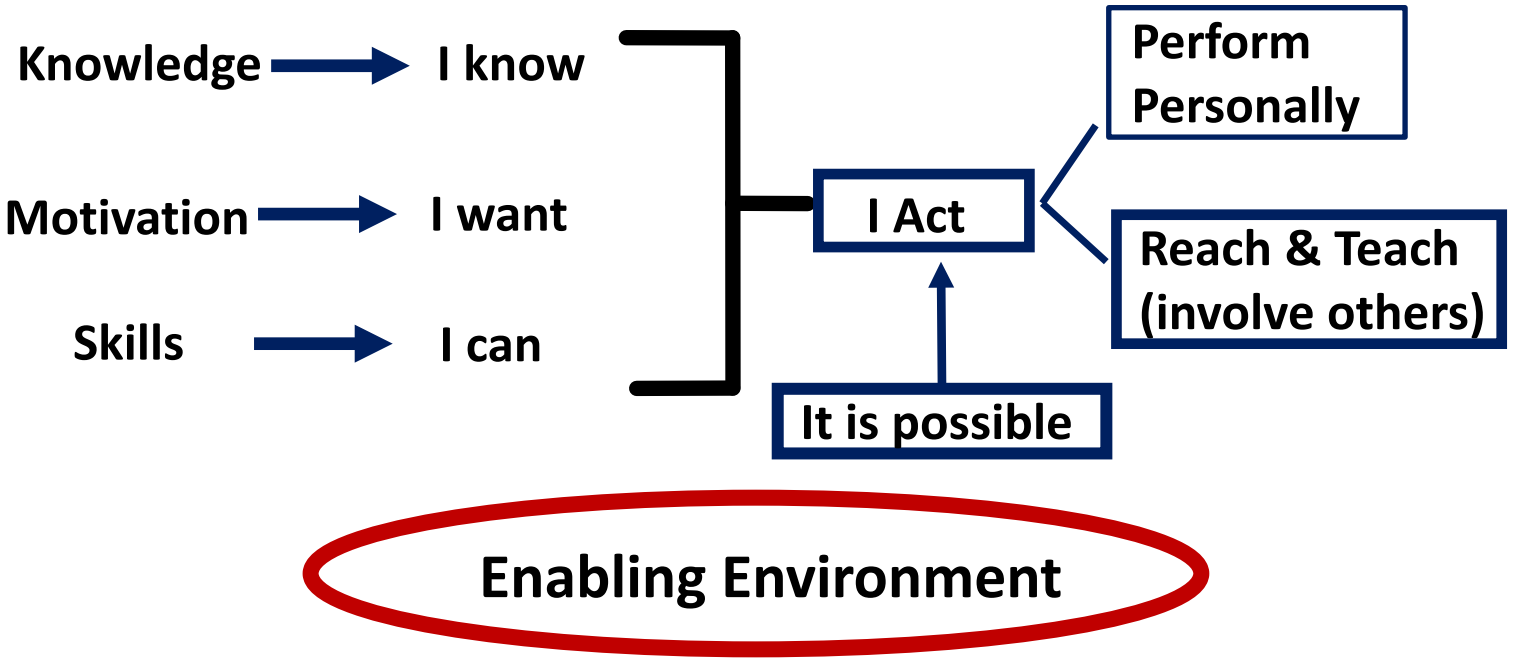
- High Sodium intake
- Low fruit and vegetable intake
- Alcohol
- Overweight/obesity
- Low physical activity

Solutions

- Lifestyle Change (Behavior change)
- Simple drugs
- Policy interventions on sodium

Personal and Environmental Changes Needed For Behaviour Change

PATHWAY TO HEALTH PROMOTION



Opportunistic Screening; some disruptive thinking

What is not so well known : Upstream determinants

Environmental determinants

- Air Pollution
- Noise pollution
- Green spaces
- Water pollution (heavy metals)
- Others

Is there evidence ?

Attributable CVD risk of pollution

- **Exposure to air pollution and Pb accounted for an estimated 10% of all deaths and 17% of cardiovascular deaths in 2017 (Global Burden of Disease, 2018)**

- **Exposure to lead (Pb) remains a serious threat to population health. (Landrigan, 2018; Lanphear, 2018; NTP, 2012; Prüss-Ustün, 2016)**

- **Lanphear et al. (2018) estimated that as much as 18% or 412,000 deaths per year (all-cause mortality) in the United States could be attributed to environmental Pb exposure (Lanphear, 2018)**

Air Pollution, Built environment and green spaces: Example from India

Sick Individuals arise from Sick Populations

Geoffrey Rose

How did we study this ?

- **CARRS**

- **Geo Health**

Centre for CArdiometabolic Risk Reduction in South Asia Surveillance (CARRS) Cohort

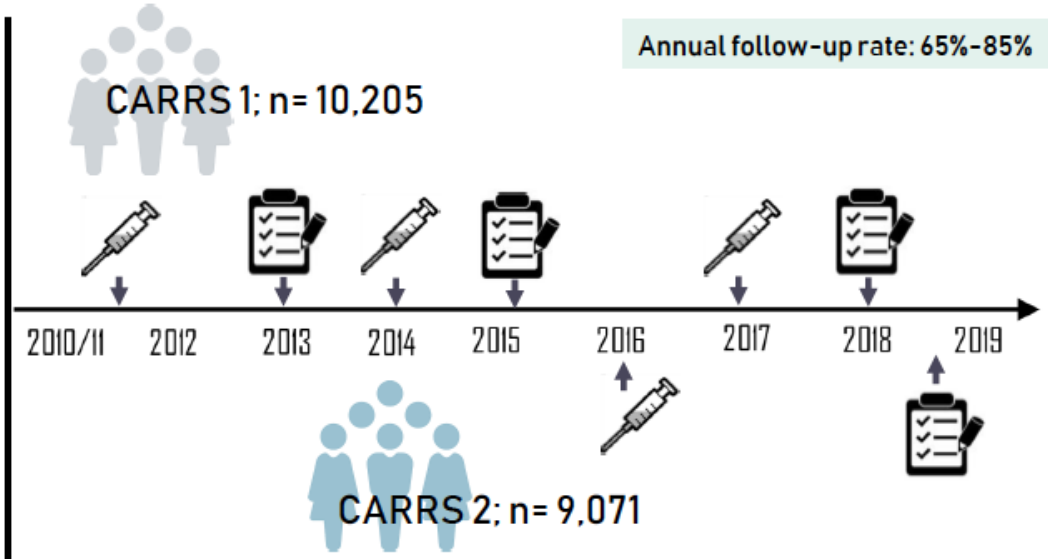
COE-CARRS

Population-based sample of 19,276 adults followed for up to 8+ years

Representative of megacities in North (Delhi) and South (Chennai) India

Carefully phenotyped and geocoded study population

360,000 (640,000) stored aliquots of sera, plasma, buffy coat, and urine; DNA for subsample (3,000)



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MADRAS DIABETES RESEARCH FOUNDATION

The Geo-Health Program

Goal: A fully integrated research and training program on air pollution and cardiometabolic diseases with policy relevance to improve health of Indians, and a hub for the region(7 in the world)

1. Developing a model to estimate ambient exposure to air pollution (AP) levels in Chennai and Delhi

2. Estimate association between exposure to AP, temperature, CM risk factors & diseases and built environment

3. Examine DNA methylation patterns associated with AP -- > bio-markers

4. Examine the association between AP & vitamin D levels

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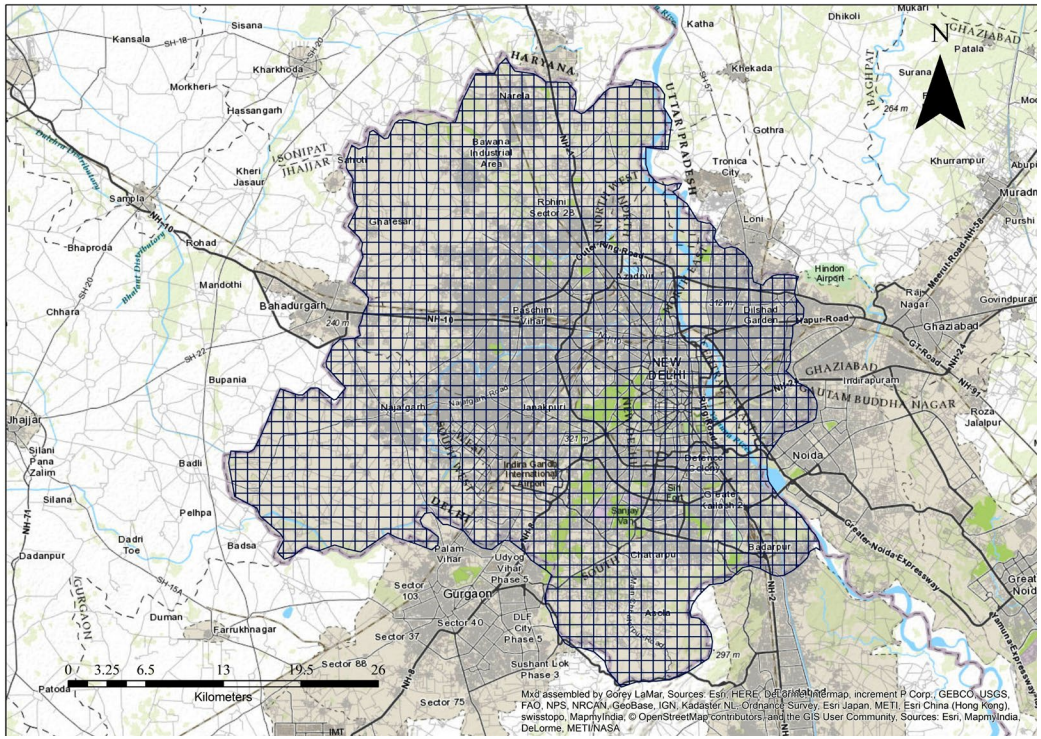
The Geo-Health Program

Main Objective : Link PM 2.5 levels to incident CVD risk factors and outcomes in Delhi and Chennai



- Develop an exposure model to predict daily $PM_{2.5}$ concentrations at a 1 sq. km. spatial resolution for Delhi.
- A total of 1635 grids, 7 years (from 2010 to 2016), 2557 days.
- 4180695 observations.
- Area: 1484 km^2

DATA FROM MULTIPLE SOURCES

POLLUTANTS

- Daily average $PM_{2.5}$ and PM_{10} concentrations at 25 stations

SATELLITE

- Aerosol optical depth
- Vegetation index
- Ultraviolet emissions
- Active fires

EMISSION INVENTORIES

- Grid level area emissions for PM2.5
- Accounts for industries and brick kilns

WEATHER

- Temperature (Air and Dewpoint)
- Relative Humidity
- Wind Speed
- Precipitation
- Cloud cover
- Evaporation
- Soil temperature

LAND USE

- Length of roads and runways
- Location of bus-stops, bus terminals, railway stations, markets, malls, industries, power plants and solid waste dumpsites
- Builtup area
- Ward level population density

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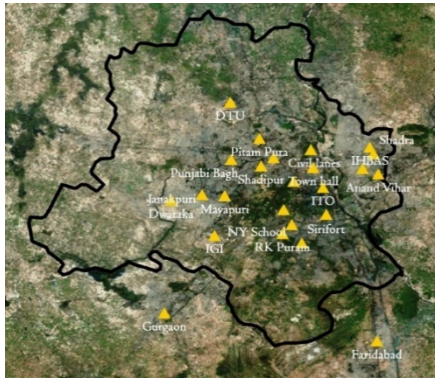
Structure of Model

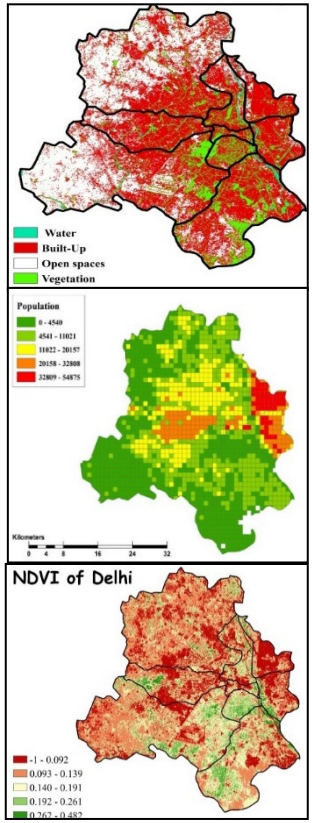
"Ensemble modelling"



Monitoring data

AOD

+



Land Use Variables

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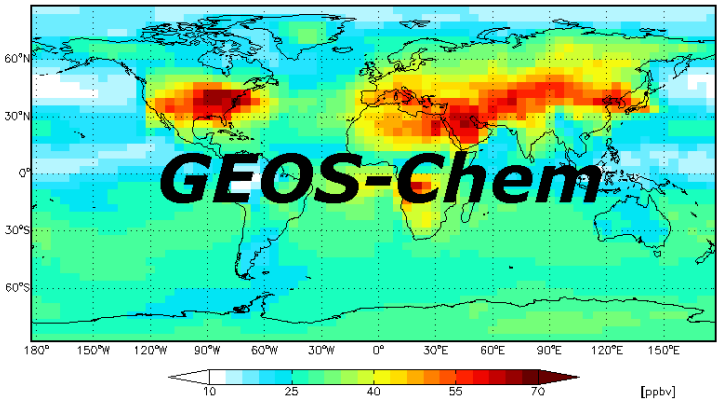
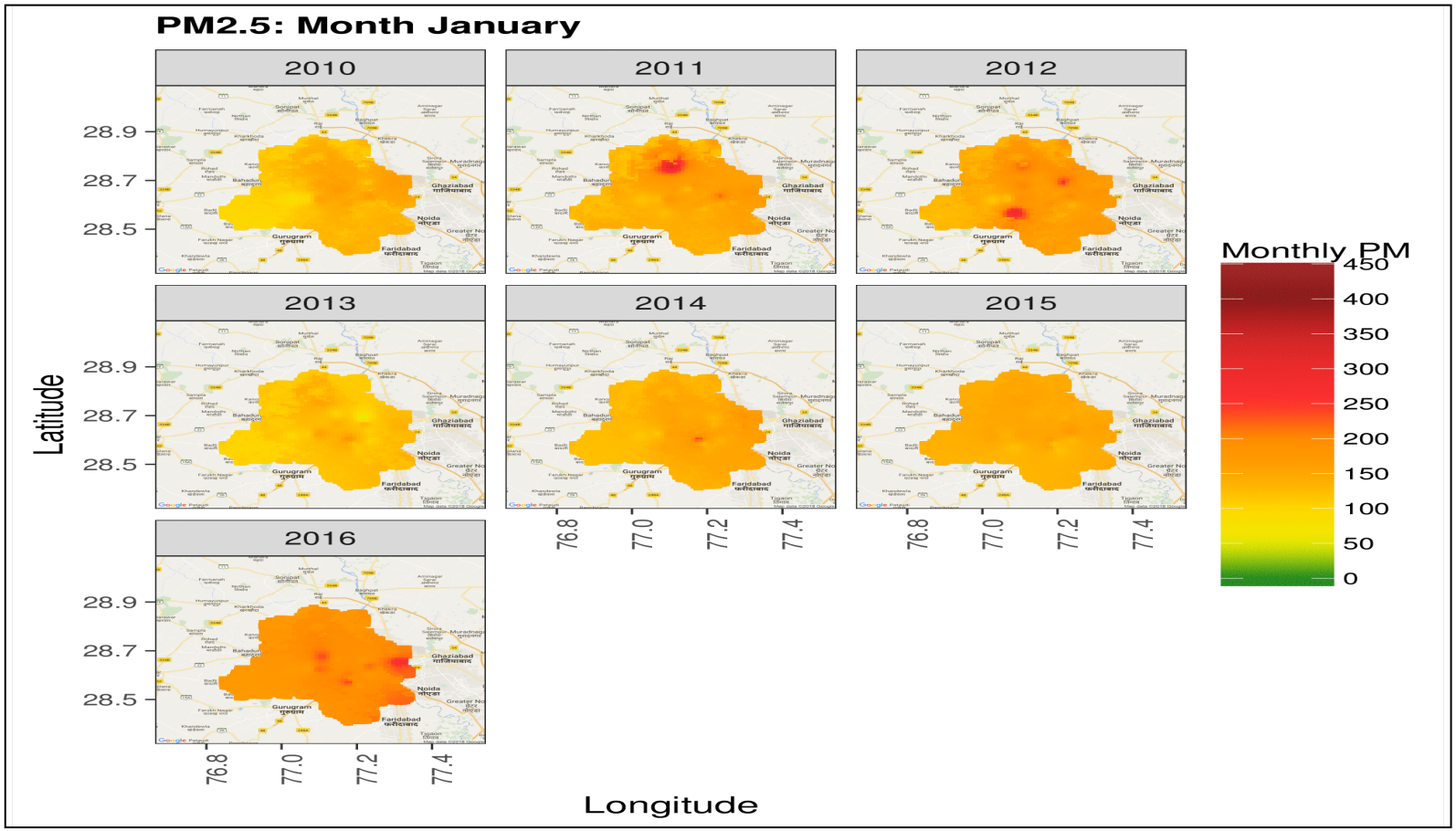


Chemical Transport Model

Adjusted for meteorogical variables

Initial estimates of $PM_{2.5}$ exposures over Delhi



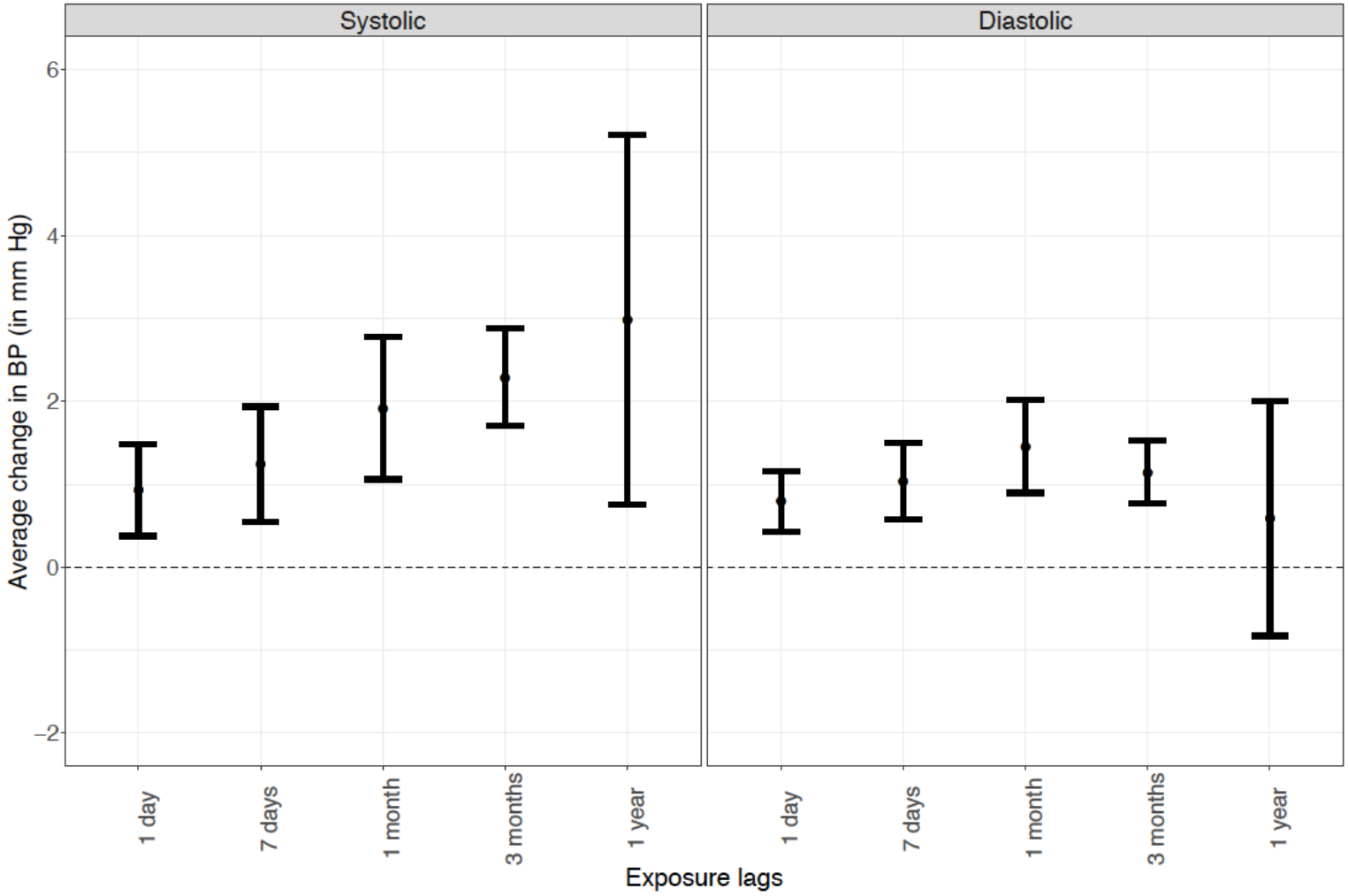
Association Of Long And Short Term Exposure To $Pm_{2.5}$ with Systolic Blood Pressure (Data From CARRS)

- 3296 individuals from 2248 households with three measures of BP over 7 years.
- Longitudinal mixed effects models adjusted for demographic variables, risk factors, road proximity and accounting for individuals clustered within wards.
- For every 25 µ/ m^3 of $PM_{2.5}$ the BP was higher by 3.5-5 mms depending on BMI
- Decreasing annual PM2.5 by 25.1 µg/m^3 can potentially decrease SBP by 2.98 mmHg

Annual average PM2.5	Decrease from current Average of 125	% decrease in prevalent hypertension
100	25	5.3
75	50	9.9
40 (National standard)	85	15.1

Unpublished data; please do not quote

Short and long-term exposure to $PM_{2.5}$ (every quartile increase) and SBP/DBP



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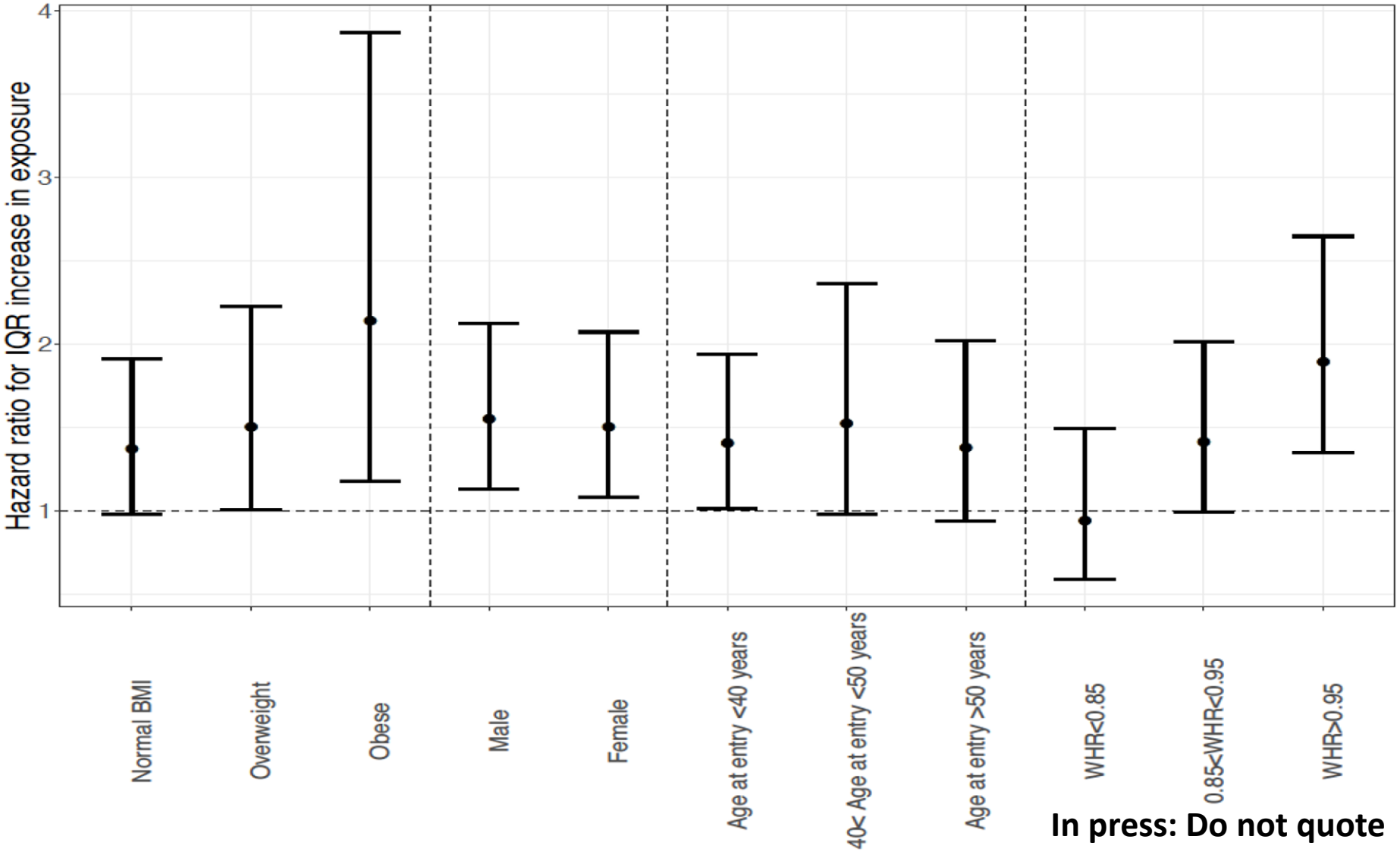
Interactions of BMI and WHR with HT and exposure to $PM_{2.5}$ (every quartile increase)



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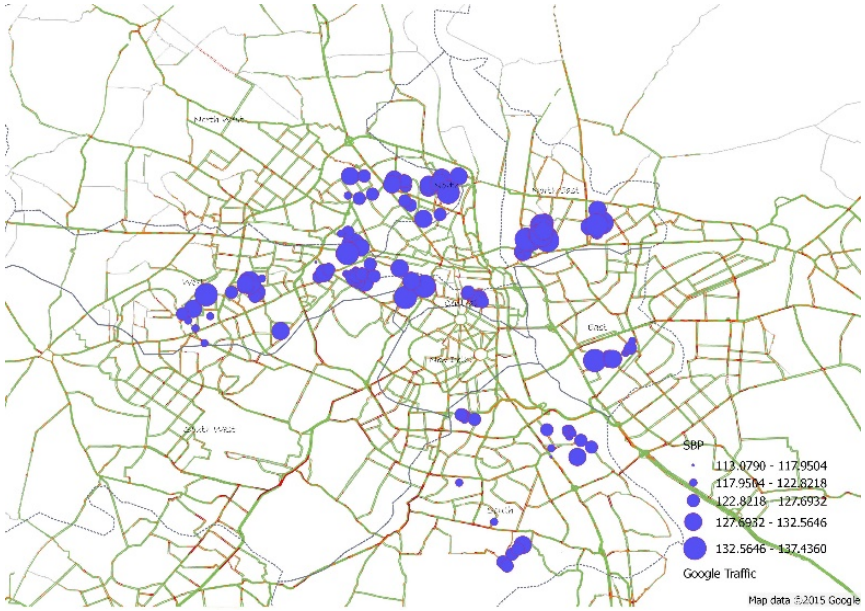
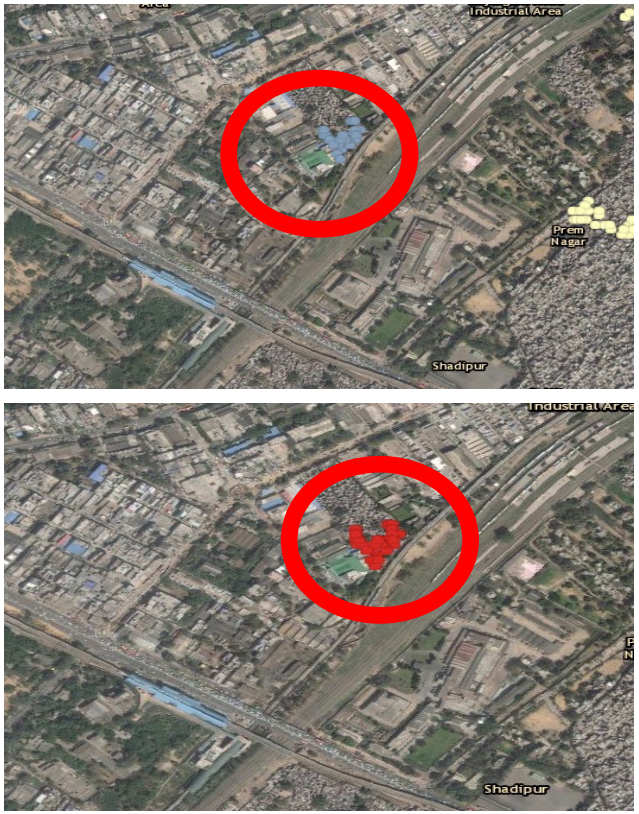
Neighborhood Systolic BP & Road Traffic in Delhi: CARRS GIS



Low Physical activity cluster = high BP



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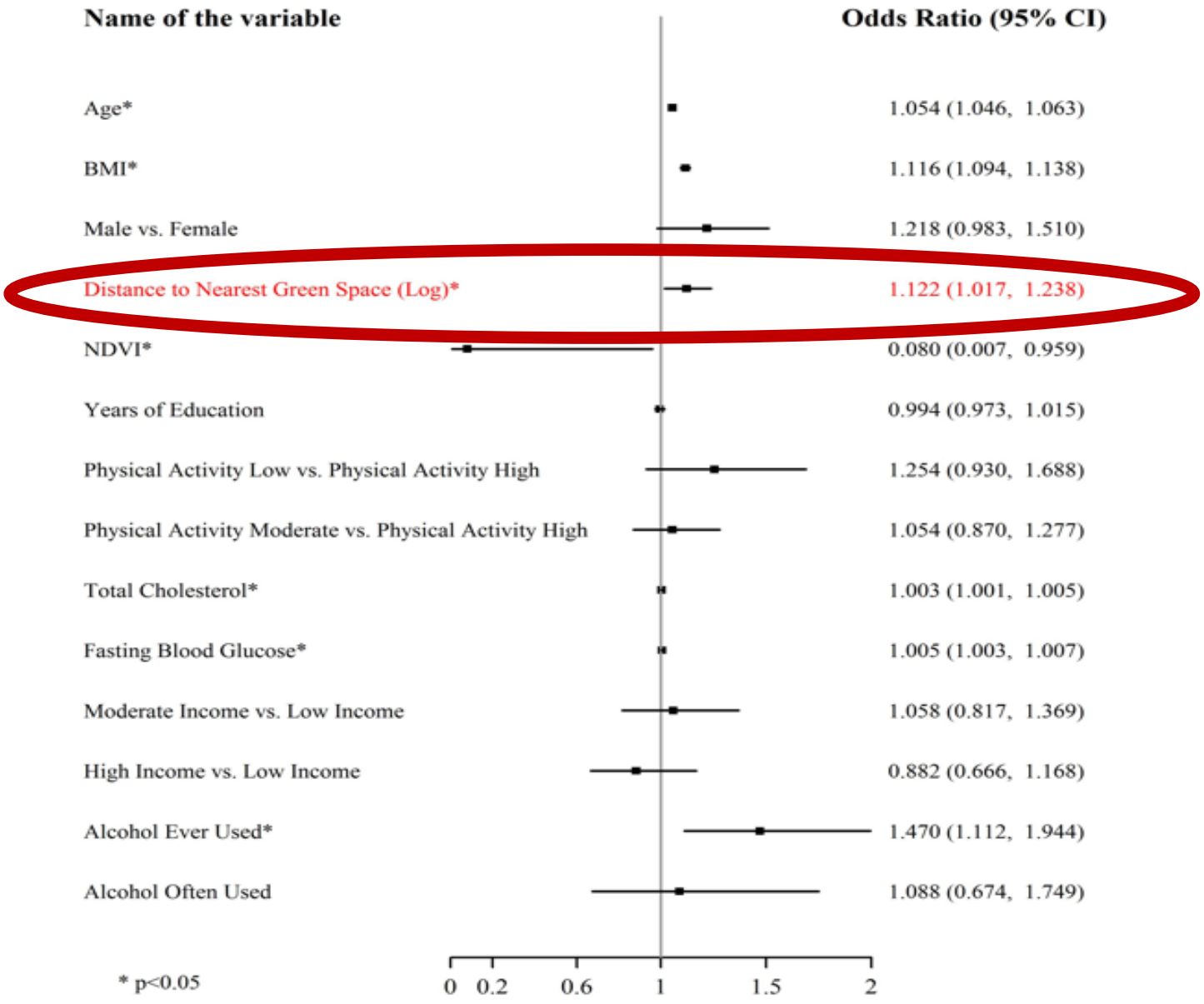

Green Spaces and Environment

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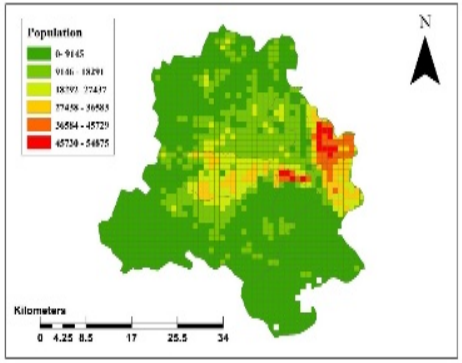
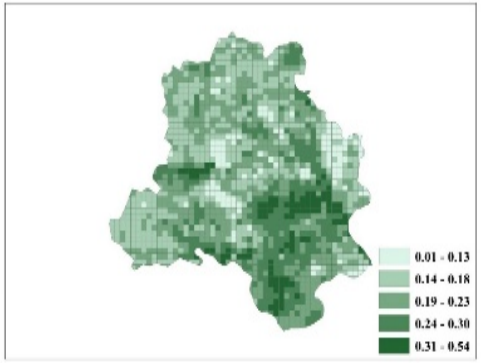
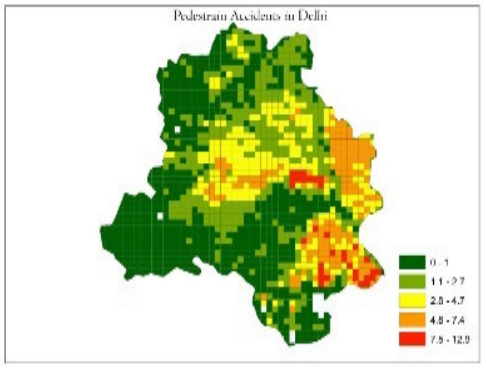
Walkability index of Delhi and challenges to physical activity



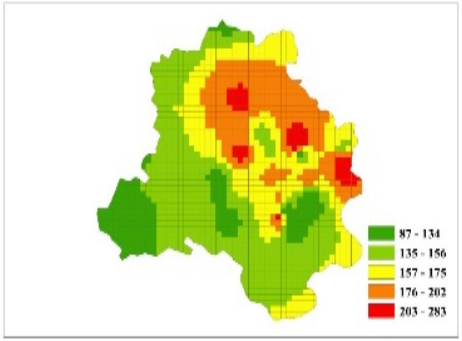
Congestion Index



Comfort Index

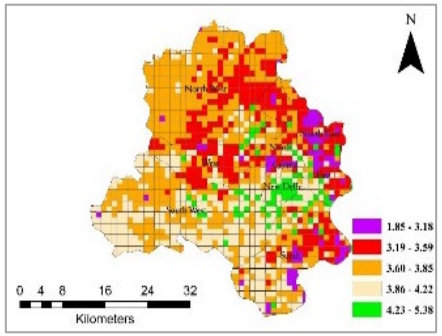


Safety Index



Exposure Index

Connectivity Index



Walkability

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Ambient air pollution and Hypertension

- **Long- and short-term exposure to elevated particulate matter concentrations is associated with increased blood pressure and risk of developing hypertension in urban India.**

- **Interquartile range increases in annual and monthly average exposure to PM2.5 were associated with 1.92 mmHg (95% CI: 1.06, 2.77) and 2.98 mmHg (95% CI: 0.75, 5.21) increase in systolic blood pressure respectively.**

- **Similarly, IQR increase in 1 year and 1.5 year average exposure increased the risk of developing hypertension by 1.53 times (95% CI: 1.19, 1.96) and 1.59 times (95% CI: 1.31, 1.92) respectively.**

- **These associations are modified by markers of obesity, such as waist hip ratio and BMI, with stronger associations in the obese population.**

What are the unanswered questions

- **Which component of PM 2.5 is responsible for HBP ?**
- **How does indoor pollution interact with ambient air pollution ?**

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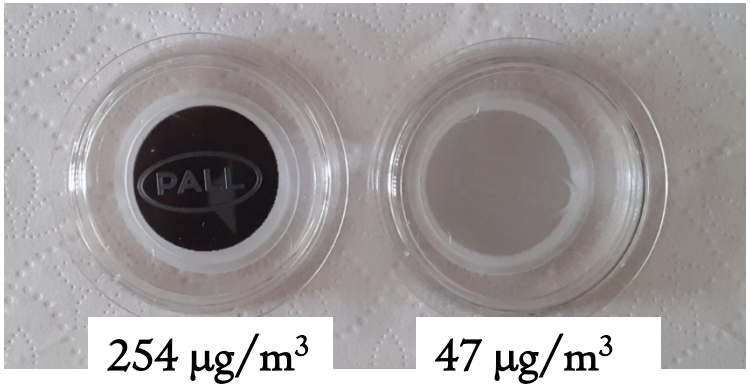
Evaluating personal $PM_{2.5}$ exposure measurements in the CARRS cohort, Delhi – A sub study of GEOHealth Air Pollution Study

- **Objectives**
  - Develop $PM_{2.5}$ exposure profiles,
  - Investigate source wise contributions in personal exposure,
  - Quantify transported ambient component in indoor $PM_{2.5}$ levels,
  - Describe levels and patterns of personal crustal and toxic metals exposure.

- $PM_{2.5}$ exposure measurements 24-hr duration per participant during
  - winter (Dec-Jan) seasons of 2018-2019
  - summer (March-May) 2019

Wife Husband

Individual exposures of a couple residing in a slum in East Delhi. Due to poor ventilation conditions, the lady who is a home maker has higher exposures than her spouse who is a driver.

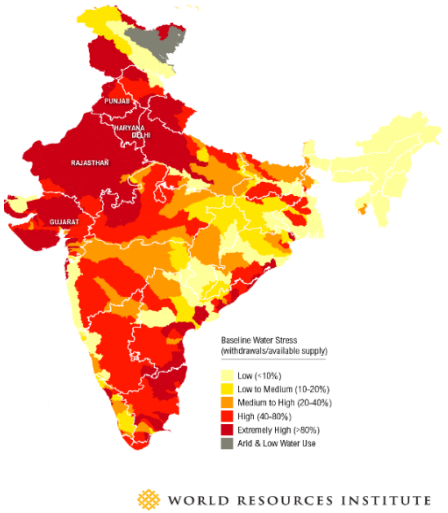


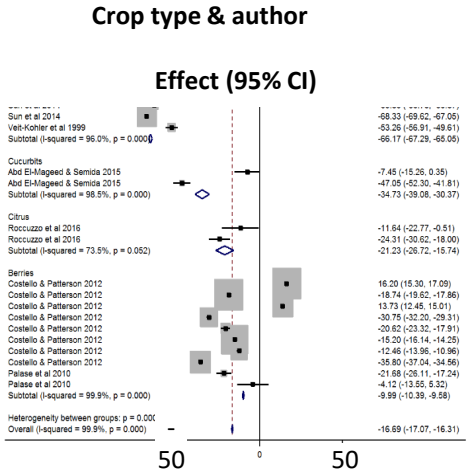
Pay attention to indoor air pollution

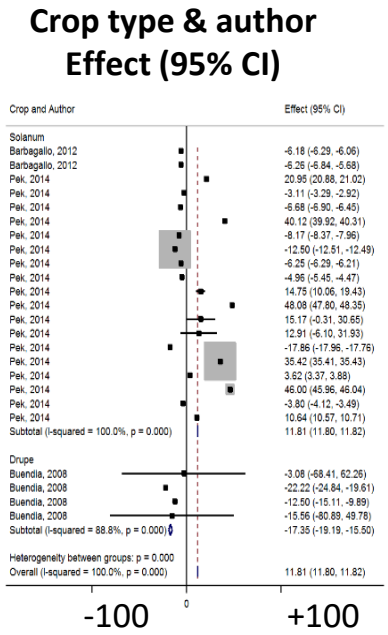
Relationship of fruit and vegetable intake and the environment

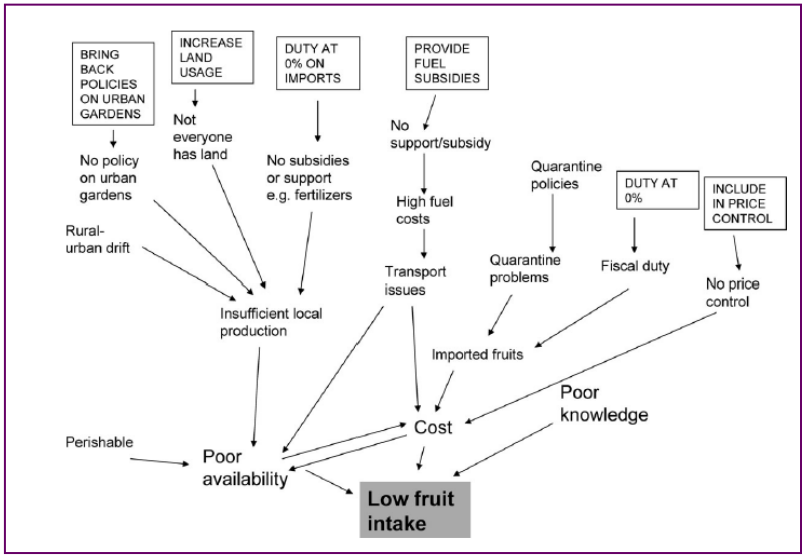
Food Systems

Systematic reviews on fruit and vegetable yields









Dangour A, : Personal communication

Snowden et al; 2012

As physicians and researchers we should also look at supply side issues

We are living in interlinked world

INDUSTRIAL SCALE LIVESTOCK BREEDING

- Obesity
- CVD
- Cancer

- Food Crisis (Grain Diversion)

- Climate Change (↑ Methane; Deforestation)

- Pandemics (Zoonotic Diseases rising)

Global Meat Production Will Double From 229 Million Tonnes in 2009 To 465 Million Tonnes In 2050

Health sector plays a key role both as a contributor and mitigator of environmental health

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HEALTH & ENVIRONMENT LEADERSHIP PLATFORM H.E.L.P

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Health Care Without Harm

Strengthening Capacity for Research, Communications and Advocacy in Air Pollution

Preliminary evidence : Greening of Hospitals improve health outcomes

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CENTRE FOR ENVIRONMENTAL HEALTH

Health Care Without Harm

Strengthening Capacity for Research, Communications and Advocacy in Air Pollution

Objective

To foster health sector leadership on environmental exposures, expanding the evidence base on air pollution exposures in tier-2 cities, advocating for effective implementation of air pollution policies, and media sensitization

Specific aims

1. **Health Sector Engagement and Capacity Building**
2. **Air pollution monitoring, policy and advocacy**
3. **Understanding Knowledge, Attitude and Practice of Health Practitioners towards Health Effects of Air Pollution in Indian cities**
4. **Roadmap to achieving the National Ambient Air Quality Standards (NAAQS) in India**

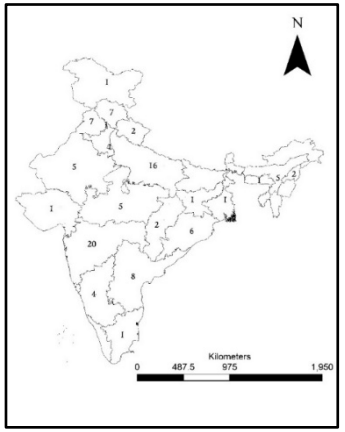
What are we doing to increase awareness on air pollution amongst health care professionals ?

Health and Environment Leadership (HELP)

HELP platform includes over 7300 HealthCare institutions in India.

Hospital based Air Pollution Monitoring

- CPCB recognises 94 cities as non attainment areas for particulate pollution.
- Absence of $PM_{2.5}$ monitoring in more than 60 cities from the list
- Hospital based air pollution monitoring



Doctors' study

- Understanding the knowledge and awareness of doctors about the health impacts of air pollution
- Do doctors communicate concerns regarding air pollution to their patients?
- Does air pollution feature as a priority within the health community?

Creation of climate smart and climate resilient hospitals

Reducing gaps in prevention and treatment of CVD in developing countries: What are the research needs

Research questions have multiple angles

- **Scientific credibility**
  (evidence & rationale?)
- **Financial feasibility**
  (cost effective? affordable?)
- **Operational stability**
  (sustainable? scalable?)
- **Political viability**
  (is the community ready & receptive?)

Multi disciplinary

Disruptive innovations

Attention to policy and upstream determinants

Combining all these: A trans disciplinary approach

Acknowledgement: Prof KS Reddy

The woods are lovely, dark and deep, But I have promises to keep, And miles to go before I sleep, And miles to go before I sleep.

Robert Frost

"There are no incurable diseases only a lack of will"

Avicenna (Ibn Sina); 980-1037