Association of Prenatal Exposure to Air Pollutants with Select Birth Defects Using the Case-Cohort Approach

Using environmental data in birth defects surveillance research

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Introduction

Objectives

- Preparing birth and birth defects data
- Assessing environmental data
- Joining birth defects and environmental data
- Example analysis

Defining cases

Relevant variables (from birth defects registry)

- British Pediatric Association (BPA) code
- Birth defects description (narrative)

Concerns

- May only have access to BPA or ICD code
- Code and narrative may contradict
- Include or exclude cases with multiple birth defects?

Calculating conception date

Relevant variables (from vital records)

- Last menstrual period (LMP)
- Clinical gestational age (with birthdate)

Concerns

- Data may be missing
- Dates may not agree
- Dates may be impossible

Determining location of mother's residence

Relevant variables (from vital records)

- Mother's residence address at birth (street, city, ZIP code, state)

Concerns

- Address may not geocode
- May have access to only part of address
- State, city, ZIP code may disagree

Determining maternal health & behavior

Relevant variables (from vital records)

- Mother's smoking & alcohol use
- Mother's prenatal care
- Mother's gestational diabetes & body-mass index

Concerns

- Data may be missing
- Data may be impossible or unreliable
- No data on father's health & behavior

Environmental considerations

Geography: How wide is coverage?

Resolution: What is the resolution level?

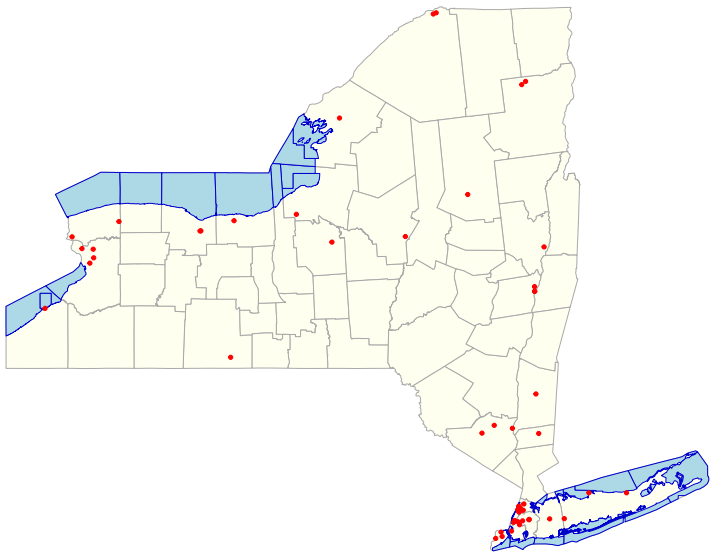
Exposure: What dosage assumptions will I make?

Frequency: Are data daily, monthly, annual?

Availability: Are data accessible?

Air pollution: monitoring stations

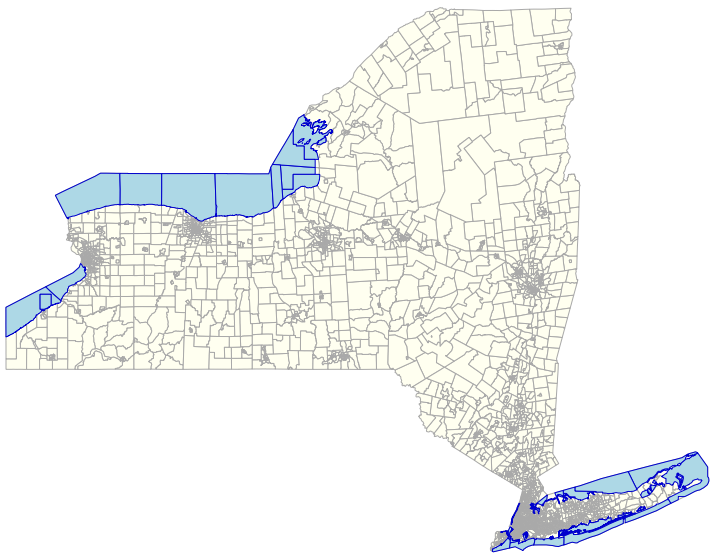
- *Geography:* Mostly urban
- *Resolution:* Points far apart
- *Exposure:* Measured values
- *Frequency:* Daily or every few days
- *Availability:* https://www.airnow.gov/



Map of New York air pollution monitors (Source: New York State Department of Environmental Conservation)

Air pollution: Downscaler model

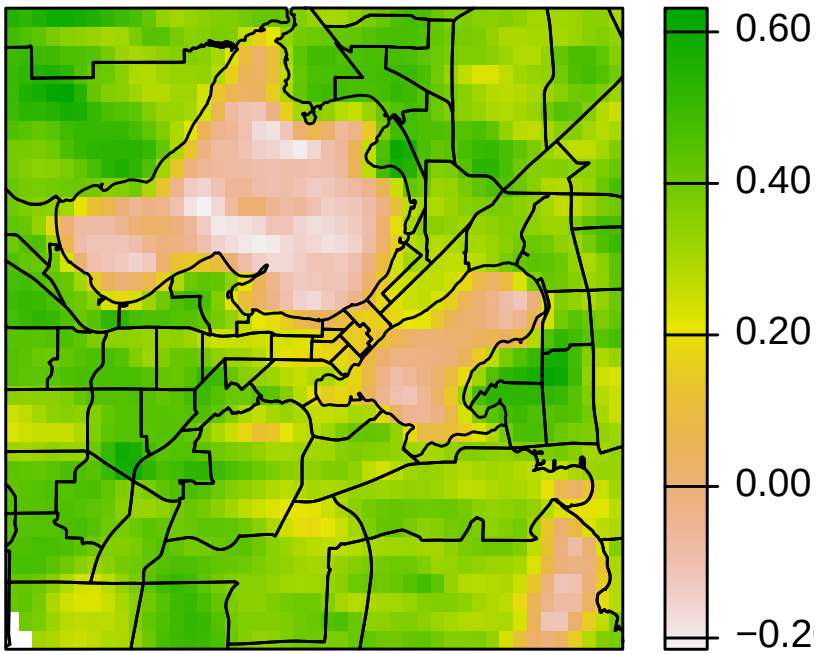
- *Geography:* Nationwide
- *Resolution:* Census tract
- *Exposure:* Estimated values
- *Frequency:* Daily
- Uses topography, weather, pollution sources
- *Availability:* https://www.epa.gov/hesc/rsig-related-downloadable-data-files



Map of New York Census tracts

Green space: Normalized Difference Vegetation Index (NDVI)

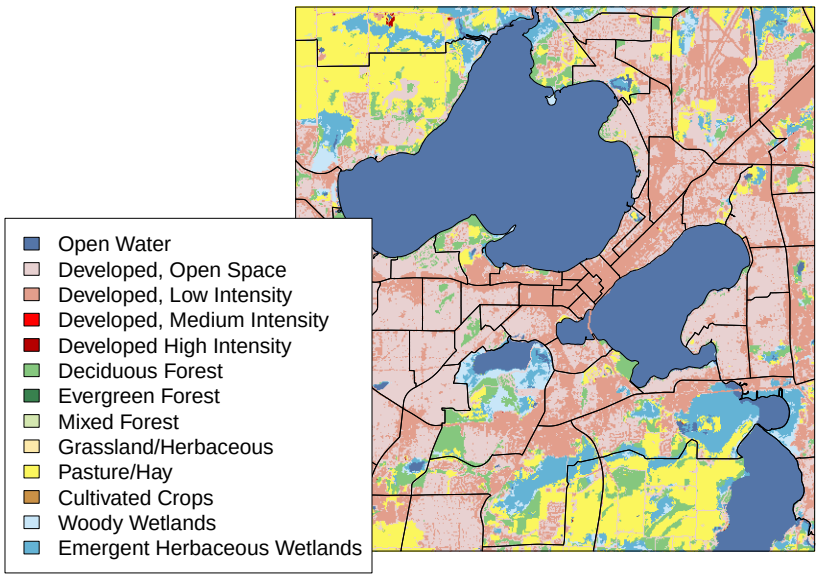
- *Geography:* Global
- *Resolution:* 250 m^2 grid
- *Exposure:* Measured values
- *Frequency:* Every 16 days
- Cloud cover, unclear land types
- *Availability:* R package MODISTools



NDVI grid and Census tracts around Madison, WI

Green space: National Land Cover Database (NLCD)

- *Geography:* Nationwide
- *Resolution:* 30 m^2 grid
- *Exposure:* Categorized land types
- *Frequency:* 3-year estimates
- *Availability:* R package FedData



NLCD grid and Census tracts around Madison, WI

Environmental datasets selected

Project requirements

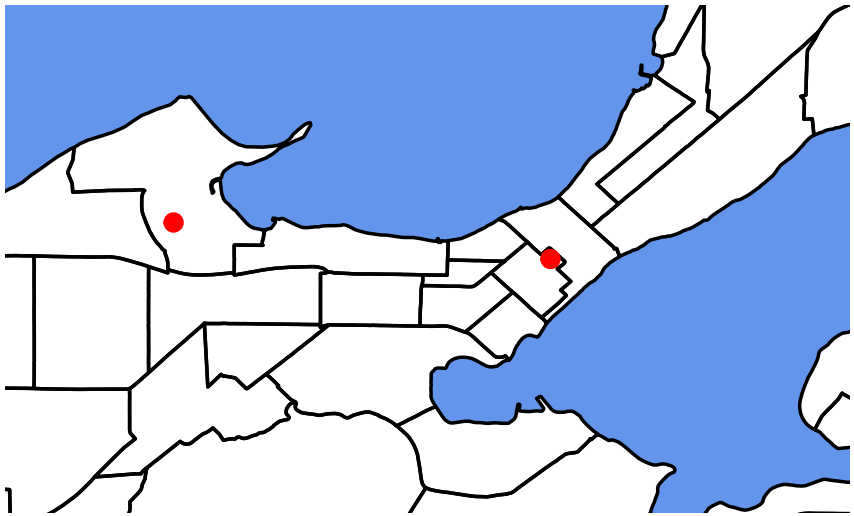
- Statewide
- Daily or weekly $PM_{2.5}$ and ozone measures
- Differentiate grasses, trees, and water

Final selections

- Air pollution: Downscaler modeled data, 2002-2015
- Green space: National Land Cover Database, 2011

Join birth defect and air pollution data

1. Plot mothers' residences and join to Census tracts
2. Join mothers' residences to air pollution data on both Census tract and conception date

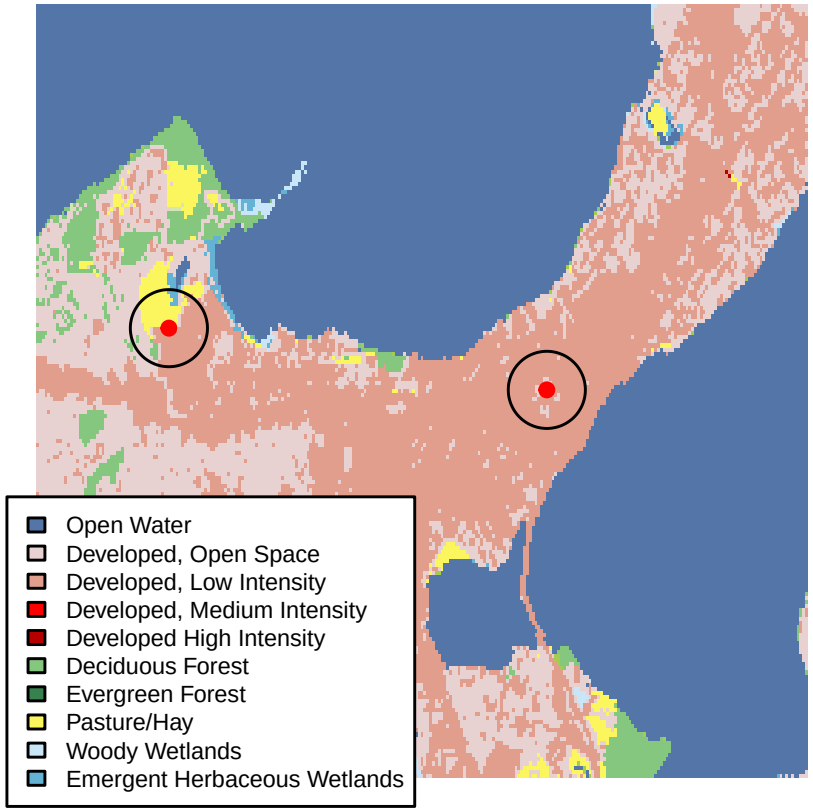


Waisman Center and Capitol Building, Madison, WI

Name	Census tract	Conception date
Capitol Building	55025001704	2019-04-01
Waisman Center	55025003200	2019-04-23

Join birth defect and green space data

1. Calculate buffers around mothers' residences and join to green space
2. Calculate proportion of buffers with each green space type



NLCD grid with Waisman Center and Capitol Building, Madison, WI

Analysis

Purpose

To determine the most vulnerable time between one month before pregnancy and the end of the third month of pregnancy.

Design

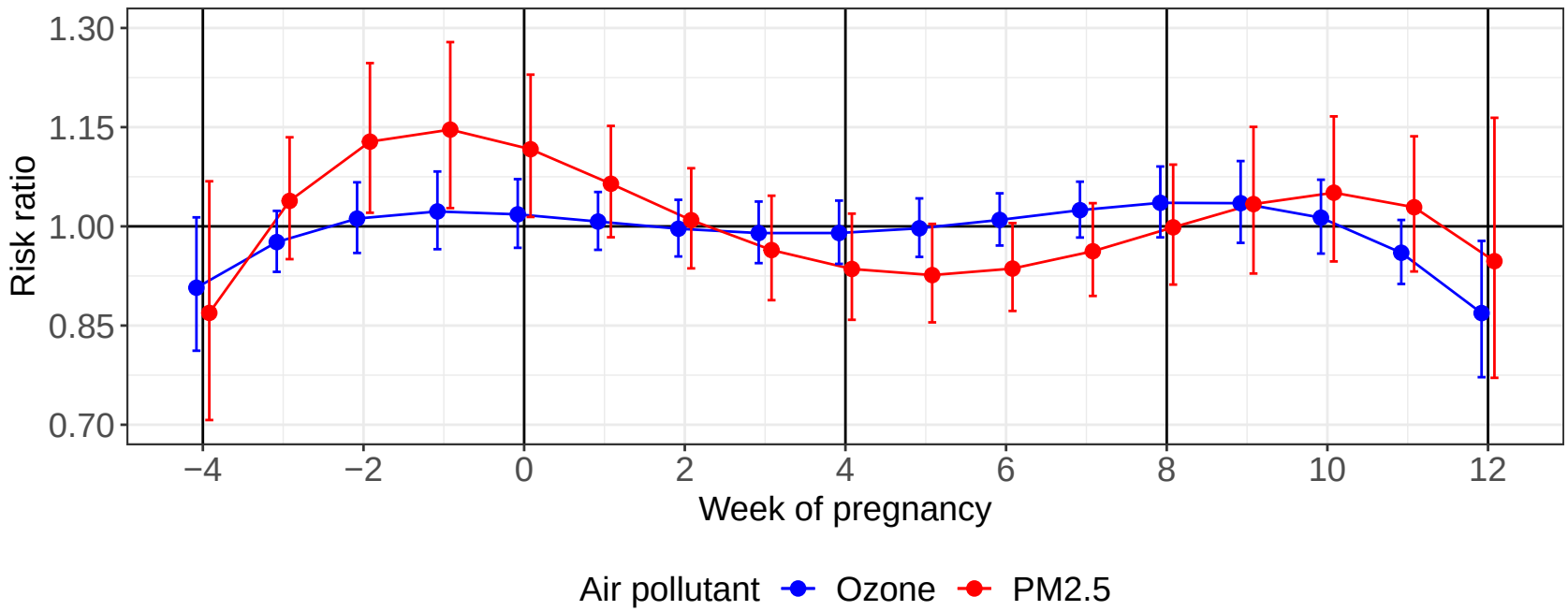
Case-cohort study, NYS excluding New York City, 2002-2015

Model

Regression with weekly exposures

Example results

Craniosynostosis models: Risk ratios by week of pregnancy with grasses and trees



Note: Models were adjusted for maternal education level, maternal smoking, tract−level median income, conception season, and the indicated green space variable. Week 0 was the week of conception. Week 12 was the end of the first trimester of pregnancy. Risk ratio applies to change in risk from the previous week given a 10−unit increase in the air pollutant (ppb for ozone and µg/m³ for PM2.5) over two standard deviations above the mean.

Summary

Greatest increases in risk

Birth defect	O3 exposure	PM2.5 exposure
Clubfoot	Pre-conception	Month 1-2
Cleft lip w/wo cleft palate	Pre-conception	Month 1
Cleft palate	Pre-conception	Month 2
Craniosynostosis	Month 1	Pre-conception

Observation

Results varied depending on air pollutant measure and model settings

Contact Information

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NYS Birth Defects Registry

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Website:
https://health.ny.gov/diseases/congenital_malformations/