Air Pollution and Effects on Respiratory Health

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London Winter, 1952

[Graph showing deaths and smoke levels over time]

[Image of thick foggy conditions]

[Images of people using flashlights in a foggy environment]
In the Past 25 years,

- Ambient air pollution levels in the US have decreased significantly
- This is a major public health success of the Clean Air Act
- The question is:
  - Have we reached a point at which further reductions in ambient air pollution levels will result in no further health benefits?
Hartford, CT
Sources of Air Pollution

- Vehicle exhaust
- Industry
- Power generation plants
- Background contamination
What Pollutant is Responsible?

- Complex and complicated
- Problems with exposure misclassification
- Changes in many pollutants are associated with changes in other pollutants
- Major pollutants are ozone, nitrogen dioxide (NO$_2$) and particulate matter 2.5 µm (PM2.5)
Outline

- The effects of air pollution in a vulnerable population, namely children with asthma
- The effects of air pollution on healthy individuals and the consequences:
  - Joggers
  - Healthy children
- Results from 2 “natural” experiments
Asthma

- Chronic, inflammatory disease of the airways associated with reversible airway narrowing, airway swelling and increased mucus production
- Symptoms of asthma are cough, wheezing and chest tightness
- Asthma is the most common, chronic disease of children.
- In the United States, 6.9 million children have asthma (2014)
Effects of Ozone on Children with Asthma

Effects of Ozone are Dose Dependent

Friedman, MS JAMA 2001:285(7):897-905
Joggers and Ozone

- Lung inflammation was present in individuals who
  - Jogged 3 or more times per week for ~2.5 miles on Governor’s Island

- Mean ozone levels were 58-69 ppb

Lung Growth in Healthy Children

- The lungs of children grow until ~ 18 years in girls and 20 years in boys.
- Lung function then declines with age and in otherwise healthy individuals becomes “limiting” around 90 years.
Lung Function Growth in Children Exposed to Nitrogen Dioxide

Children’s Health Study in Southern California involving 1,759 children (10-18 years)

Consequences of Reduced Lung Function

- An increased risk of asthma
- Increase risk of cardiovascular disease in adulthood (heart failure)
- Respiratory limitation at an earlier age
- Increased mortality
Mortality and Air Pollution
Lifetime Pollution and the Lungs

Graph showing the difference in FVC (mL) for various time periods and proximity to roadways, with PM$_{2.5}$ and BC levels.

Rice MB, Am J Respir Crit Care Med 2016; 193 (8) 881-888
Air Pollutants and ED Visits: Atlanta 1996 Summer Olympics

- 27.9% decrease in ozone
- 11.1% decrease in ED visits
- 19.1% decrease in Hospitalizations for asthma

Graph showing mean no. events/day and % of NAAQS for various pollutants.
Olympics 2016: Rio de Janeiro
Improvements in Air Quality and Children’s Lung Growth

From: Gauderman, WJ NEJM 2015
Summary

- Ozone at levels consistent with the EPA Standard affects asthma symptoms and medical service utilization in children in a dose dependent manner.
- Ozone exposure causes airway inflammation even in otherwise healthy individuals.
- Air pollution decreases lung growth in children.
- Decreased lung growth is associated with asthma, cardiovascular disease and increased mortality.
- Decreasing air pollution results in decreased morbidity in children with asthma and improvements in lung growth.