Social and physical environmental determinants of childhood asthma

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Today’s Presentation

- What is asthma?
- Asthma-related morbidity
- Brief primer on confounding
- Brief primer on causality
- Three highlighted studies
- Conclusions
What is Asthma?

Chronic respiratory disease with three clinical characteristics:

- Inflammation, resulting in wheezing, chest tightness, cough
- (Reversible) airflow obstruction
- Bronchial hyperresponsiveness
What Causes Asthma?

• Etiology of asthma is unclear

**Genetic Component**
- Parents with asthma
- Tendency towards allergic reactions (atopy)

**Environmental Component**
- Early childhood respiratory infections
- Exposure to aeroallergens or viruses in early life

Photo Source: NIEHS
Asthma-Related Morbidity = \( f \) 

- Social Environment
- Built Environment
- Political/Economic Environment
- Medical Care
- Natural Environment
- Host Factors
Pediatric Asthma

• Most common chronic disease of childhood

• Single most prevalent cause of childhood disability

• Disproportionate morbidity levels among socially disadvantaged
Asthma-Related Morbidity

• Measures of asthma-related morbidity:
  
  • 14 million missed days of school
  
  • 3rd ranking cause of hospitalizations for children ages 15 and under
  
  • Over 2 million ED visits for asthma

• Consistently higher among socially disadvantaged urban children

Unclear if this relationship is driven by race or socioeconomic status (SES)
What is Confounding?
Research Question

Socio/Demographic Characteristics

Proximity to Freeways

Asthma Event

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Minority and poor children are more likely to:

• Live in areas with high traffic density [Gunier et al. 2003; Meng et al. 2006]

• Reside near point source air pollution sites [Chakraborty and Zandbergen 2007]

• Attend schools located near high traffic volume roads [Green et al. 2004]
What is Causality?

Adolescents w/ Asthma

< 500ft from Fwy?

Y

THEN

WE

GO BACK

IN TIME

Emergency Care Utilization?

Y

N

Adolescents w/ Asthma

< 500ft from Fwy?

N

Emergency Care Utilization?

Y

N
Randomize Adolescents w/ Asthma dx to be…

500ft from Fwy?

Emergency Care Utilization?

Emergency Care Utilization?
Assessing Causality

If we can’t go back in time or randomize, other options:

• Natural experiments
  • Isolated change in one aspect of the environment when all other factors remain the same

• Statistical methods
The Natural Experiment

Friedman et al. (2001):

• Compared number of childhood asthma acute care events in the Atlanta Metro Area:
  • 17 days of the 1996 Summer Olympic Games
  • 4 weeks directly prior to and after the Games

Rationale: Increase in alternative transportation options for the Olympics, including: 24 hour public transportation, addition of 1,000 buses, and encouragement of telecommuting.
The Natural Experiment: Results

- 46% decrease in acute asthma events among Medicaid children during Summer Games compared to baseline periods.
- Non-asthma acute events decreased 3% during Summer Games compared to baseline periods.

Table 1. Changes in Pollutant Levels from Baseline to Summer Games

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-hr Peak O3</td>
<td>-27.9%*</td>
</tr>
<tr>
<td>CO</td>
<td>-18.5%*</td>
</tr>
<tr>
<td>NO2</td>
<td>-6.8%</td>
</tr>
<tr>
<td>PM10</td>
<td>-16.1%*</td>
</tr>
<tr>
<td>SO2</td>
<td>+22.1%</td>
</tr>
</tbody>
</table>
The Natural Experiment: Results

Table 2. Changes in Traffic from Baseline to Summer Games

<table>
<thead>
<tr>
<th>Traffic Metric</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday 1-hr morning peak traffic counts</td>
<td>-22.5%*</td>
</tr>
<tr>
<td>Weekend morning peak traffic counts</td>
<td>-9.7%*</td>
</tr>
<tr>
<td>Public transportation ridership</td>
<td>217%*</td>
</tr>
</tbody>
</table>

Conclusion: Alternative transportation options for the 1996 Summer Olympics reduced air pollution (particularly ozone) linked to asthma exacerbations.

Follow-Up: Similar findings for the relation between traffic mitigation and asthma hospitalizations for the 2002 Summer Asian Games in Busan, South Korea (Lee et al. 2007)
The Natural Experiment: Part II

Tonne et al. (2008):

• Investigated the impact of London’s Congestion Charging Scheme (CCS) on:
  • Levels of Traffic Pollutants -- Life Expectancy – SES Inequalities

Findings:

- An estimated 1888 years of life gained from implementation of CCS
- Lower SES areas had greater decreases in air pollution and greater increases in life expectancy compared to high SES areas
The Instrument

Kim et al. (2004):

- Compared information on respiratory symptoms and asthma diagnosis for elementary school children who:
  - Attended elementary schools upwind of major roadway
  - Attended elementary schools downwind of a major roadway

**Rationale**: The natural environment can greatly influence the concentration of pollution in near freeway environments; can assume that socioeconomic factors (race, SES) are distributed similarly for upwind/downwind schools.
• Traffic-related air pollutants were measured at each of the school sites.

• Concentration of several traffic-related air pollutants were higher at downwind schools, compared to upwind schools or schools >300m from a major traffic source.

Source: Kim et al. (2004)
The Instrument: Results

Findings: Modest but significant increases in asthma diagnosed in the previous 12 months and exposure to NOx for girls who lived in current home for 1 year or more

Table 3. Demographics for Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Downwind FWY Schools</th>
<th>Upwind/Far FWY Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>7.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Latino</td>
<td>47.6</td>
<td>41.2</td>
</tr>
<tr>
<td>HHD @/below FPL</td>
<td>31.8</td>
<td>31.0</td>
</tr>
<tr>
<td>Biological Mom with asthma</td>
<td>9.5</td>
<td>13.7</td>
</tr>
<tr>
<td>Smoker in HHD since child’s birth</td>
<td>13.1</td>
<td>20.6</td>
</tr>
</tbody>
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**Conclusion:** Downwind location of schools is an important determinant of increased exposure to traffic pollutants.

**Epidemiologic issues of interest:**

*Measurement issues.* Characterization of the physical environment (i.e. air pollution) is a crucial element in the determination of the exposure/disease relationship.

*Duration/location of exposure.* Characterization of both home and school environments are important factors in the determination of overall exposure levels.
An estimated 25,000 children were living or attending school in lower Manhattan on 9/11.

Thousands more were in the path of the plume of building debris and smoke and exposed to particulates and toxic substances.

[Thomas et al. 2008]
Disaster Epidemiology

Thomas et al. (2008):

- Examined respiratory health outcomes and disaster-related exposure among children enrolled in the World Trade Center Health Registry

**Results:**

- 45% of children reported dustcloud exposure on 9/11
- 6% of children had a new physician diagnosis of asthma post 9/11
- Dust cloud exposure was significantly related to new asthma diagnosis
Conclusions

• Asthma is a complex, multifaceted disease

• Asthma-related morbidity is associated with an array of factors, many of which are hard to disentangle: particularly sociodemographic factors and environmental exposures

• Several events (planned and unplanned) as well as creative study designs have highlighted ways to understand the independent exposure of the physical environment on asthma exacerbation
  • So.....What do we do?
Thank You

Questions/Comments/Random Musings:

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