Estimating Morbidity and Mortality Attributable to Air Pollution in New York City

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Overview

• NYC neighborhood air pollutant burden analysis
  • Motivation
  • Data inputs
  • Results and Reporting
• Other projects using BenMAP
  • Climate
• Future work and challenges
Background

• EPA and state regulatory agencies routinely conduct air quality health impact analyses to evaluate proposed NAAQS, SIPs and other actions
• Local and state health programs are well positioned to conduct similar analyses
  • Access to spatially/temporally resolved health data
    • Variation in health events often greater than ambient pollutant levels
• Increased public and stakeholder engagement
Objectives: Burden Analysis

• Estimate attributable public health burden from current ambient PM$_{2.5}$ and ozone vs. background

• Estimate potential benefits of 10% decrease and meeting City air quality improvement goals

• Describe distribution of burden by age and neighborhood poverty

• Summarize in format for local policy makers and the public

• Develop capacity to evaluate and prioritize local air quality improvement initiatives
Methods: Overall Approach

- Baseline Exposure Scenario
- Control Scenario

Change in population exposure

Concentration-Response
(Epidemiological Literature)

Baseline health event rates
(Hospitalization, vital statistics)

Exposed Population
(Census)

Attributable Fraction

Number of Health Events

- Target levels
- Background
- Modeled estimates from changes in emissions/climate

- Spatial/Temporal distribution of impacts
- Disparity by SES
Data Inputs: Air Quality

• Air Quality Data
  • EPA AQS Data for PM$_{2.5}$ and O$_3$, daily and hourly data used to calculate seasonal metrics matching C-R functions of interest (2005-2007 average)

• Calculated three rollback scenarios:
  • Policy relevant background (modeled estimates with no anthropogenic emissions)
  • 10% improvement
  • 22% improvement in PM$_{2.5}$ (City sustainability goal)

• IDW average exposure metrics calculated at neighborhood level (42 zip code aggregate, sub-county)
Data Inputs: Health Data

- Vital Statistics Data
  - Census tract

- Hospital discharge data
  - Zip code level for outpatient and inpatient visits
  - Based on billing data reported to the State

Mortality Counts (natural and specific cause)

Morbidity Counts (specific cause)

Merge with denominator data (census)

Stratify by season, neighborhood, age-group, gender

Format rates for BenMAP
Selecting CR Functions

- Limited to mortality, respiratory hospitalizations and ED visits, cardiovascular hospitalizations
- Preferentially selected studies conducted in NYC
- When NYC studies were not available, selected large US Multi-City Studies, shrunken estimate for NYC when available
- Gave preference to studies included in recent EPA RIAs (EPA 2008, 2010)
- Other studies included in sensitivity analysis
Results: NYC, City-wide

- Summed seasonal estimates to generate average annual impact (2005-2007 average)

- Summed neighborhood estimates to generate city-wide estimates

- Results reported with 95% CI based on SE from CR function.

*Apr-Sept ozone season
PM$_{2.5}$- Attributable Burden Rates

**Mortality** (Krewski et al 2009)

- 2.7-fold variation by neighborhood
- 73% of deaths occur in ages 65 and above

**ED Visits, Asthma** (Ito et al 2007)

- 30-fold variation by neighborhood
O₃- Attributable Burden Rates

**Mortality** (Huang *et al* 2005)

- 5-fold variation by neighborhood
- 84% of deaths occur in ages 65 and above

**ED Visits, Asthma** (Ito *et al* 2007)

- 11-fold variation by neighborhood
Distribution by Poverty, PM$_{2.5}$

PM$_{2.5}$- Attributable Mortality  
PM$_{2.5}$- Attributable ED Asthma Visits

Rates per 100,000 adults >30  
Rates per 100,000 children <18

*Poverty status* = neighborhood tertiles % of residents in households <200% federal poverty level, US Census
2020s Climate-Change Attributable Impacts

- DOHMH/CDC effort to assess heat impacts of future climate
- Used to inform climate adaptation planning
- Data Sources:
  - Temperature: NYPCC 2020 projections
  - Ozone: Columbia University (CMAQ model) of IPCC A2 Scenario
  - Effect Estimates: NYC analyses, published literature
  - Baseline Outcome Rates: Vital Statistics, hospital discharge data
  - Exposed Population: 2020 population estimates

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Health Outcome</th>
<th>Annual # of Events above Baseline</th>
<th>Source of Effect Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat</td>
<td>Natural-Cause Mortality</td>
<td>110 – 260*</td>
<td>Metzger, Ito, Matte, 2010</td>
</tr>
<tr>
<td>Heat</td>
<td>Cardiovascular Hospitalizations</td>
<td>80 – 200*</td>
<td>Lin et al, 2009</td>
</tr>
<tr>
<td>Ozone</td>
<td>Asthma ED visits</td>
<td>240 (170, 310)</td>
<td>Ito et al, 2007</td>
</tr>
</tbody>
</table>

*Corresponds to upper and central range warm season average temperature projections from the 2009 NYC Panel on Climate Change report.

Preliminary estimates, do not cite or quote
Dissemination of Results: NYC

- Public report and manuscript on air quality burden assessment
- Burden estimates and benefits associated with improvements used to support local emissions reduction initiatives (PlaNYC). Estimates cited in annual reports, press releases, and talking points
- Climate impacts cited in sustainability reports and used in resiliency planning
- Public reporting through local portal (upcoming)
Summary and Challenges

• Local AQ impact analyses are a useful tool for distilling data for public and stakeholder communication
  • Used to support regulations to phase out residual heating oil
  • Neighborhood results and air quality data used to target neighborhoods for early fuel conversions
  • Climate results are being used to inform resiliency planning
• Challenges still remain for communicating results with the public
• Analysis requires many assumptions and analysts for developing multiple datasets
• Limitations
  • Spatial resolution of air/heat data, model uncertainties
  • Does not include all symptoms and limited activity/productivity
  • CR Functions: population susceptibility, co-pollutant and particle composition
Thank You

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Reports available at:  http://www.nyc.gov/health/nyccas