THE NEW YORK CITY DEPARTMENT OF HEALTH AND MENTAL HYGIENE

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

Iyad Kheirbek

EPA BenMAP Webinar
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Contributors
Kathryn Lane, Sarah Walters, Daniel Kass, Thomas Matte
NYC Department and Health and Mental Hygiene
Bureau of Environmental Surveillance and Policy

Overview

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

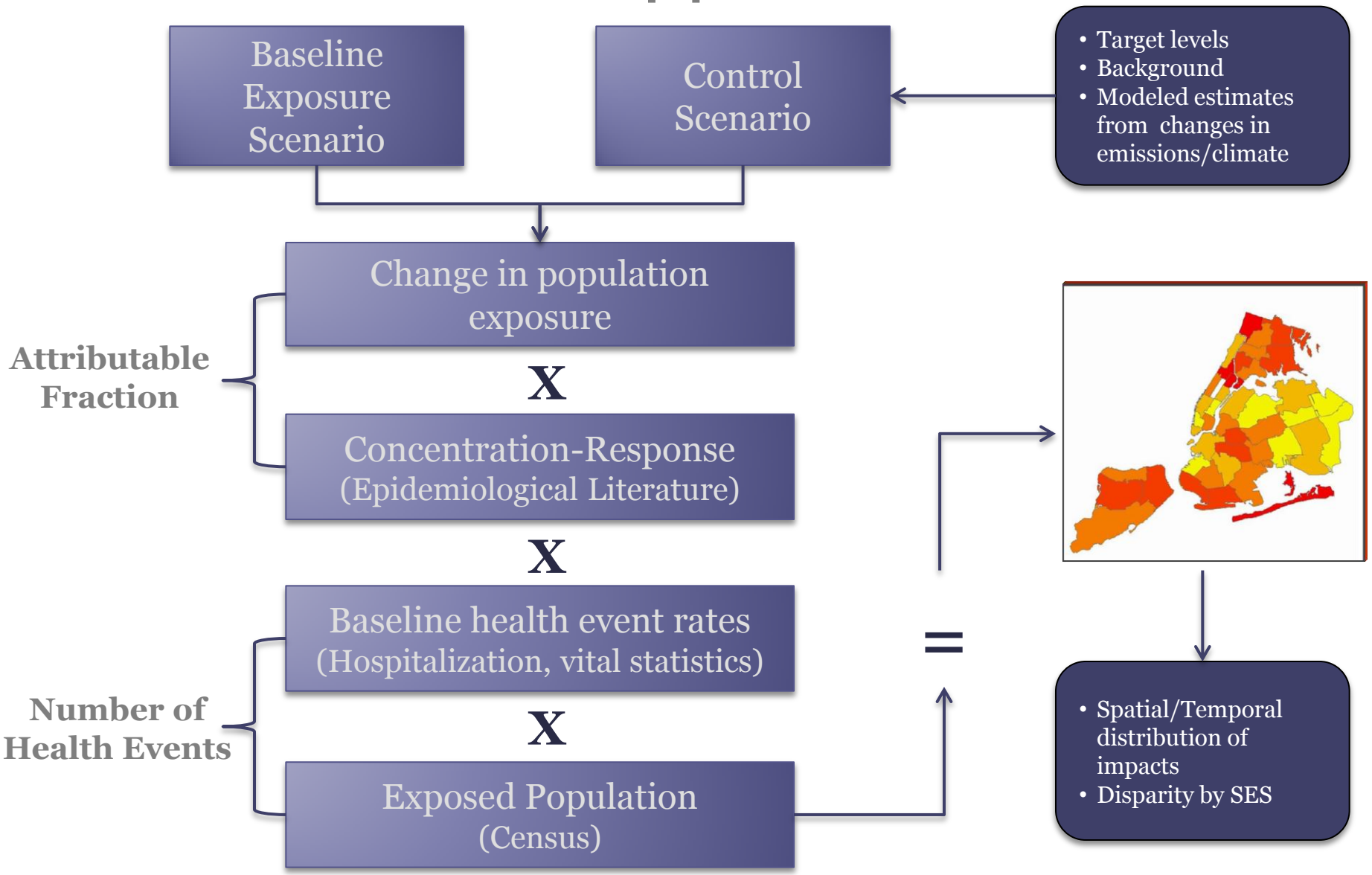
Background

- 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

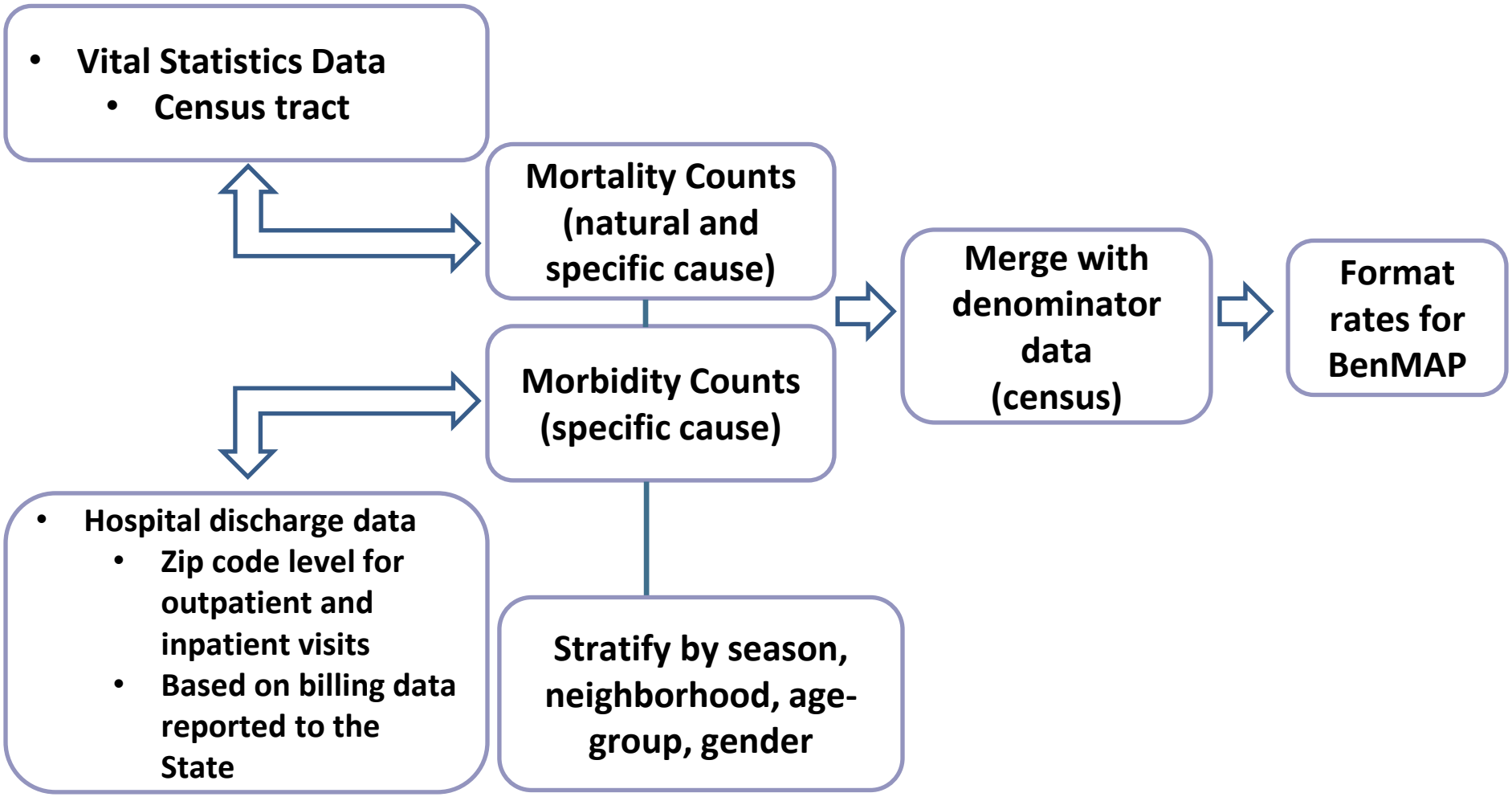
Methods: Overall Approach



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



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

	Health Effect	Age Group (in years)	Acute or Chronic Exposure/Metric Average	Effect Estimate	Study Location	Source of Effect Estimate
$PM_{2.5}$	Premature mortality	30 and older	Chronic/Annual	6% increase in all-cause mortality associated with 10 µg/m³ increase in $PM_{2.5}$	United States (116 cities)	Krewski, 2009
	Emergency department visits for asthma	All ages	Acute/Daily 24-hour	Relative risk of 1.23 (summer) and 1.04 (winter) per 25.4 µg/m³ and 21.7 µg/m³ respective increase in $PM_{2.5}$	New York City	Ito, 2007
	Hospital admissions for all cardiovascular causes	40 and older	Acute/Daily 24-hour	0.8% (warm season) and 1.1% (cold season) increase in daily cardiovascular disease hospitalizations per 10 µg/m³ increase in $PM_{2.5}$	New York City	Ito, 2010
	Hospital admissions for all respiratory causes	20-64	Acute/Daily 24-hour	2.2% increase in daily chronic respiratory disease hospitalizations per 10 µg/m³ increase in $PM_{2.5}$	Los Angeles	Moolgavkar, 2000
		65 and older	Acute/Daily 24-hour	1.3%-4.3% increase in daily chronic respiratory disease admissions with 10 µg/m³ increase per $PM_{2.5}$ (depending on season)	26 U.S. communities	Zanobetti, 2009

	Health Effect	Age Group	Acute or Chronic Exposure Metric	Effect Estimate	Study Location	Source of Effect Estimate
O_3	Premature mortality	All ages	Acute, daily 24-hour average	2.33% increase in cardiovascular and respiratory mortality per 10ppb increase in ozone levels over the previous week	New York City	Huang, 2005
	Emergency department visits for asthma	All ages	Acute, daily 8-hour maximum	Relative risk of 1.32 per 53.5 ppb increase in ozone	New York City	Ito, 2007
	Hospital admissions for asthma	All ages	Acute, daily 8-hour maximum	Relative risk of 1.06-1.20 (varies by age group) per 22 ppb increase in ozone	New York City	Silverman, 2010

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.

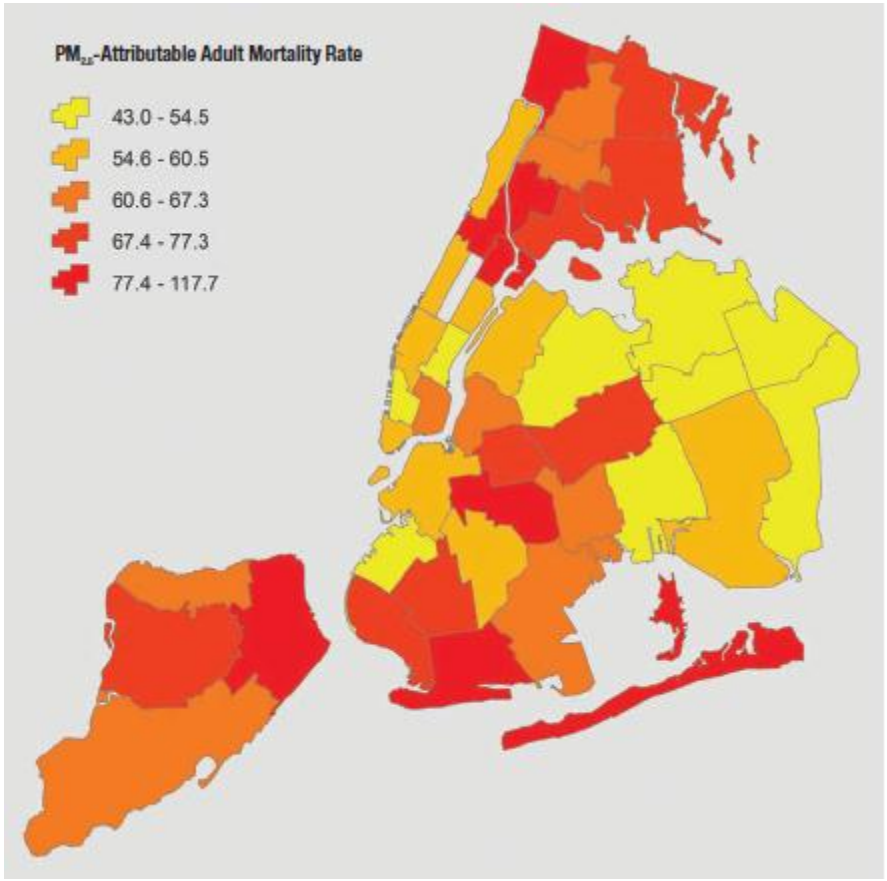
*Apr-Sept ozone season

			Annual Health Events Attributable to Current $PM_{2.5}$ Compared to Background Levels			Annual Health Events Prevented: $PM_{2.5}$ Levels Reduced 10%		
	Health Effect	Age Group	Number of Events (95% CI)*	Rate per 100,000 people	Percent (%) of Events**	Number of Events (95% CI)	Annual Rate per 100,000 people	Percent (%) of Events**
PM_{25}	Premature mortality	30 and older	3,200 (2200,4100)	65	6.4	380 (240,460)	7.1	0.7
	Hospital admissions for respiratory conditions	20 and older	1,200 (460,1900)	20	2.6	130 (50,210)	2.1	0.3
	Hospital admissions for cardiovascular conditions	40 and older	920 (210,1630)	26	1.1	100 (20,170)	2.8	0.1
	Emergency department visits for asthma	Under 18	2,400 (1400,3400)	130	5.6	270 (160,370)	14	0.6
	Emergency department visits for asthma	18 and older	3,600 (2200,4900)	57	6.1	390 (240,550)	6.3	0.7

			Annual Health Events Attributable to Current Ozone Compared to Background Levels			Annual Health Events Prevented If Ozone Levels Reduced by 10%		
	Health Effect	Age Group	Number of Events (95% CI)**	Annual Rate per 100,000 people	Percent (%) of Events*	Number of Events (95% CI)**	Annual Rate per 100,000 people	Percent (%) of Events
O_3-Related Health Effects	Premature mortality	All Ages	400 (200,600)	4.9	3.1	80 (40,120)	1.0	0.6
	Hospital admissions-asthma	Less than 18 years	420 (260,580)	21	11	90 (50,130)	4.4	2.4
	Hospital admissions-asthma	18 and older	450 (240,650)	7.2	6.1	90 (50,130)	1.5	1.2
	Emergency department visits for asthma	Less than 18 years	1,800 (1300,2200)	91	10	370 (260,470)	19	2.0
	Emergency department visits for asthma	18 and older	2,900 (2100,3600)	45	11	600 (430,770)	9.5	2.2

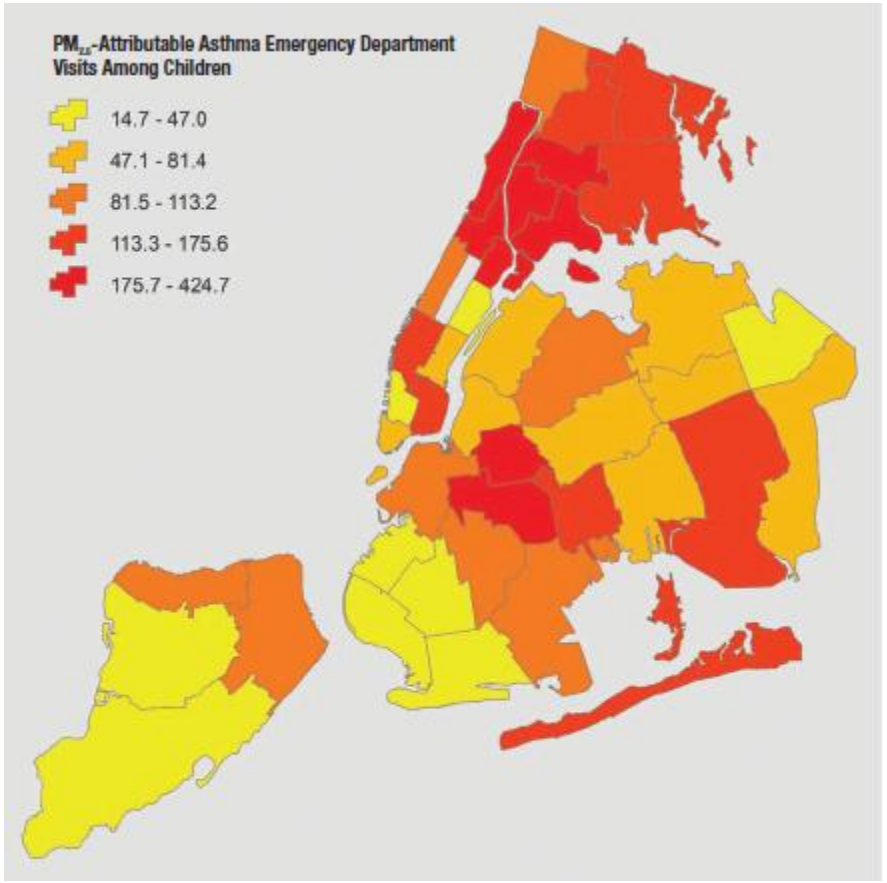
$PM_{2.5}$- Attributable Burden Rates

Mortality (Krewski *et al* 2009)



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

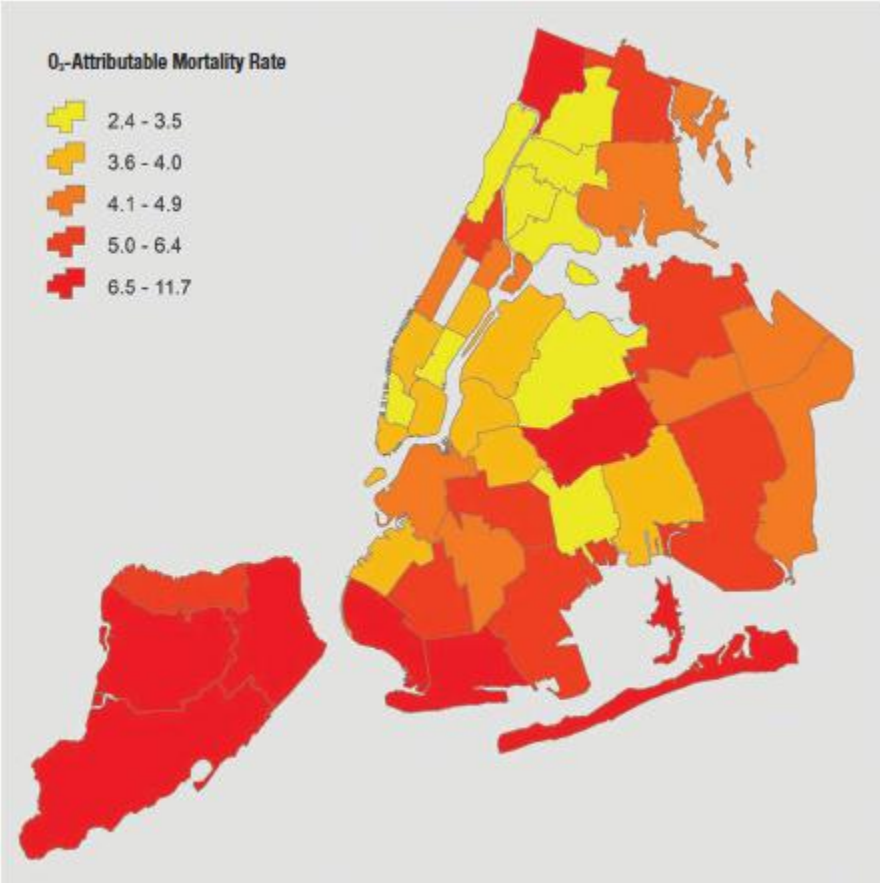
ED Visits, Asthma (Ito *et al* 2007)



30-fold variation by neighborhood

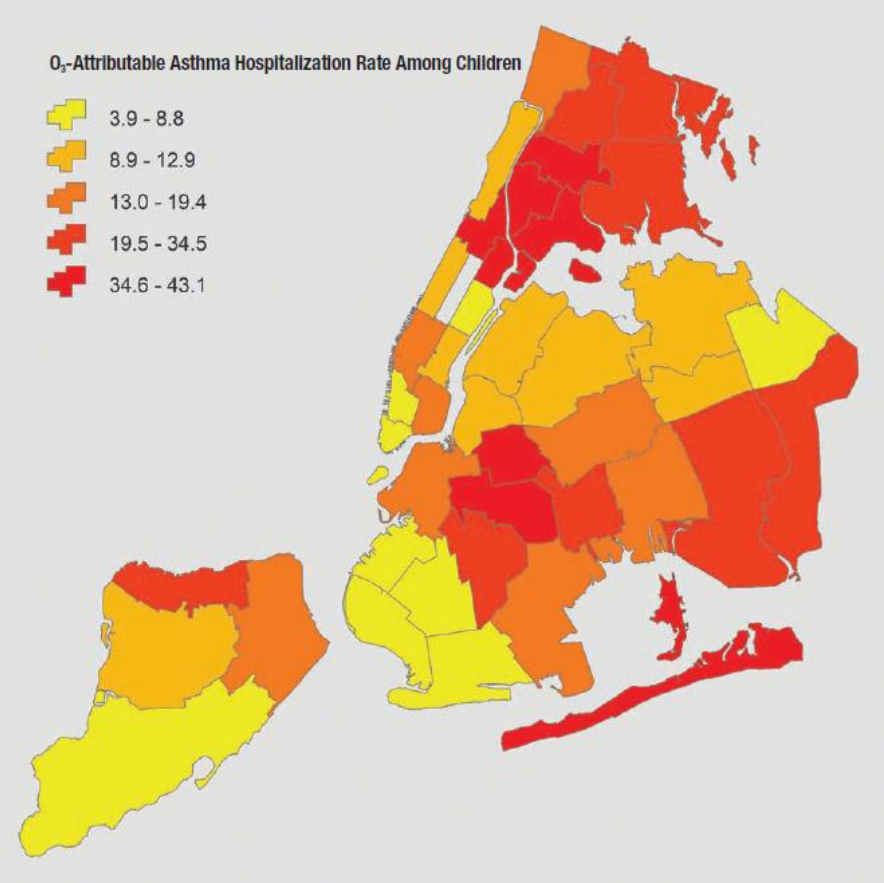
O_3- Attributable Burden Rates

Mortality (Huang *et al* 2005)



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

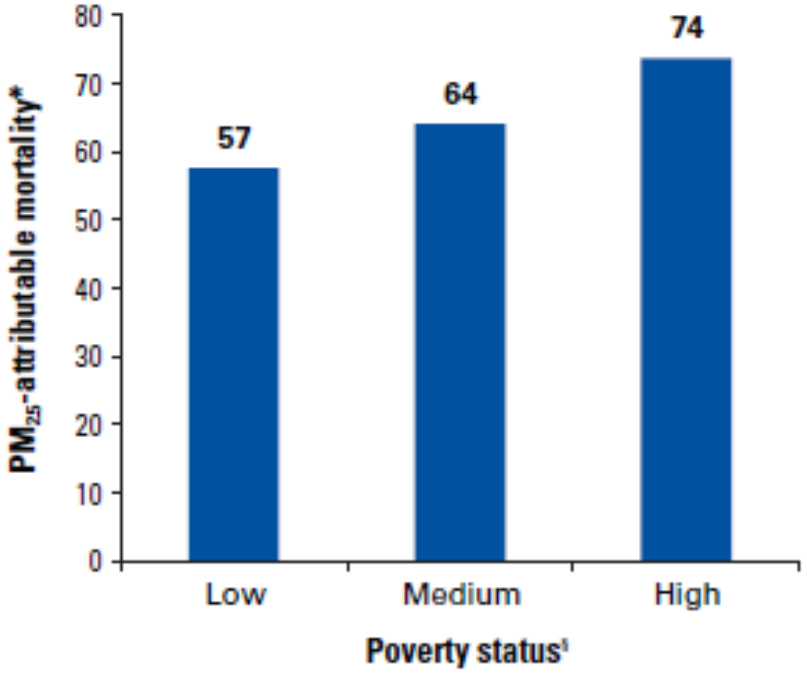
ED Visits, Asthma (Ito *et al* 2007)



11-fold variation by neighborhood

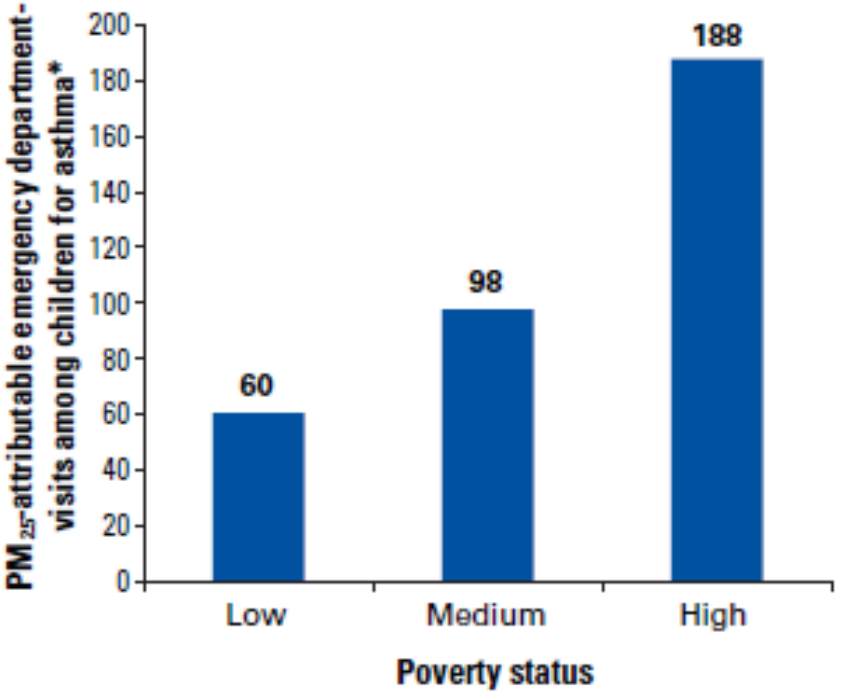
Distribution by Poverty, $PM_{2.5}$

$PM_{2.5}$- Attributable Mortality



Rates per 100,000 adults >30

$PM_{2.5}$- Attributable ED Asthma Visits



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

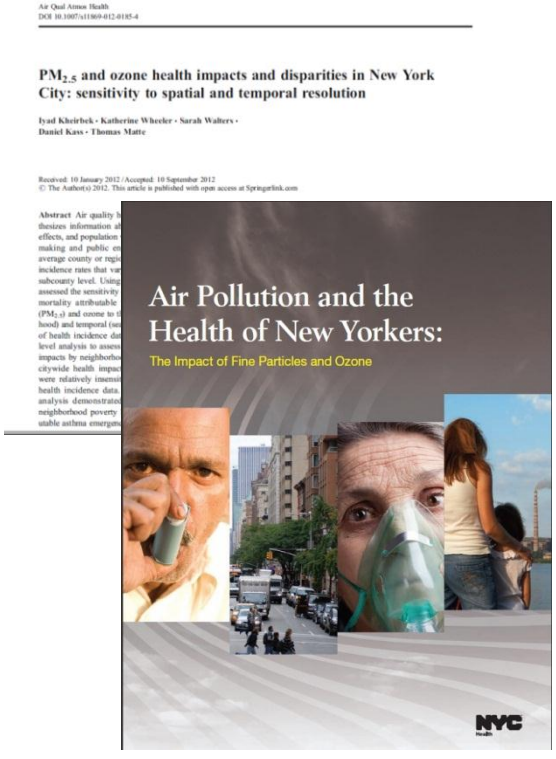
Exposure	Health Outcome	Annual # of Events above Baseline	Source of Effect Estimate
Heat	Natural-Cause Mortality	110 – 260*	Metzger, Ito, Matte, 2010
Heat	Cardiovascular Hospitalizations	80 – 200*	Lin et al, 2009
Ozone	Asthma ED visits	240 (170, 310)	Ito et al, 2007

*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

Iyad Kheirbek
ikheirbe@health.nyc.gov

Reports available at: http://www.nyc.gov/health/nyccas
http://www.nyc.gov/html/planyc2030/html/home/home.shtml