Air Pollution and Public Health

Where have we been?

Where are we going?

Joel Schwartz

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Lead from Carthaginian and Roman Spanish Mines Isotopically Identified in Greenland Ice Dated from 600 B.C. to 300 A.D.†

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"...[London's] Inhabitants breathe nothing but an impure and thick Mist, accompanied with a fuliginous and filthy vapor,... corrupting the Lungs and disordering the entire habit of their Bodies;..."

John Evelyn,
Fumifugium, 1661

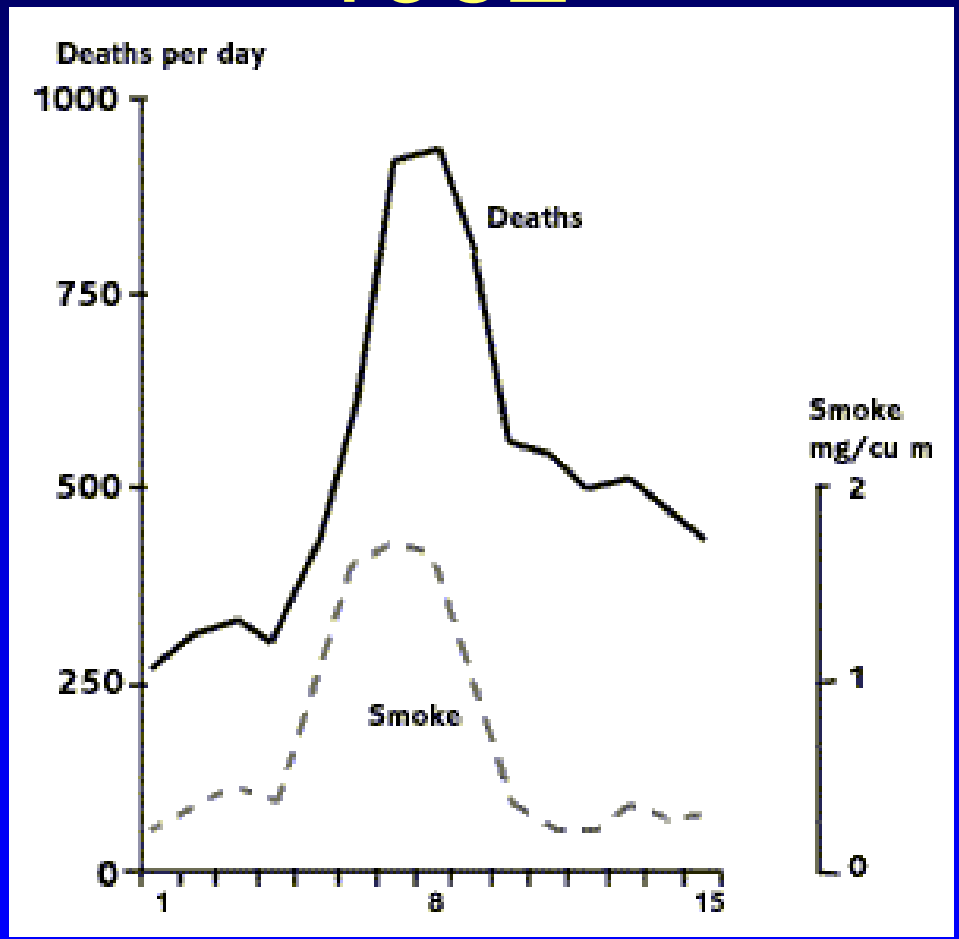
Meuse Valley Disaster

- December 1—5 1930
  - Intense Fog in valley between Liege and Huy
  - Worst on December 3 and 4
  - Over 60 Deaths, 14 in Engis which normally had 65 deaths per year

Notable Remarks

- A Similar Episode in London would kill Over 3000 People
- Many of the Deaths were Cardiovascular Deaths, following respiratory distress
- Submicron particles found in the alveolar region of the lung, Macrophages filled with Particles

London Smog, December 1952



First Response

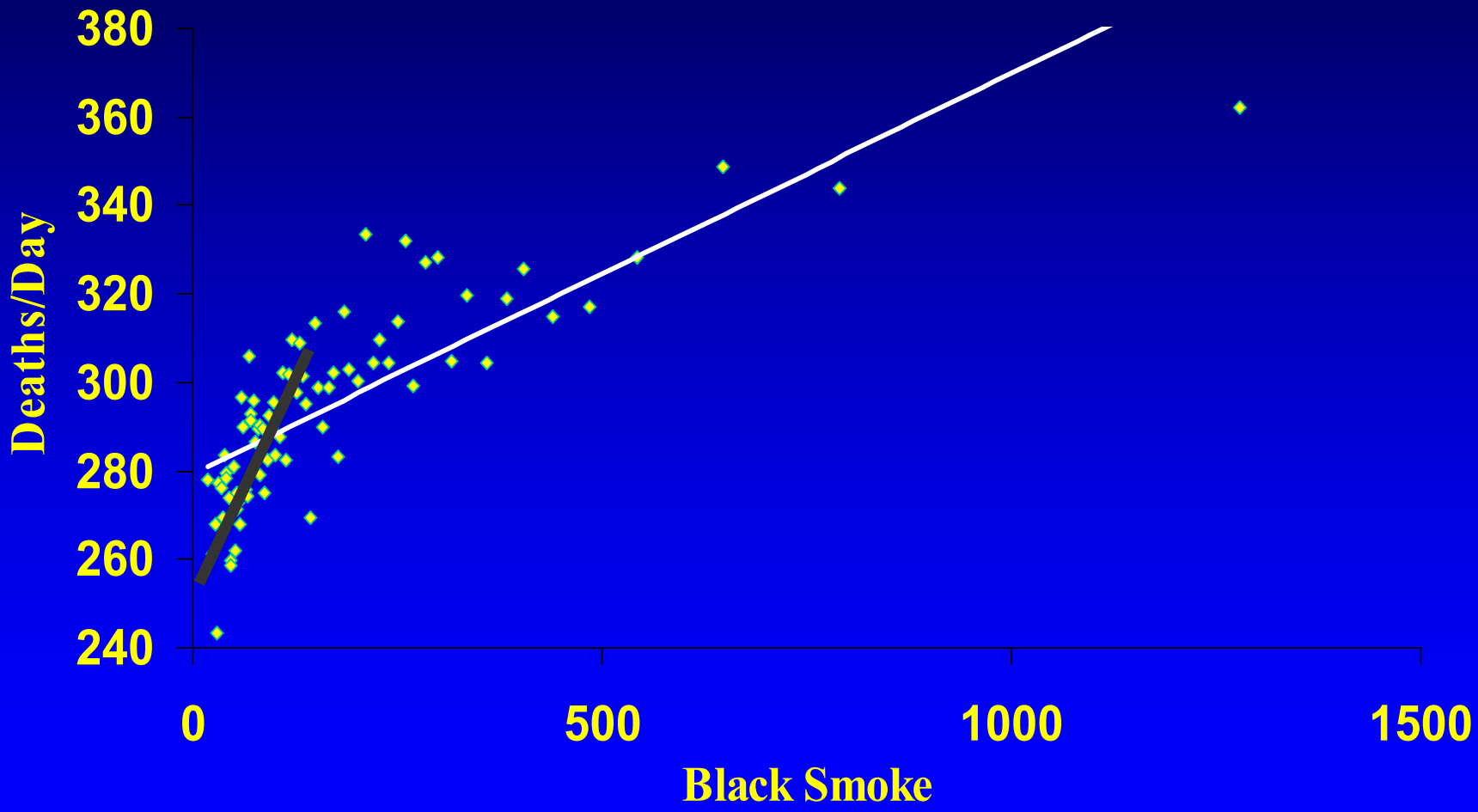
- British Clean Air Act 1956
- US Clean Air Act 1963
- Levels Lowered
- Problem Solved

St. Louis smog events in the 1930s; L.A. smog events and protests, 1940s and 50's

http://www.aqmd.gov/news1/50th_photos.htm

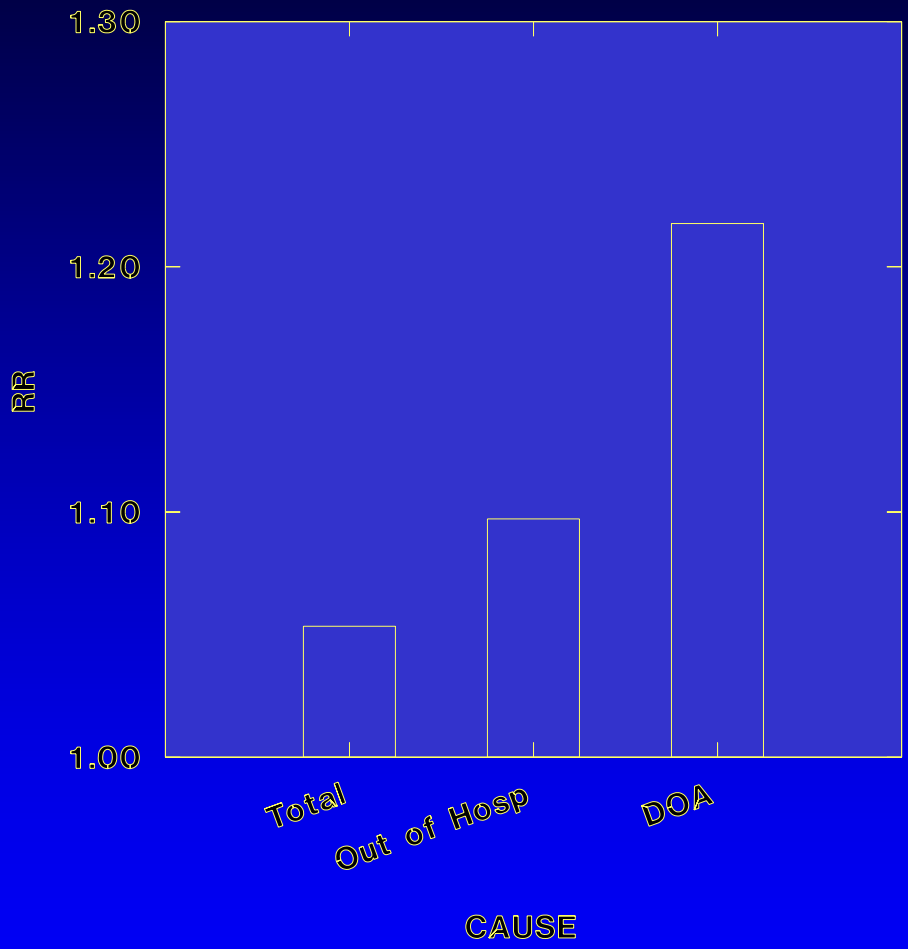
London Mortality Time Series

Schwartz & Marcus, Am J Epi 1990



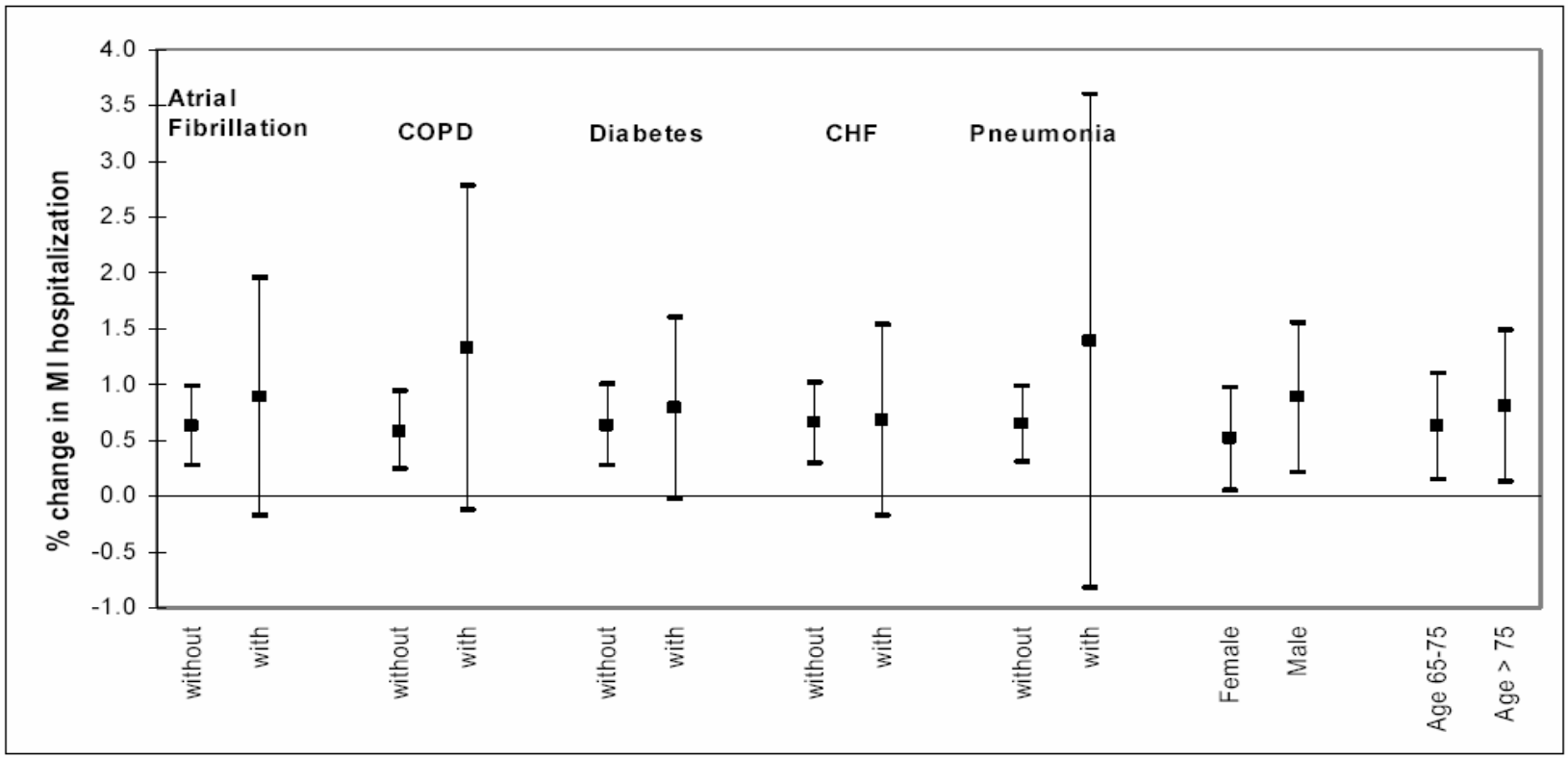
How Can this Happen?

- What are people dying of?
- What increases your risk of dying of those diseases?
- What possible mechanism can there be?



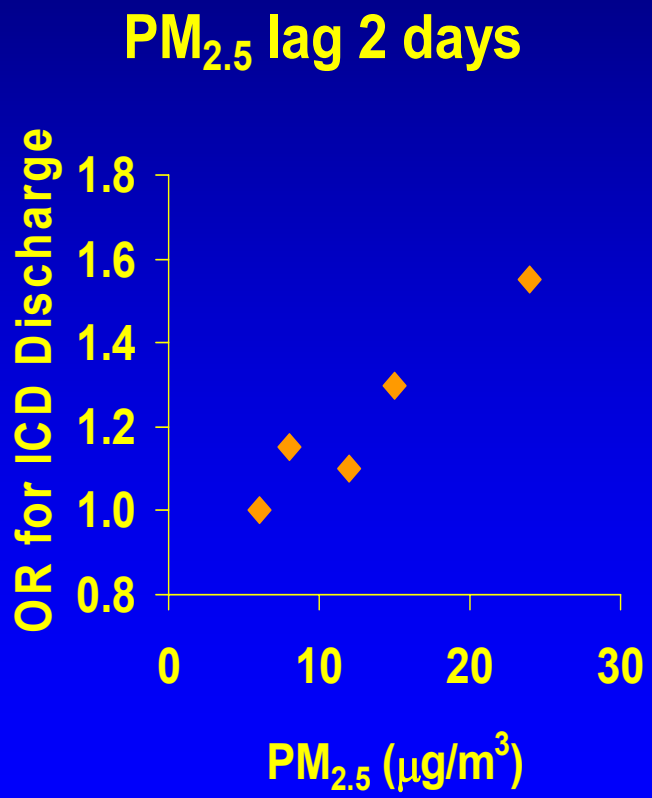
Look at Sudden Deaths

Effect of 10 μg/m^3 PM10 on the Risk of Heart Attacks in 36 US Cities



Air Pollution and Incidence of Cardiac Arrhythmias: Boston
(*Peters et al, Epidemiology 2000*)

- OR for ICD Discharge associated with $PM_{2.5}$, Black Carbon, and NO_2
- Stronger associations among 6 patients with 10+ events (effect of 5%-95% air pollution)
  - $PM_{2.5}$ 1.22 (0.7,2.0)
  - BC 2.16 (1.0,4.9)
  - NO_2 3.13 (1.8,5.6)



How is this Happening?

- Autonomic Dysfunction
- Arterial Dysfunction
- Thrombosis

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Heart Rate Variability

- Variability of time between heart beats
- More Variability Protects against Arrhythmia
  - Decreases in Boston (3 studies), Baltimore (2 studies), Utah Valley (2 studies), Mexico City (2 studies), ARIC Study, Elderly Chamber Study
  - No effect (Vancouver)
- Seems stronger in Elderly

Arterial Dysfunction

Associations between 6-day moving average exposure to particulate air pollutants and vascular reactivity, controlling for age, race, sex, BMI*, season, apparent temperature, and disease status (for total subjects estimate)

Subjects	Pollutant	n	Endothelium dependent % change per IQR † (95% CI ‡)	n	Endothelium independent % change per IQR (95% CI)
Type 2	Black carbon	148	-12.8 (-23.5, -0.6)	135	-6.8 (-15.1, 2.4)
	$PM_{2.5}$	183	-8.8 (-17.0, 0.1)	169	-8.5 (-14.1, -2.5)
	Particle #	125	-6.3 (-24.5, 16.2)	114	-11.1 (-23.8, 3.8)
	Sulfate	125	-12.1 (-19.3, -4.2)	115	-6.2 (-11.5, -0.6)

* Body mass index

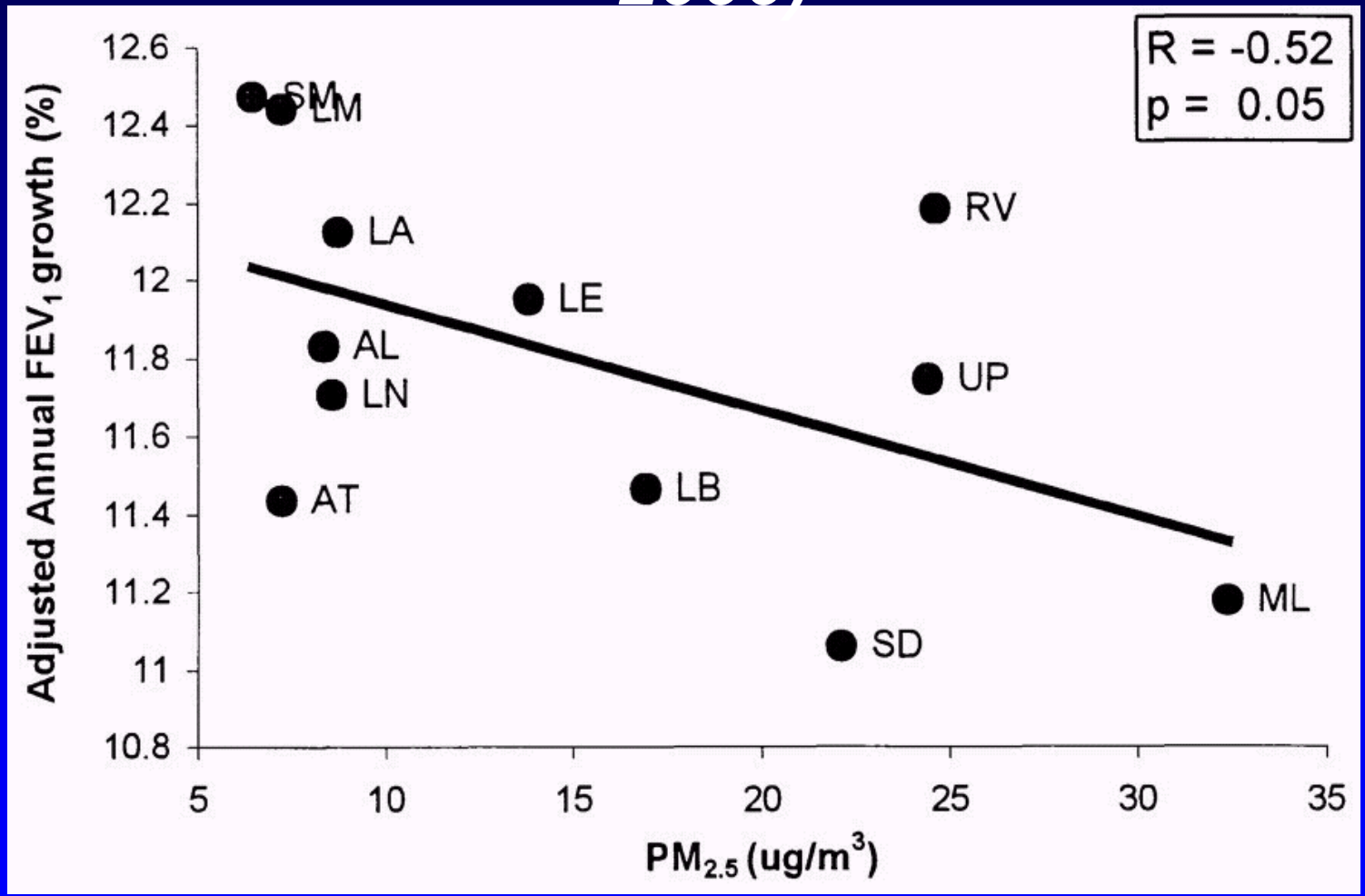
† Interquartile range of the pollutant, for the days under consideration

‡ confidence interval

Thrombosis

- Peters et al 2001 Increases in CRP
- Fibrinogen Increases (Ghio 2000, Pekkanen 2000, Schwartz 2001)
- Von Willibrand's Factor (Liao 2005, O'Neill in review)

FEV_1 Growth vs $PM_{2.5}$ in Southern California Children *(Gauderman et al., 2000)*

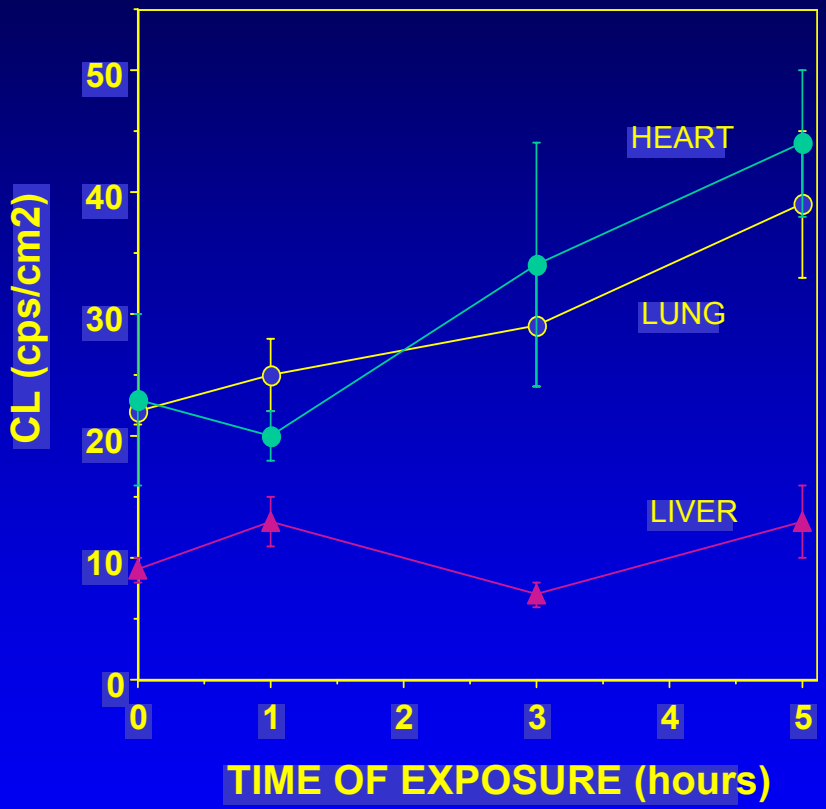


New Directions

- Mechanistic Pathways
- Traffic Pollution and Fine Scale Exposure
- Developing Countries

Role of oxidants in the pulmonary and cardiac responses to inhaled ambient particles.

Particles induced oxidative Stress in the lung and heart.



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Chemiluminescence (CL) of lung, heart, and liver after various durations of CAPs exposure.

ROS related Genes

- Gilliland et al (2004) found GSTM1 null and GSTP1 wildtype had enhanced allergic response to Diesel exhaust particles
- Gilliland et al (2001) found ETS exposure in utero associated with asthma and wheeze only in GSTM1 null children.

GSTM1, PM, and HRV in the Normative Aging Study

Category	% Decrease in HF	95%CI
GSTM1 Null, No Statin	*-34.0*	-53.0, -7.2
GSTM1 Null, Statin	-6.4	-66.5, 161.9
GSTM1 Present, No Statin	-3.6	-40.5, 56.2
GSTM1 Present, Statin	-3.2	-50.0, 87.2

Traffic Pollution

- Not uniform over space
- Big difference in a few blocks

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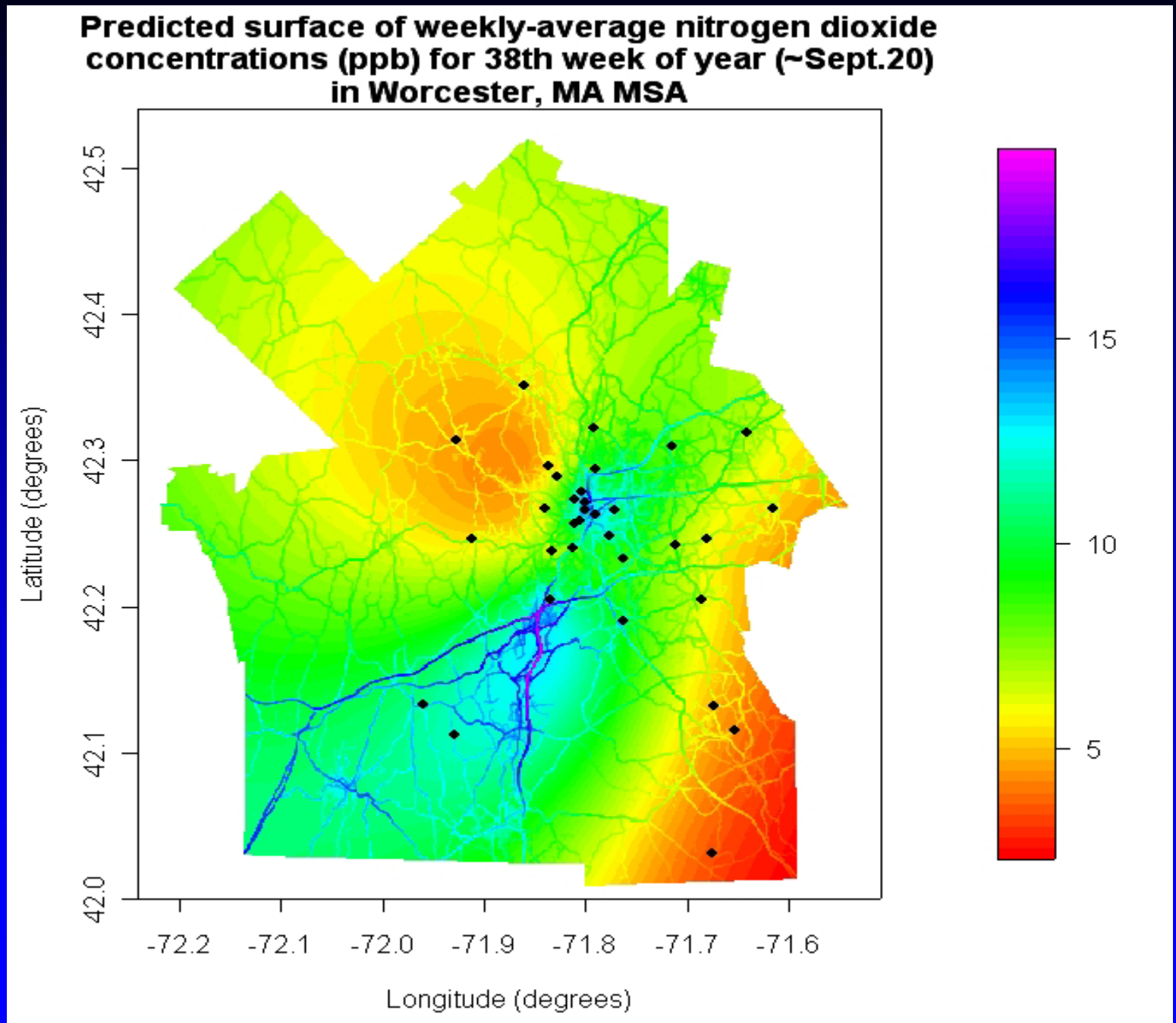

Predicted surface of weekly-average nitrogen dioxide concentrations (ppb) for 38th week of year (~Sept.20) in Worcester, MA MSA
Latitude (degrees)
42.0
42.1
42.2
42.3
42.4
42.5
-72.2
-72.1
-72.0
-71.9
-71.8
-71.7
-71.6
Longitude (degrees)
15
10
5

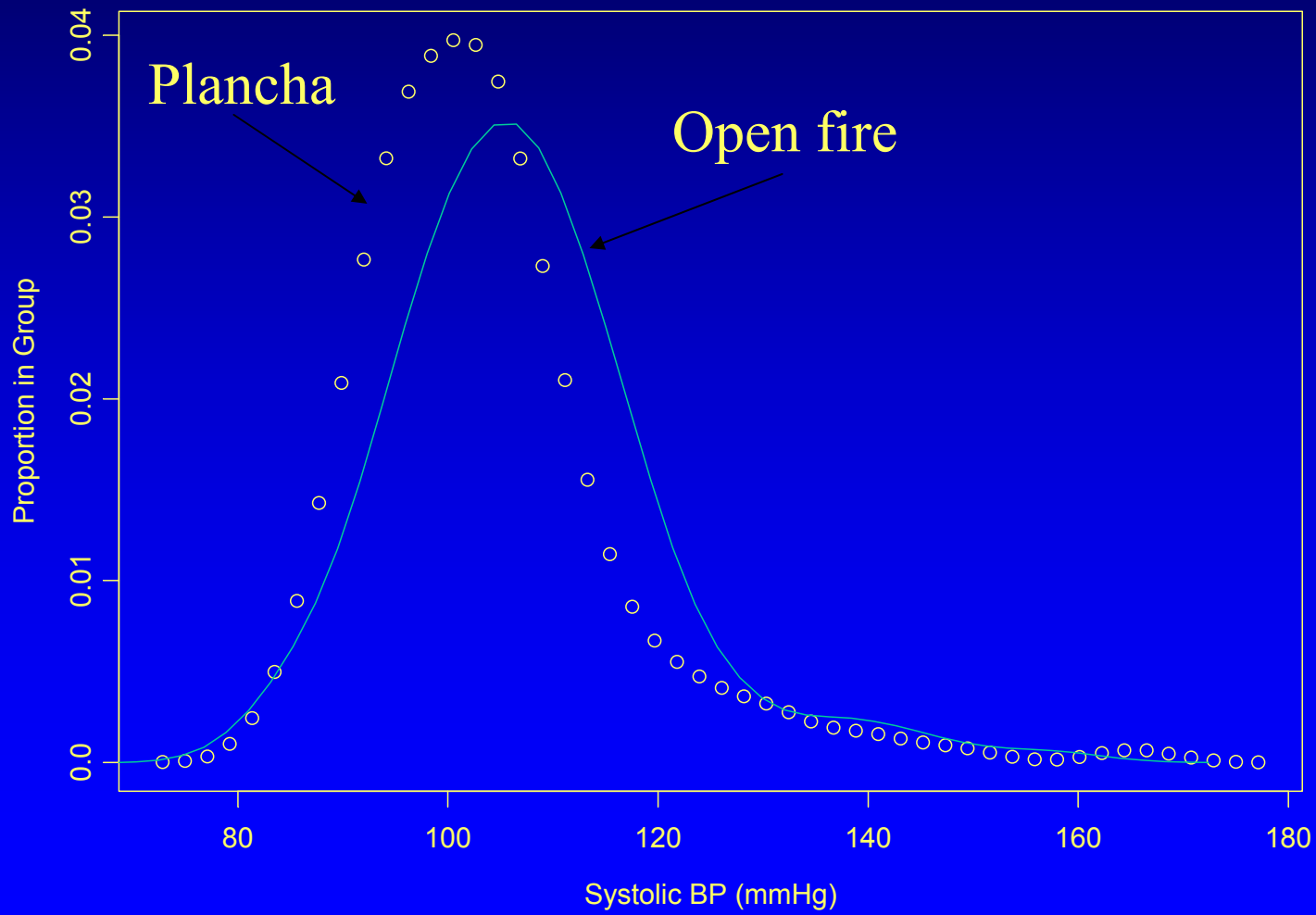
Dutch Cohort Study (Hoek et al)

- Estimated Traffic Particle Exposure at Home Address
- Larger Increase in Risk of Death than Previous Cohort Studies

Cardiovascular Effects of Biomass Smoke:

A Randomized Stove Trial in Guatemala

Effect of Intervention on Distribution of Systolic Blood Pressure



What happens if we Improve Air Quality?

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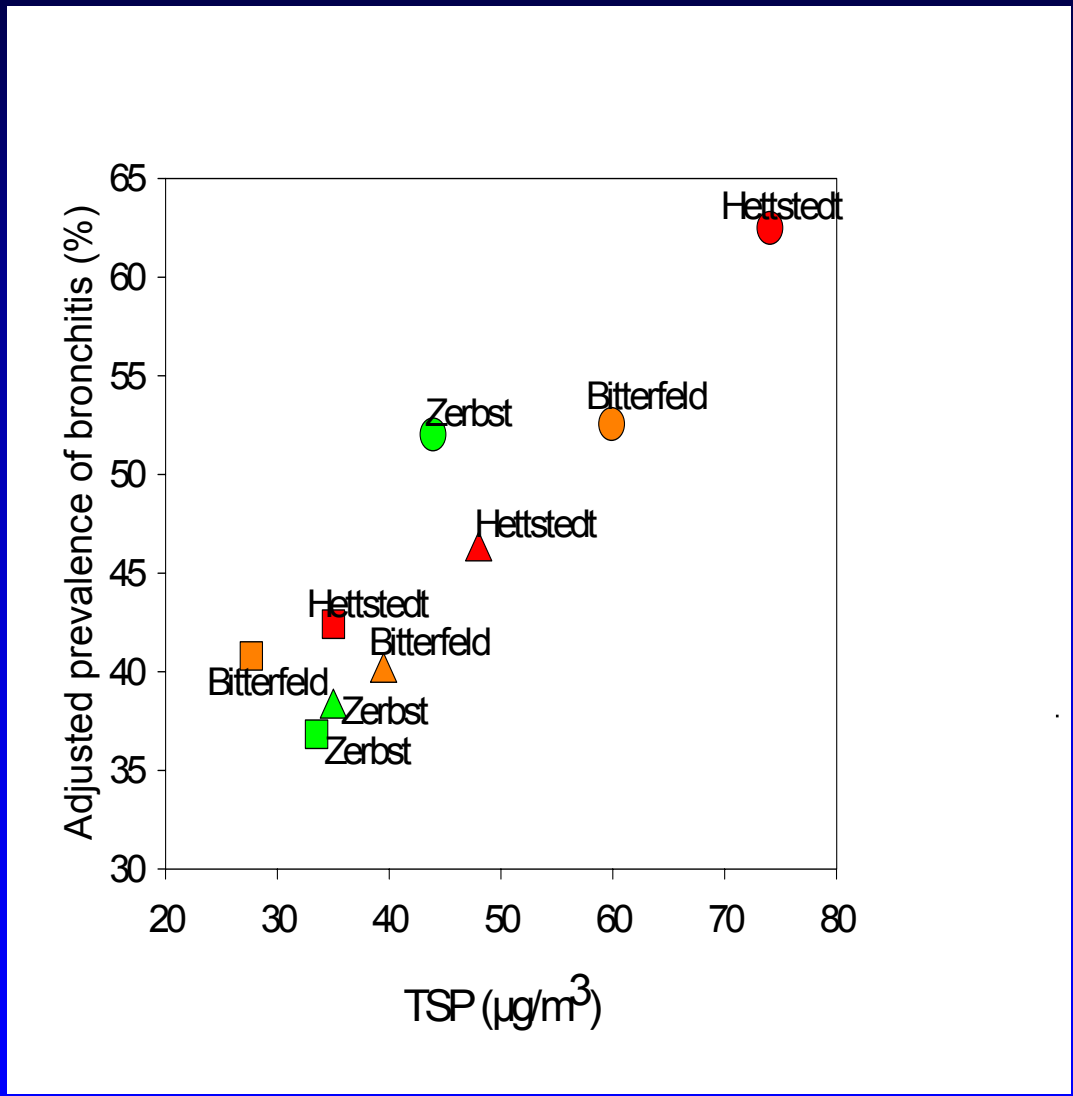
Adjusted prevalence of bronchitis in children and annual TSP two years prior to the examination



Relative Risk of Death in Six US Cities during Two Follow-up Periods