

Air Pollution and Public Health

Where have we been?

Where are we going?

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**Harvard School of Public
Health**

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**





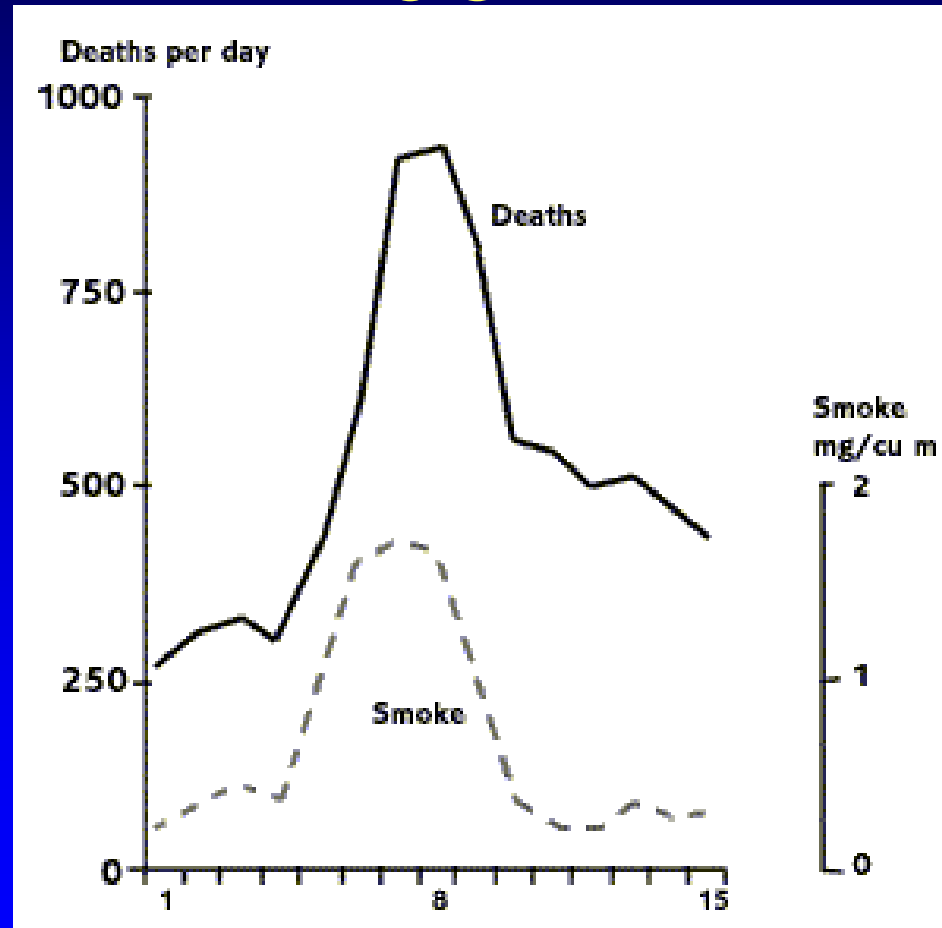
Meuse Valley Disaster

- 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

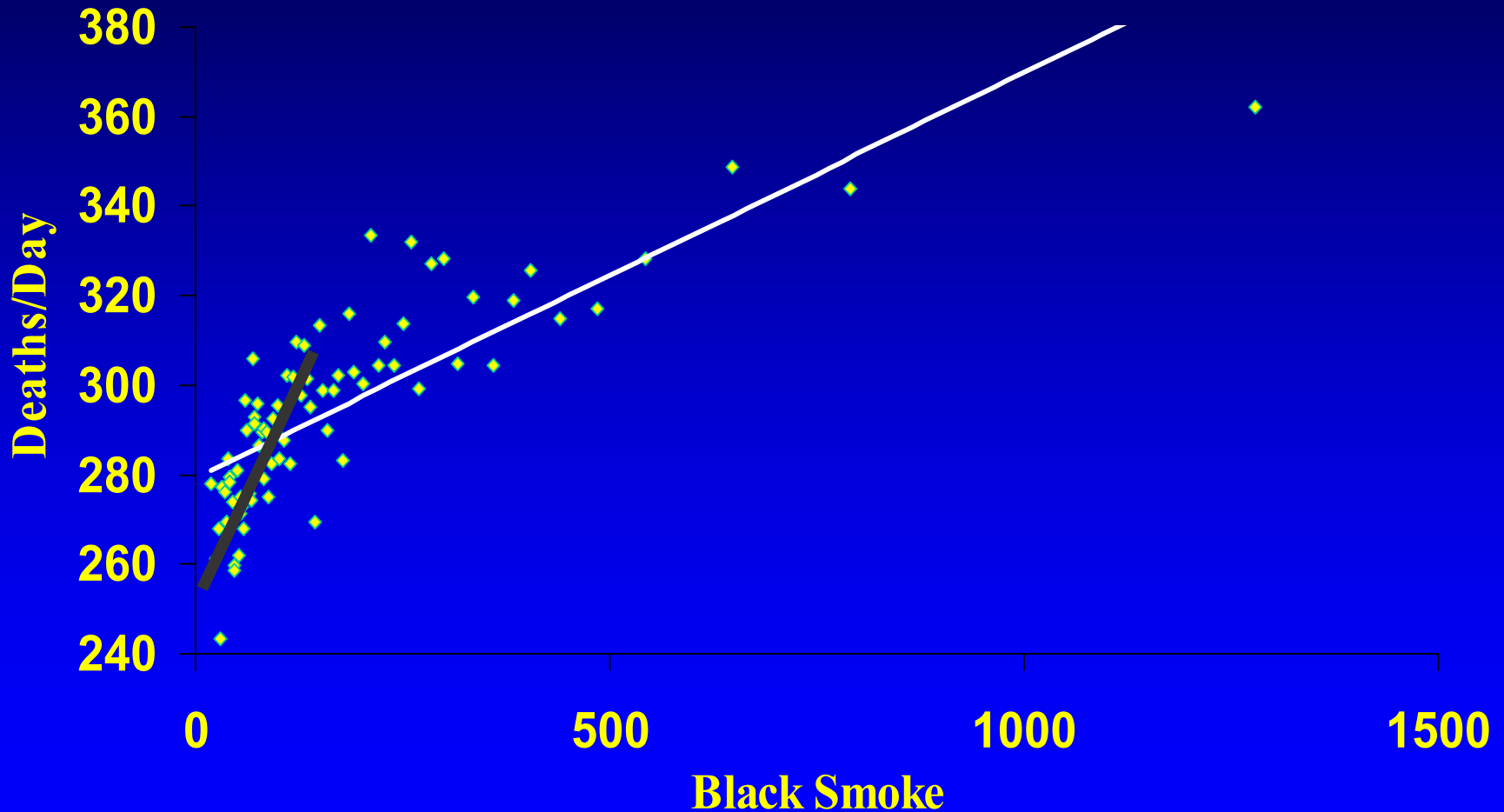
- British Clean Air Act 1956
- US Clean Air Act 1963
- Levels Lowered
- Problem Solved

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



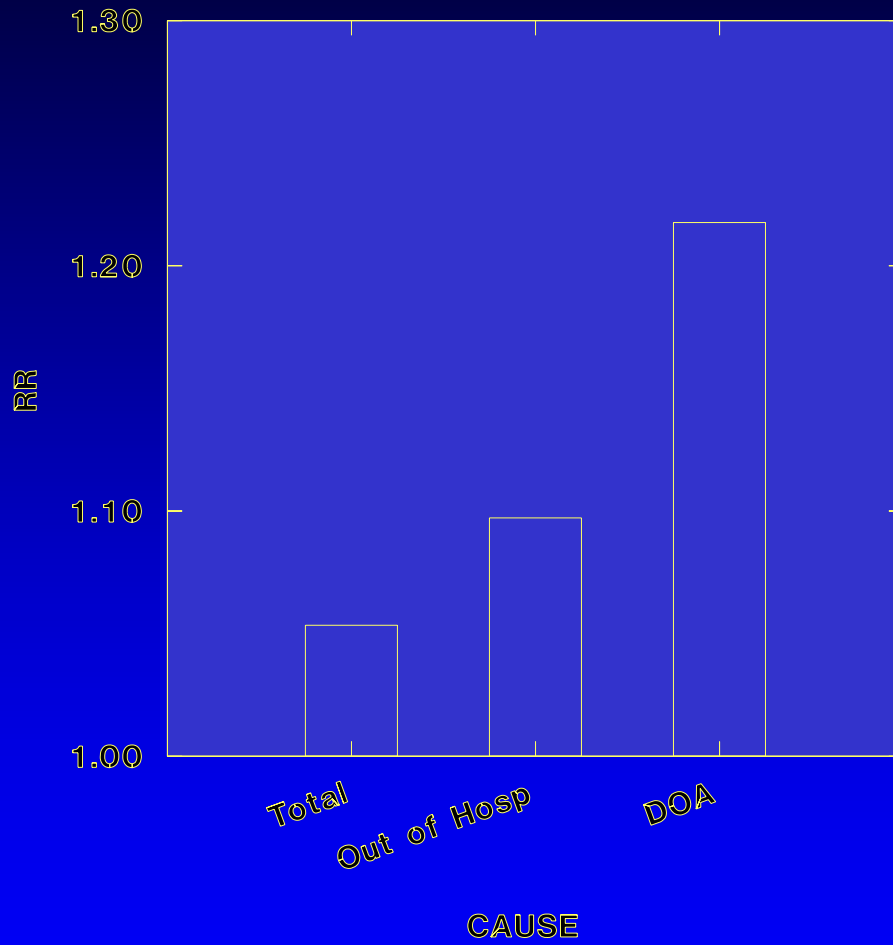
London Mortality Time Series

Schwartz & Marcus, Am J Epi 1990



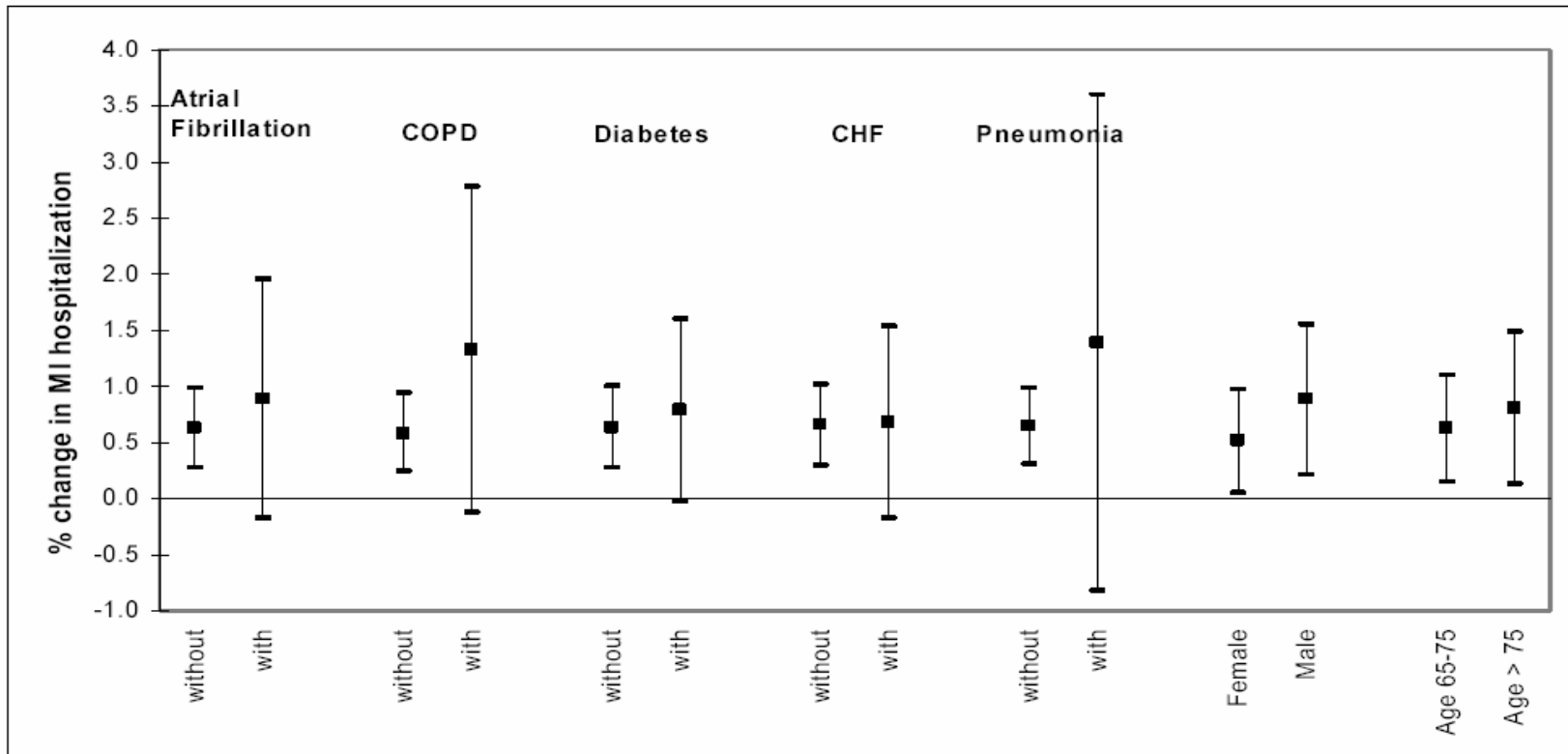
How Can this Happen?

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



Look at Sudden Deaths

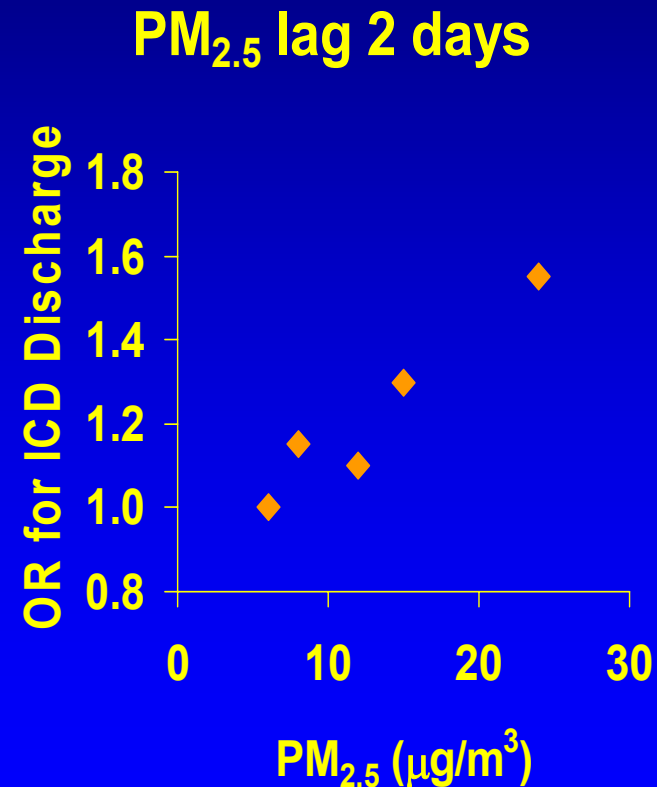
Effect of $10 \mu\text{g}/\text{m}^3$ PM10 on the Risk of Heart Attacks in 36 US Cities



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 NO₂
- 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)
 - NO₂ 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	Endothelium dependent		Endothelium independent	
		n	% change per IQR † (95% CI ‡)	n	% 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

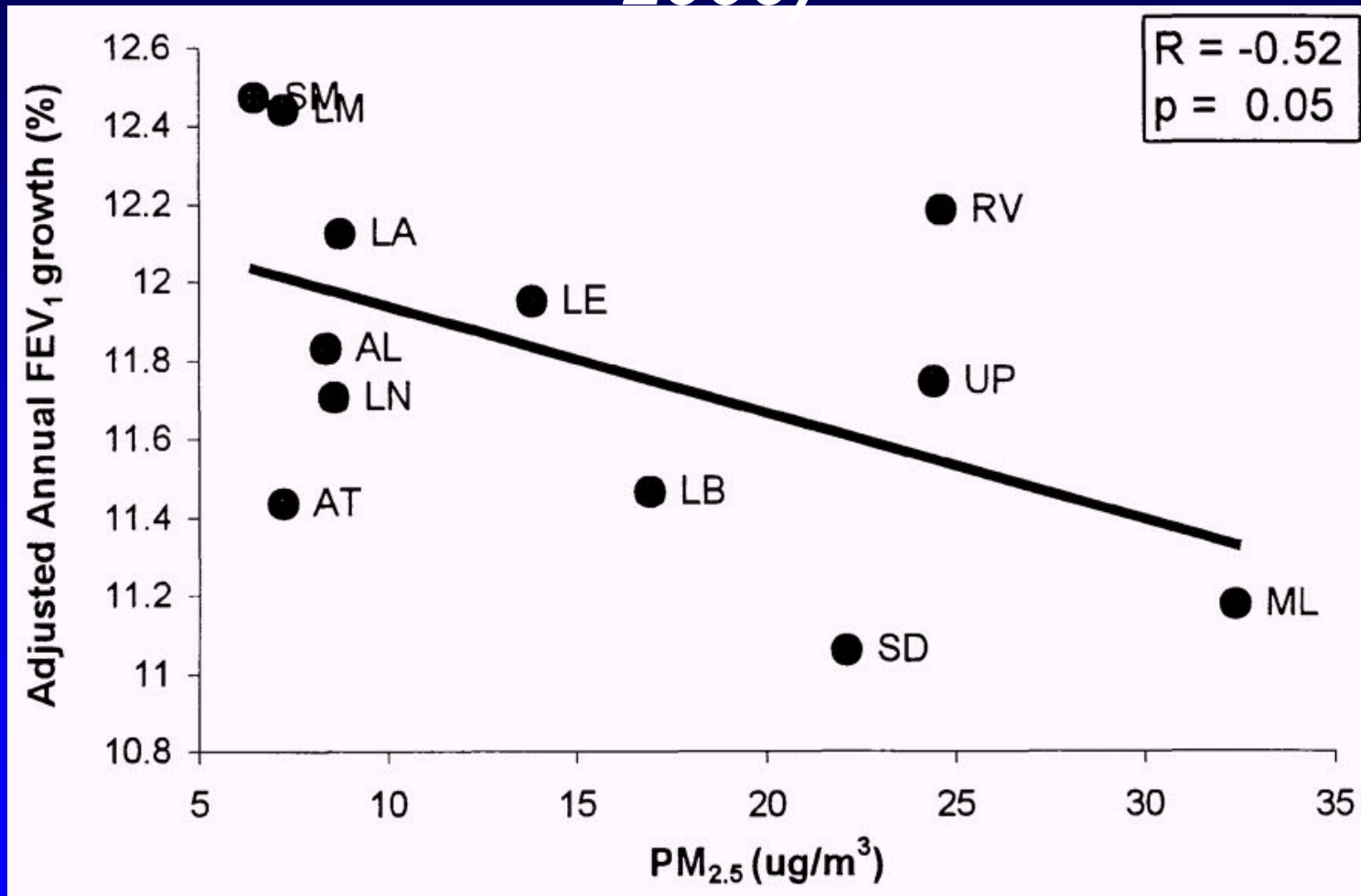
† Interquartile range of the pollutant, for the days under consideration

‡ 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)

FEV₁ Growth vs PM_{2.5} in Southern California Children (*Gauderman et al., 2000*)

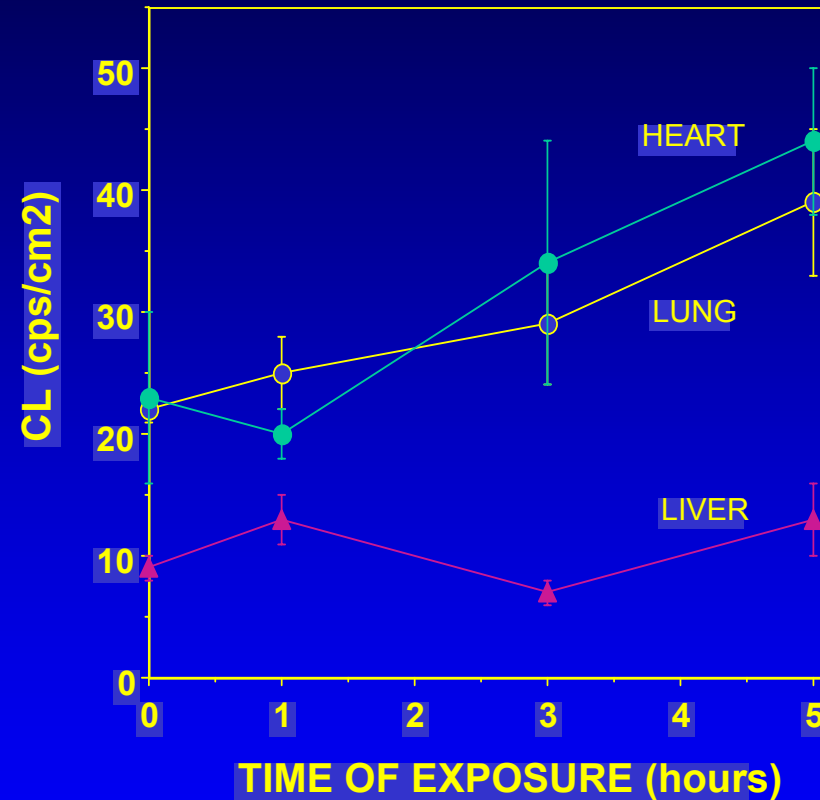


New Directions

- 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.



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



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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

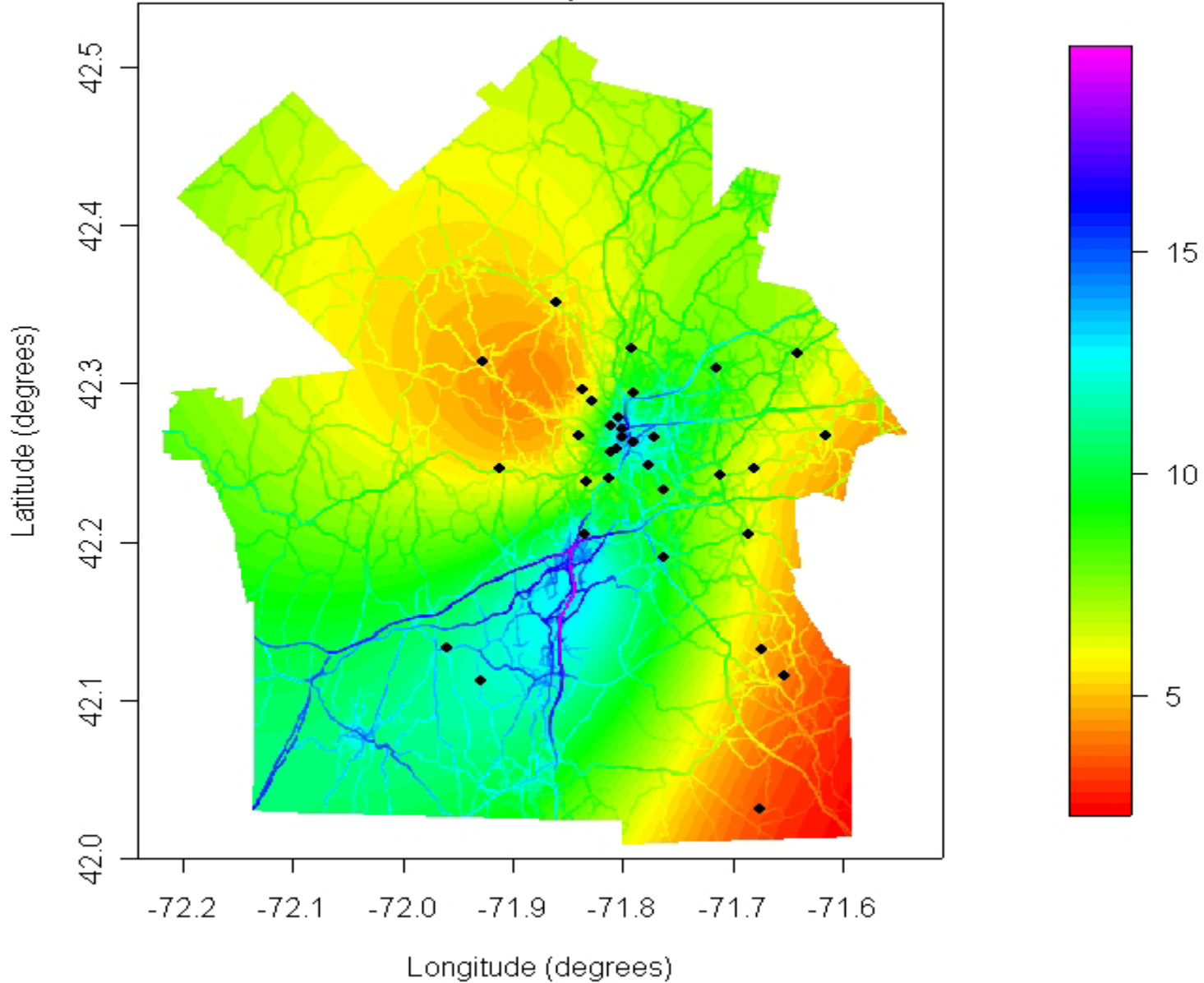
Category	% Decrease in HF	95%CI
GSTM1 Null, No Statin	-34.0	-53.0, -7.2
<i>GSTM1 Null, Statin</i>	-6.4	-66.5, 161.9
GSTM1 Present, No Statin	-3.6	-40.5, 56.2
GSTM1 Present, Statin	-3.2	-50.0, 87.2

Traffic Pollution

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



Predicted surface of weekly-average nitrogen dioxide concentrations (ppb) for 38th week of year (~Sept.20) in Worcester, MA MSA



Dutch Cohort Study (Hoek et al)

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

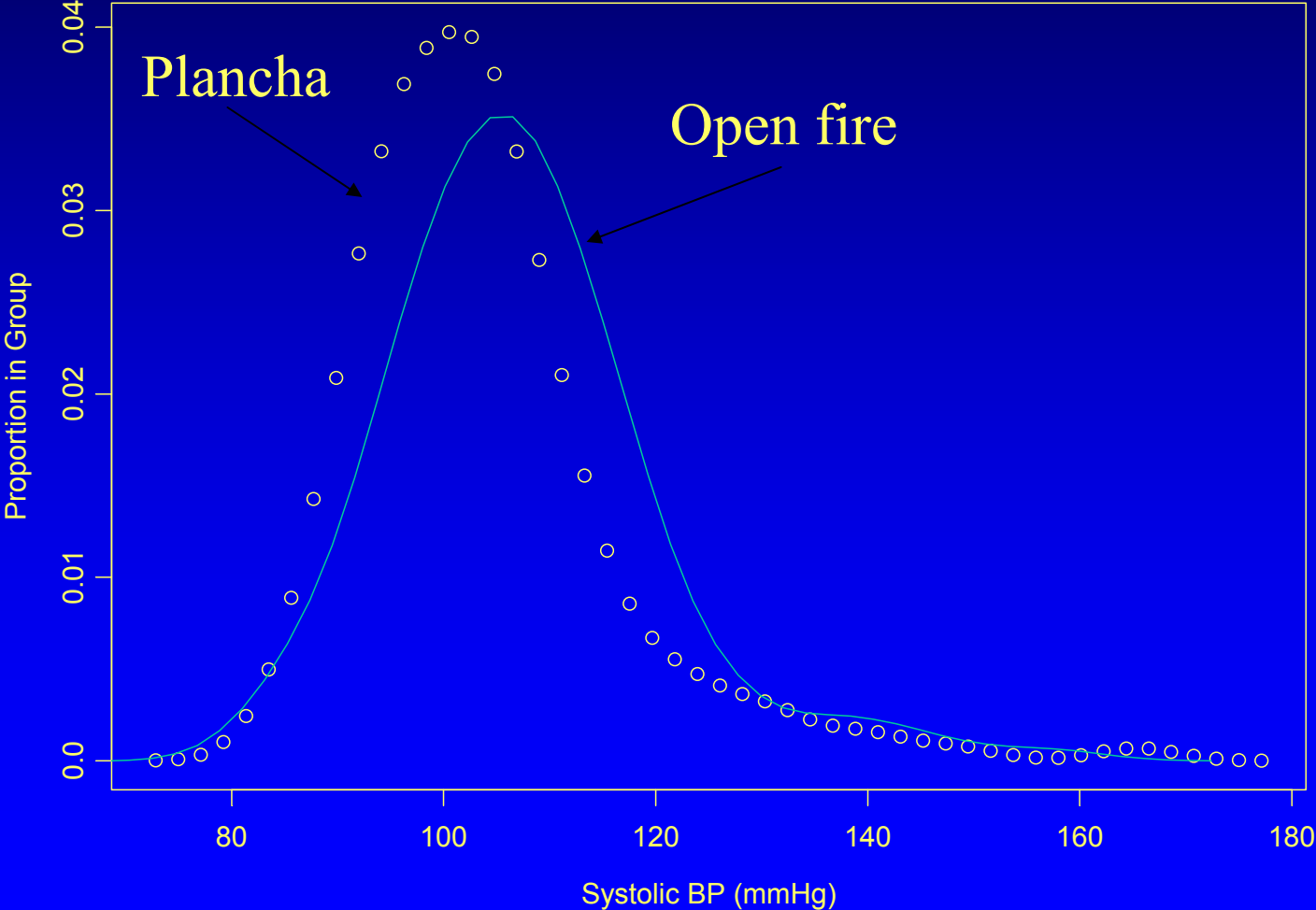
Cardiovascular Effects of Biomass Smoke:

A Randomized Stove Trial in
Guatemala





Effect of Intervention on Distribution of Systolic Blood Pressure

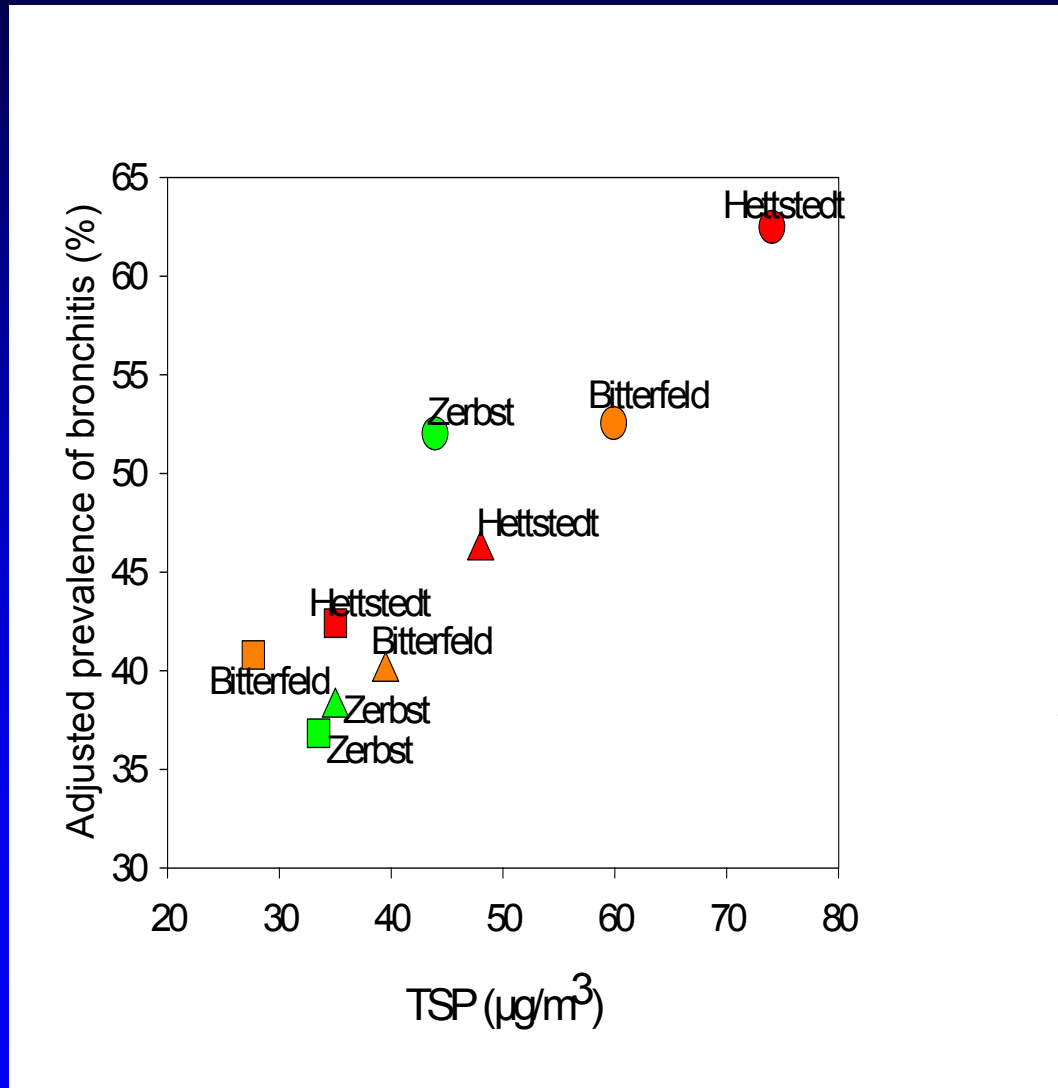


What happens if we Improve Air Quality?



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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

