

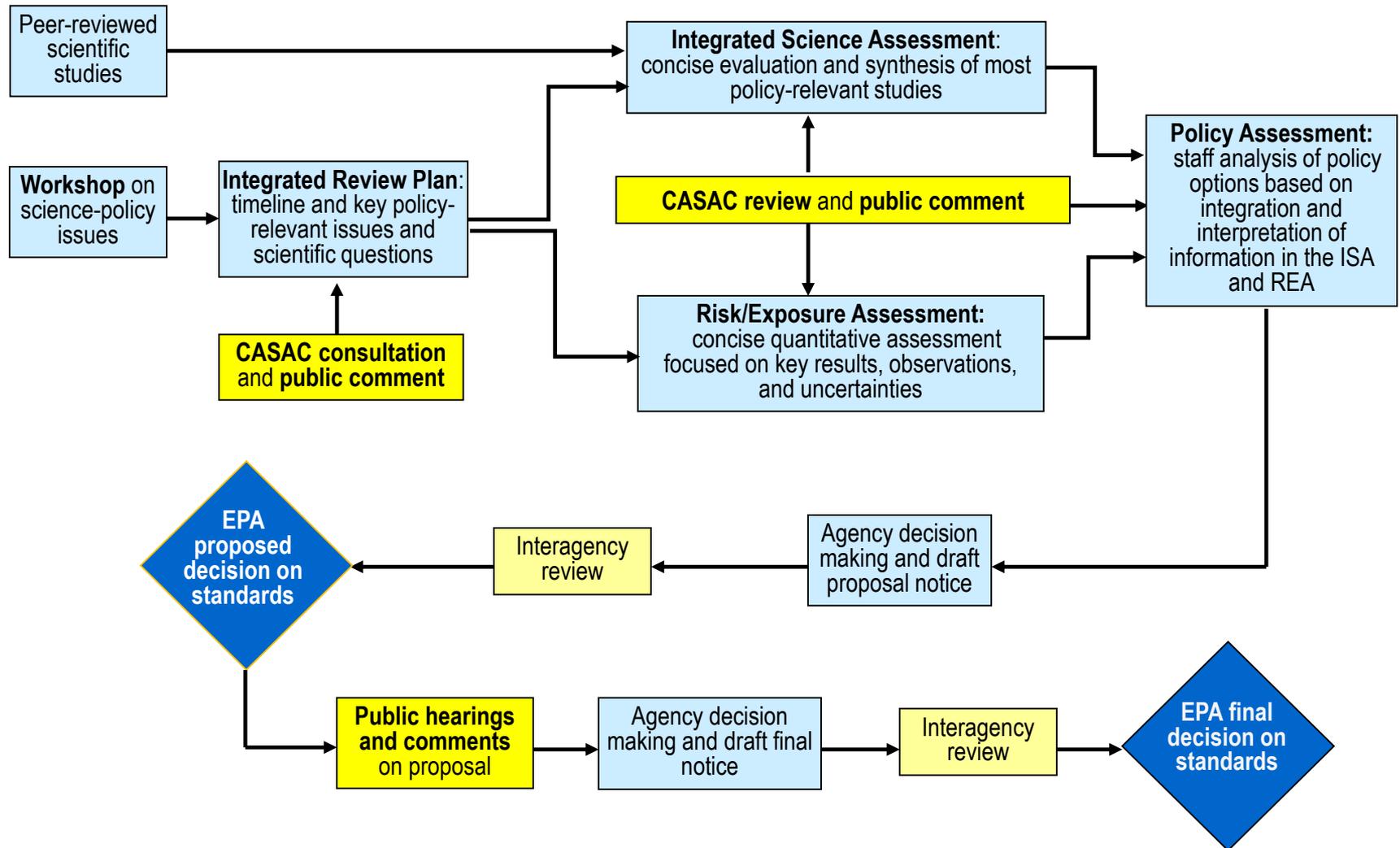
# How Air Pollution Is Affecting Our Health

**Environmental Science Institute for Teachers  
July 8, 2014**

**Susan Lyon Stone  
US EPA Office of Air Quality Planning and  
Standards  
[stone.susan@epa.gov](mailto:stone.susan@epa.gov)**



# Overview of NAAQS Review Process



# Human Lung

- Air conducting

- Trachea

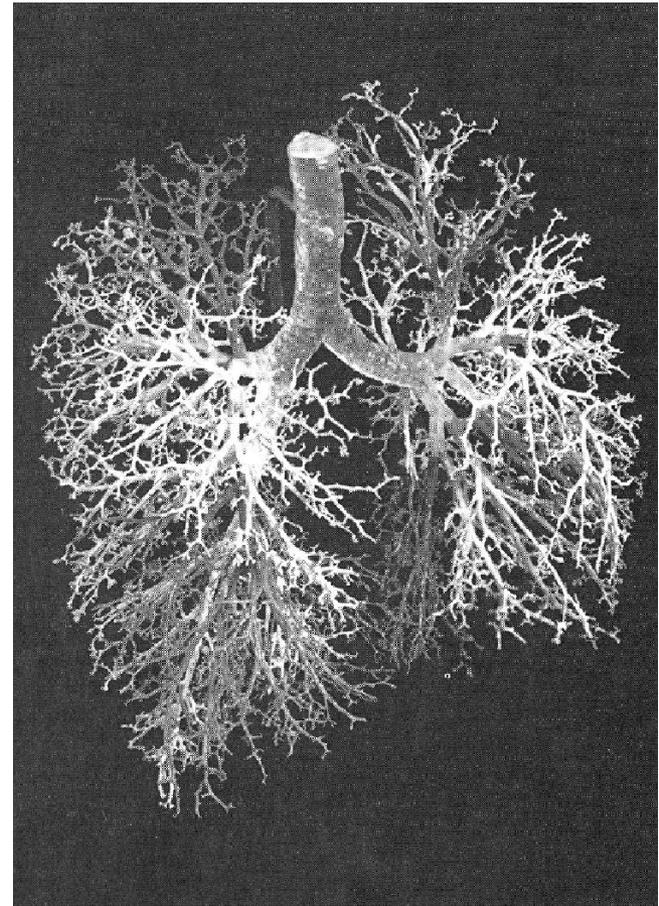
- Bronchi

- Bronchioles

- Gas exchange

- Respiratory bronchioles

- Alveoli

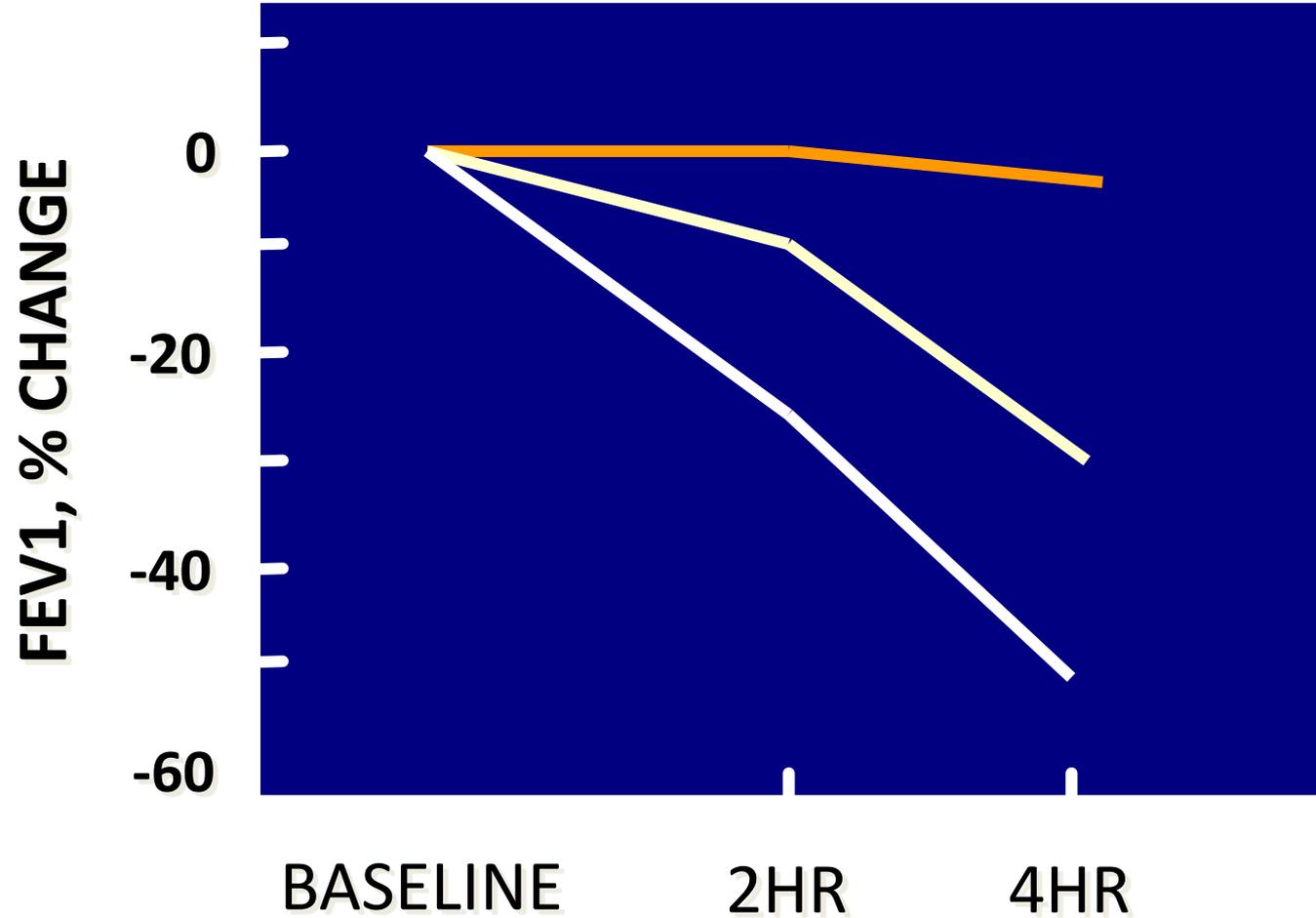


# Ozone Irritates Airways

- Symptoms
  - Cough
  - Sore or scratchy throat
  - Pain with deep breath
  - Fatigue
- Rapid onset
- Asthma symptoms - greater in people with asthma, also occur in people without asthma



# Variability in Lung Function Responses



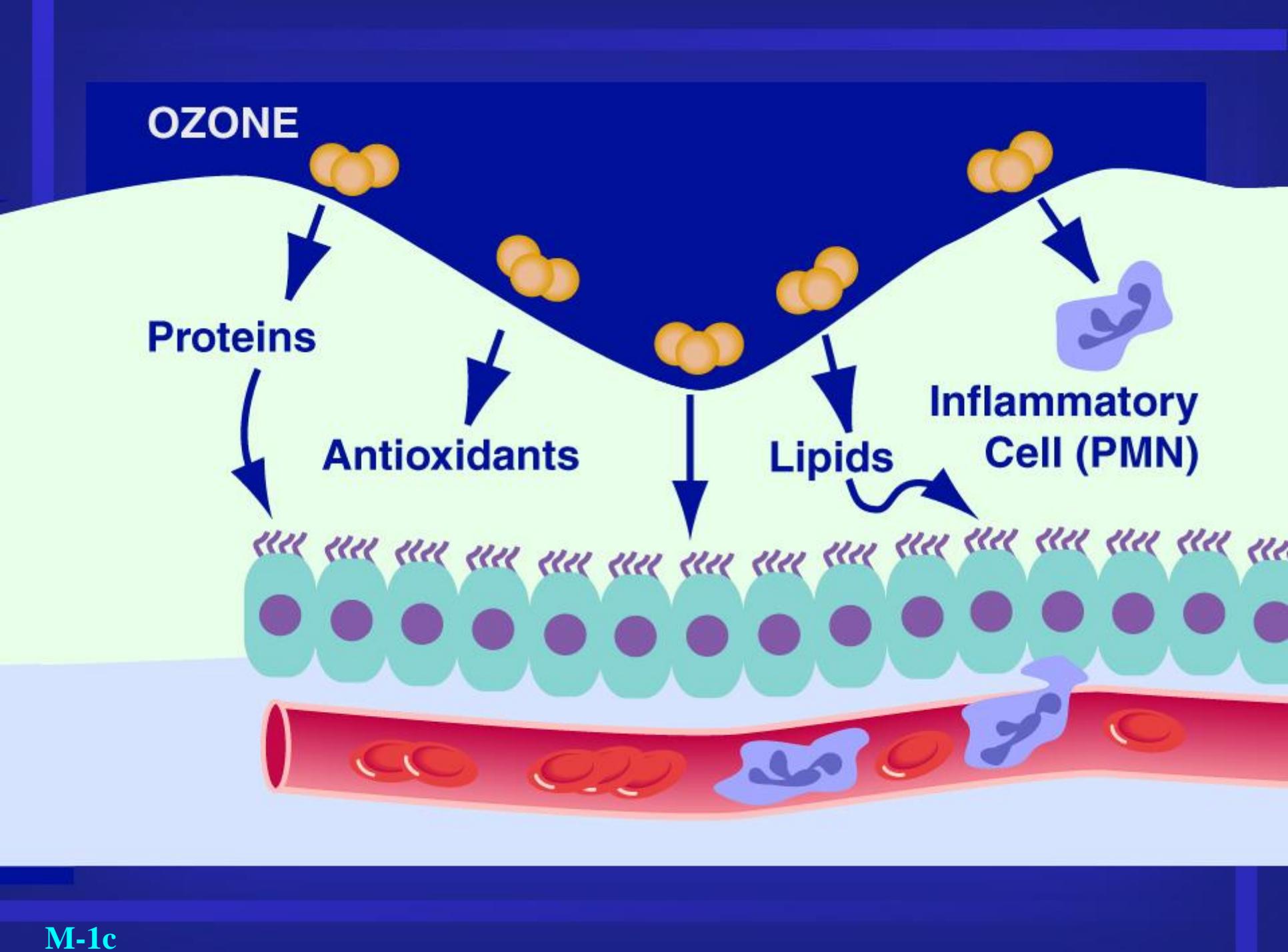
**OZONE**

**Proteins**

**Antioxidants**

**Lipids**

**Inflammatory Cell (PMN)**

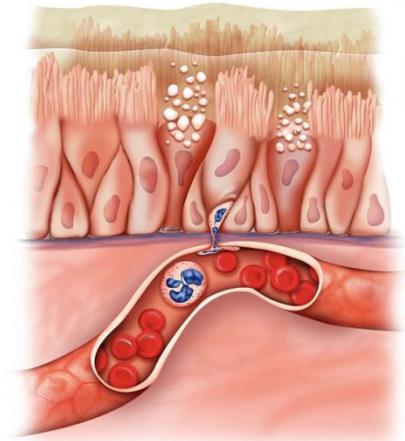


# Ozone Causes Inflammation

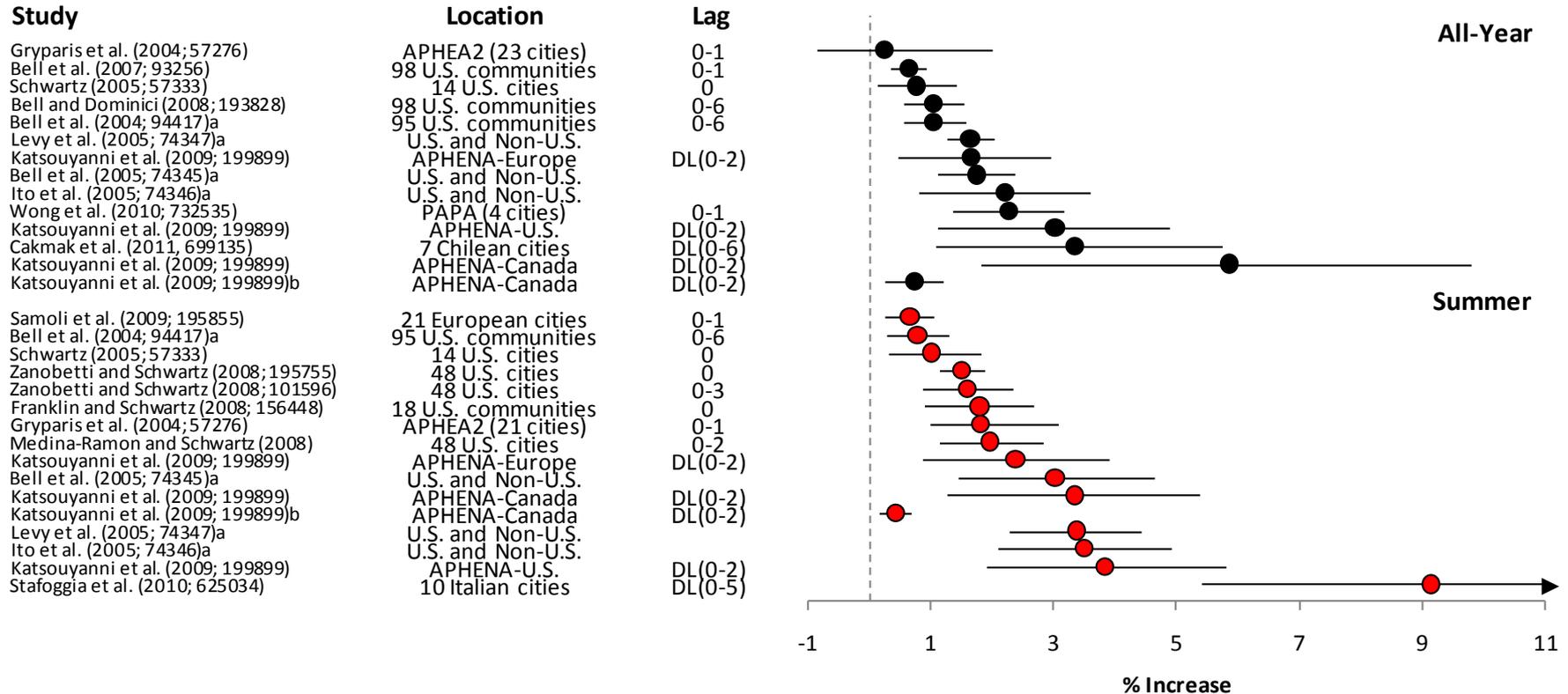
- Ozone reacts completely in surface layer - forms reactive oxygen molecules
- Increases permeability of cells that line airways
- Influx of white blood cells and proteins
- Damages cells that line the airways
- Effect is greater 24 hours after exposure
- Increases airway reactivity
- Concern about repeated exposures

# Short-Term O<sub>3</sub> Exposure and Respiratory Effects

- Lung function decrements
  - Large body of clinical, toxicological, and epidemiologic evidence
  - Epidemiologic evidence for children, especially asthmatics
- Respiratory symptoms and asthma medication use
  - Clinical and epidemiologic evidence
- Airway inflammation and oxidative stress
  - Large body of toxicological and clinical evidence
  - New epidemiologic evidence with parallel findings in asthmatic children
- Increased airway permeability, airways hyperresponsiveness, allergic responses, and susceptibility to infection
  - Large body of clinical and toxicological evidence
- Hospital admissions/ED visits
  - Consistent positive associations across endpoints
  - Stronger associations during the summer, specifically for asthma and COPD



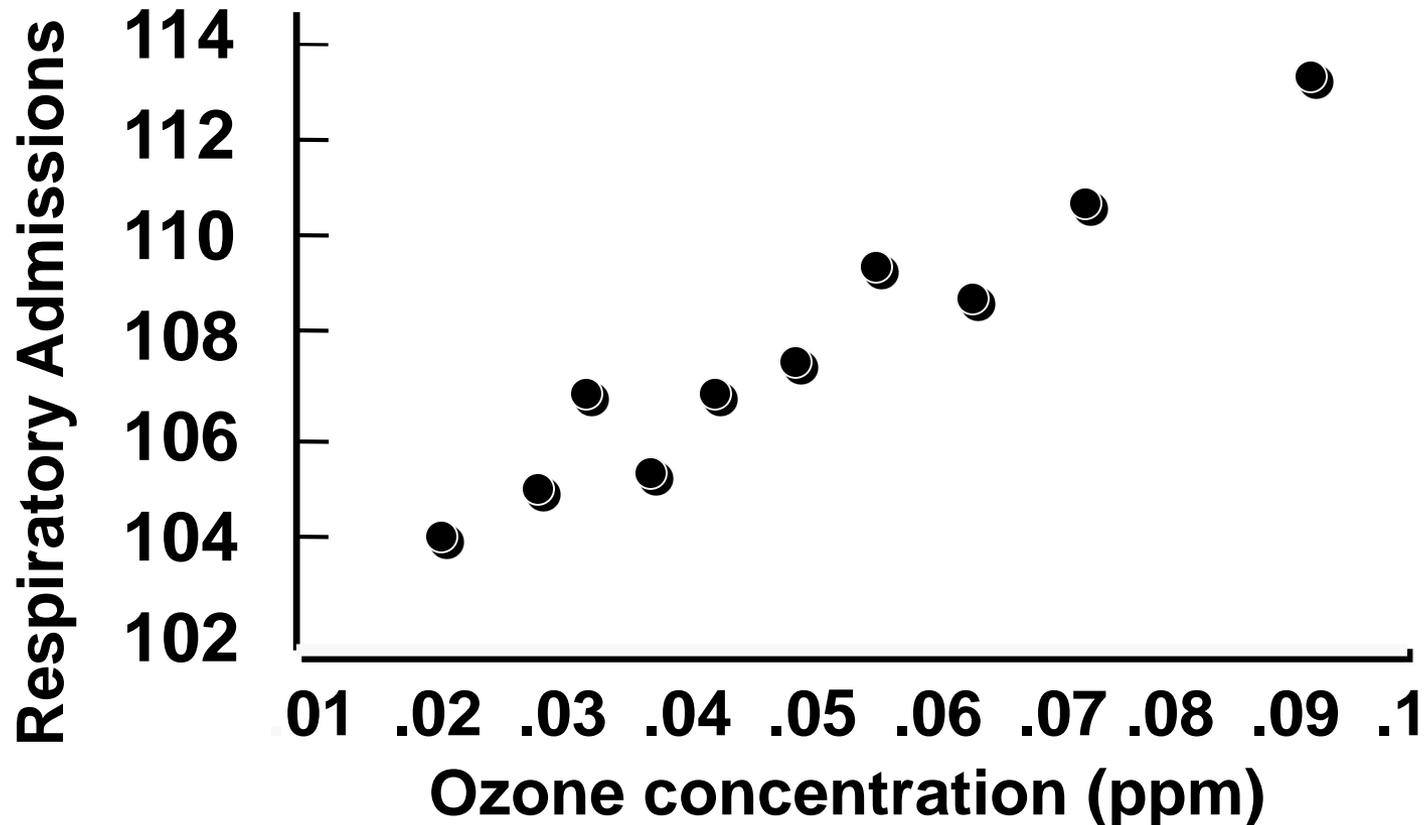
# Short-Term O<sub>3</sub> Exposure and All-Cause (Nonaccidental) Mortality



\*Effect estimates standardized to 20 ppb increase in 24-h avg; 30 ppb increase in 8-h max; and 40 ppb increase in 1-h max O<sub>3</sub> concentrations.

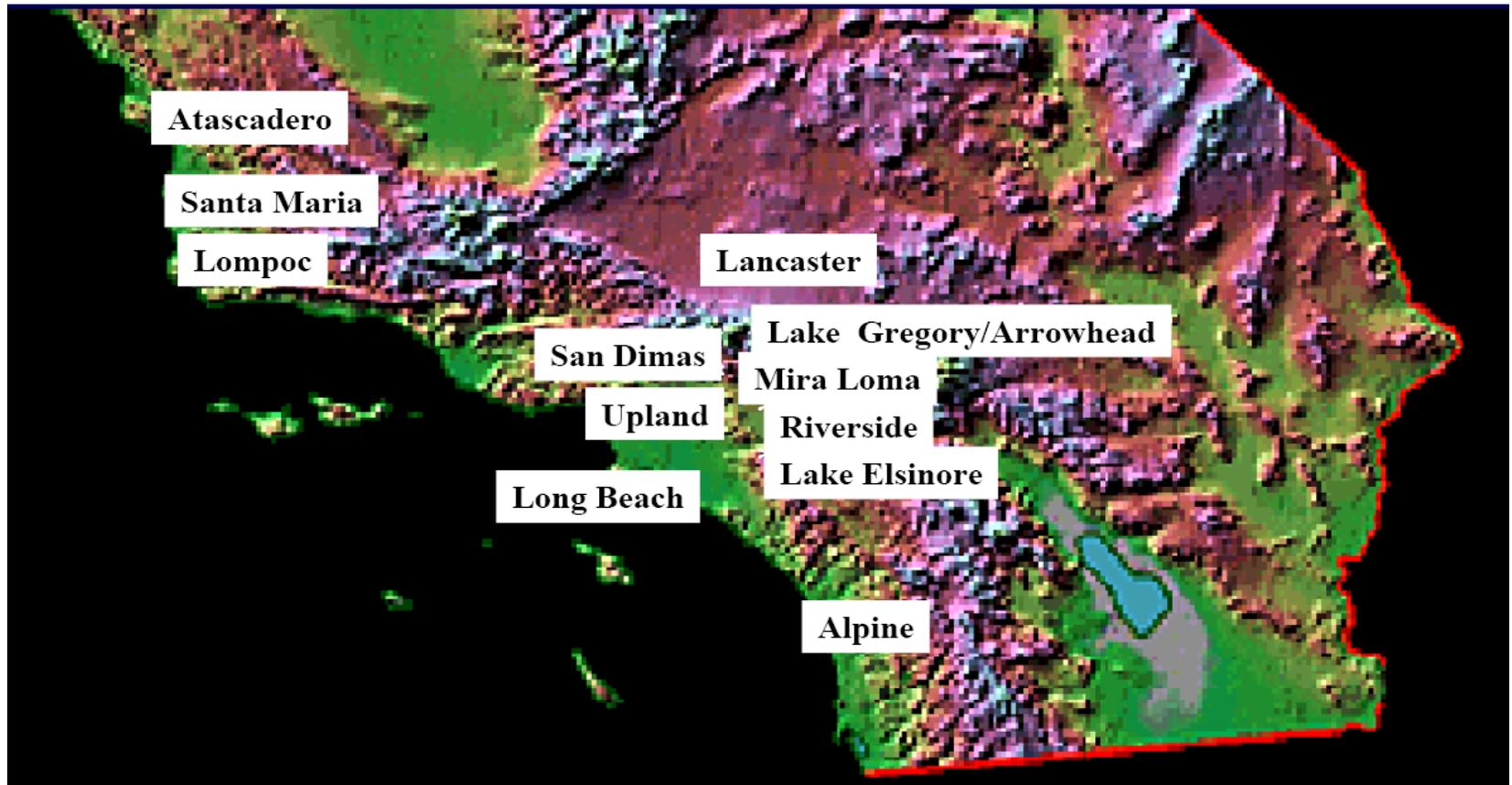
# Respiratory Hospital Admissions by Daily Maximum Ozone Level, Lagged One Day

(Burnett et al, 1994)



# California Children's Health Study

## Study of Effects of Long-term Exposures



# CHS: Ozone and School Absences

- 20 ppb increase in  $O_3$  associated with an 83% increase in school absences for acute respiratory disease (Gilliland et al., 2001)
- Large economic impact of pollution-related school absences (Hall and Lurmann, 2003)

# CHS: Ozone and New-onset Asthma

<u>Sports</u>	<u>Low O<sub>3</sub> Towns</u>		<u>High O<sub>3</sub> Towns</u>	
	#	RR	#	RR
0	58	1.00	46	1.00
1	50	1.28	40	1.28
2	20	0.82	16	1.28
≥3	9	0.79	20	3.31

# Sensitive Groups for Ozone

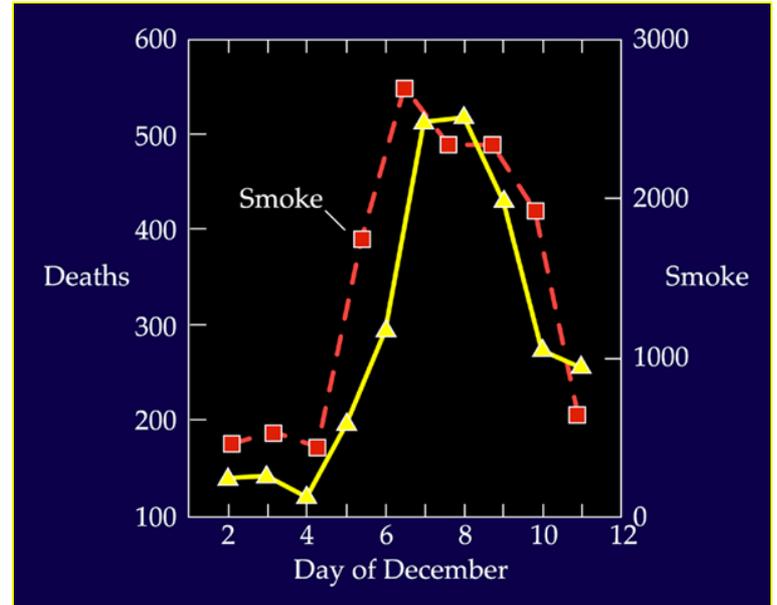
- People with asthma
- Children and older adults
- Outdoor workers and people who are active outdoors
- People with reduced intake of certain nutrients (e.g., vitamins C and E)
- People with certain genotypes, related to oxidative stress



# Particle Pollution Disasters



**Donora, PA at noon on Oct. 29, 1948**



**London buses are escorted by lantern at 10:30 in the morning.**



**Wood-Burning Stoves**



**Forest Fires**



**Heavy Duty Diesel Engines**

**Natural Sources**



**Particle pollution is a complex mixture derived from many sources**

**Cars and Trucks**



**Non-Road Vehicles**



**Leaf Burning**

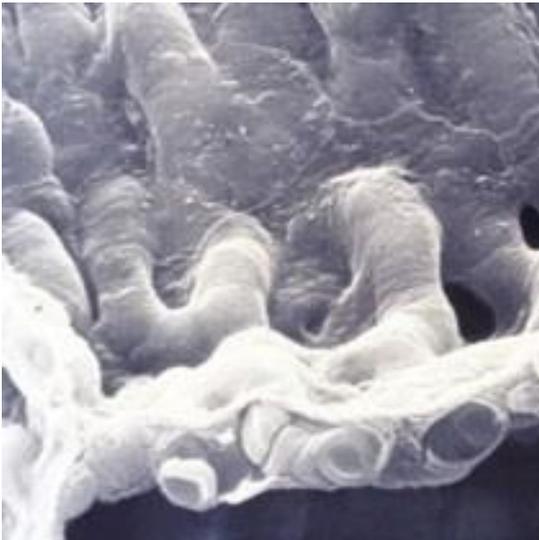


**Industrial Sources**



# Particle Deposition

- Larger particles ( $> PM_{10}$ ) deposit in the upper respiratory tract
- Inhalable particles ( $\leq PM_{10}$ ) penetrate into lungs



- Some particles (e.g., less than  $0.1 \mu m$ ) may enter bloodstream
- Particles may react, accumulate, be cleared or absorbed

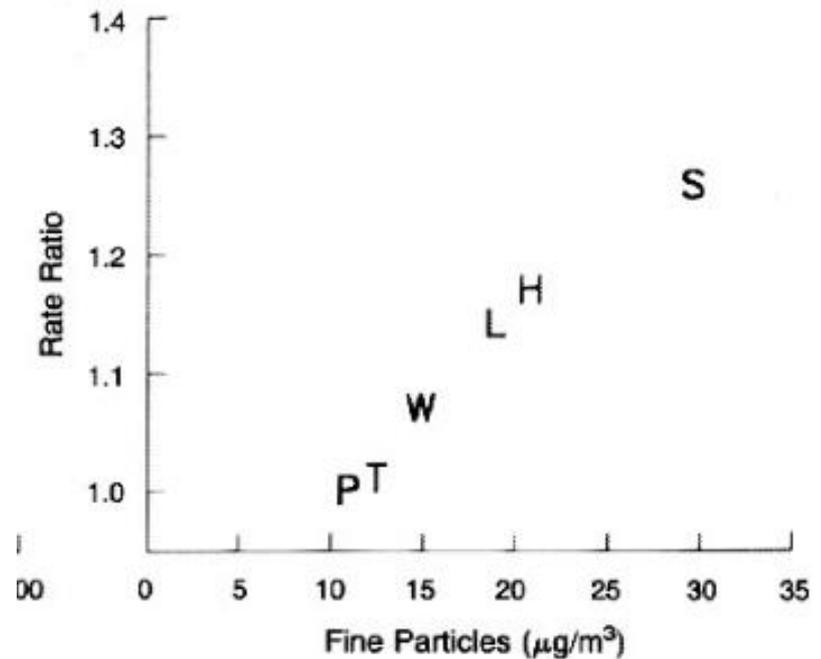
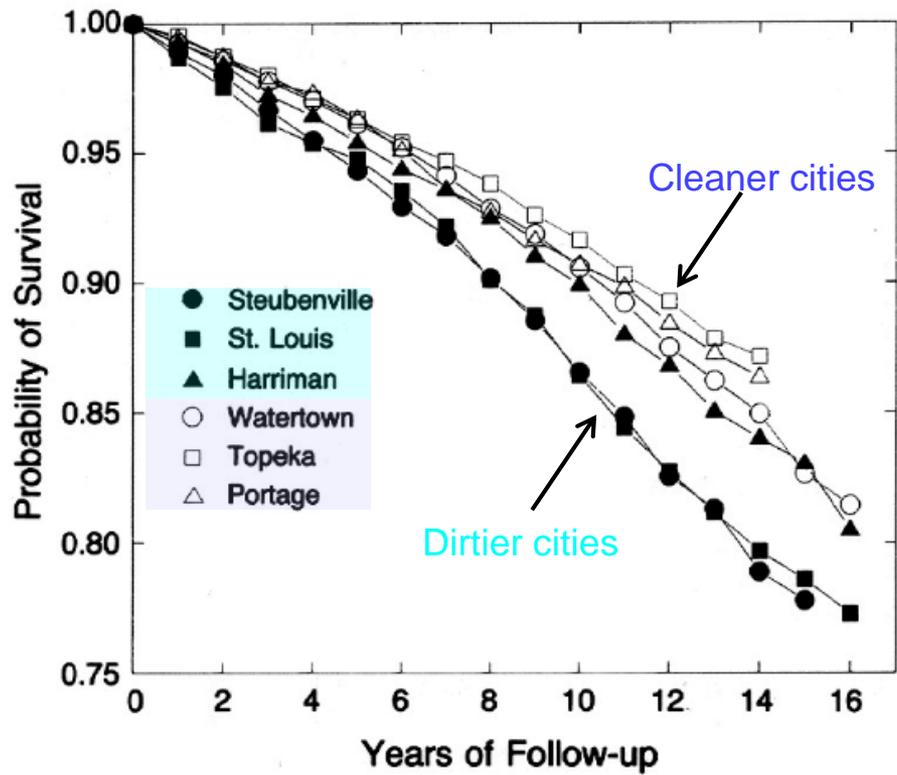
# Living in Areas with High Air Pollution Associated with Shorter Life Expectancy



The NEW ENGLAND  
JOURNAL of MEDICINE

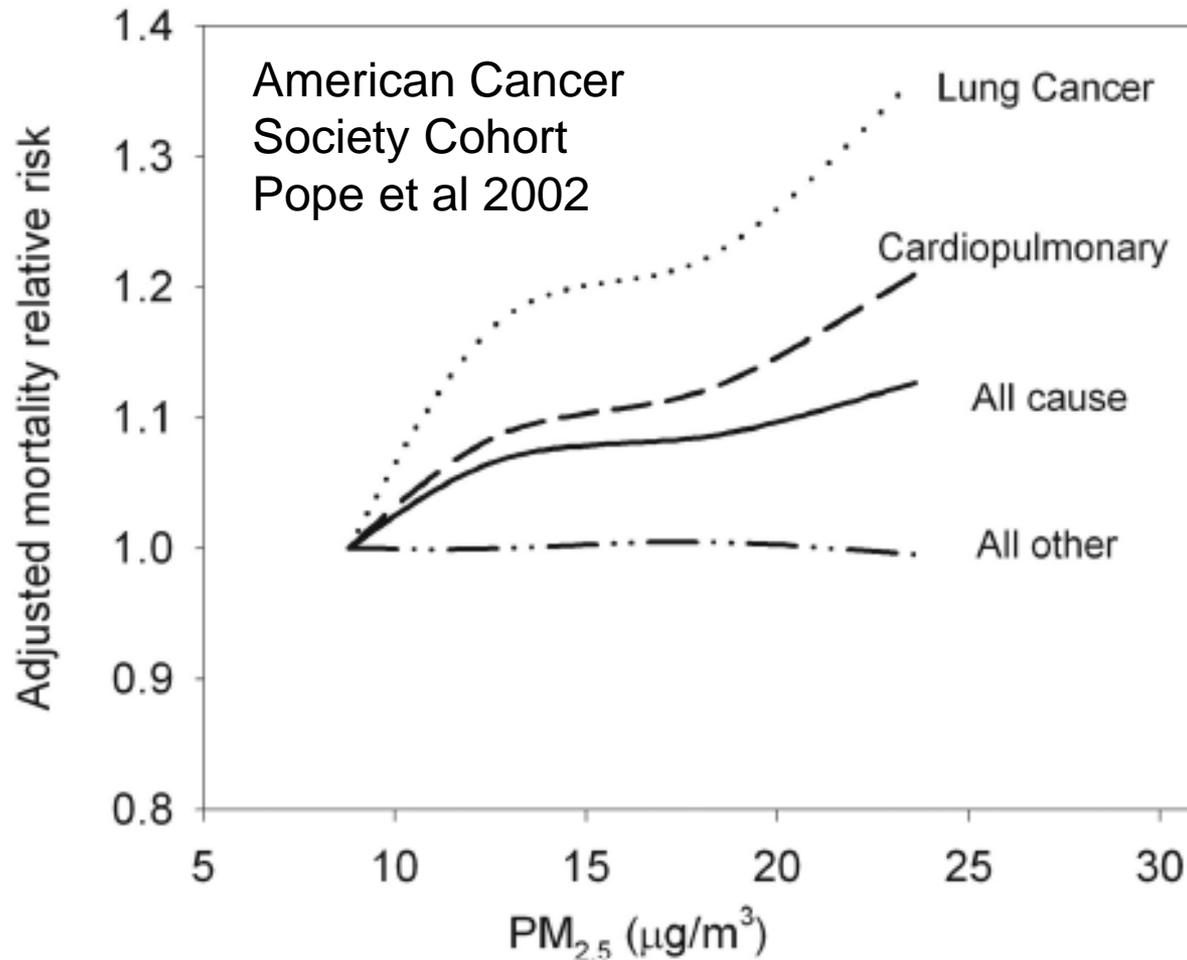
## An Association between Air Pollution and Mortality in Six U.S. Cities

Douglas W. Dockery, C. Arden Pope, Xiping Xu, John D. Spengler, James H. Ware, Martha E. Fay, Benjamin G. Ferris, Jr., and Frank E. Speizer  
N Engl J Med 1993; 329:1753-1759 | December 9, 1993



- Linear relationship after control for traditional risk factors

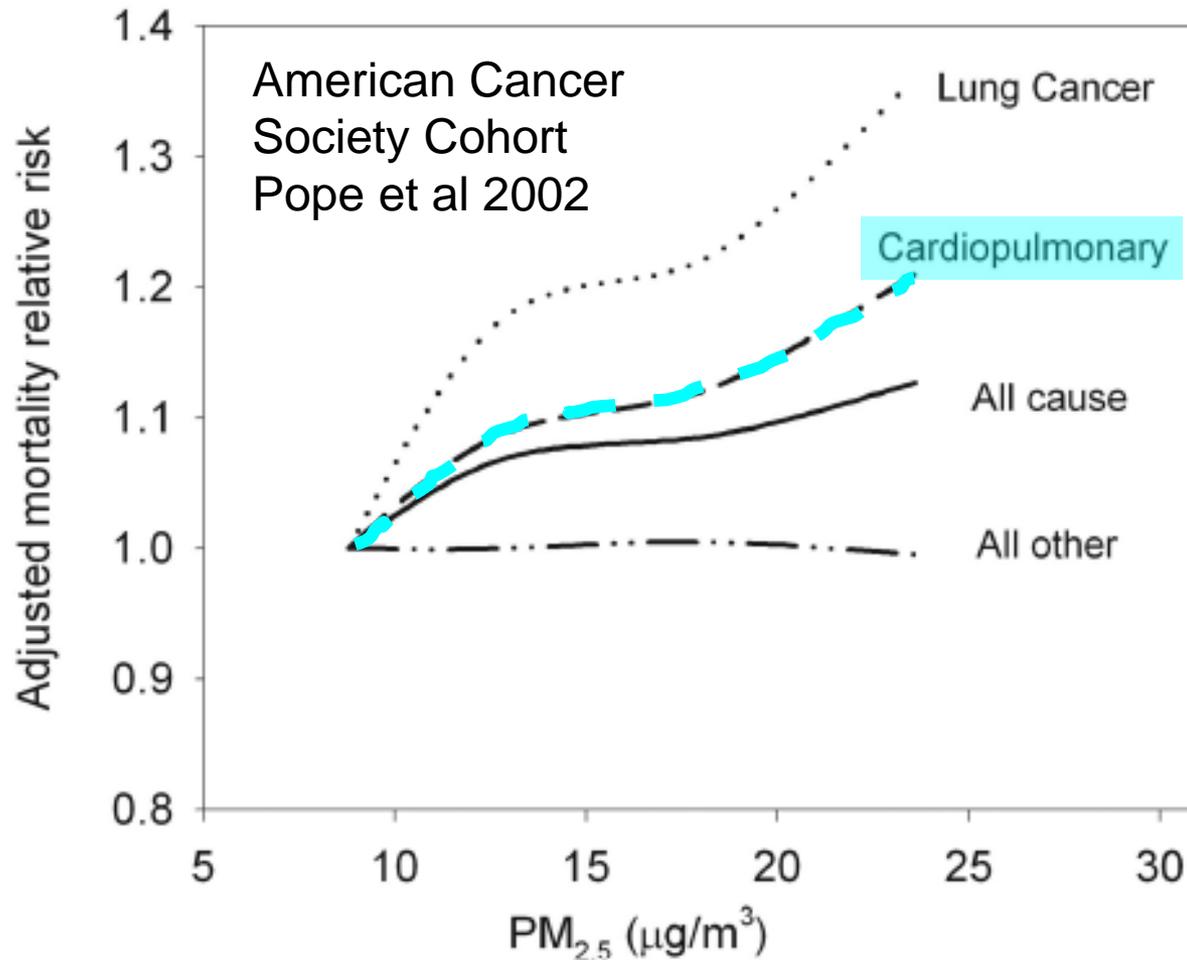
## Findings Replicated by Large American Study and Others



Pope and Dockery 2006

- >500,000 adults from 151 metropolitan areas
- Followed prospectively and controlled for traditional risk factors

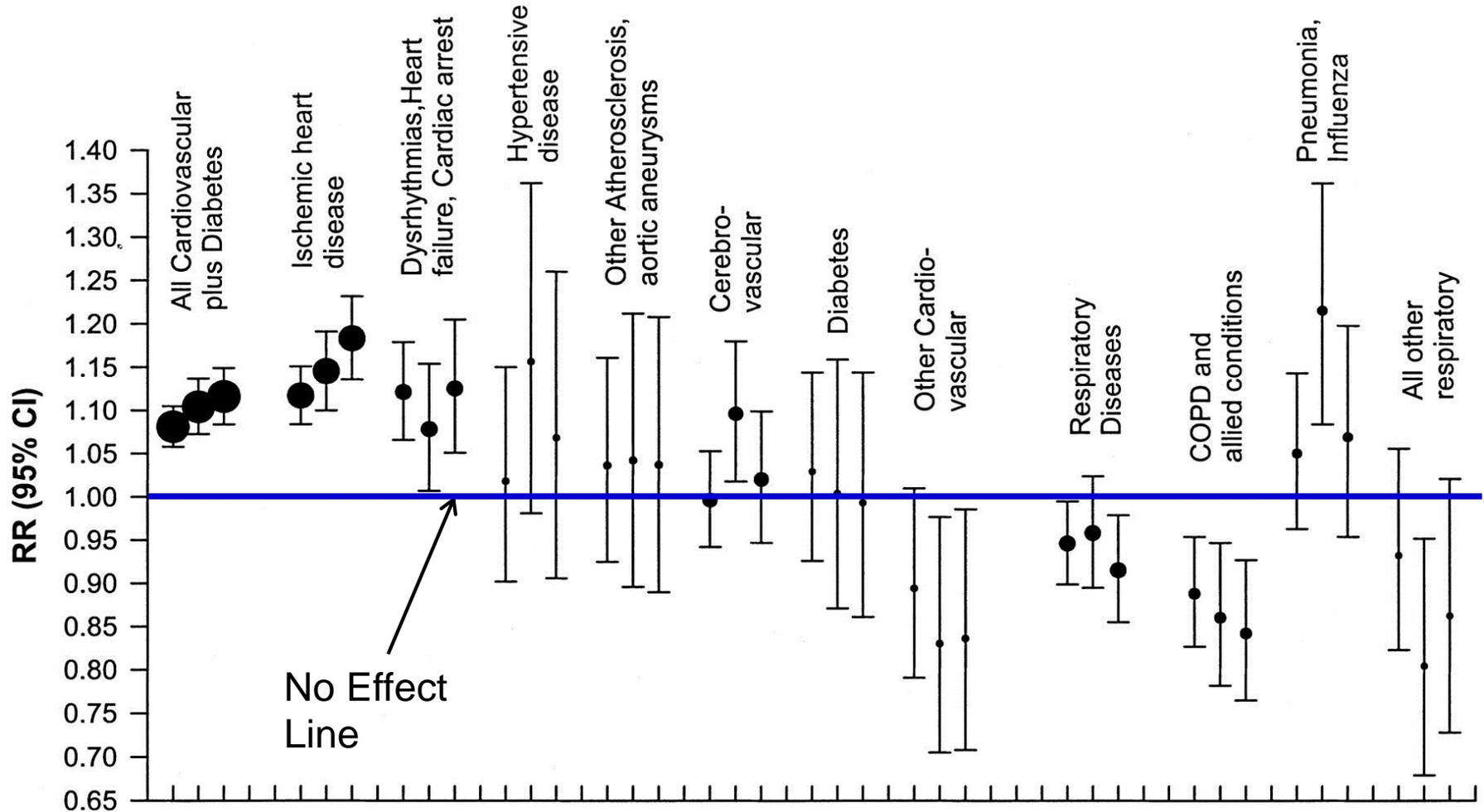
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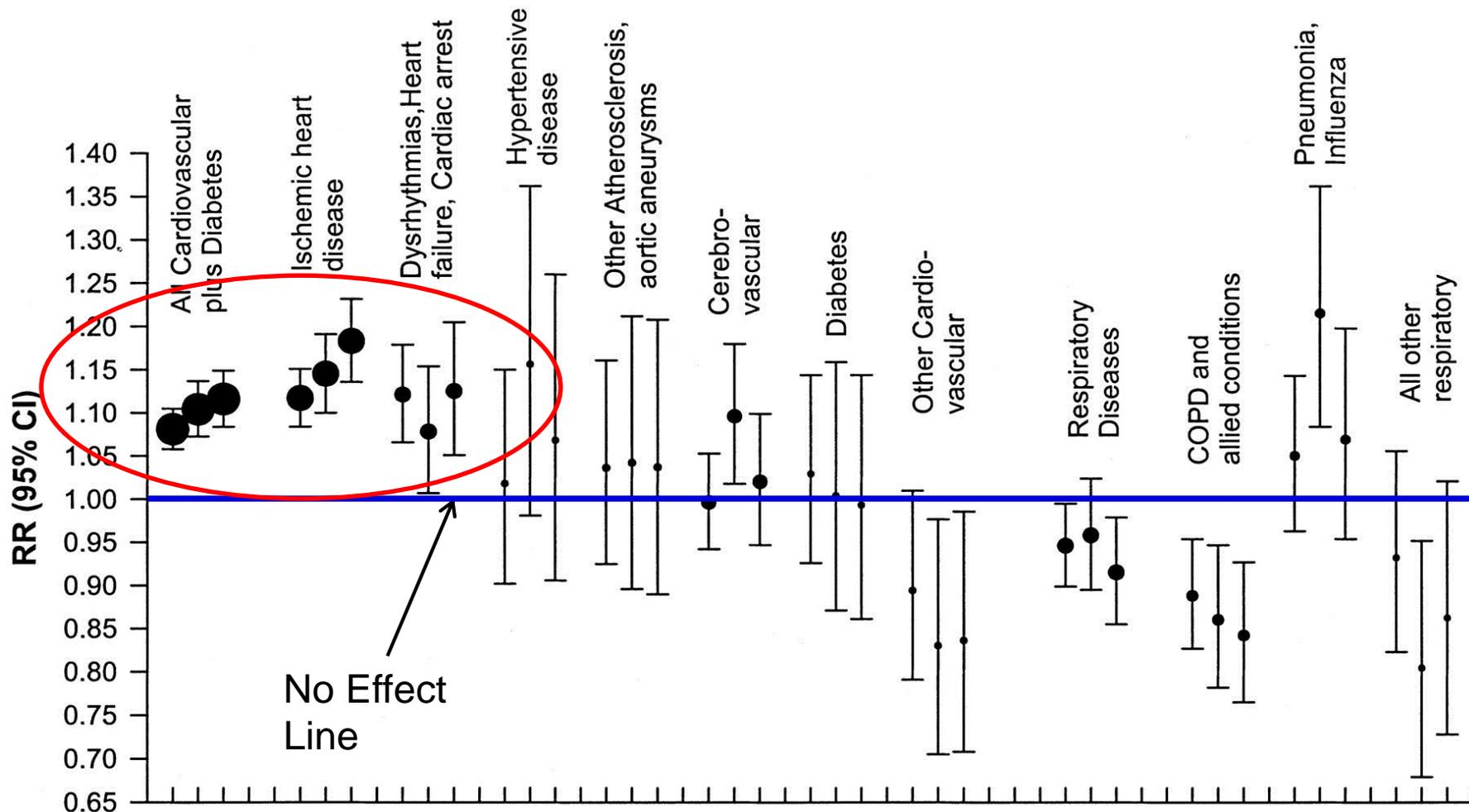
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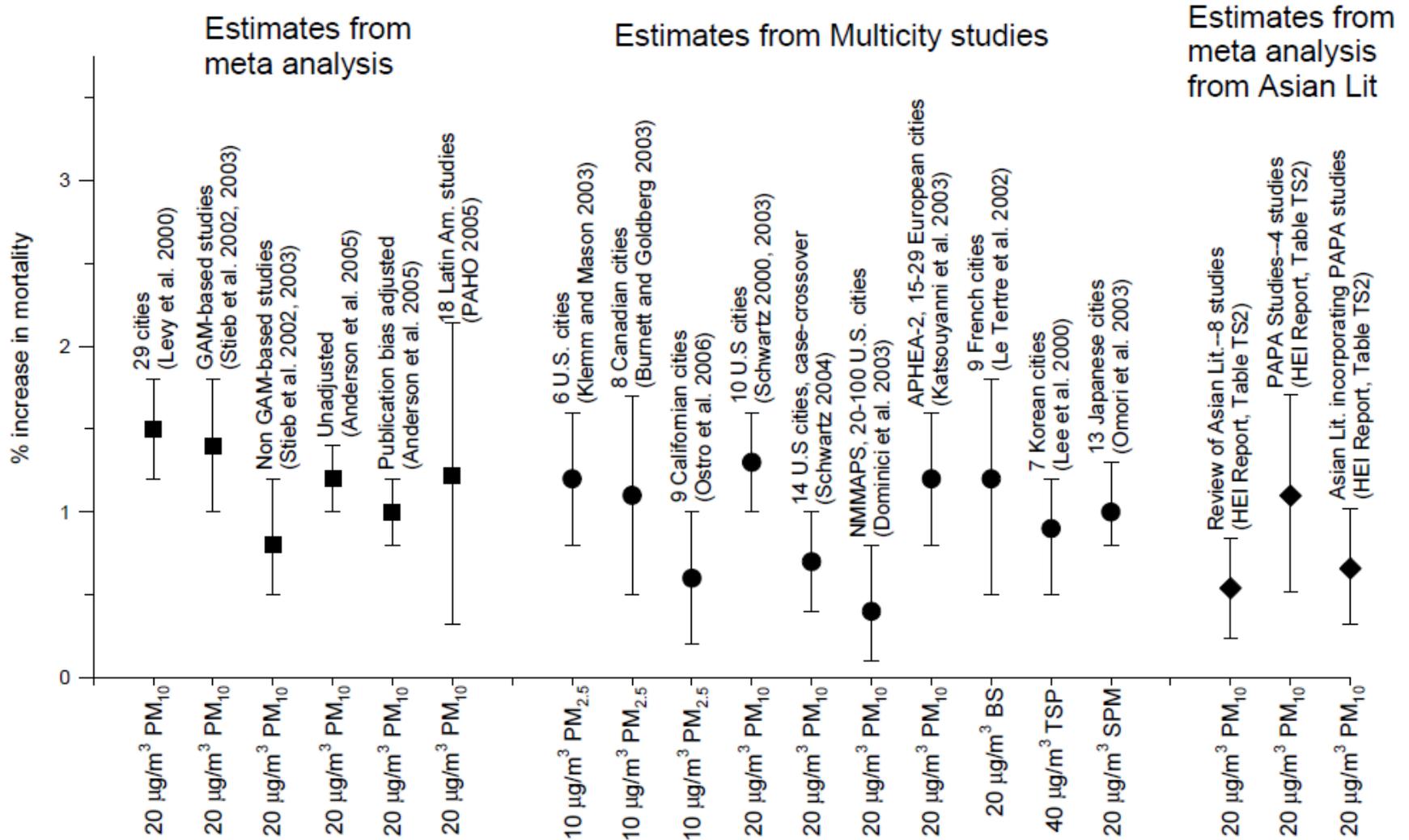
# Strongest Associations For Cardiovascular Endpoints



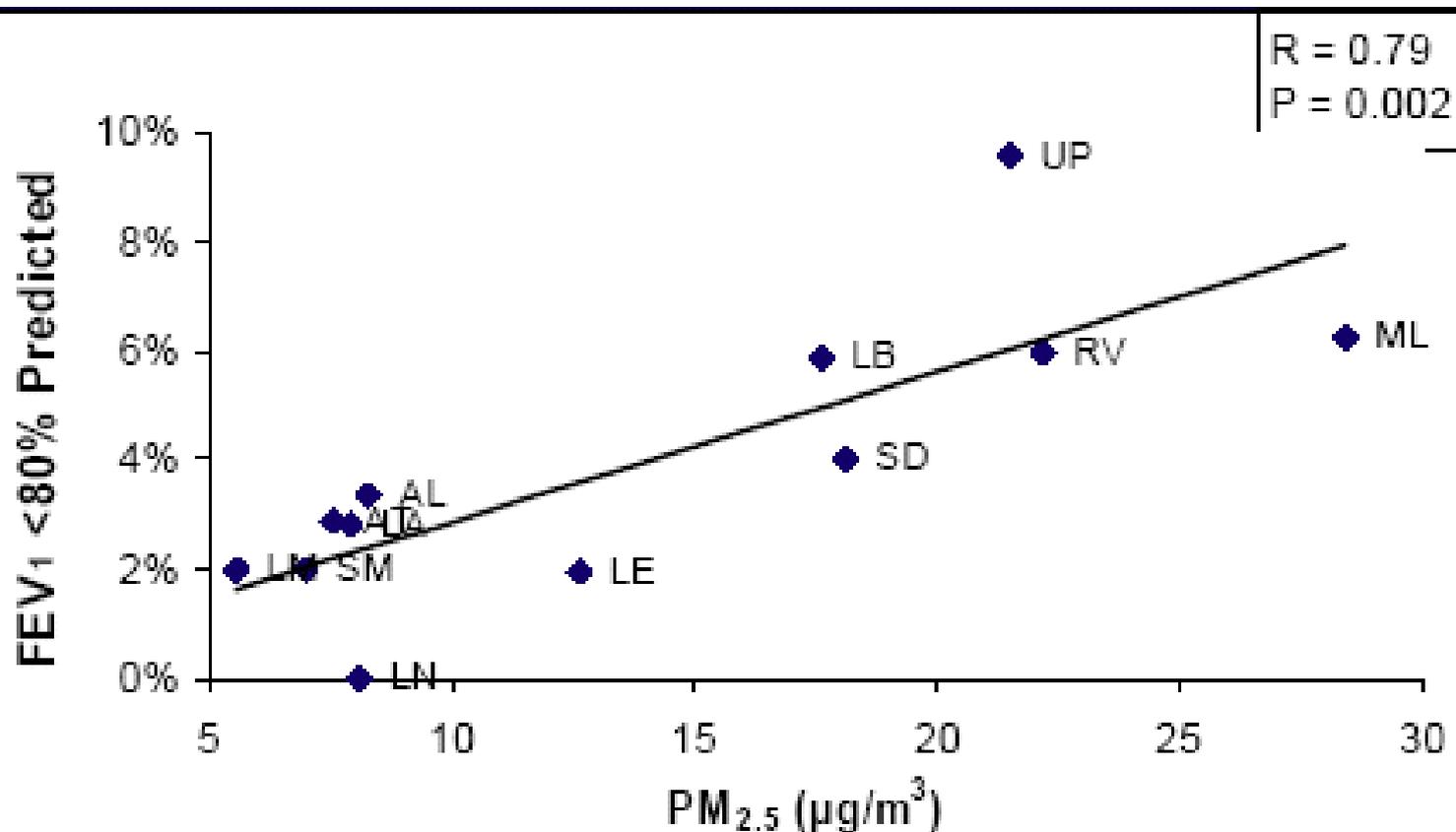
# Strongest Associations For Cardiovascular Endpoints



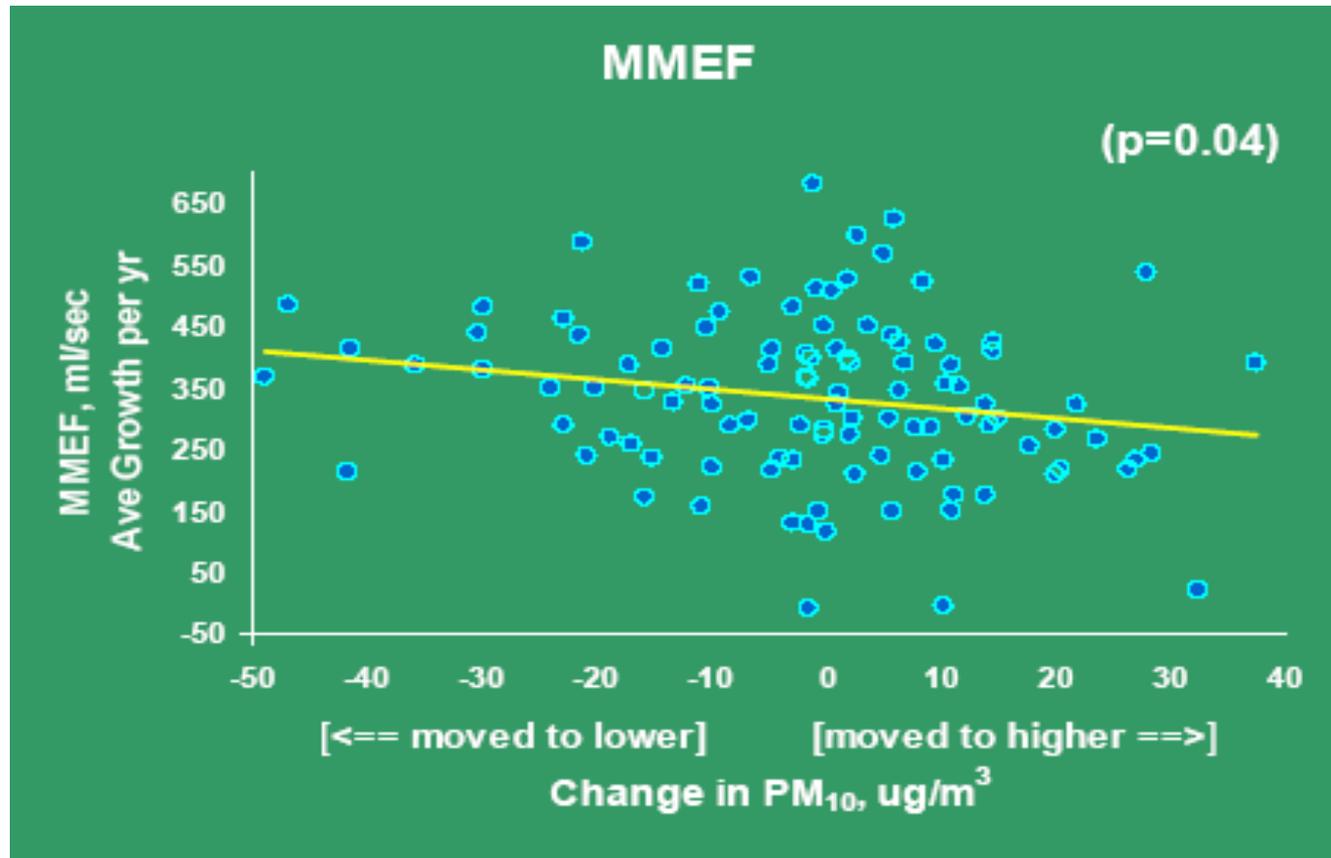
# Small but Consistent Increases in Mortality with Short-Term Changes in PM



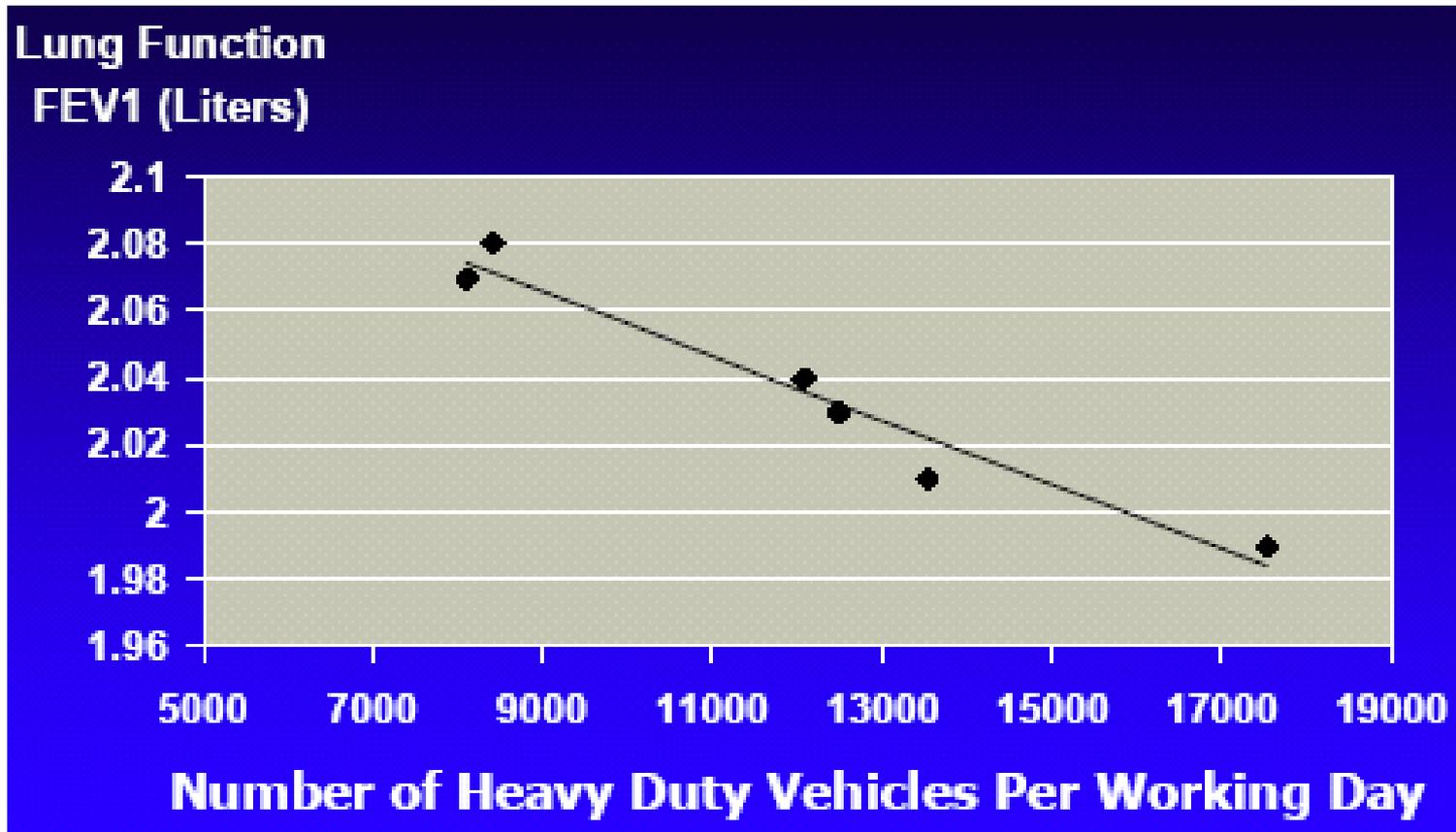
# CHS: Low FEV<sub>1</sub> at Age 18 vs. Pollution



# CHS: Lung Function Growth in Movers



# Living Within 300 Meters of Local Roadways Affects FEV<sub>1</sub>



# Traffic Exposures

- Traffic exposure linked to respiratory symptoms in several European studies
- San Francisco bay area study linking pollution exposures at schools to symptoms (Kim et al., 2004)
- CHS study of residential NO<sub>2</sub>, traffic linked to asthma prevalence, symptoms, and medication use (Gauderman et al., 2005)

# Sensitive Groups for PM

- People with cardiovascular disease
- People with lung disease
- Older adults
- Children
- People of lower socioeconomic status

# Air Quality Index

<b>Descriptors</b>	<b>Cautionary Statement</b>
<b>Good</b> <b>0 – 50</b>	No message
<b>Moderate</b> <b>51 – 100</b>	Unusually sensitive individuals
<b>Unhealthy for Sensitive Groups</b> <b>101 - 150</b>	Identifiable groups at risk - different groups for different pollutants
<b>Unhealthy</b> <b>151 - 200</b>	General public at risk; sensitive groups at greater risk
<b>Very Unhealthy</b> <b>201 - 300</b>	General public at greater risk; sensitive groups at greatest risk

# Air Quality Index

- Pollutant-specific health effects and cautionary statements address question “who will be affected”
- Based on health information supporting EPA’s air quality standards ([www.epa.gov/ttn/naaqs](http://www.epa.gov/ttn/naaqs))

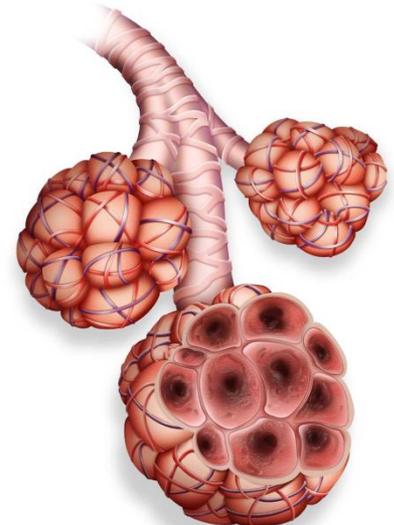
## Dose = Concentration x Ventilation Rate x Time

C - be active outdoors when air quality is better

V - take it easier when active outdoors

T - spend less time being active outdoors

- Pay attention to symptoms
- People with asthma – follow asthma action plan
- Coaches – rotate players frequently
- People with heart disease – check with your doctor



# AirNow

The screenshot displays the AirNow website interface. At the top left is the AirNow logo. To its right is a search bar with a 'Go' button. Below the search bar is a 'Local Air Quality Conditions' section with a 'Zip Code:' input field, a 'Go' button, a 'State:' dropdown menu set to 'Alabama', another 'Go' button, and a 'National Summary' link.

The main content area is divided into several sections:

- Forecast** (selected), **Current AQI**, and **More Maps** tabs.
- Today's AQI Forecast** for Tuesday, July 09, 2013, featuring a map of the United States with color-coded AQI regions. A 'Hawaii' inset map is visible at the bottom left of the main map. The map is generated on 2013-07-09 14:54:52Z.
- Wildfire Smoke Advisories and Forecasts** section with a 'For more information' link and an 'Announcements' sub-section listing advisories from 7/3/13, 6/4/13, and 5/2/13, with a 'more announcements' link.
- Air Quality Basics** section with links for 'Air Quality Index / Ozone / Particle Pollution / UV / Smoke from fires / What You Can Do'.
- Health Learning Center** section with expandable options.
- A row of color-coded AQI categories: Good (green), Moderate (yellow), USG (orange), Unhealthy (red), Vary Unhealthy (dark red), and Hazardous (purple), followed by an 'Action Day' icon.
- Highest 5:** U.S. Air Quality Summary | Canada Air Quality
- Today's Forecasts** (selected), **Tomorrow's Forecasts**, and **Current AQI** tabs.
- A list of locations with their current AQI: C San Bernardino M, CA (187, red); Denver, CO (USG, orange); Fort Collins, CO (USG, orange).

At the bottom right, there is a grid of social media and utility links: Apps, EnviroFlash Email, Facebook, Widgets, Webcams, RSS, Videos, Twitter, AirNow on Google Earth.



# Air Quality Notifications



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[EnviroFlash Challenge](#)

[EnviroFlash Fact Sheet](#) (PDF)  
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[AIRNow RSS Feeds](#)

[EnviroFlash Toolkit](#)  
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[About the Air Quality Index \(AQI\)](#)  
(PDF)

[Today's National Air Quality Forecast](#)

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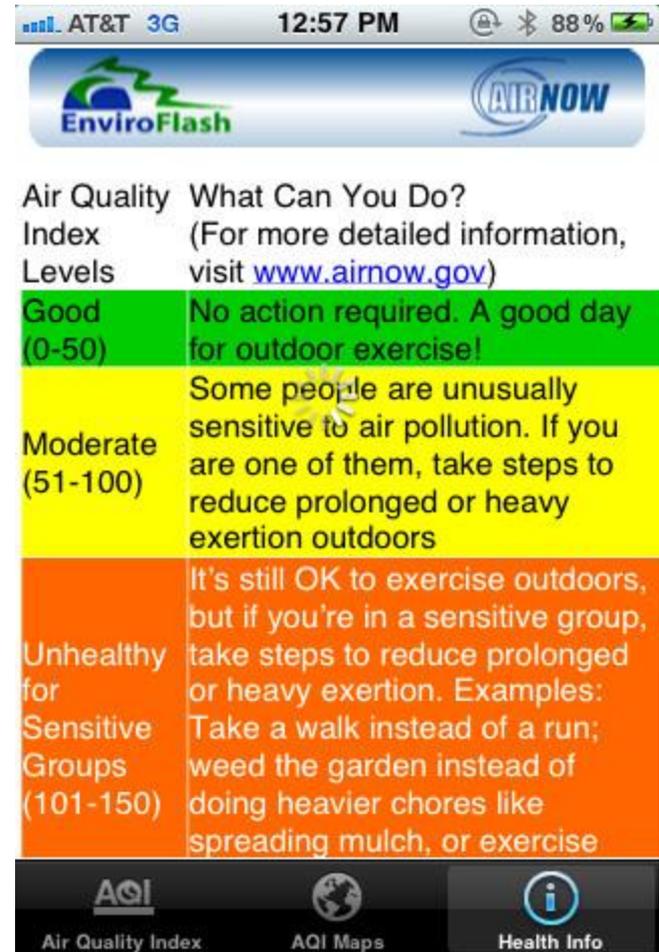
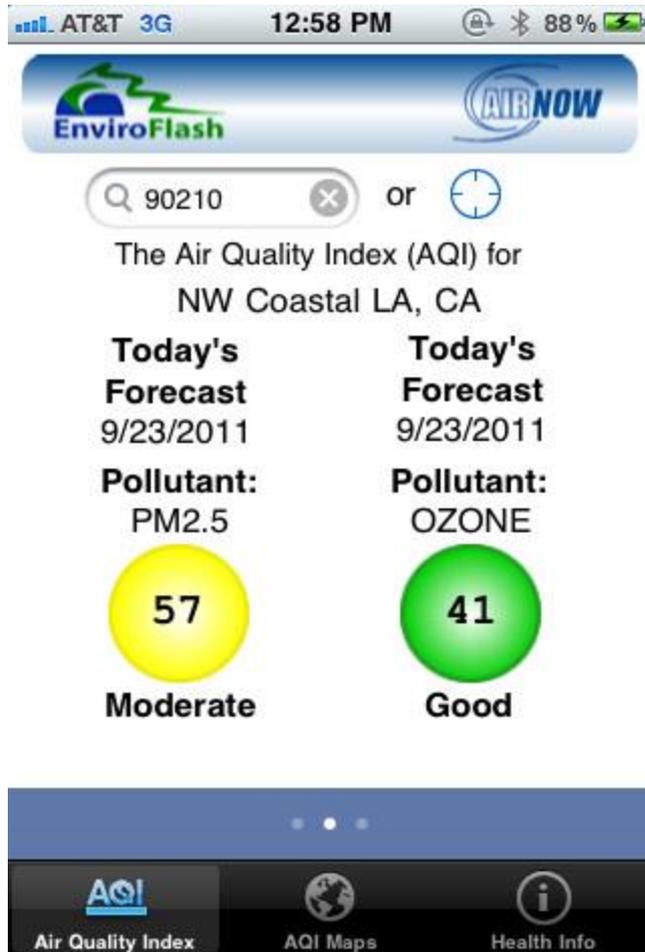
EnviroFlash: *Air quality information straight to your inbox!*

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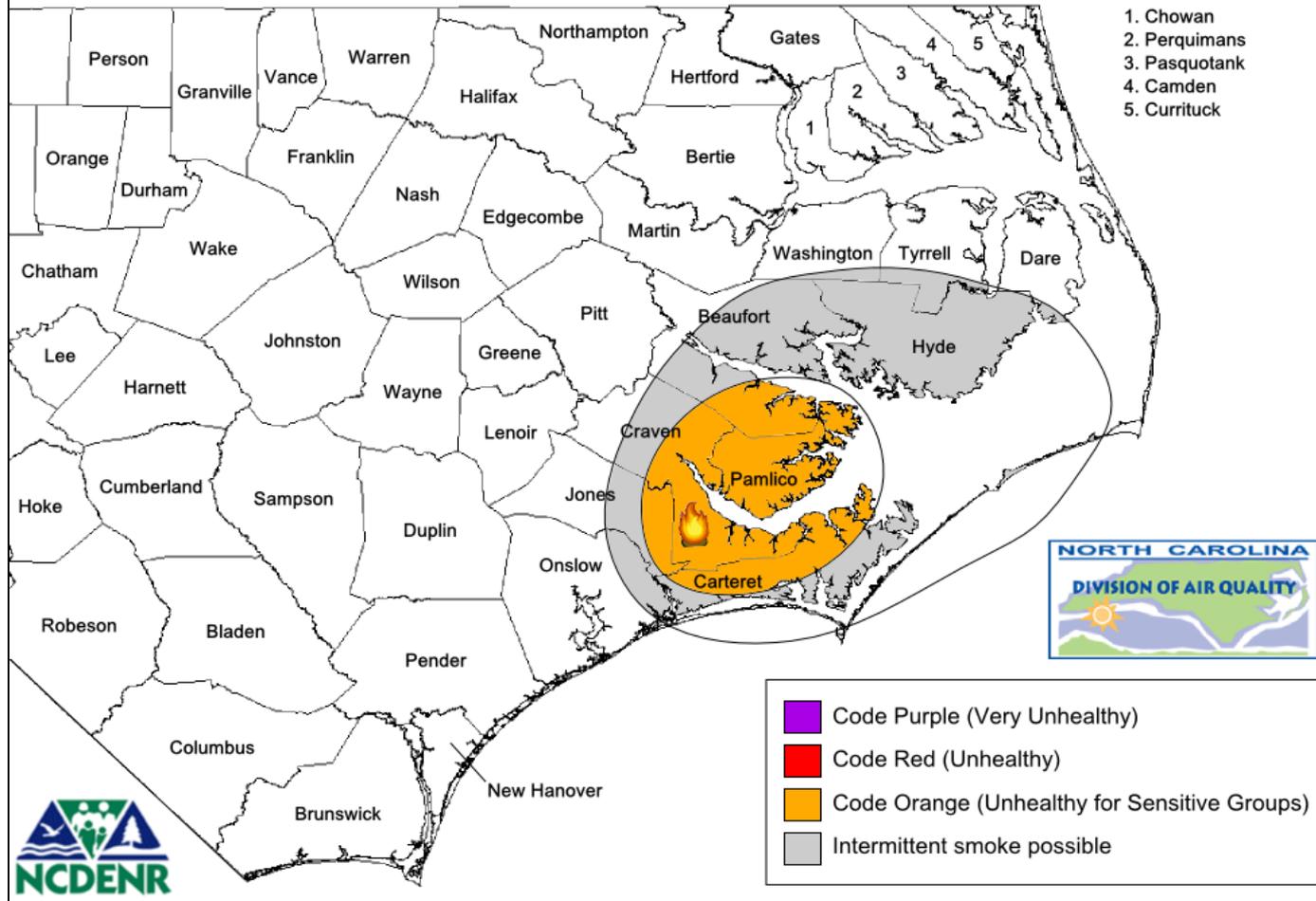


[AIRNow Home](#)

# AirNow App on Smart Phones



# Special Air Quality/Smoke Forecast for June 23, 2012



# School Flag Program and School Activity Guidelines

- Helps school and community be aware of daily air quality conditions
- Participating schools raise a flag in front of the school that signals the air pollution forecast for that day
- By comparing the colored flags to the Air Quality Index (AQI), members of the school can tell what daily air quality is, and adjust activities to reduce children's exposure to air pollution as needed
- We have partnered with CDC on air quality and outdoor activity guidelines for schools
- We have developed a picture book that explains AQI and flag program to children

**Air Quality and Outdoor Activity Guidance for Schools**

Regular physical activity — at least 60 minutes each day — promotes health and fitness. The table below shows when and how to modify outdoor physical activity based on the Air Quality Index. This guidance can help protect the health of all children, including teenagers, who are more sensitive than adults to air pollution. Check the air quality daily at [www.airnow.gov](http://www.airnow.gov).

Air Quality Index	Outdoor Activity Guidance
<b>Green</b> GOOD	Great day to be active outside!
<b>Yellow</b> MODERATE	Good day to be active outside! Students who are unusually sensitive to air pollution could have symptoms, so watch for coughing or shortness of breath. These are signs to take it easier.
<b>Orange</b> UNHEALTHY FOR SENSITIVE GROUPS	It's OK for students to be active outside, especially for short activities such as recess and physical education (PE) class. For longer activities such as athletic practice, students should take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. Students with asthma should follow their asthma action plans and keep their quick relief medicine handy.
<b>Red</b> UNHEALTHY	For all outdoor activities, students should take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. Consider moving activities indoors or rescheduling. Students with asthma should follow their asthma action plans and keep their quick relief medicine handy.
<b>Purple</b> VERY UNHEALTHY	Move all activities indoors or reschedule to another day.

**Go for 60!**  
CDC recommends that children get 60 or more minutes of physical activity each day. [www.cdc.gov/healthyschools/physicalactivityguidelines/](http://www.cdc.gov/healthyschools/physicalactivityguidelines/)

**Watch for Symptoms**  
Air pollution can make asthma symptoms worse and trigger attacks. Symptoms of asthma include coughing, shortness of breath, wheezing, and chest tightness. Even students who do not have asthma could experience these symptoms when exposed to unhealthy levels of air pollution.

**Plan Ahead for Ozone**  
There is less ozone in the morning. On days when ozone is expected to be at unhealthy levels, plan outdoor activities in the morning.

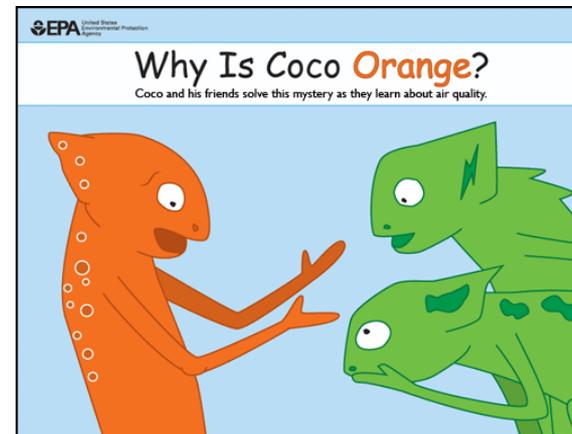
**Be active!**  
Indoors, so it is OK to keep recess out packets then the weather is important that day. Do exercise as well as a game on an open space ball. If restricted to the field, action needs from a school activities.

**What the local air quality will be. The AirNow website also has a forecast for the Air Quality Index (AQI) and register your school.**

**Be active!**  
Indoors, so it is OK to keep recess out packets then the weather is important that day. Do exercise as well as a game on an open space ball. If restricted to the field, action needs from a school activities.

For more information on the management of asthma, it includes medication plans, control of triggers, and how to recognize and manage worsening asthma symptoms. See [www.cdc.gov/asthma/actionplan](http://www.cdc.gov/asthma/actionplan) for a link to sample asthma action plans. When asthma is well managed and well controlled, students should be able to participate fully in all activities. For a booklet on "Asthma and Physical Activity in the School" see <http://bit.ly/asthmaattheschool>.

EPA United States Environmental Protection Agency | CDC | School Flag Program | EPA-655-F-13-002 March 2013

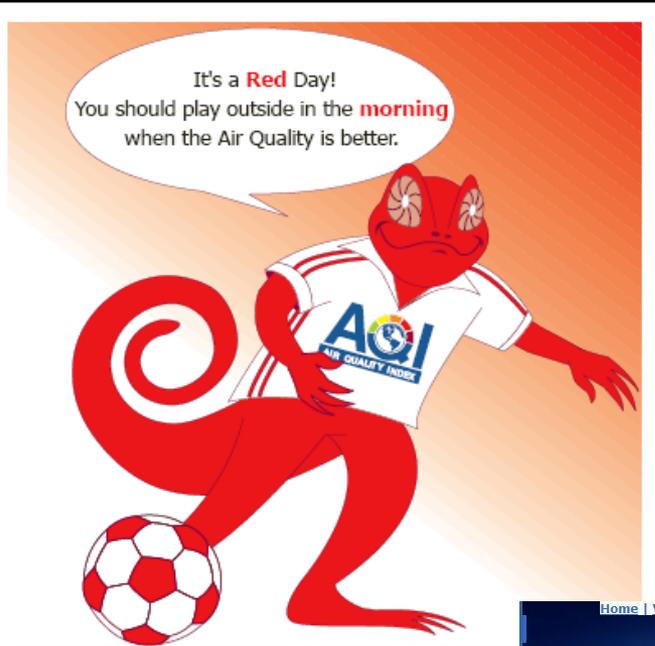






- Issue: Heart disease is the number one killer for women but many women think of a heart attack as a problem for men.
  - Each year, about 400,000 women in the U.S. die from heart disease; > 42 million women are currently living with cardiovascular disease.
  - Heart disease kills more women than the next seven causes of death combined
- Webinars are a key communications mechanism
- Provides information about where people can find out about daily air quality in their own community to reduce unhealthy exposures.
  - EPA has developed related materials, such as downloadable fact sheets, for use by healthcare providers
- EPA partnering with organizations such as American Heart Association, American College of Cardiology, CDC and CDC's Million Hearts Campaign

# AQI Curriculum for Children and Students



## Colorful lessons and games for children and students



Home | Visitor's Tour Guide | About The Site | Who We Are | Download Smog City 2 | Links | Help

### smog city 2

Using an interactive air pollution simulator to control the air quality in Smog City 2, you can see how individual choices, environmental factors, and different types of land use affect air pollution. In Smog City 2 you are in charge - so whether your visit is a healthy or unhealthy experience depends on the decisions that you make.

Visitor's Tour Guide  
How You Control a Day In Smog City 2

- Save Smog City 2 from Ozone!
- Save Smog City 2 from Particle Pollution!
- Create Your Own Smog City 2 Experience

### Air Quality Index Kids Website Teacher's Reference

**Clean Air and Dirty Air**

On a clear breezy day, the air smells fresh and clean. Clean air is air that has no pollutants (dirt and chemicals) in it. Clean air is good for people to breathe.



On a hot day with no wind, the air can feel heavy and have a bad smell. Once in a while, the air can even make your chest feel tight, or make you cough. Dirt and chemicals that get into the air make the air dirty or polluted. Dirty air is not good for people to breathe.

**Dirty Air Can Make You Sick**

When the air has some dust, soot or chemicals floating in it, people who are inside probably won't notice it. People who are outside might notice it.




People with asthma, a disease that can make it hard to breathe, and children who play outside a lot might feel a little strange. When you are active outdoors, for example, when you run and jump a lot, you breathe faster and take in more air. Any pollutants in the air go into your lungs.

When the air is very dirty, almost everyone will notice it. It would be good if we could stop breathing on those days, but of course we can't!

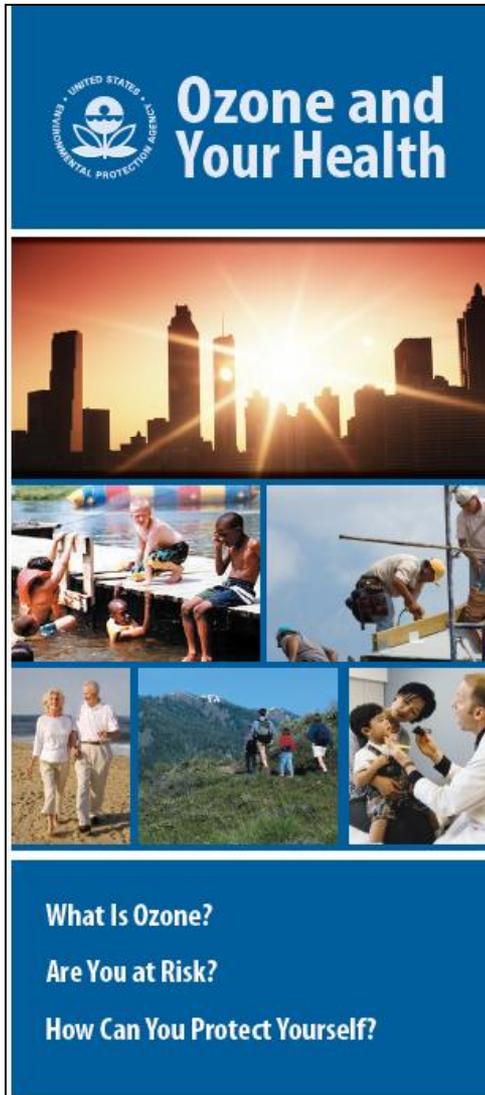
**How Can I Tell if the Air is Clean or Dirty?**

Have you ever been stopped behind a truck or a bus at a traffic light? When it starts up, sometimes a puff of dark smoke comes out of the exhaust pipe.

For information about visibility:  
<http://www.epa.gov/air/visibility/>

1

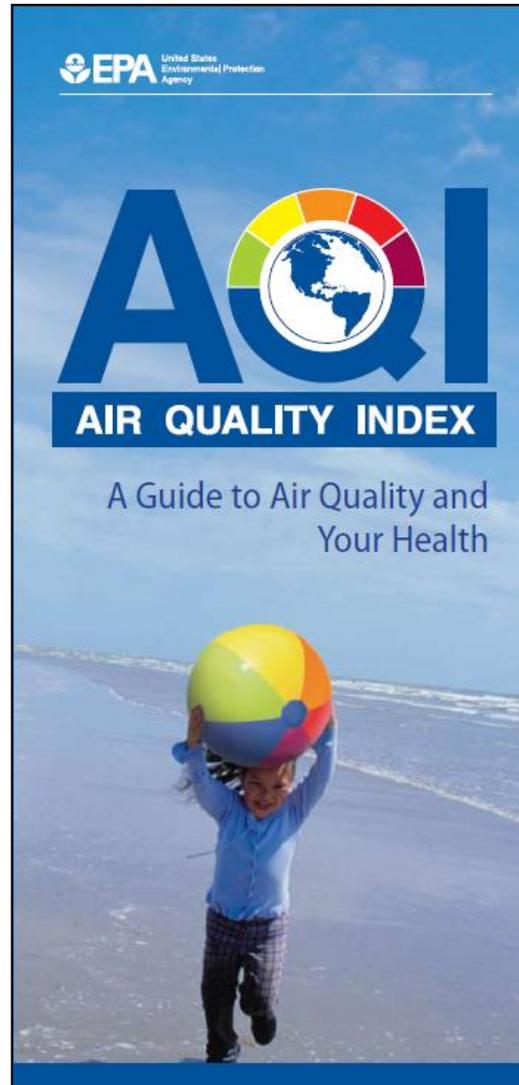
# Pollutant-Specific Information



The cover features the EPA logo at the top left. The title "Ozone and Your Health" is prominently displayed in white text on a blue background. Below the title is a collage of images: a city skyline at sunset, people swimming and sunbathing at a beach, and a doctor examining a child. At the bottom, three questions are listed in white text on a blue background.

**Ozone and Your Health**

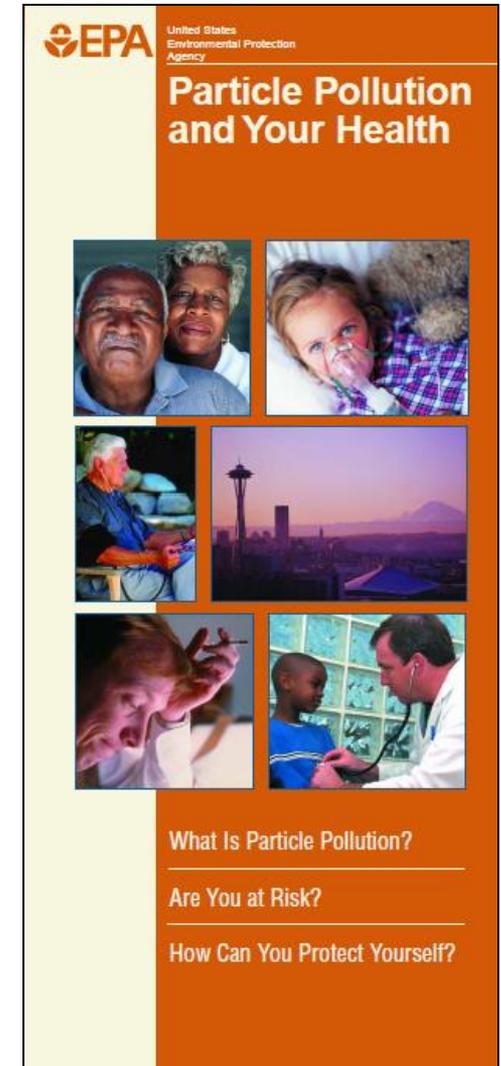
What Is Ozone?  
Are You at Risk?  
How Can You Protect Yourself?



The cover features the EPA logo at the top left. The title "AQI AIR QUALITY INDEX" is prominently displayed in large blue letters, with a globe icon integrated into the letter 'Q'. Below the title is the subtitle "A Guide to Air Quality and Your Health". The main image shows a child running on a beach holding a colorful beach ball.

**AQI**  
**AIR QUALITY INDEX**

A Guide to Air Quality and Your Health



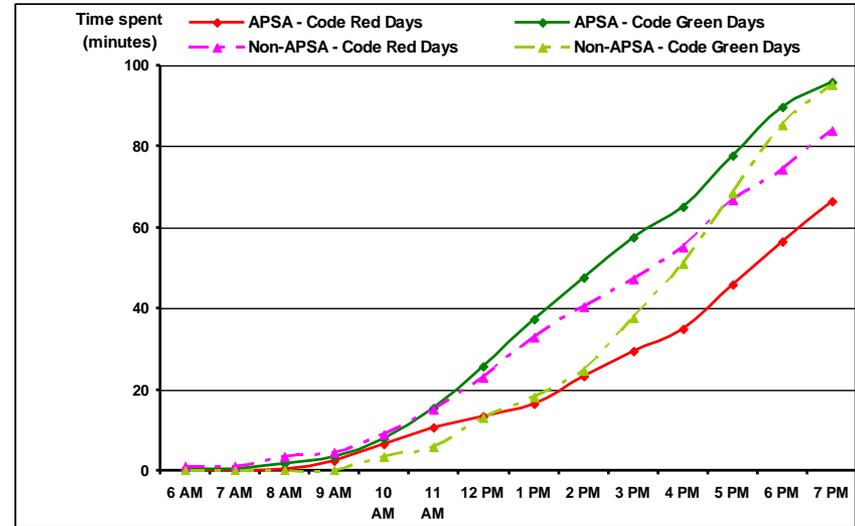
The cover features the EPA logo at the top left. The title "Particle Pollution and Your Health" is prominently displayed in white text on an orange background. Below the title is a collage of images: an elderly couple, a child with a respiratory mask, a man sitting in a chair, a city skyline at dusk, a child coughing, and a doctor examining a child. At the bottom, three questions are listed in white text on an orange background.

**Particle Pollution and Your Health**

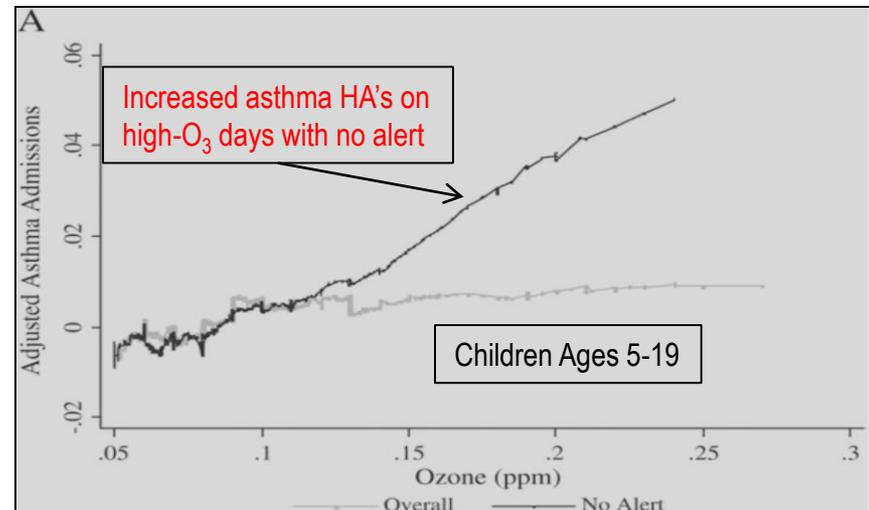
What Is Particle Pollution?  
Are You at Risk?  
How Can You Protect Yourself?

# Public Health Benefits of the AQI

- Surveys indicated that 50 to 80% of public aware of AQI
  - Of those, 50% report taking exposure reduction measures
- People who are susceptible, more likely to report taking measures, including older adults, children, and people with heart or lung disease
- Activity studies provide evidence of exposure reduction
- Health studies provide evidence of reductions in hospital admissions and emergency department visits for asthma due to advisories



Mansfield et al., 2007



Neidell and Kinney 2009