

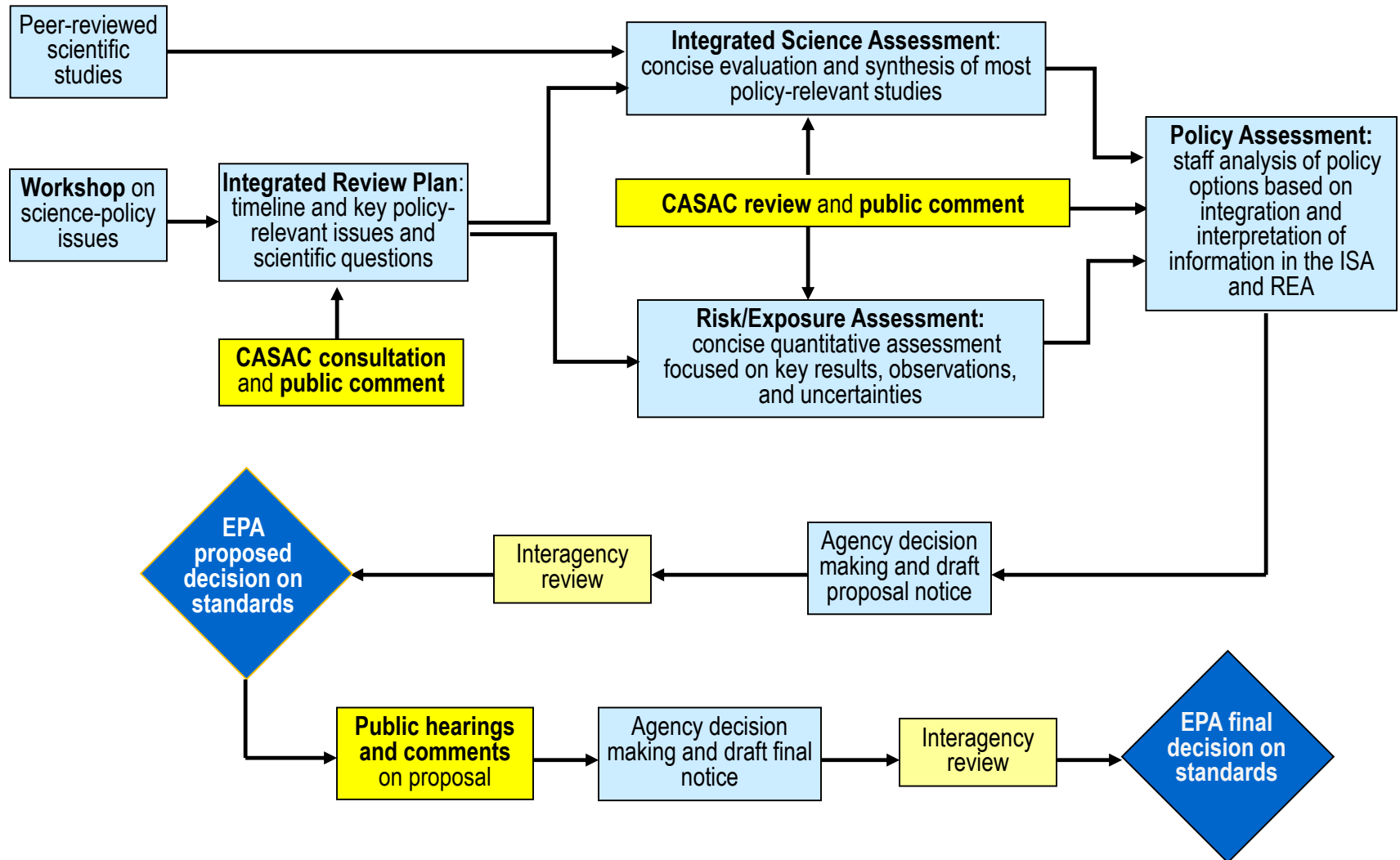
How Air Pollution Is Affecting Our Health

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

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Standards
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Overview of NAAQS Review Process



Human Lung

- Air conducting

- Trachea

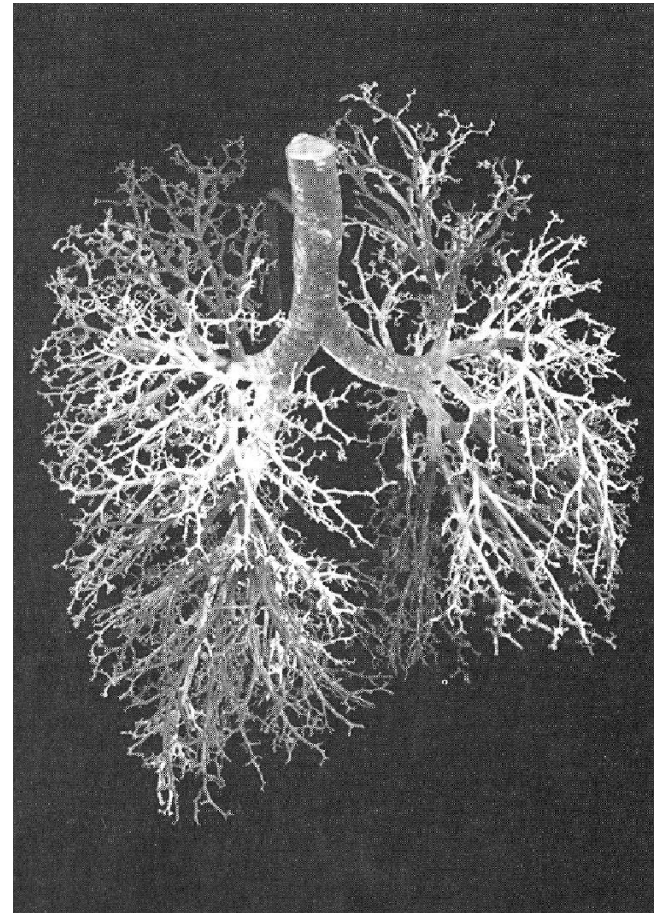
- Bronchi

- Bronchioles

- Gas exchange

- Respiratory bronchioles

- Alveoli

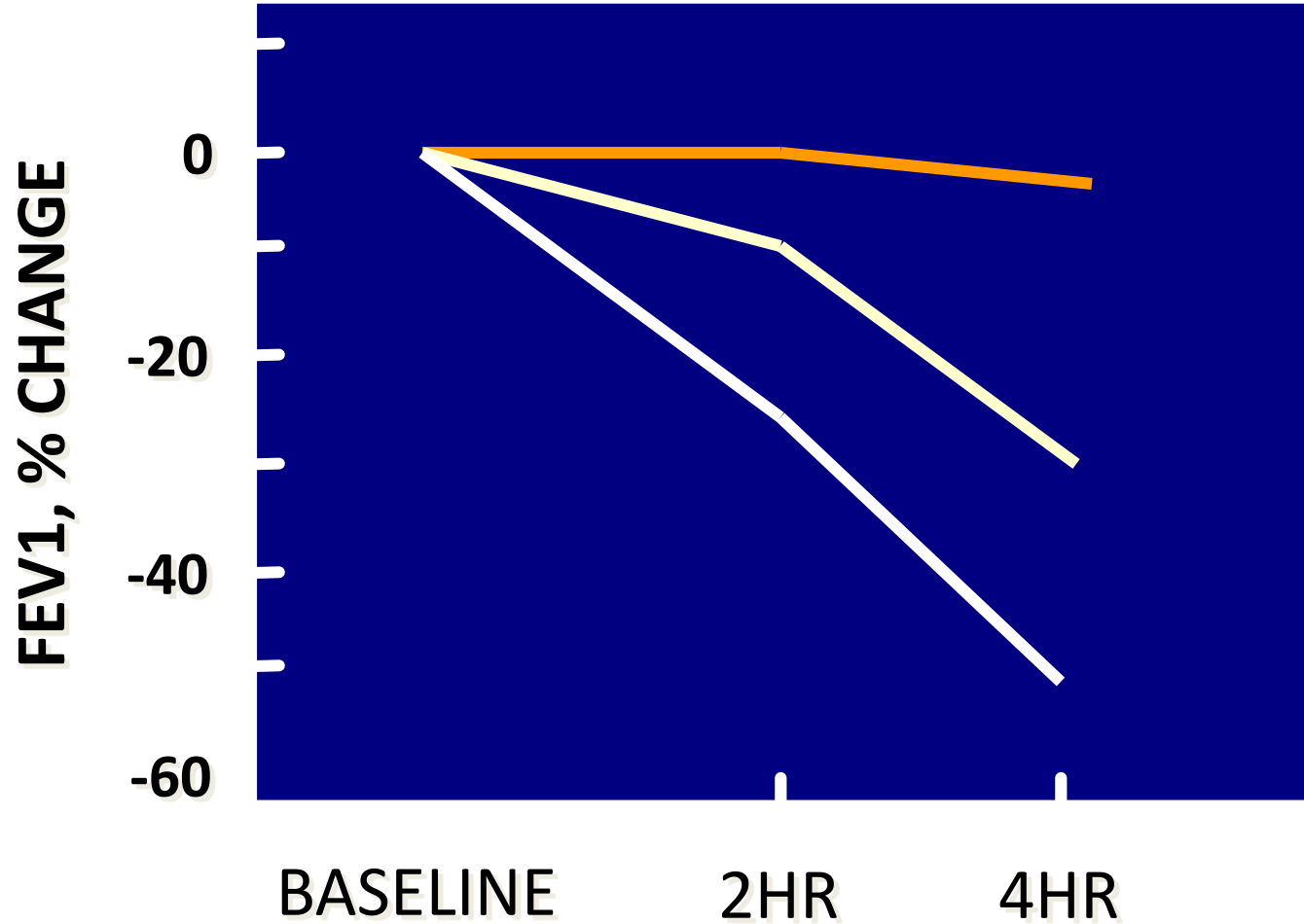


Ozone Irritates Airways

- 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



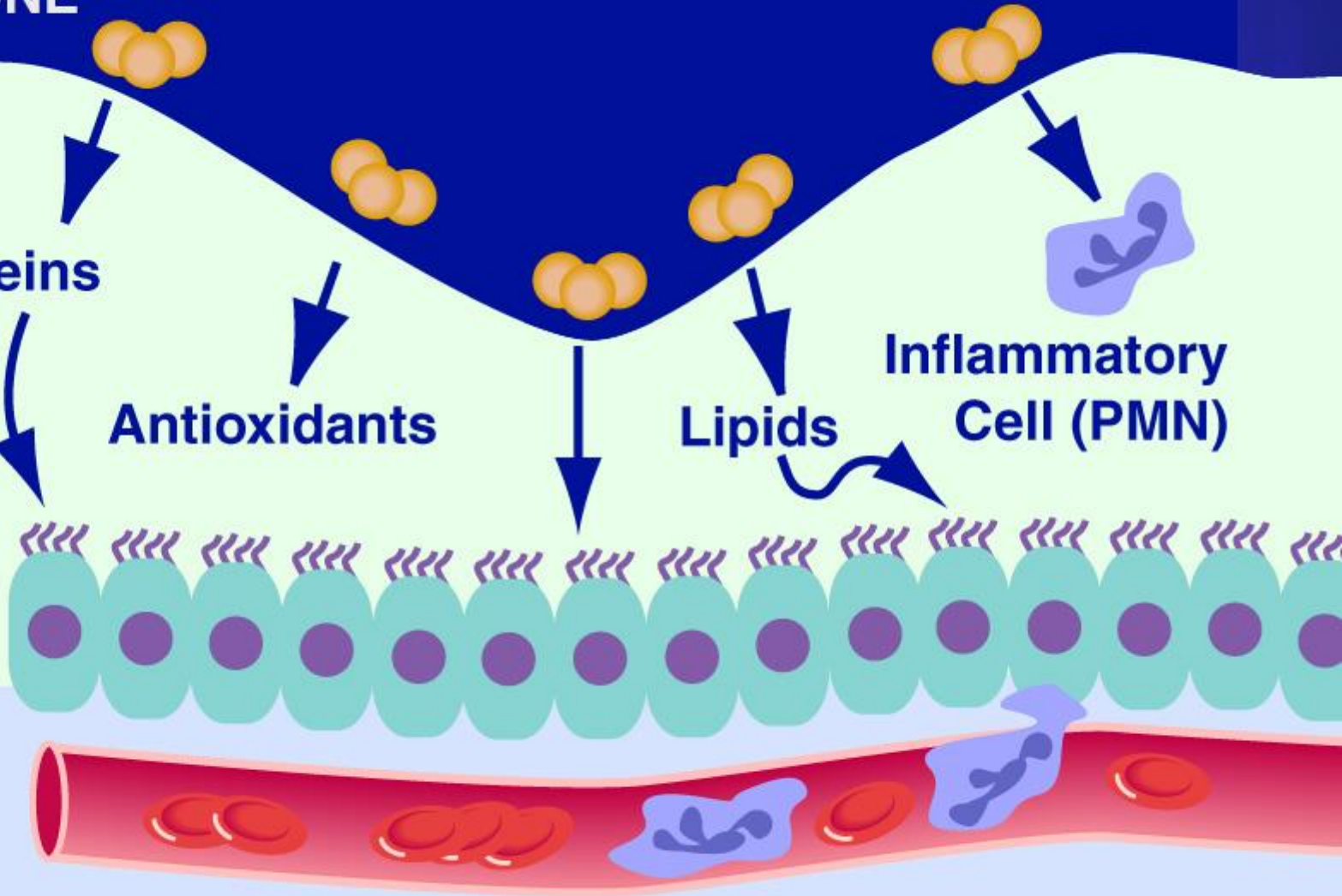
OZONE

Proteins

Antioxidants

Lipids

Inflammatory Cell (PMN)

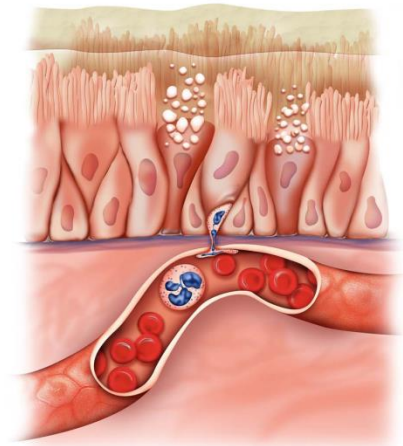


Ozone Causes Inflammation

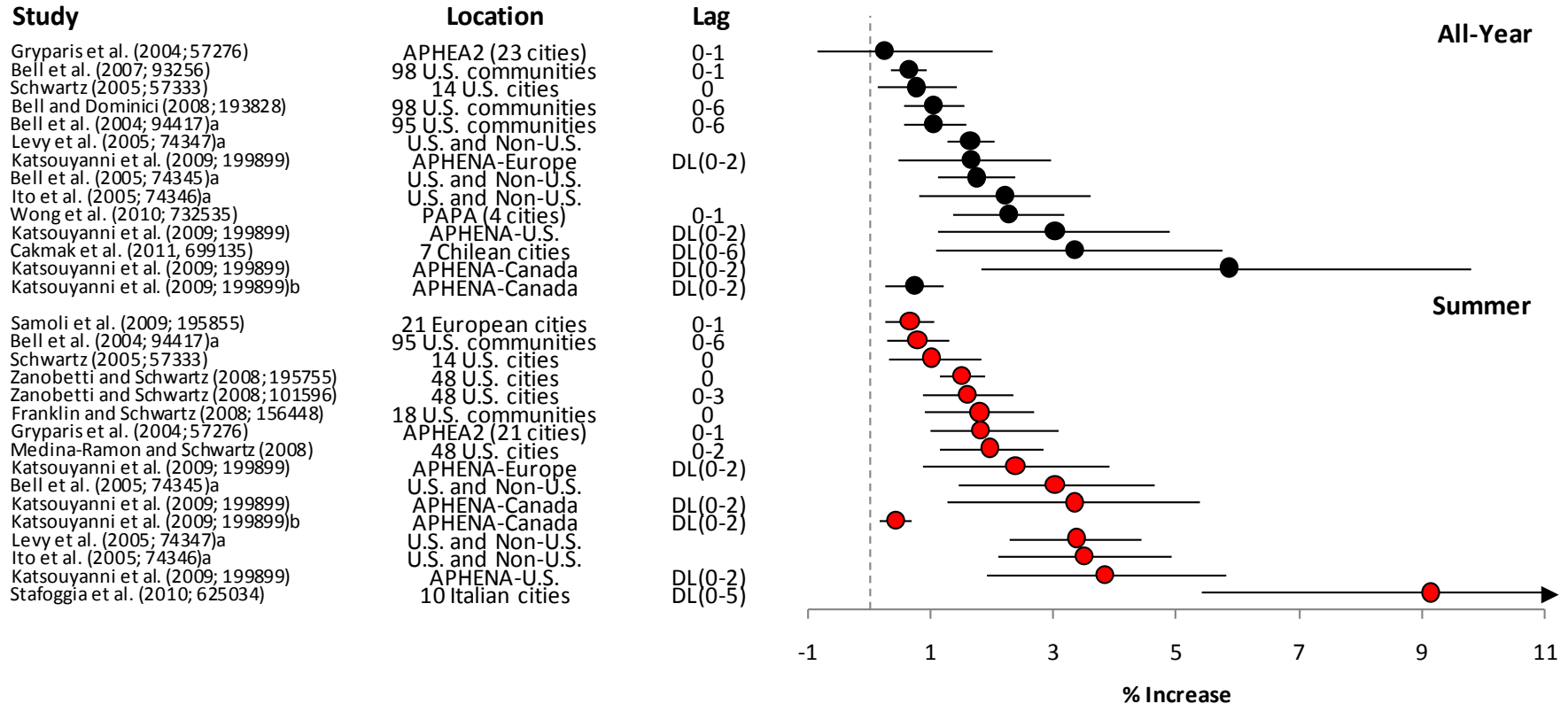
- Ozone reacts completely in surface layer - forms reactive oxygen molecules
- Increases permeability of cells that line airways
- Influx of white blood cells and proteins
- Damages cells that line the airways
- Effect is greater 24 hours after exposure
- Increases airway reactivity
- Concern about repeated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

Short-Term O₃ 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



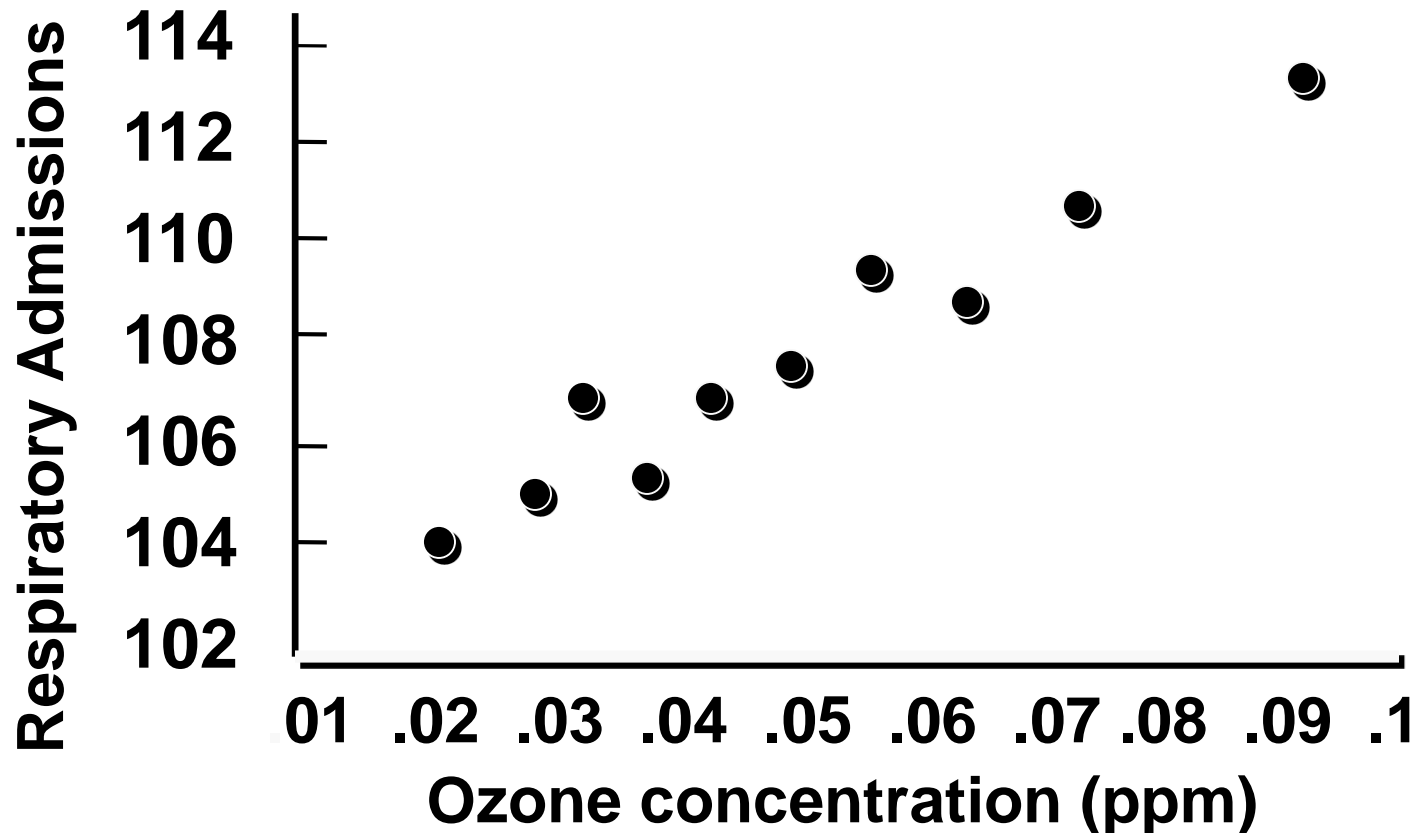
Short-Term O₃ Exposure and All-Cause (Nonaccidental) Mortality



*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 O₃ concentrations.

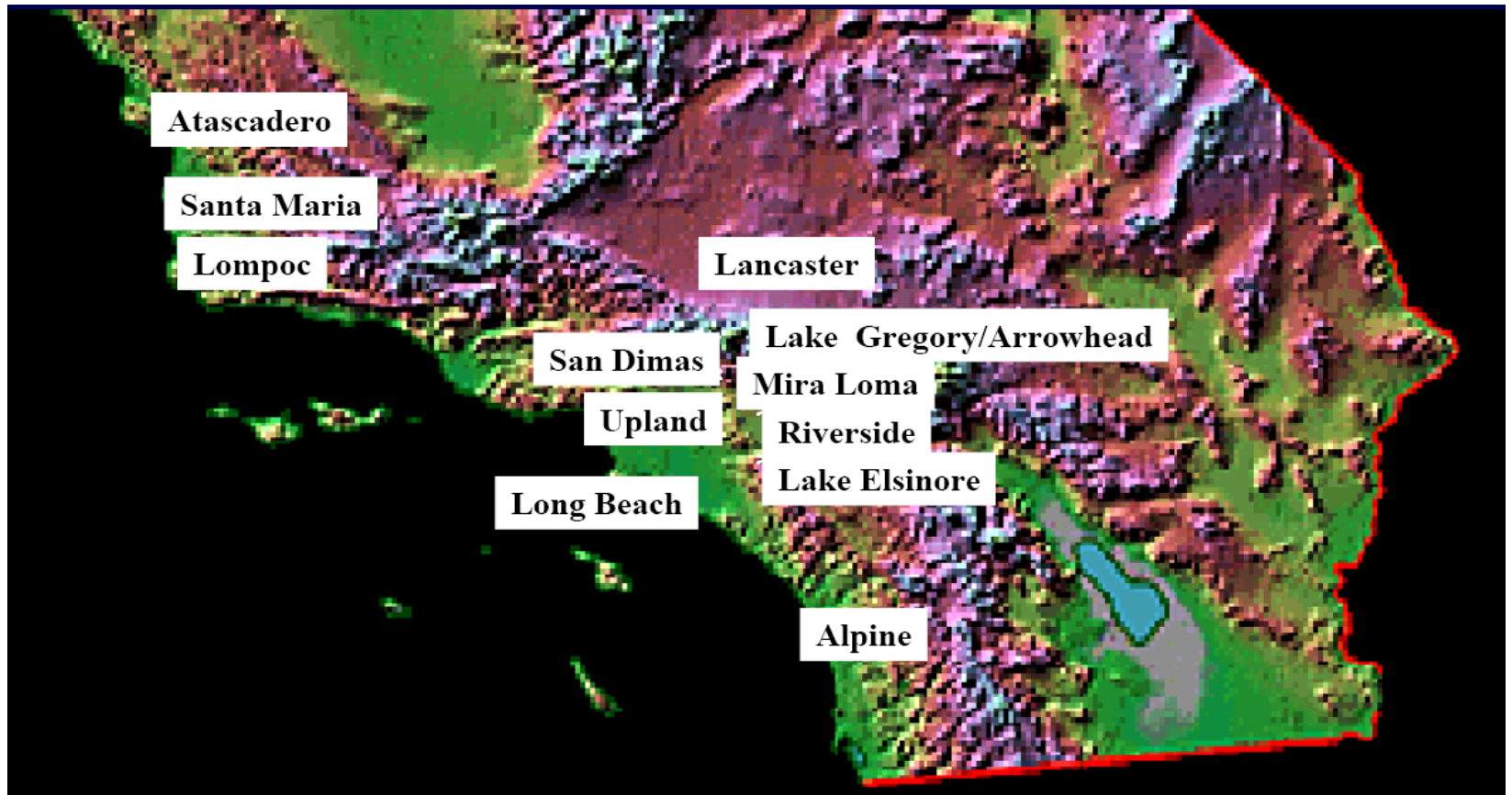
Respiratory Hospital Admissions by Daily Maximum Ozone Level, Lagged One Day

(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 O₃ Towns</u>		<u>High O₃ 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

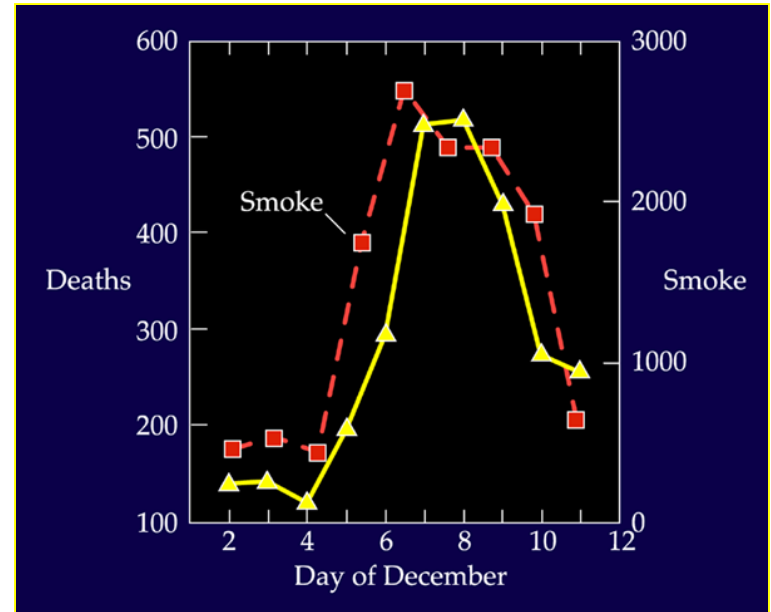
Sensitive Groups for Ozone

- 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

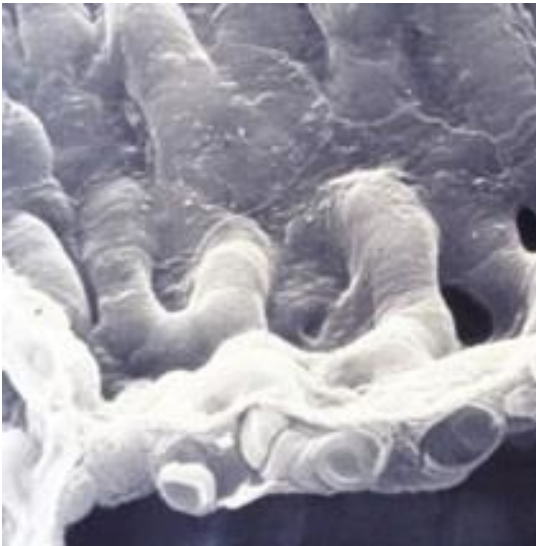


Industrial Sources



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

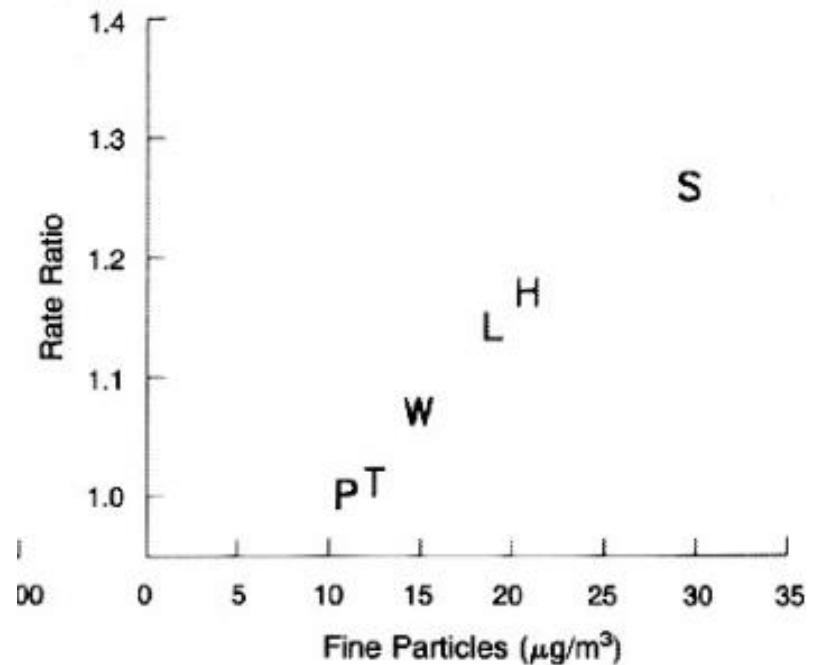
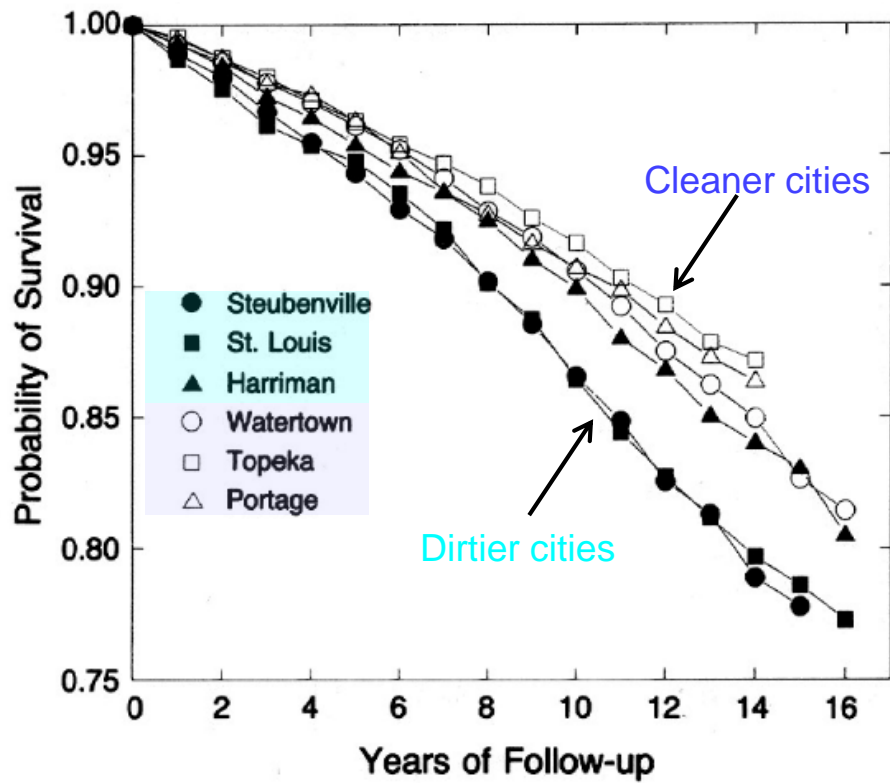
Living in Areas with High Air Pollution Associated with Shorter Life Expectancy



The NEW ENGLAND
JOURNAL of MEDICINE

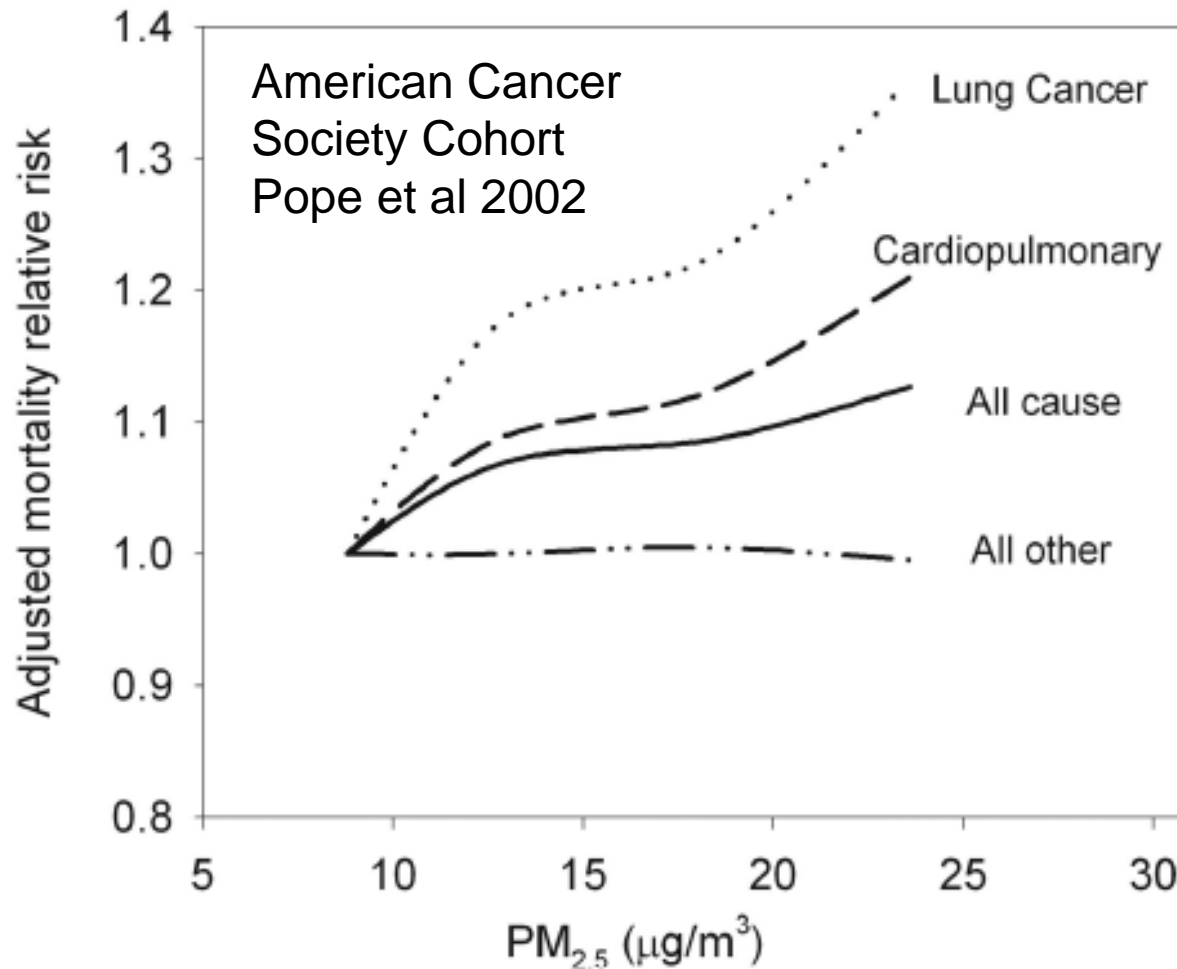
An Association between Air Pollution and Mortality in Six U.S. Cities

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

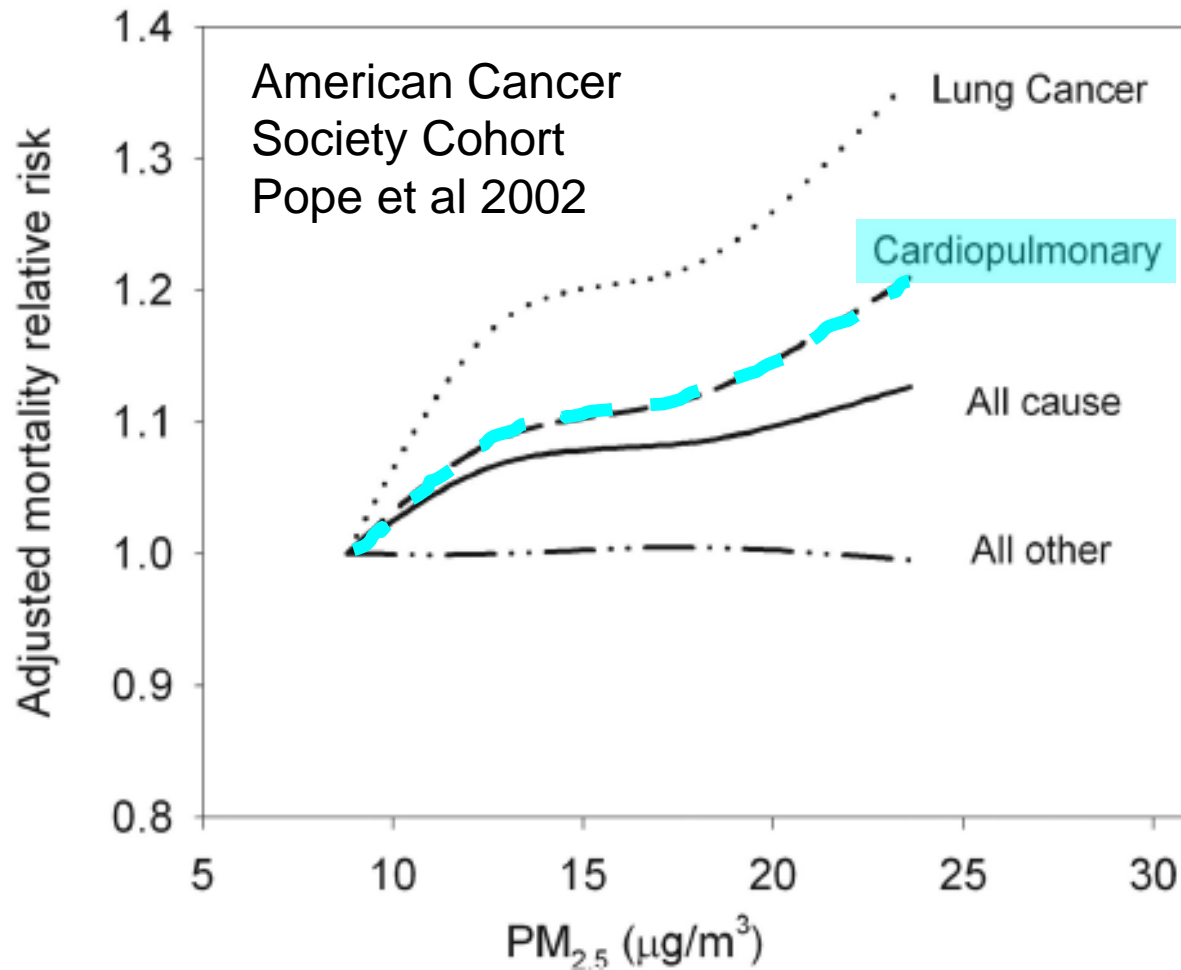
Findings Replicated by Large American Study and Others



Pope and Dockery 2006

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

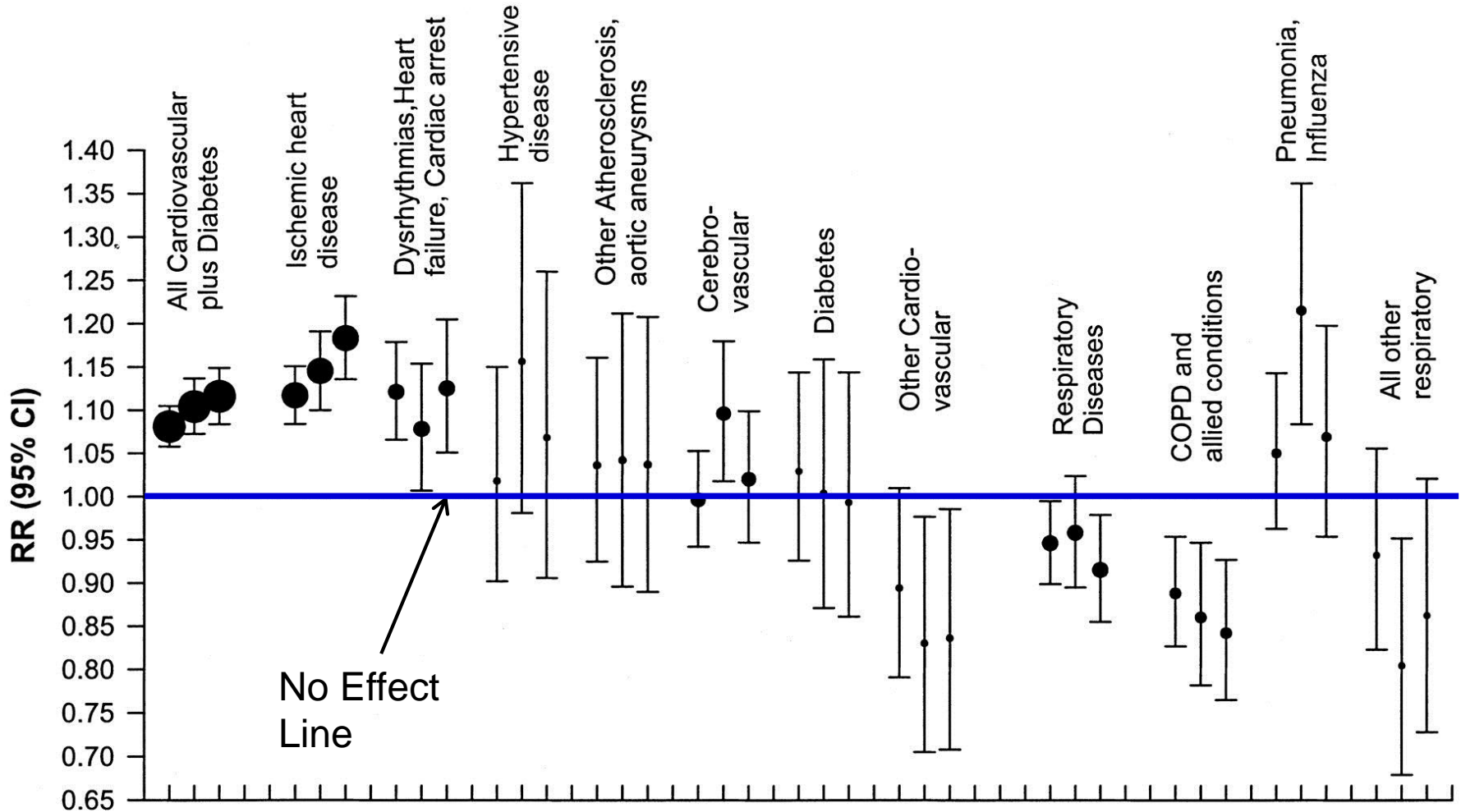
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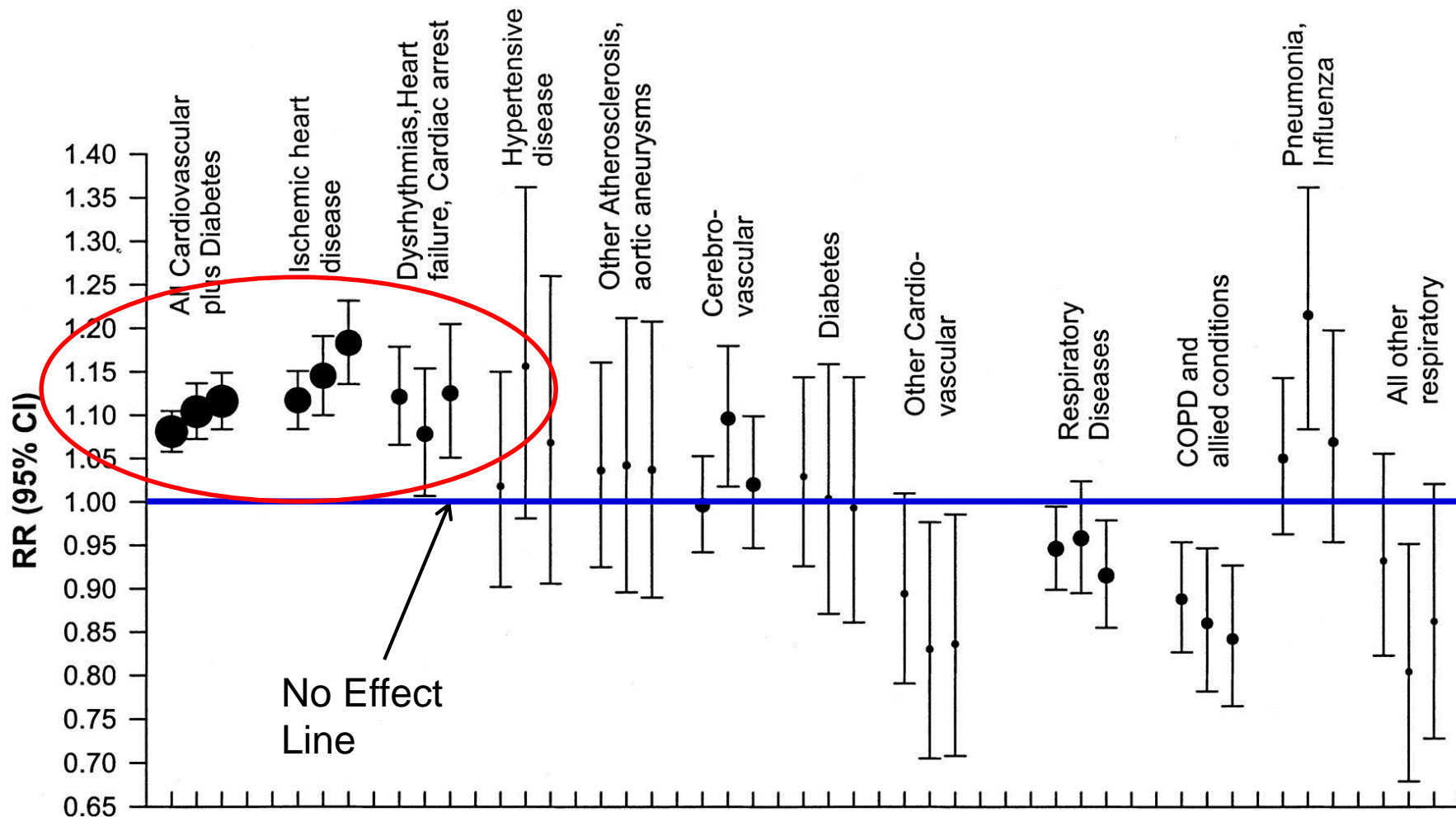
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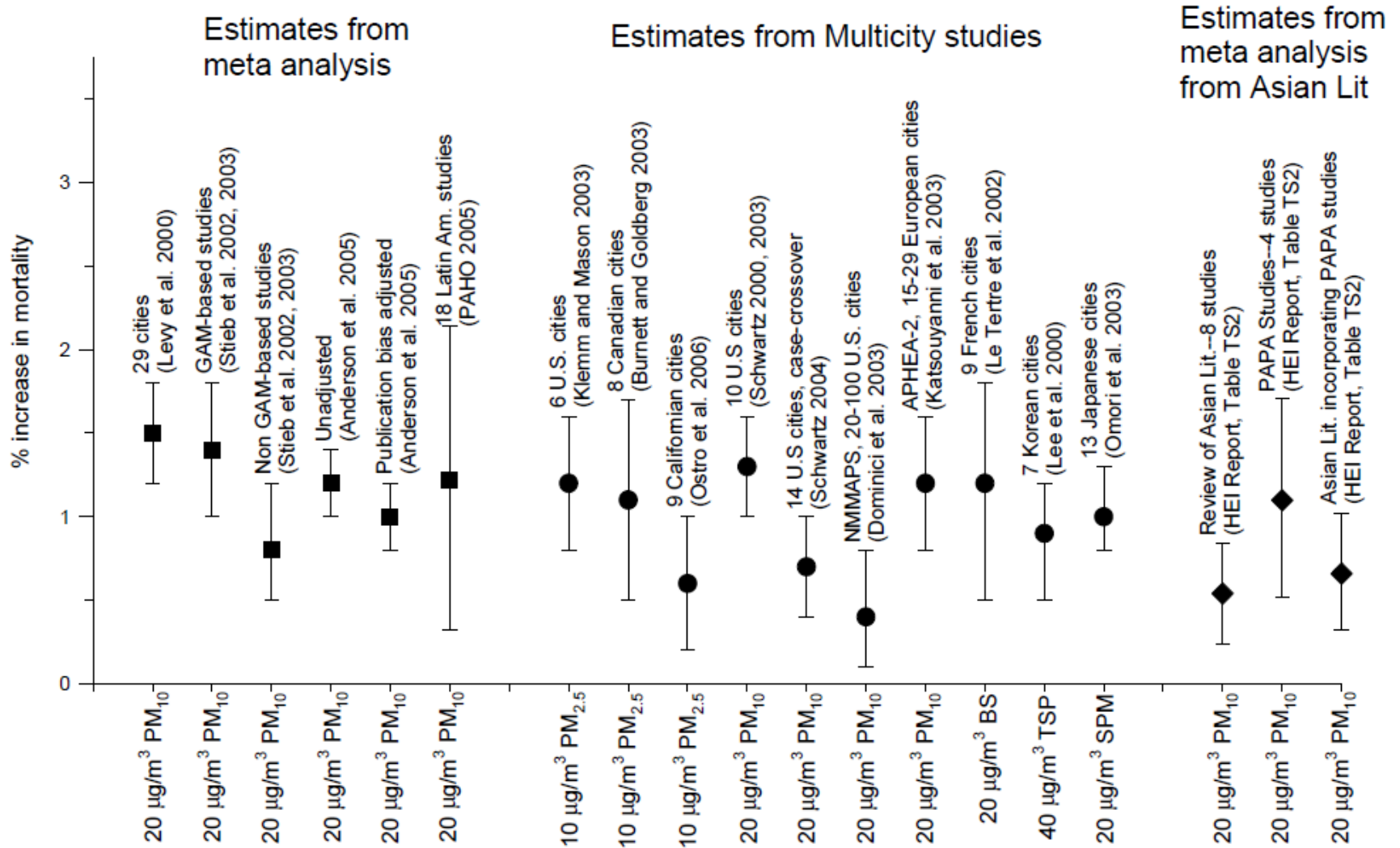
Strongest Associations For Cardiovascular Endpoints



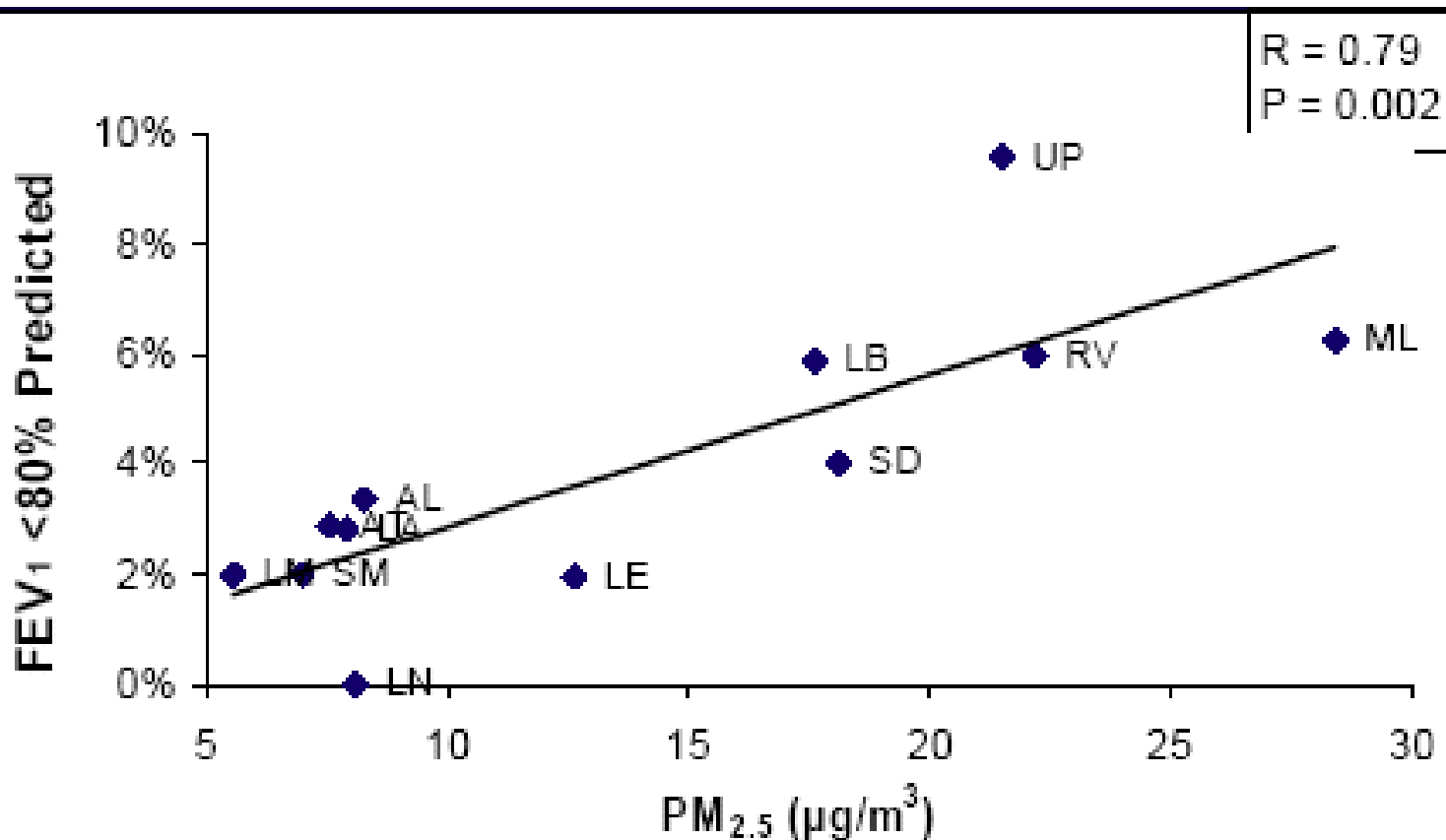
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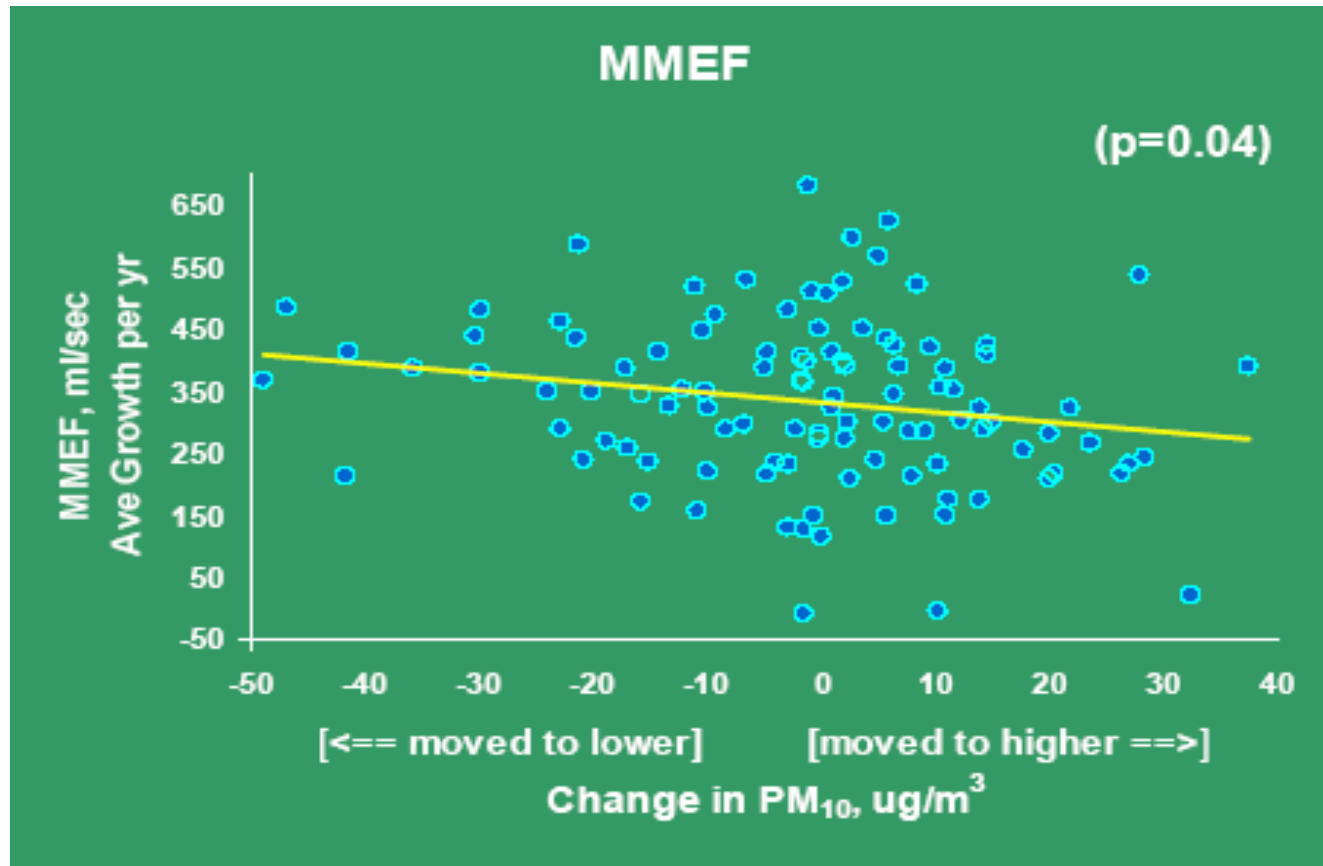
Small but Consistent Increases in Mortality with Short-Term Changes in PM



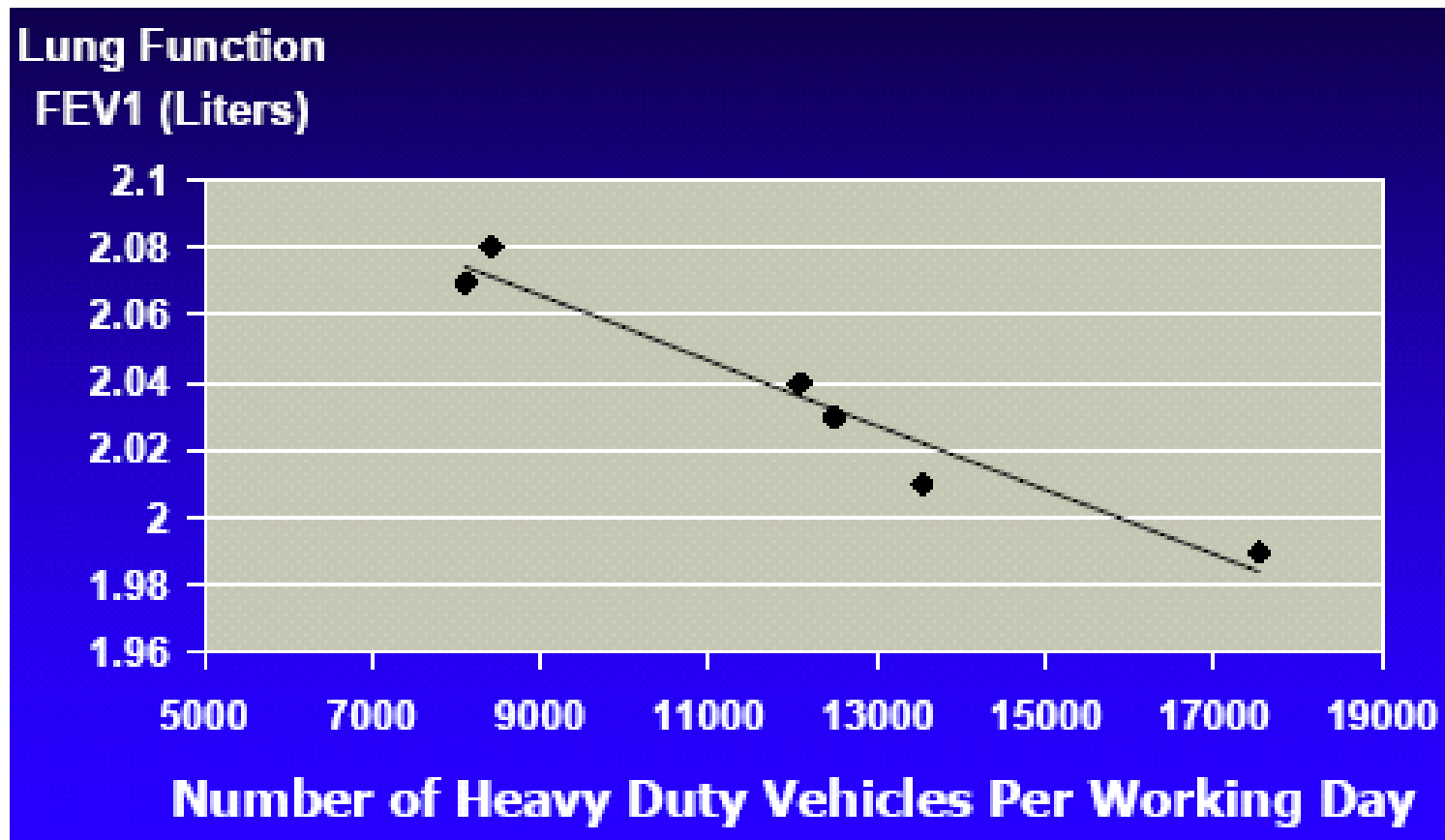
CHS: Low FEV₁ at Age 18 vs. Pollution



CHS: Lung Function Growth in Movers



Living Within 300 Meters of Local Roadways Affects FEV₁



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 NO₂, 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

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

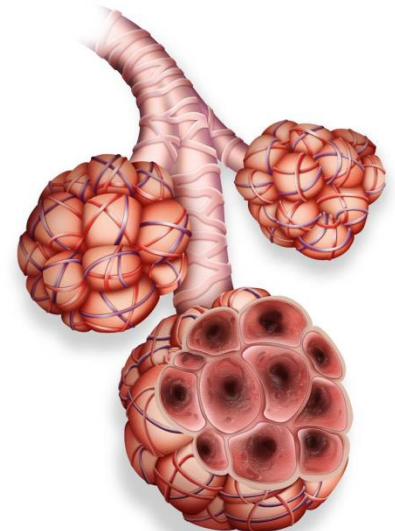
Dose = Concentration x Ventilation Rate x Time

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 section for 'Local Air Quality Conditions' 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. A timestamp 'Generated: 2013-07-09 14:54:52Z' is at the bottom right of the map.
- 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** and **Learning Center** sections with expandable arrows.
- A row of color-coded AQI categories: **Good** (green), **Moderate** (yellow), **USG** (orange), **Unhealthy** (red), **Vary Unhealthy** (purple), **Hazardous** (dark red), and **Action Day** (red exclamation mark).
- 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 AQI status: 'C San Bernardino M, CA' (187, red), 'Denver, CO' (USG, orange), and '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



[EnviroFlash Home](#)

[EnviroFlash Challenge](#)

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

[EnviroFlash Toolkit](#)
Available to AIRNow partner agencies

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

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

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Welcome to EnviroFlash! Air quality affects how you live and breathe. Like the weather, it can change from day to day, or even hour to hour. Up-to-date information allows you to make decisions based on air quality forecasts. EnviroFlash comes to you through a partnership between the US EPA and your state or local air quality agency - notifying you about air quality so you don't have to go searching for it!



An [on-line subscription page](#) allows you to sign up, edit your profile, or cancel the service. After you choose the type and frequency of service you want, EnviroFlash will be sent to your email or cell phone as specified.



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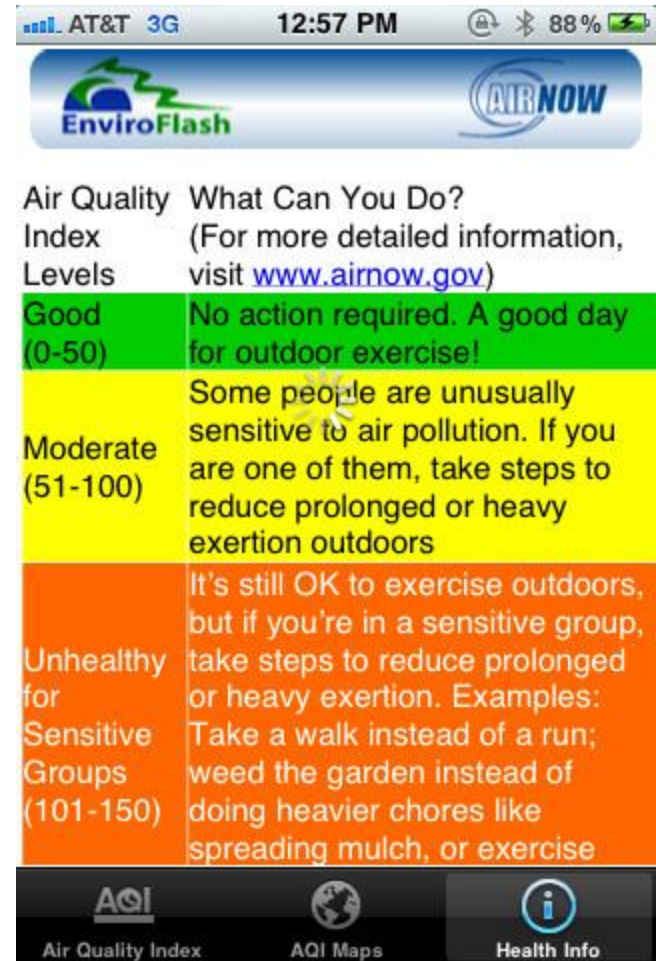
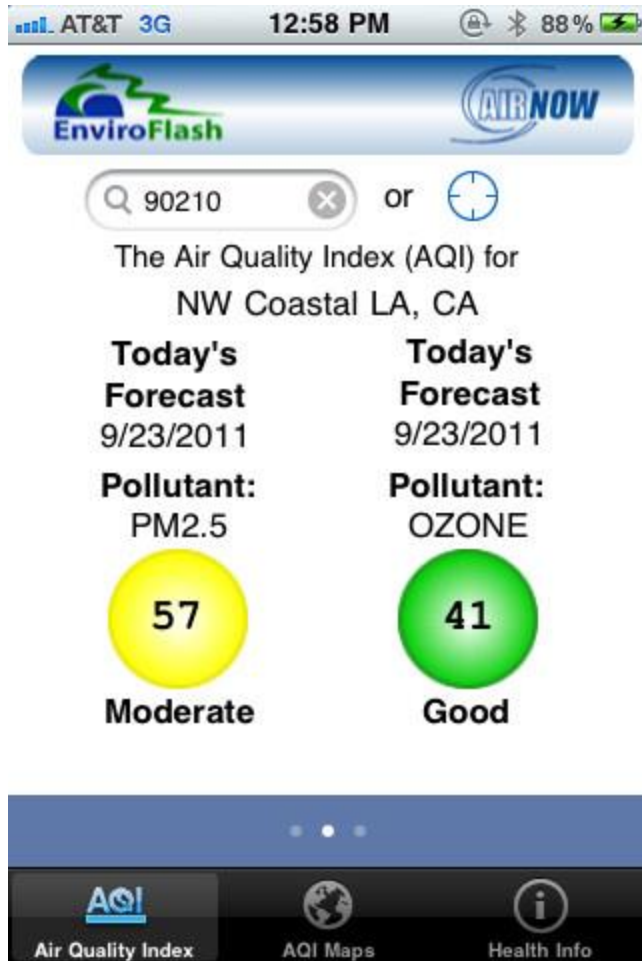
EnviroFlash: *Air quality information straight to your inbox!*

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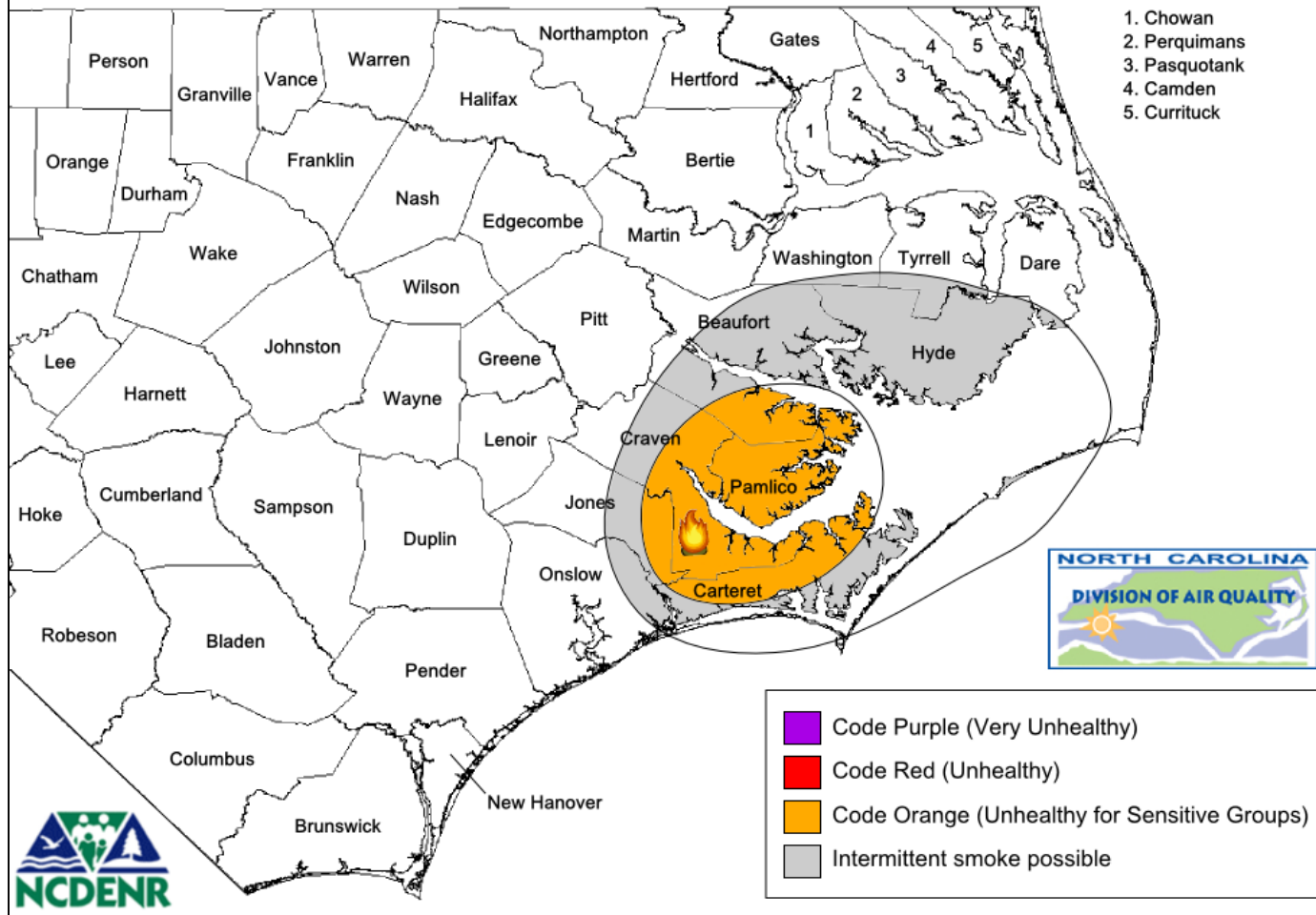


[AIRNow Home](#)

AirNow App on Smart Phones



Special Air Quality/Smoke Forecast for June 23, 2012



Web Courses for Healthcare Providers

- Updated ozone Web course
 - Offers CME credit from the American Academy of Family Physicians (AAFP)
 - Supporting tools
- PM Web course
 - Developing with CDC
 - CDC will offer CME credit
 - Will contain section on emergency situations

Ozone and Your Patients' Health Training for Health Care Providers

About this Course

During the summer months, millions of people in the United States are exposed to the ambient air pollutant ozone at levels that can cause uncomfortable but reversible respiratory symptoms as well as a number of more serious health effects. **Ozone and Your Patients' Health** is a short, evidence-based training course that:

- Describes the physiological mechanisms responsible for the lung function changes and symptoms caused by exposure to ground-level ozone
- Describes the relationships observed between ground-level ozone and other adverse health effects
- Discusses in detail the effects of ozone exposure on patients with asthma
- Helps health care providers advise their patients about exposure to ozone
- Provides practical Patient Education Tools to help patients understand what causes their symptoms and how to alleviate them.

Ozone and Your Patients' Health is designed for family practice doctors, pediatricians, nurse practitioners, asthma educators, and other medical professionals who counsel patients about asthma, air pollution, or exercise. Patients and their families may also use this material to learn the science behind ozone's effect on respiration and how to manage their respiratory health using the Air Quality Index. **CME credit** is available for the course.

Course Objectives

Upon completion of this course, you will be able to:

1. Describe how ozone is formed and where it is found
2. Identify the effects that exposure to ozone has on the general population

Effects of Common Air Pollutants

RESPIRATORY EFFECTS

- Symptoms: Cough, Wheezing, Irritation, Shortness of breath, Chest pain, Over-tiredness, Increased asthma and preexisting death from asthma.
- Increased asthma and preexisting death from asthma.
- Development of new diseases: Chronic bronchitis, Emphysema, Asthma, Lung cancer.
- How Pollutants Cause Symptoms:
 - Effects on Lung Tissues:** Irritation, Swelling, Increased mucus production, Thickening of airways, Decreased ability to clear the lungs.
 - Alters Immune System:** Alters normal immune response, Increases susceptibility to respiratory infection, Increases severity of respiratory infection.

CARDIOVASCULAR EFFECTS

- Symptoms: Chest pain, Shortness of breath, Dizziness, Lightheadedness, Rapid heart rate, Irregular heart rhythm, Increased asthma and preexisting death from asthma.
- Increased asthma and preexisting death from asthma.
- How Pollutants May Cause Symptoms:
 - Effects on Cardiovascular System:** Increased blood pressure, Increased heart rate, Irregular heart rhythm, Increased risk of heart disease, Increased risk of stroke.
 - Effects on Cardiovascular System:** Increased blood pressure, Increased heart rate, Irregular heart rhythm, Increased risk of heart disease, Increased risk of stroke.

Reduce your risk by using the Air Quality Index (AQI) to plan outdoor activities - www.airnow.gov

AQI Levels of Health Concern	AQI Values	What Action Should People Take?
Good	0-50	Enjoy outdoor activities.
Moderate	51-100	People unusually sensitive to air pollution should consider reducing outdoor activities.
Unhealthy for Sensitive Groups	101-150	Sensitive groups should consider reducing outdoor activities. Sensitive groups include people with asthma, people with heart disease, older people, and people who work or exercise outdoors.
Unhealthy	151-200	Everyone should consider reducing outdoor activities. Sensitive groups should consider avoiding outdoor activities.
Very Unhealthy	201-300	Everyone significantly should consider avoiding outdoor activities. Sensitive groups should avoid outdoor activities.

SEPA and **AMERICAN COLLEGE OF CARDIOLOGY**

Heart Disease, Stroke, and Outdoor Air Pollution

Did you know that air pollution can trigger heart attacks, stroke, and other health effects?

Medical studies show that air pollution can trigger heart attacks, stroke, and irregular heart rhythms—especially in people who are already at risk for these conditions. Also, for people with a medical condition called heart failure, air pollution can further reduce the ability of the heart to pump blood the way that it should. Very small particles are the pollutants of greater concern for triggering these effects. Greater pollution is found in haze, smog, and dust—and sometimes in air that looks clean. This fact sheet tells you how you can:

- Get up-to-date information about your local air quality.**
- Protect your health when particle pollution is at unhealthy levels.**
- Are you at higher risk?**
 - For most people, the risk is small. Older adults and people with risk factors for heart disease or stroke may be at greater risk. You are at greater risk if you:
 - Have had a heart attack, angina, bypass surgery, angioplasty with or without a stent, a stroke, blood clots in the neck or leg arteries, heart failure, heart rhythm problems, diabetes, or chronic obstructive lung disease.
 - You may be at greater risk of heart disease or stroke (and therefore at greater risk from particle pollution) if any of these apply:
 - You are a man 45 years or older, or a woman 55 years or older.
 - You have a family history of stroke or early heart disease (father or brother diagnosed before age 55, mother or sister diagnosed before age 65).
 - You have high blood pressure or high blood cholesterol.
 - You are overweight or not physically active.
 - You smoke cigarettes.
- How can you protect your health?**
 - Regular exercise is important for staying healthy, especially if you have heart disease. By adjusting when and where you exercise, you can lead a healthier lifestyle and help reduce your risk of heart problems or stroke triggered by air pollution. In addition:
 - If you have heart disease or have experienced a stroke, check with your health care provider about the best ways to protect your health when the air quality is unhealthy.
 - If you're at risk of heart disease or stroke and plan to exercise more than usual, discuss this with your health care provider.
 - Particle pollution levels can be high any time of year. Levels can be especially high when the weather is calm, allowing air pollution to build up. Particle levels can also be high:
 - Near busy roads in urban areas (especially during rush hour), and in industrial areas.
 - When there is smoke in the air from wood stoves, fireplaces, burning vegetation, or forest fires.
 - Know when and where particle pollution levels may be unhealthy.**
 - Particle pollution levels can be high any time of year. Levels can be especially high when the weather is calm, allowing air pollution to build up. Particle levels can also be high:
 - Near busy roads in urban areas (especially during rush hour), and in industrial areas.
 - When there is smoke in the air from wood stoves, fireplaces, burning vegetation, or forest fires.



- 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/>

Pollutant-Specific Information

Ozone and Your Health

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

AQI
AIR QUALITY INDEX

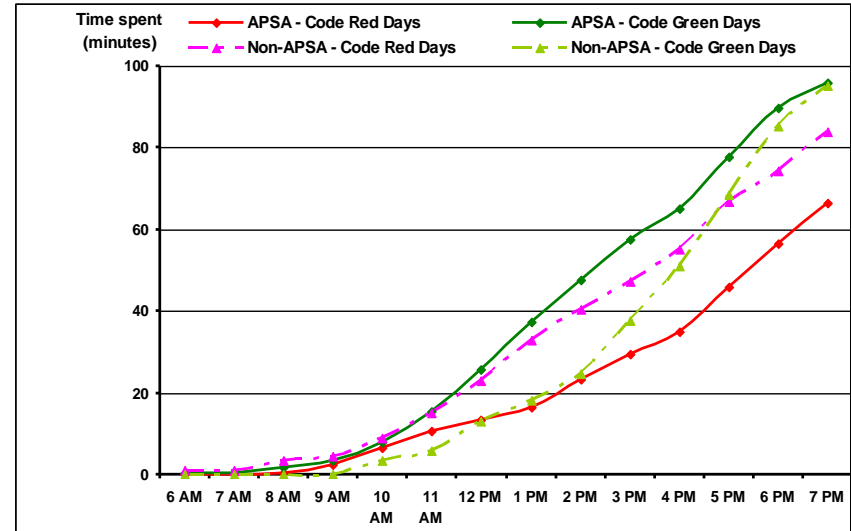
A Guide to Air Quality and Your Health

Particle Pollution and Your Health

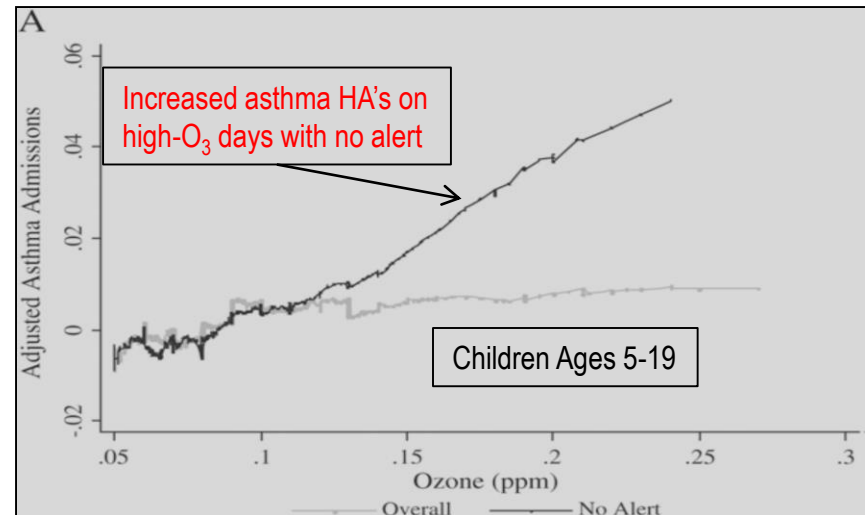
What Is Particle Pollution?
Are You at Risk?
How Can You Protect Yourself?

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