

How Air Pollution Is Affecting Our Health

Air Quality Workshop for Teachers
July 13, 2016

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Human Lung

- Air conducting

- Trachea

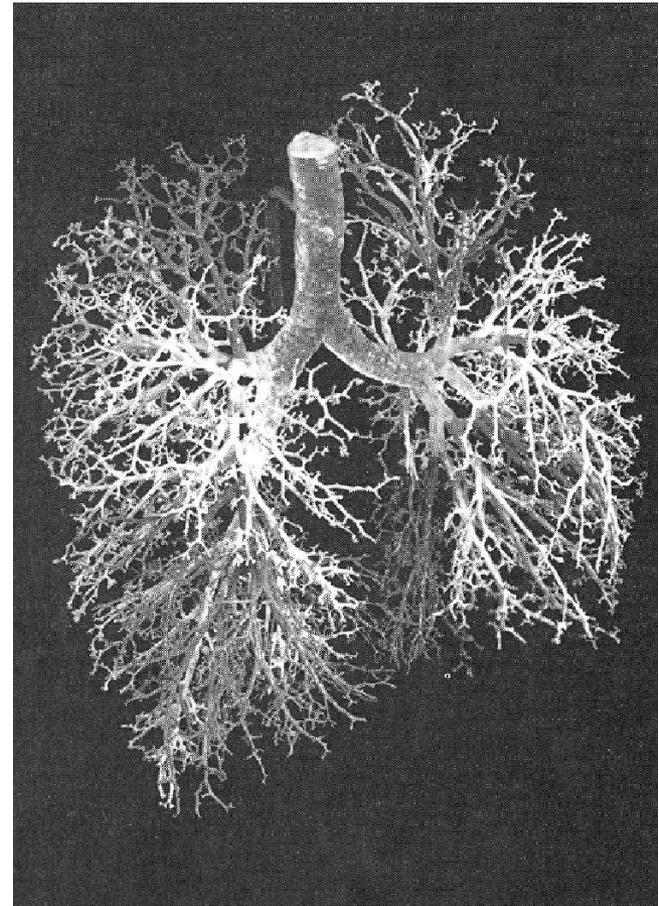
- Bronchi

- Bronchioles

- Gas exchange

- Respiratory bronchioles

- Alveoli

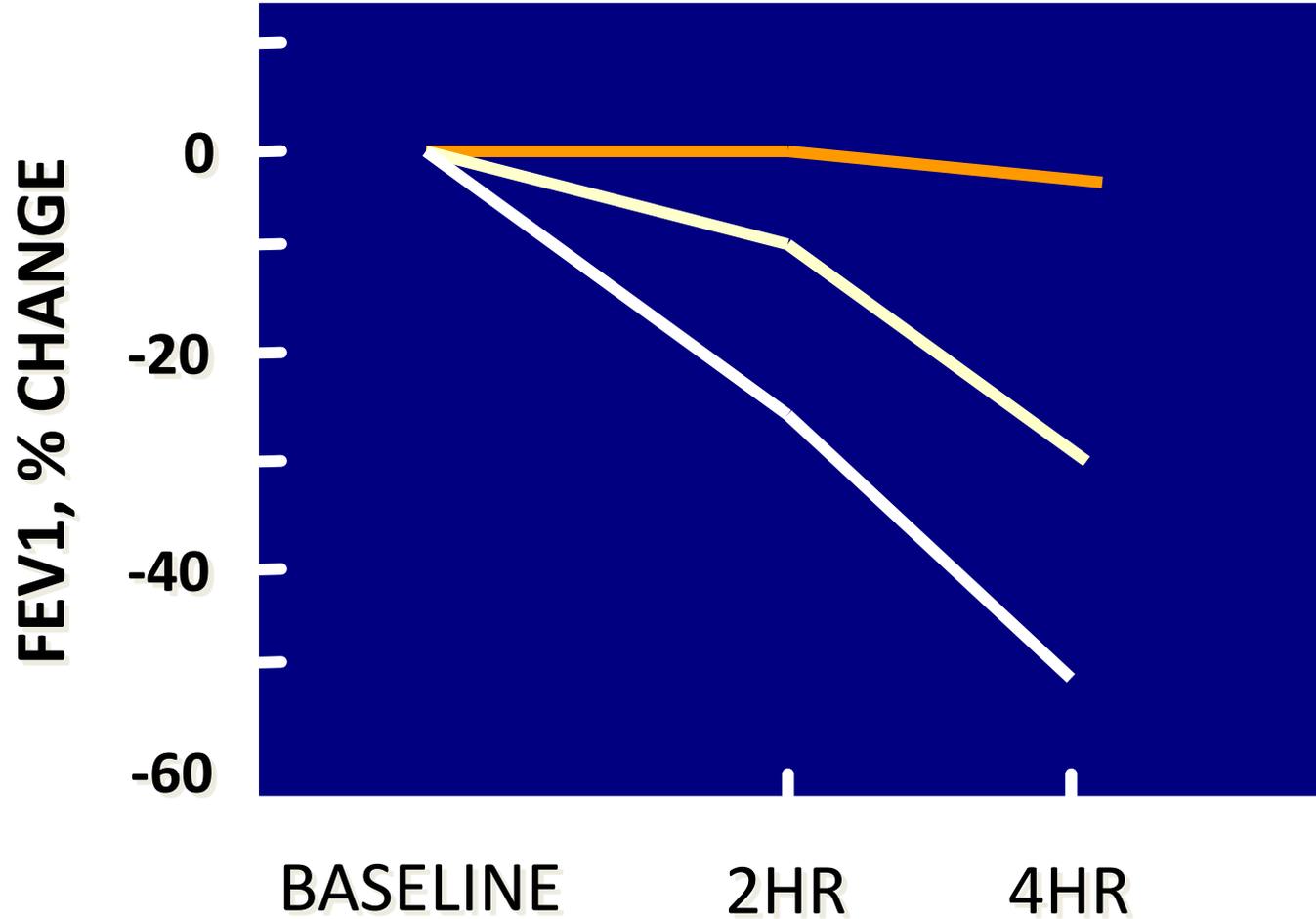


Ozone Irritates Airways

- 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



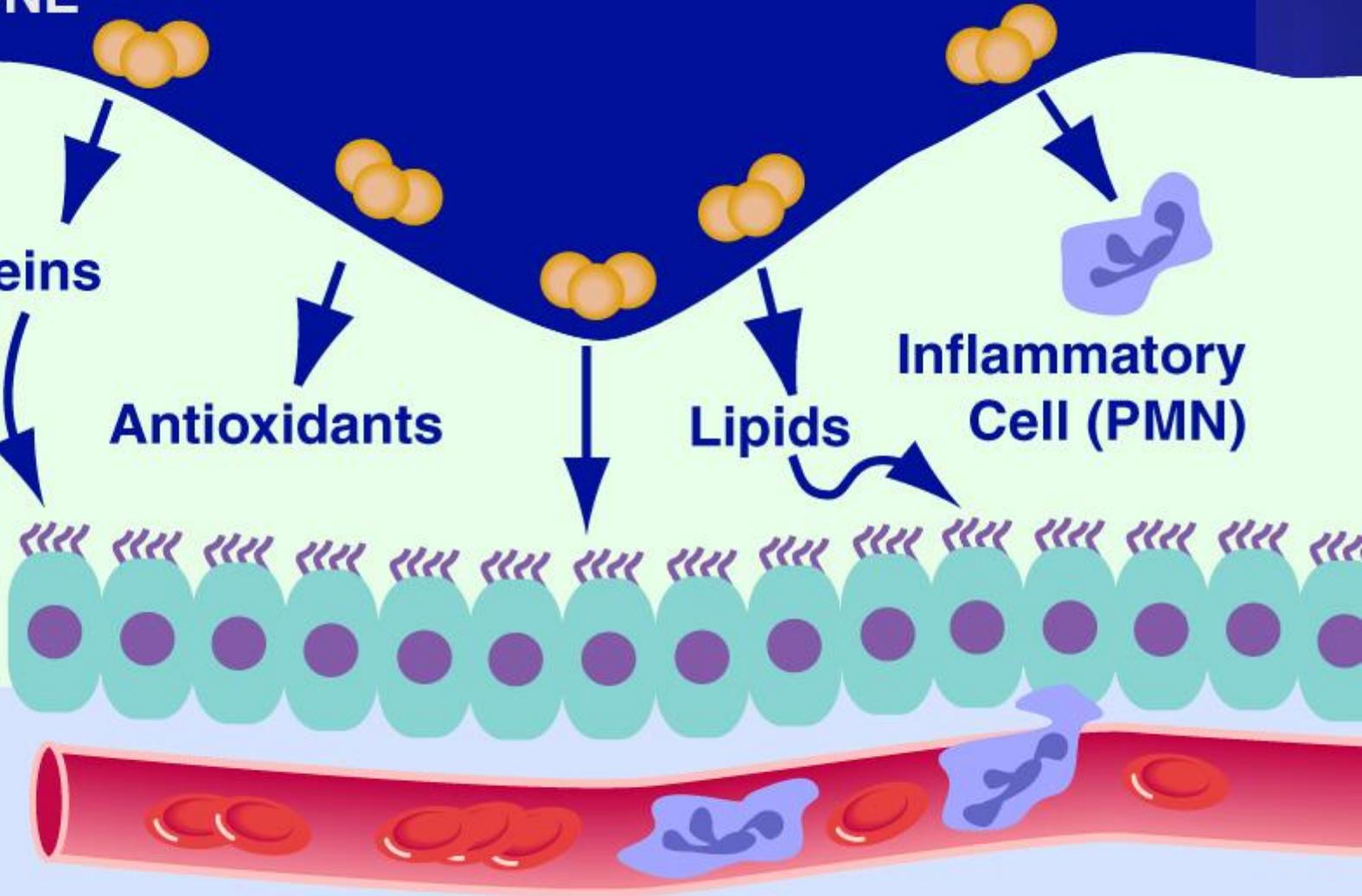
OZONE

Proteins

Antioxidants

Lipids

Inflammatory Cell (PMN)

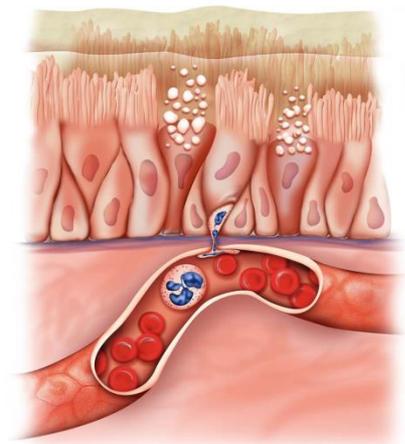


Ozone Causes Inflammation

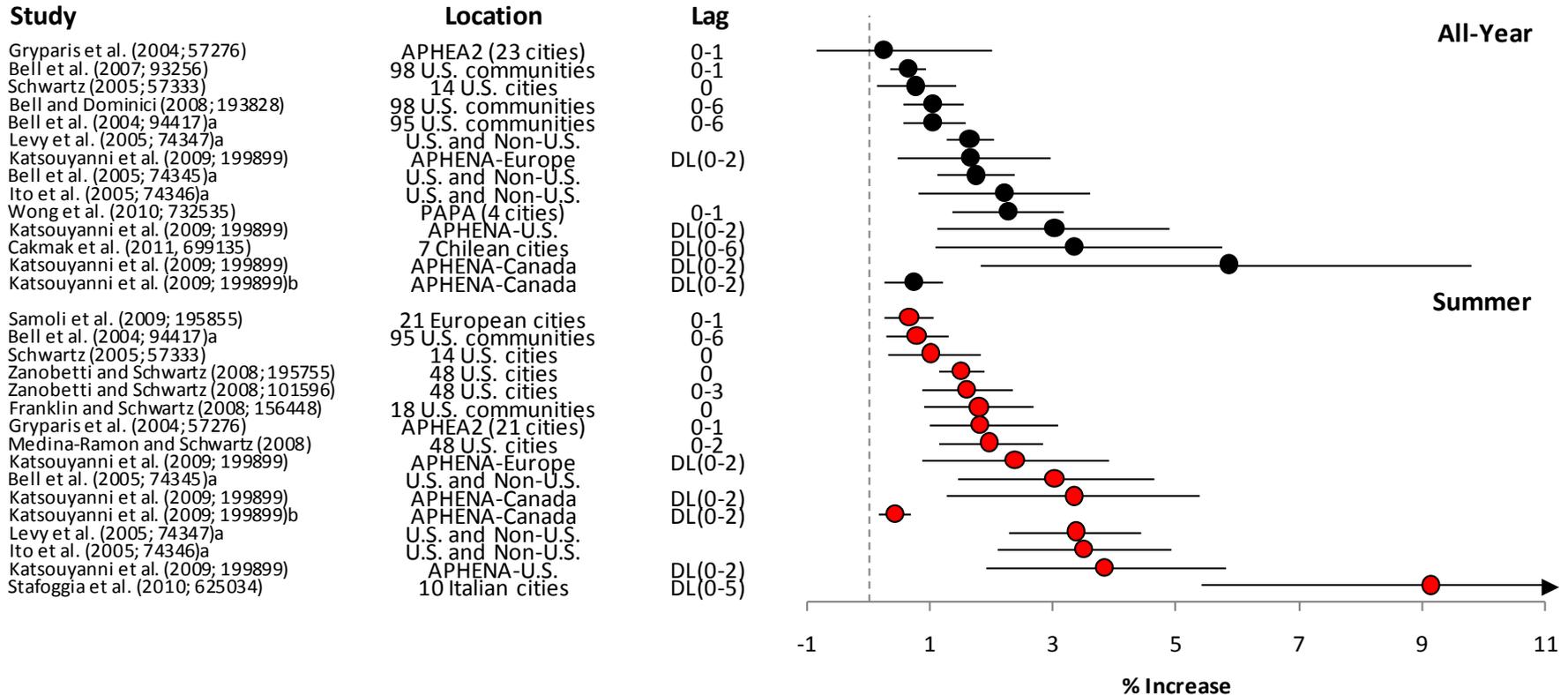
- Ozone reacts completely in surface layer - forms reactive oxygenated molecules
- Increases permeability of cells that line airways
- Influx of white blood cells and proteins
- Damages cells that line the airways
- Effect is greater 24 hours after exposure
- Increases airway reactivity
- Concern about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



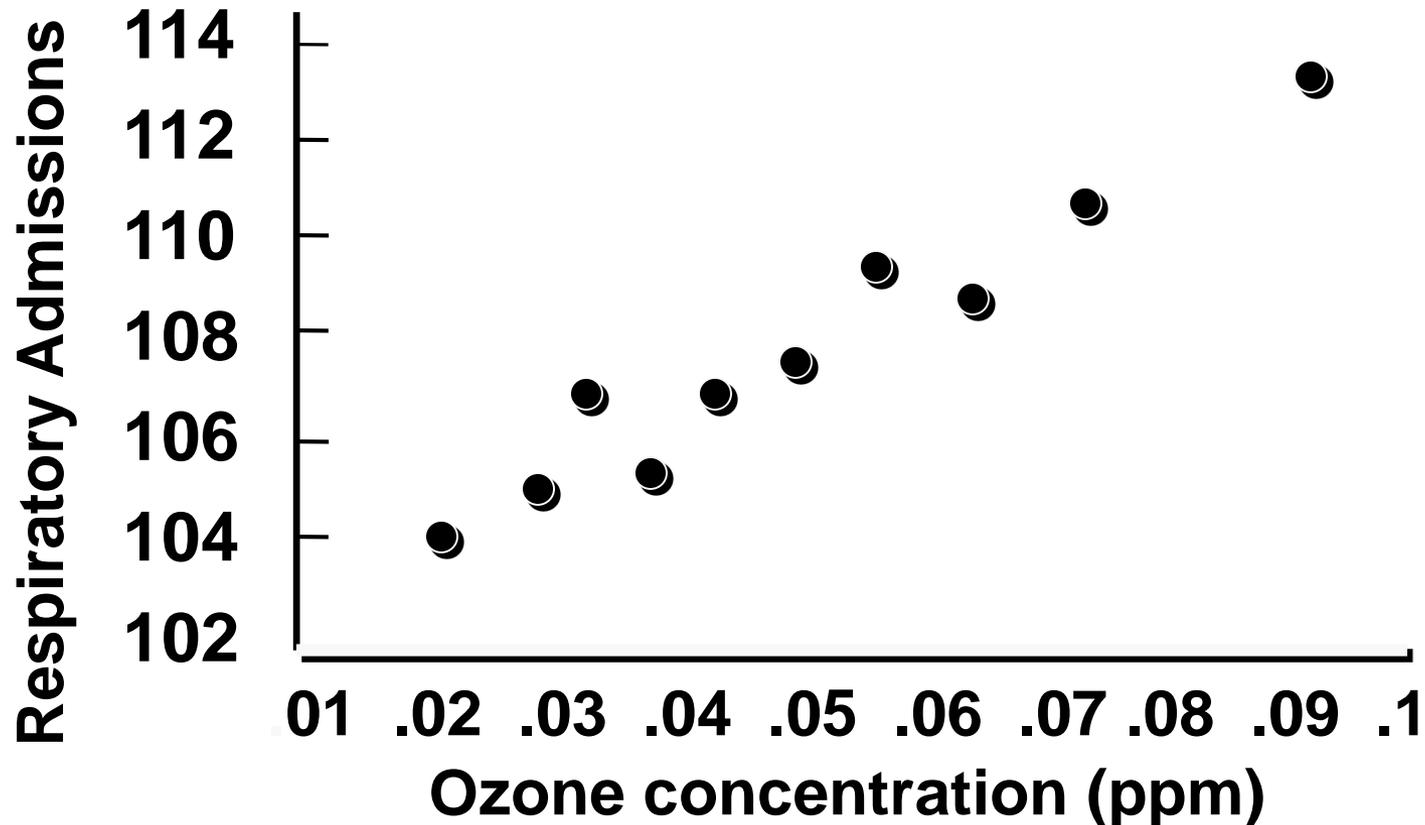
Short-Term O₃ Exposure and All-Cause (Nonaccidental) Mortality



*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.

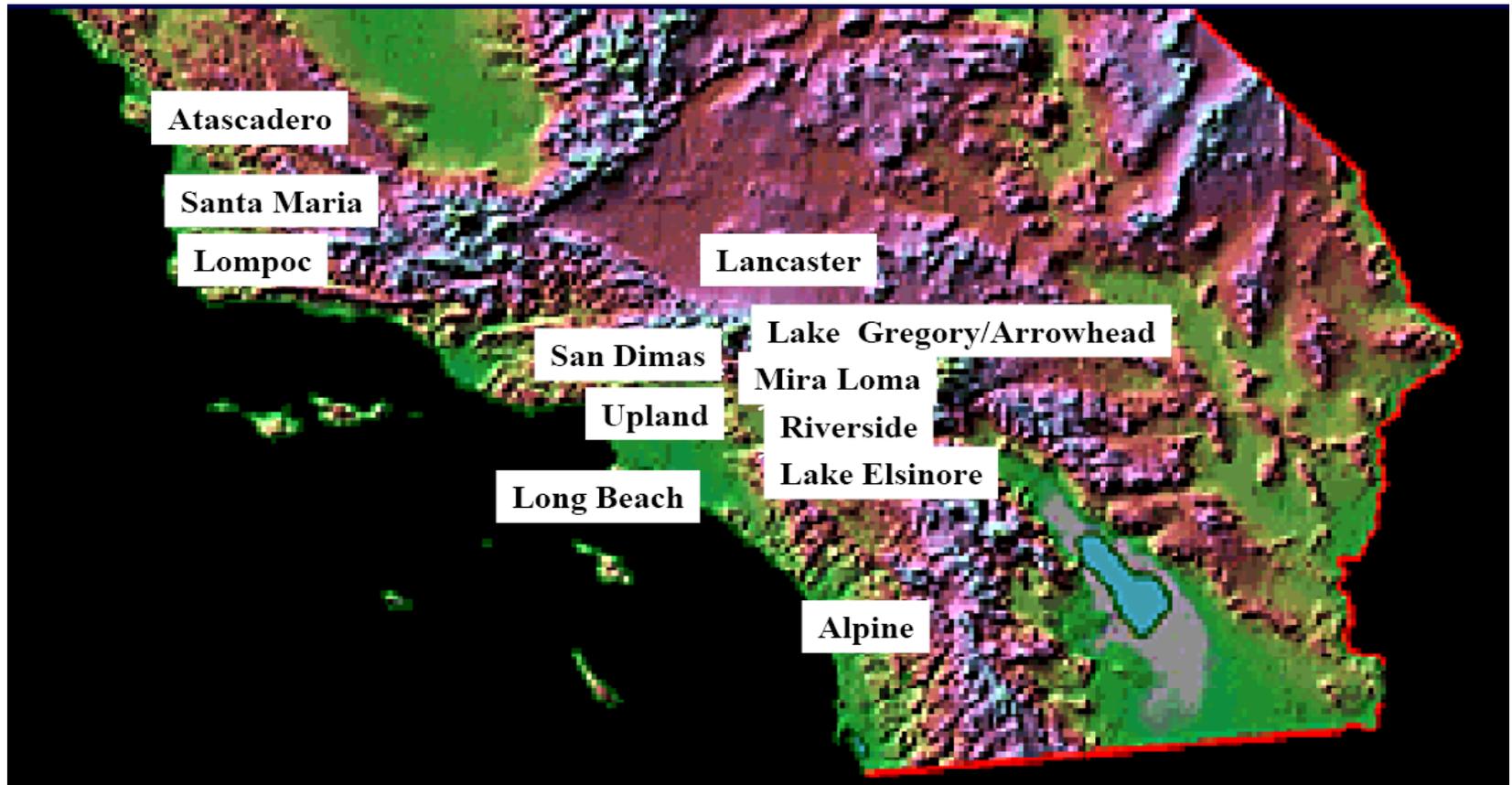
Respiratory Hospital Admissions by Daily Maximum Ozone Level, Lagged One Day

(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

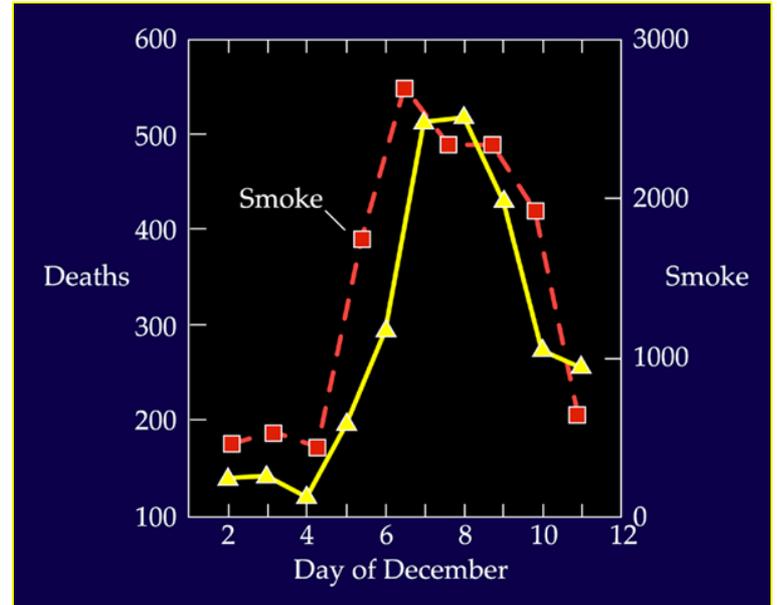
Sensitive Groups for Ozone

- 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

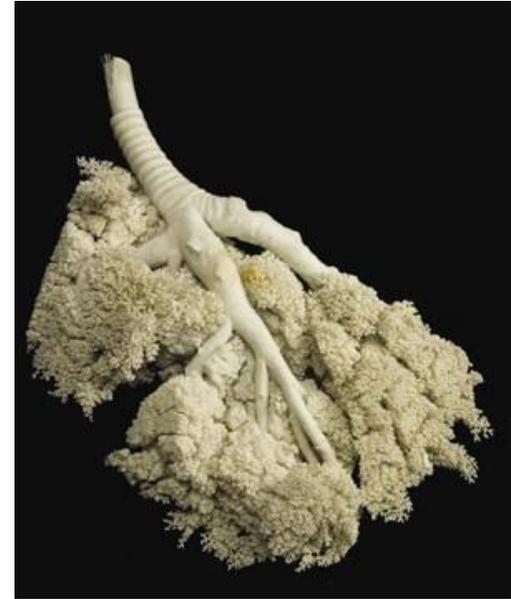
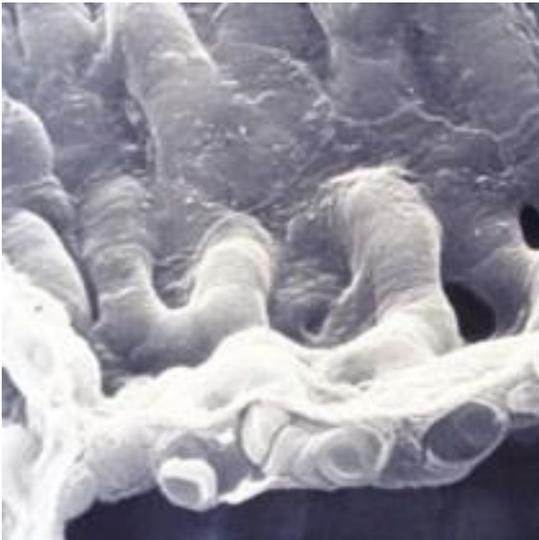


Industrial Sources



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

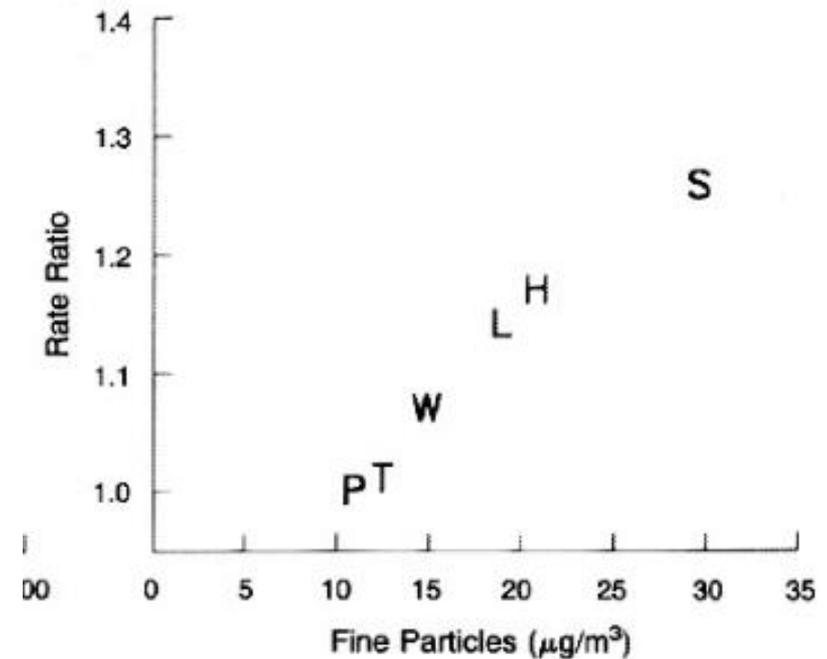
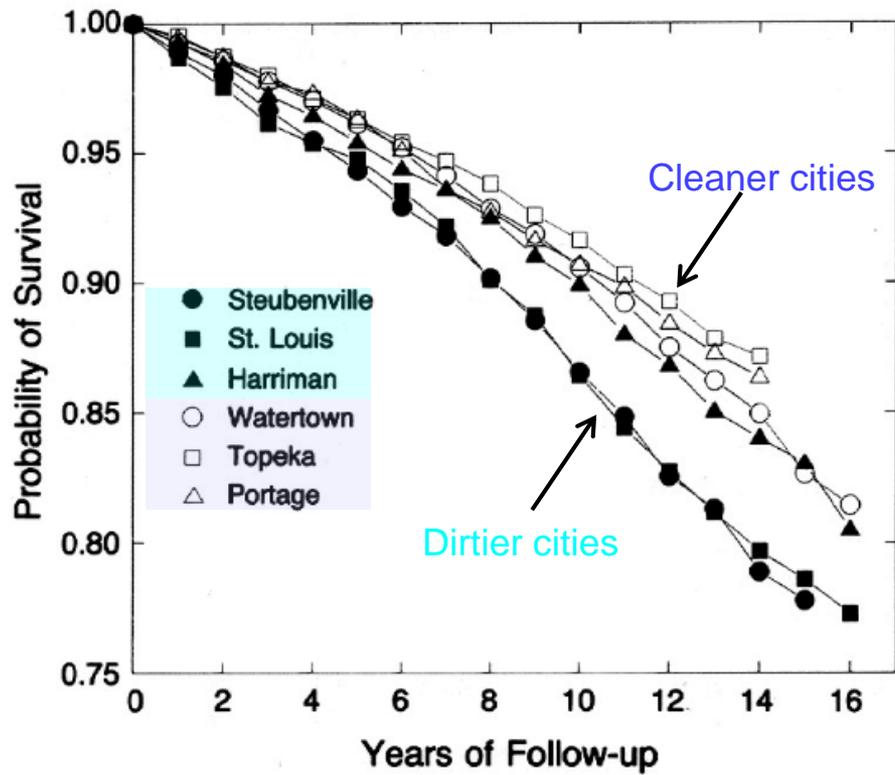
Living in Areas with High Air Pollution Associated with Shorter Life Expectancy



The NEW ENGLAND
JOURNAL of MEDICINE

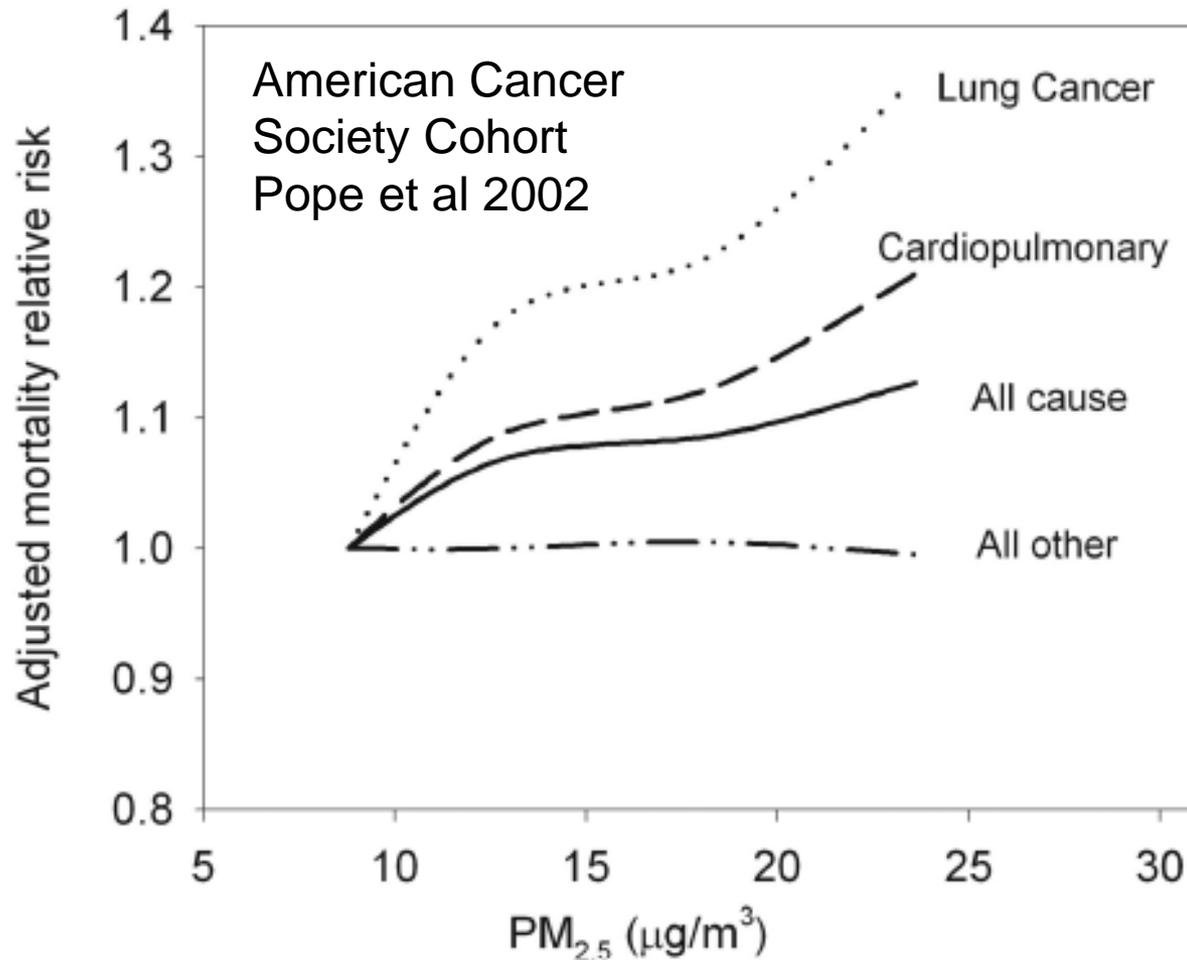
An Association between Air Pollution and Mortality in Six U.S. Cities

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

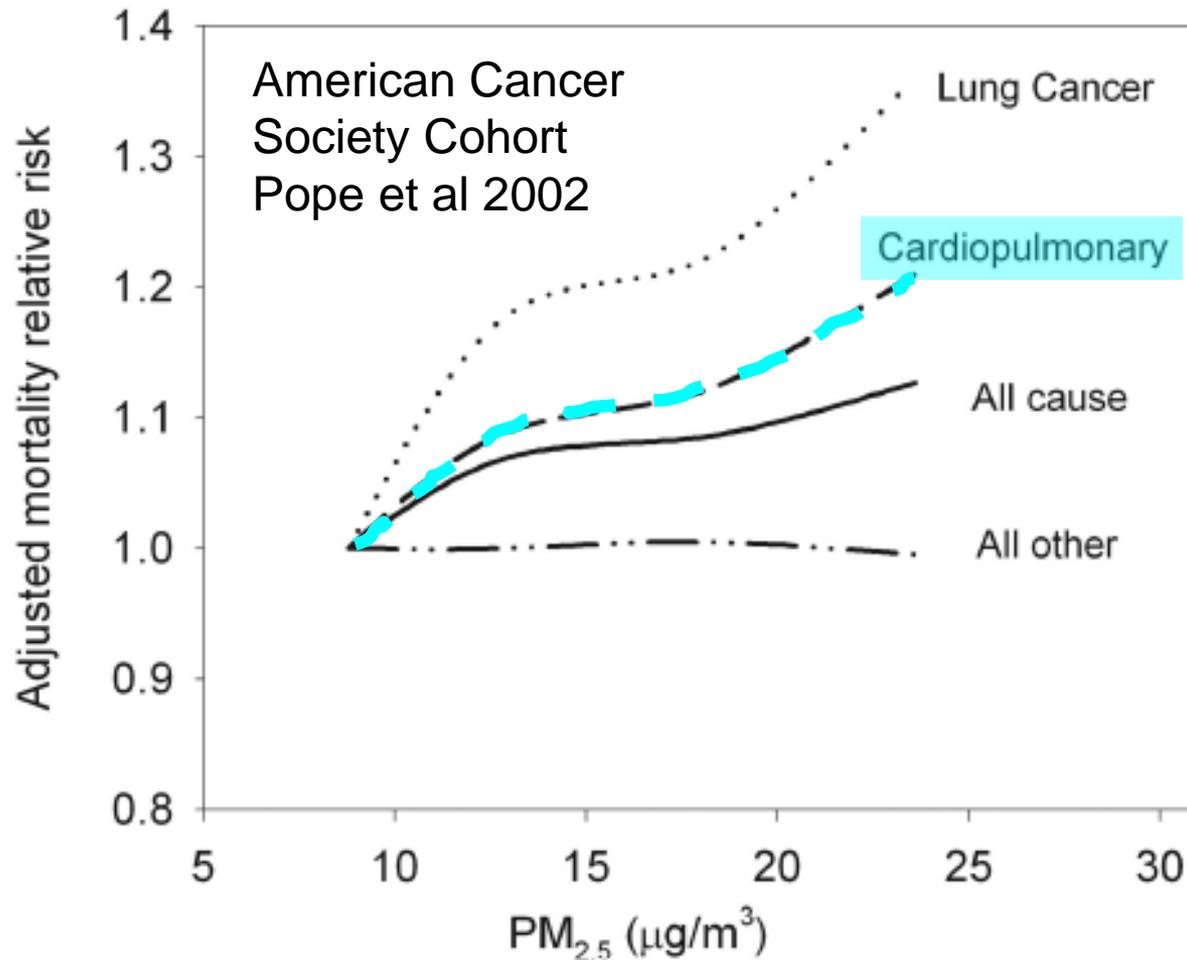
Findings Replicated by Large American Study and Others



Pope and Dockery 2006

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

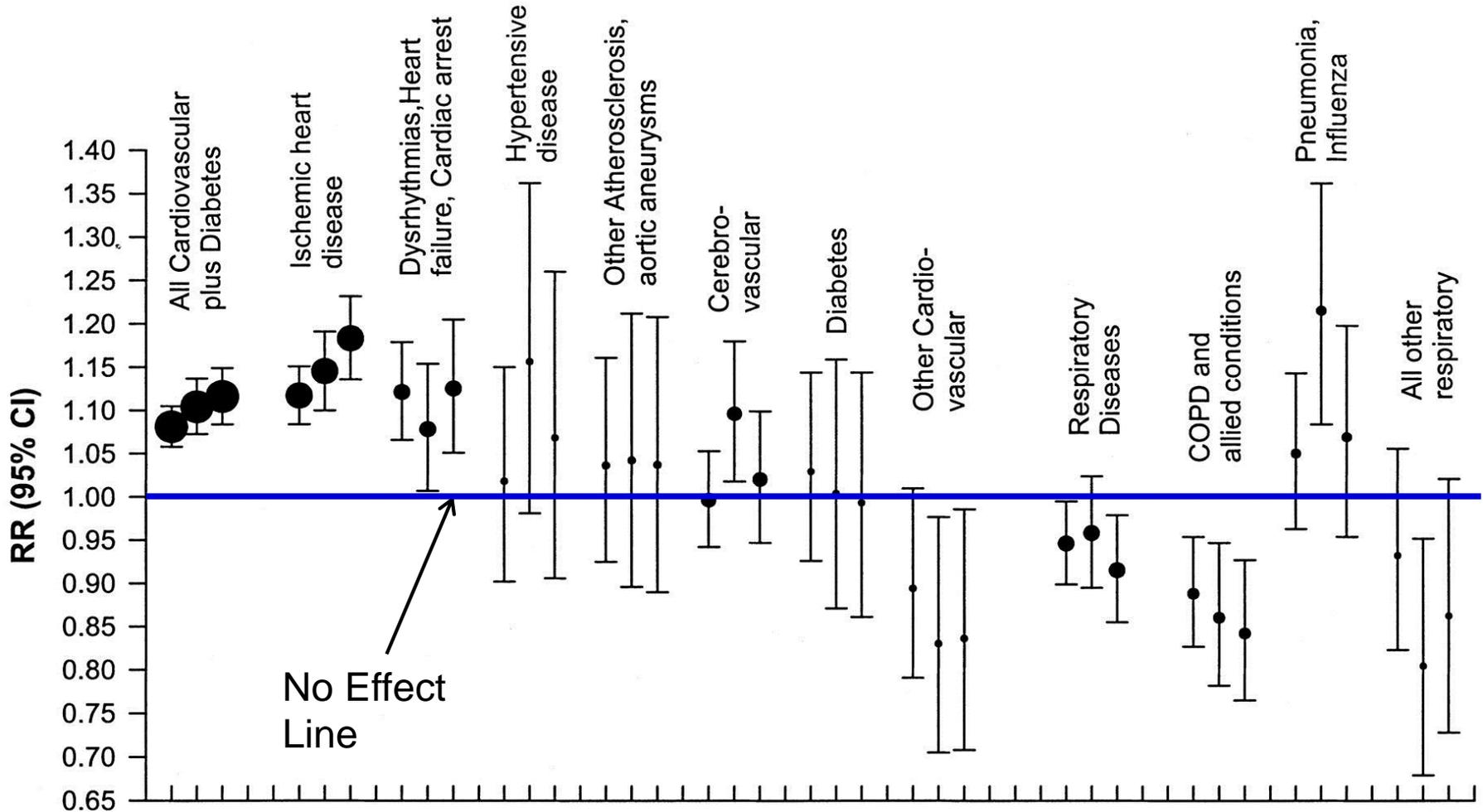
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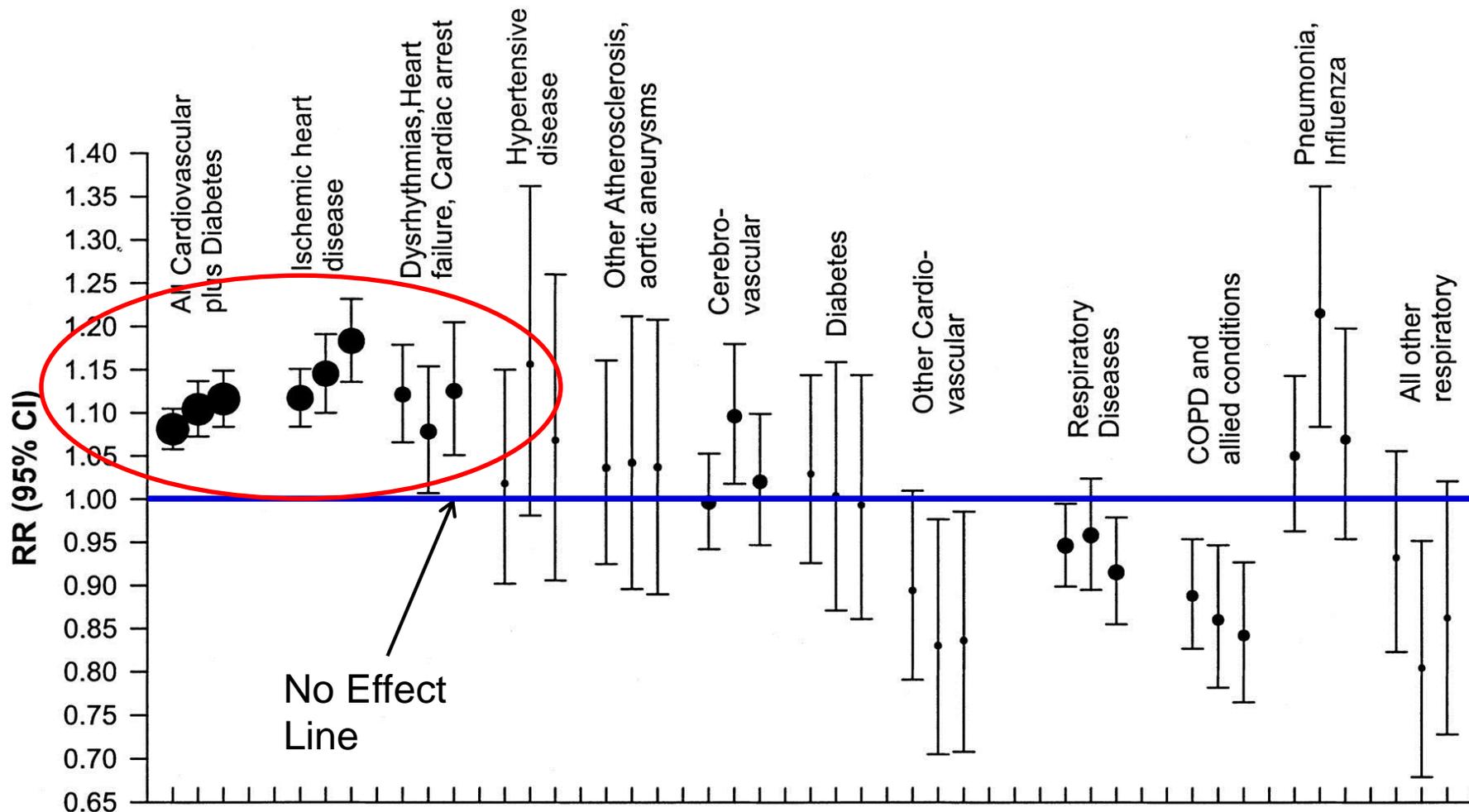
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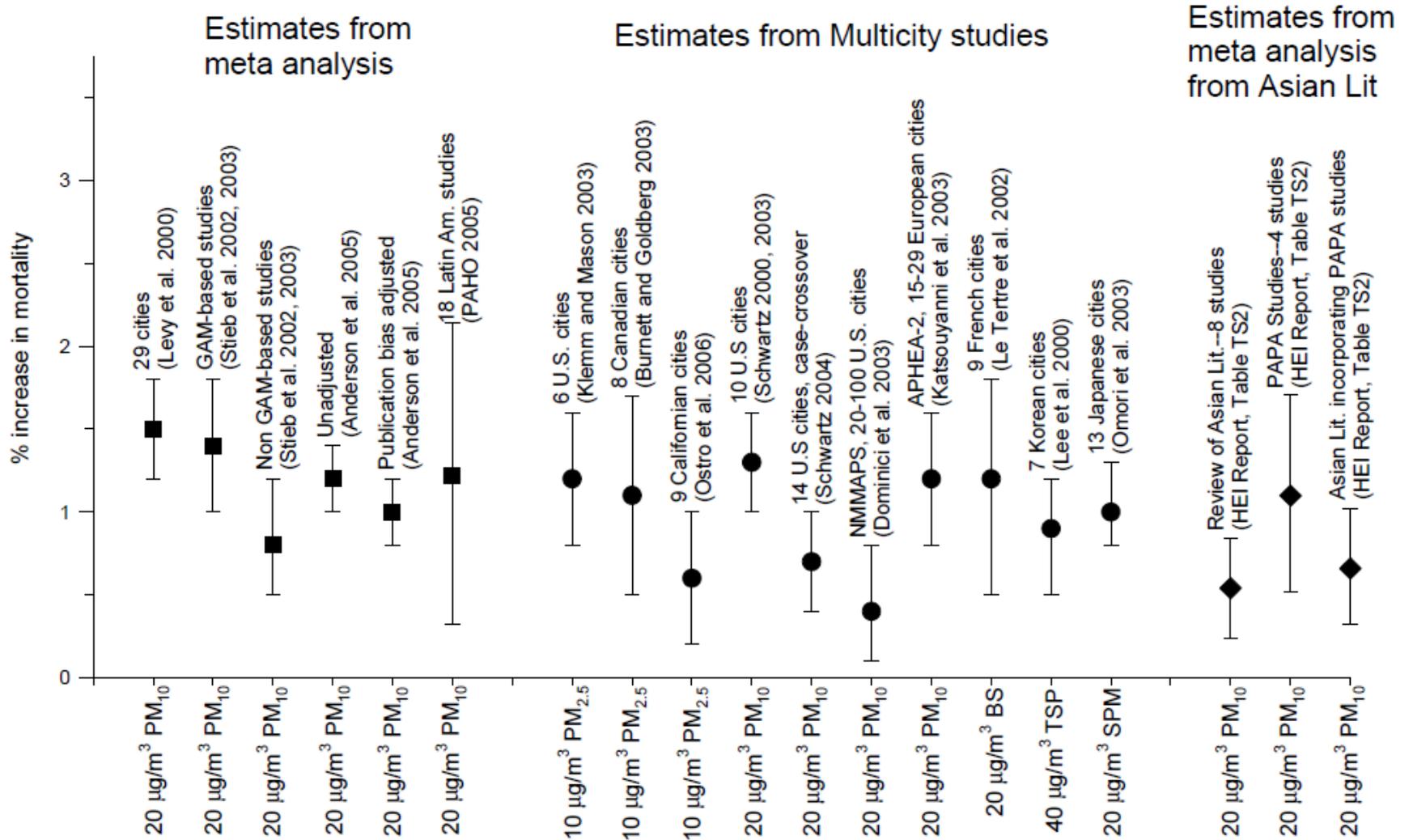
Strongest Associations For Cardiovascular Endpoints



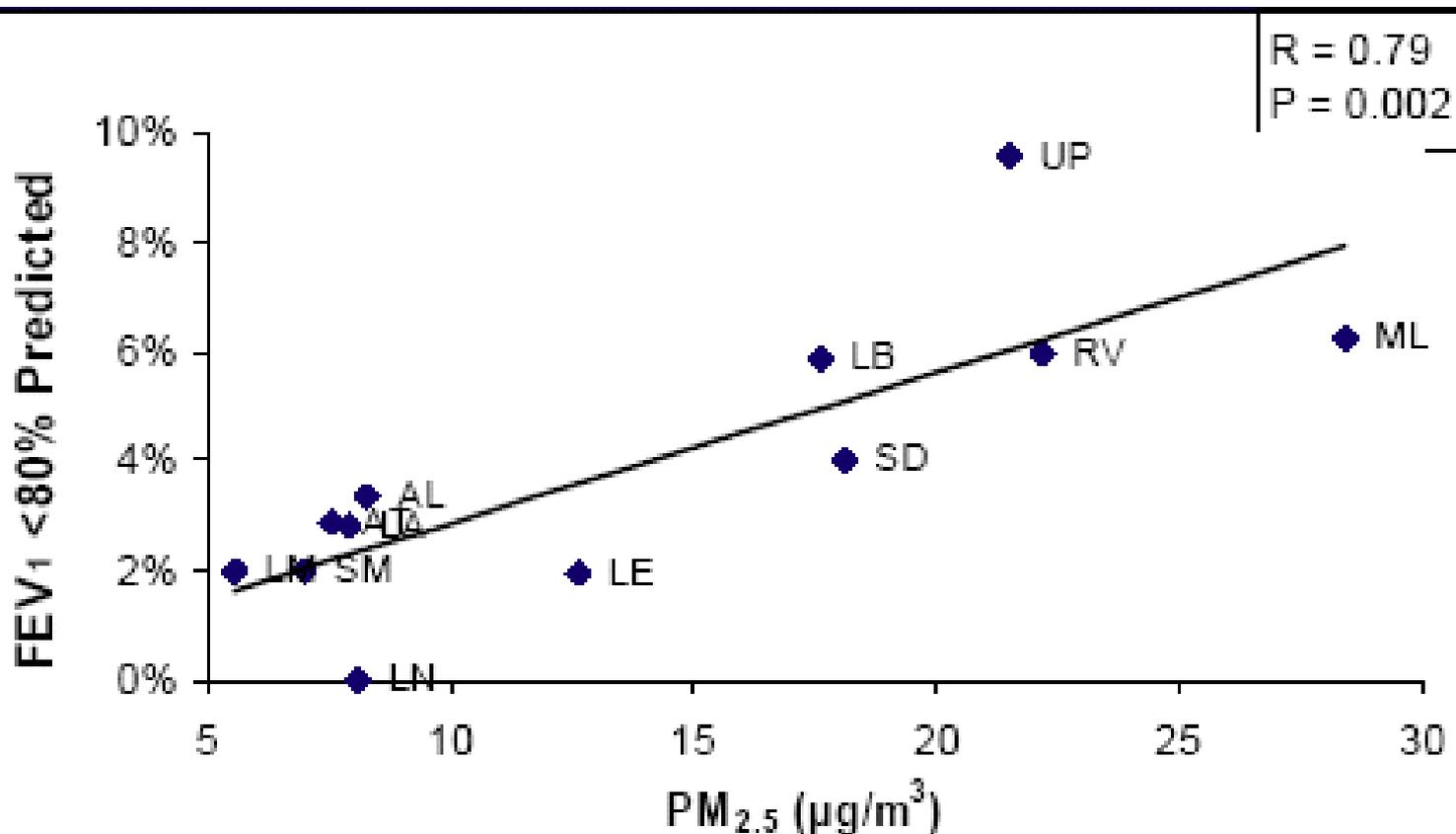
Strongest Associations For Cardiovascular Endpoints



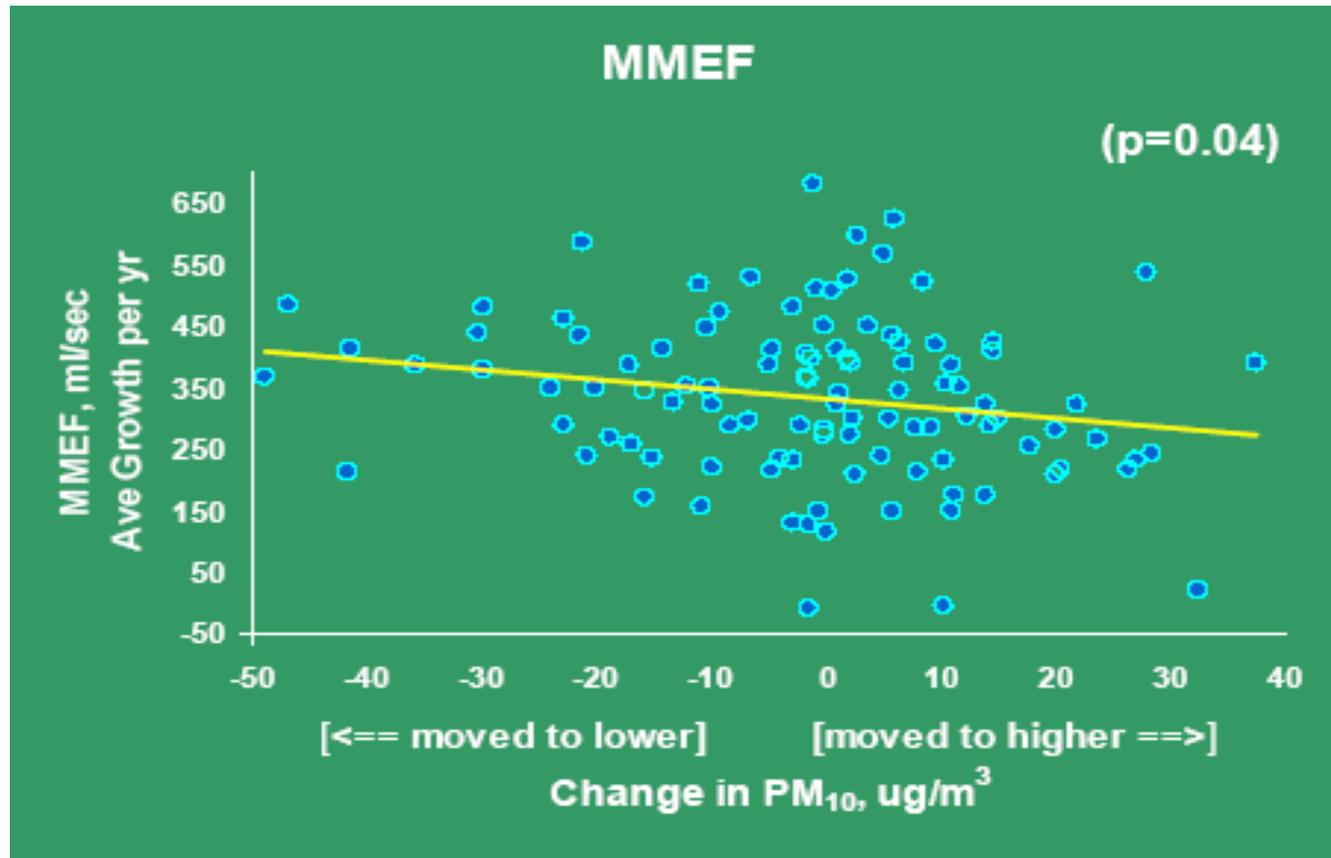
Small but Consistent Increases in Mortality with Short-Term Changes in PM



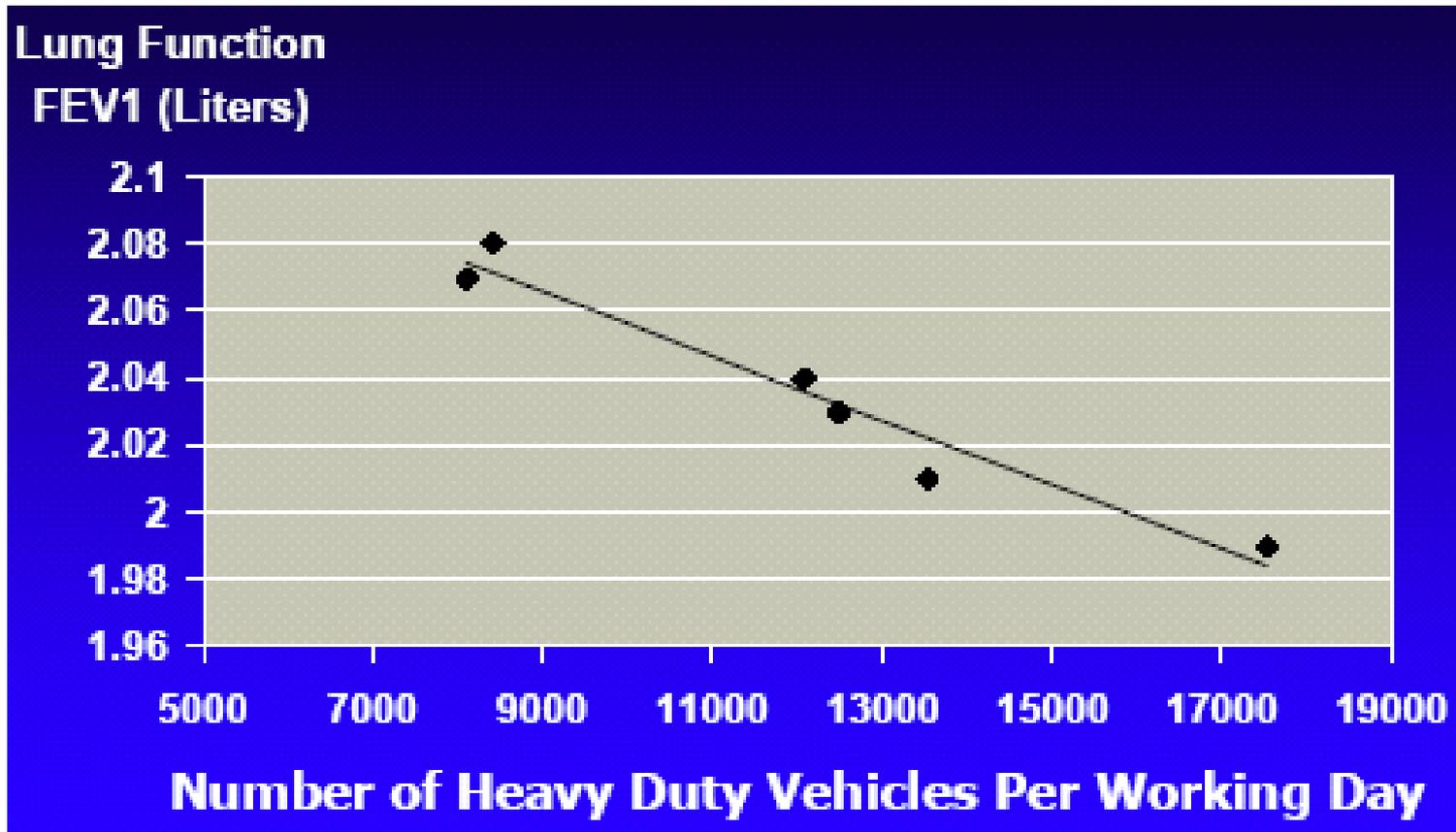
CHS: Low FEV₁ at Age 18 vs. Pollution



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)

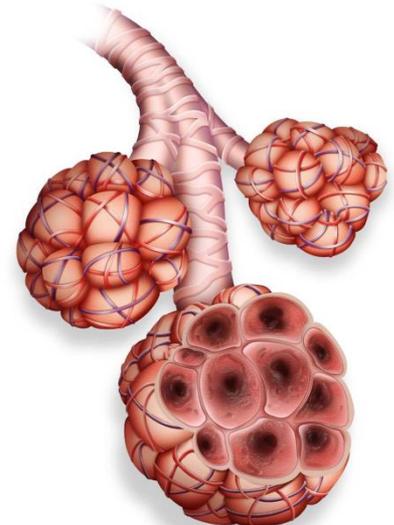
Dose = Concentration x Ventilation Rate x Time

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 shows the AirNow website interface. At the top left is the AirNow logo. To the right is a search bar for "Local Air Quality Conditions" with fields for "Zip Code" and "State" (set to Alabama) and "Go" buttons. Below this is a navigation menu with "Forecast", "Current AQI", "AQI Loop", and "More Maps". The main content area features a map titled "Today's AQI Forecast Monday, July 11, 2016" showing air quality across the United States with color-coded regions. Below the map are buttons for "Alaska", "Hawaii", "Monterrey Mexico City", and "Puerto Rico". To the right of the map is a "Fires: Current Conditions" section with a red circle around the "U.S. Embassies and Consulates" link. Below that is an "Announcements" section with news items. Further down is an "Air Quality Basics" section with a red circle around the "Health Learning Center" link. At the bottom left is a "Highest 5:" section with a color-coded legend (Good, Moderate, USC, Unhealthy, Very Unhealthy, Hazardous) and a table of top AQI locations. At the bottom right is a "Developer Tools" section with icons for various services like Apps, Facebook, Webcams, Videos, AirNow on Google Earth, EnviroFlash Email, Widgets, RSS, and Twitter.

Local Air Quality Conditions
Zip Code: Go State: Alabama Go

Forecast Current AQI AQI Loop More Maps

Today's AQI Forecast
Monday, July 11, 2016

Canada

Alaska Hawaii Monterrey Mexico City Puerto Rico

Generated: 2016-07-11 19:32:20Z

Fires: Current Conditions
[Click to see map](#)

U.S. Embassies and Consulates
Data from air quality monitors at select U.S. embassies and consulates around the world

Announcements
06/22/16: [Wildfire Smoke, A Guide for Public Health Officials, 2016](#), now available.
6/14/16: Air Quality Flag Program [Spring Challenge Winners!](#)
[more announcements](#)

Air Quality Basics
[Air Quality Index](#) | [Ozone](#) | [Particle Pollution](#) | [Smoke from fires](#) | [What You Can Do](#)

Health Learning Center

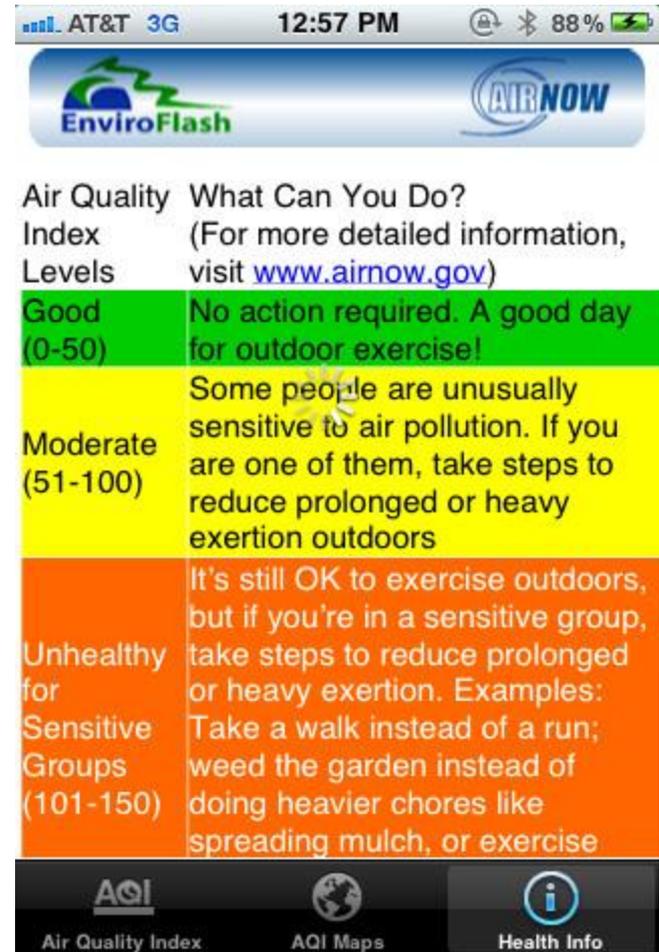
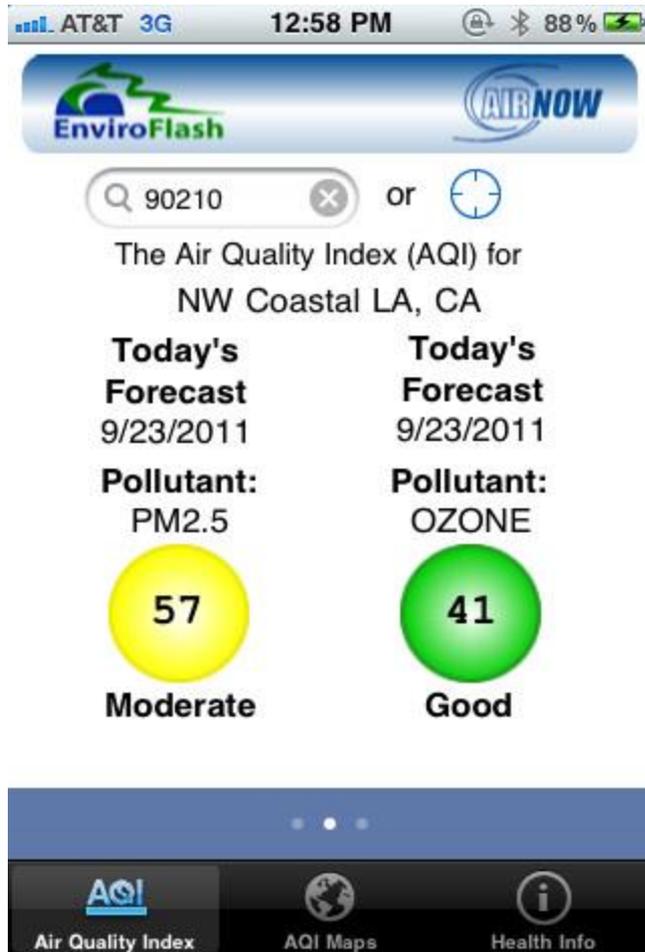
Good **Moderate** **USC** **Unhealthy** **Very Unhealthy** **Hazardous** ! Action Day

Highest 5:
About the Highest 5

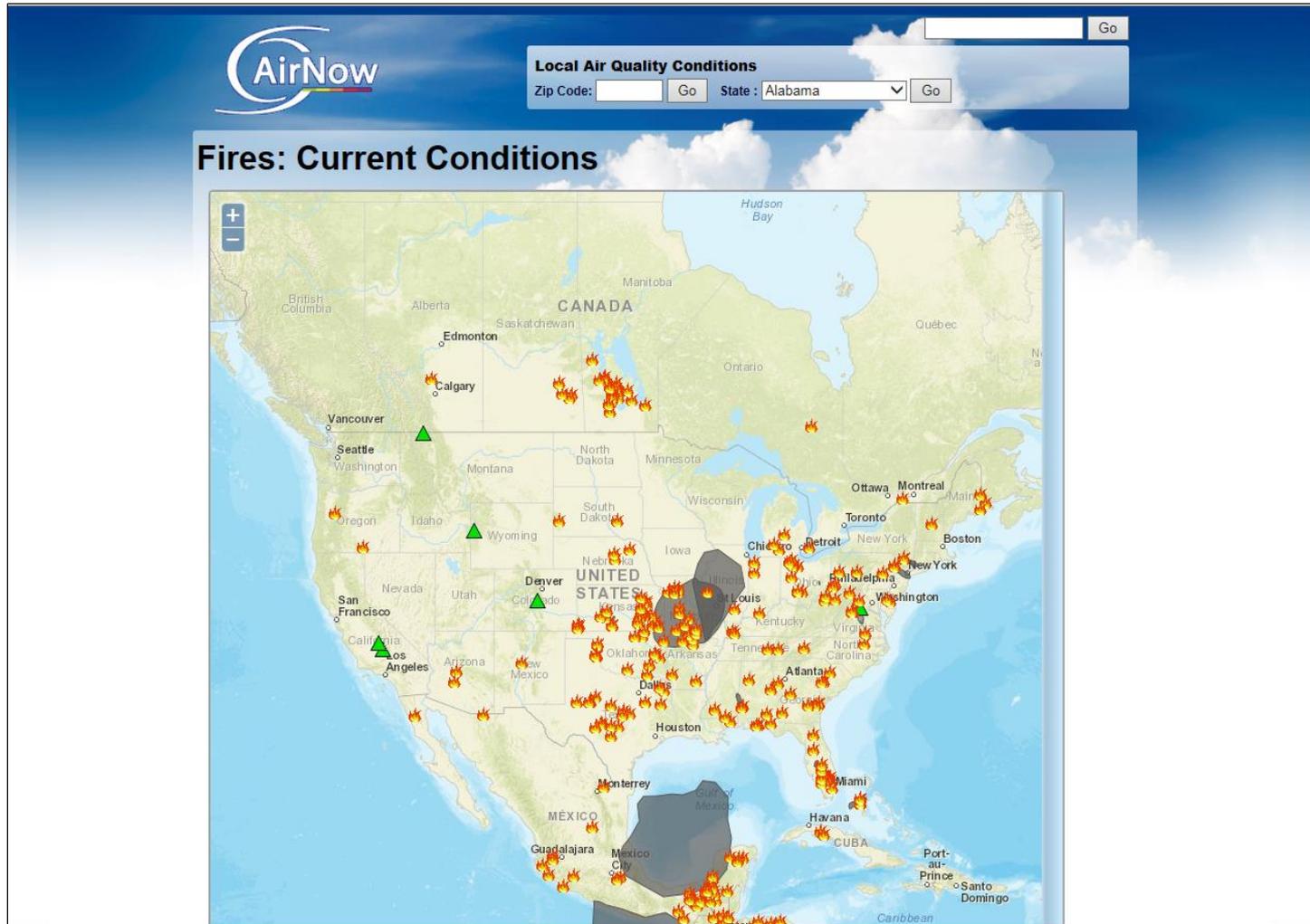
Today's Forecasts	Tomorrow's Forecasts	Current AQI
C San Bernardino M, CA		132
C San Bernardino-2, CA		132
Cincinnati, OH		! 120
Charlotte, NC		101
Denver, CO		! USC

Developer Tools
Apps EnviroFlash Email
Facebook Widgets
Webcams RSS
Videos Twitter
AirNow on Google Earth Developer Tools

AirNow App on Smart Phones



Fires: Current Conditions



Wildfire Smoke

A Guide for Public Health Officials

Revised May 2016



U.S. Environmental Protection Agency * U.S. Forest Service * U.S. Centers for Disease Control and Prevention * California Air Resources Board

Available on the
Fires: Current Conditions
webpage

Web Courses for Healthcare Providers

- Updated ozone web course
- PM web course
 - Online summer 2016
 - CDC will offer CME credit to physicians, nurse and health educators
 - Will contain section on high PM events
- Supporting tools
 - Medical poster
 - 1-page fact sheets

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: Wheezing, Irritation, Cough, Shortness of breath, Chest pain, Other symptoms
- Increased asthma and prevention death rates
- Development of new diseases: Chronic bronchitis, Emphysema, Lung cancer
- How Pollutants Cause Symptoms:
 - Effects on Lung Function:** Irritation, Swelling of airways, Decreased lung capacity, Decreased ability of the lung
 - Asthma Exacerbation:** Increased asthma attacks, Increased asthma-related hospitalizations, Increased asthma-related deaths
 - Increased Susceptibility to Respiratory Infection:** Increased risk of respiratory infections, Increased severity of respiratory infections

CARDIOVASCULAR EFFECTS

- Symptoms: Chest pain, Shortness of breath, Dizziness, Fainting, Other symptoms
- Increased asthma and prevention death rates
- Development of new diseases: Heart disease, Stroke, Atherosclerosis, Coronary artery disease, Congestive heart failure
- How Pollutants May Cause Symptoms:
 - Effects on Cardiovascular Function:** Increased stiffness and pressure in blood vessels, Increased risk of heart disease, Increased risk of stroke, Increased risk of atherosclerosis, Increased risk of coronary artery disease, Increased risk of congestive heart failure
 - Stroke Exacerbation:** Increased risk of stroke, Increased severity 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 Active Older People Do?
Good	0-50	Enjoy Active
Moderate	51-100	People generally sensitive to air pollution should limit strenuous outdoor activities. Sensitive groups should limit strenuous outdoor activities. Sensitive groups should avoid strenuous outdoor activities.
Unhealthy for Sensitive Groups	101-150	Sensitive groups should limit strenuous outdoor activities. Sensitive groups should avoid strenuous outdoor activities.
Unhealthy	151-200	Everyone should limit strenuous outdoor activities. Sensitive groups should avoid strenuous outdoor activities.
Very Unhealthy	201-300	Everyone should avoid strenuous outdoor activities. Sensitive groups should avoid strenuous outdoor activities.

SEPA and **AMERICAN COLLEGE OF CARDIOLOGY**

Heart Disease, Stroke, and Outdoor Air Pollution

1. 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 greatest concern for triggering these effects. Particulate pollution is found in haze, smoke, 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 particulate pollution is at unhealthy levels.

2. 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 particulate 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.

3. 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.

Know when and where particulate pollution levels may be unhealthy.

Particulate 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. Particulate 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.

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 forecast to be, 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.

Air Quality Index	Outdoor Activity Guidance
GOOD	Great day to be active outside!
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.
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.
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.
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/

Watch for Symptoms

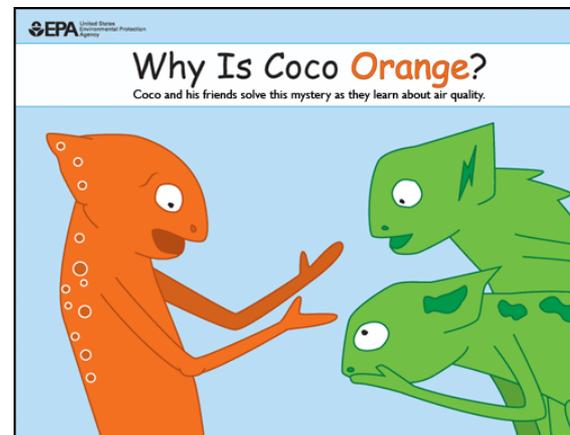
Air pollution can make asthma symptoms worse and trigger attacks. Symptoms of asthma include coughing, shortness of breath, wheezing, and chest tightness. Even students who do not have asthma could experience these symptoms when exposed to unhealthy levels of air pollution.

Plan Ahead for Ozone

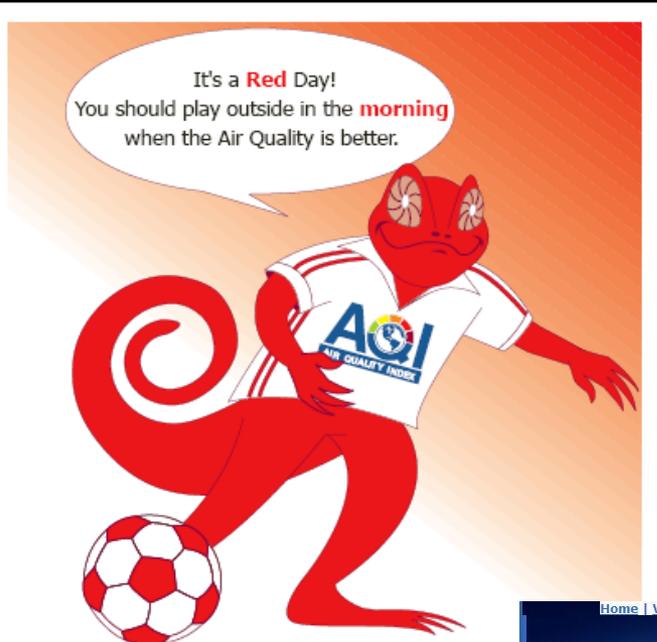
There is less ozone in the morning. On days when ozone is expected to be at unhealthy levels, plan outdoor activities in the morning.

For more information on the management of asthma, this includes medication plans, control of triggers, and how to recognize and manage worsening asthma symptoms. See 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-655-E-13-012
March 2013



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.

Sometimes people with asthma like me, feel bad when the air is very dirty.



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

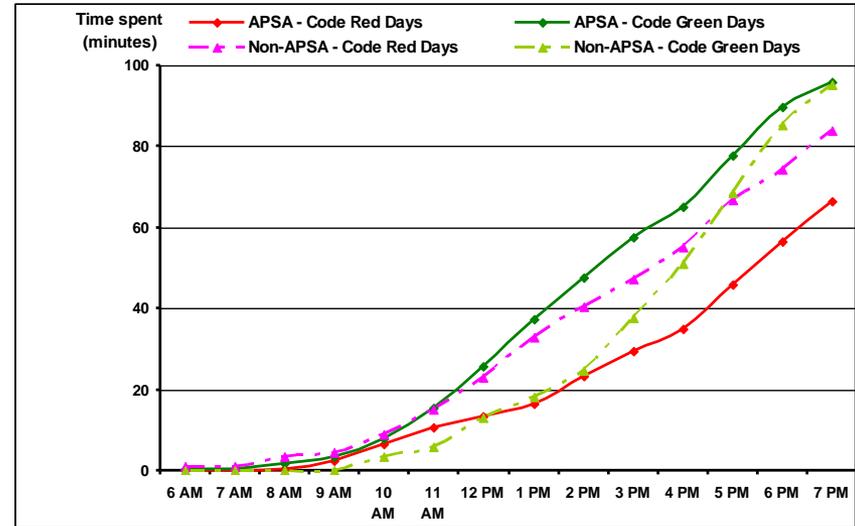
A Guide to Air Quality and Your Health

Particle Pollution and Your Health

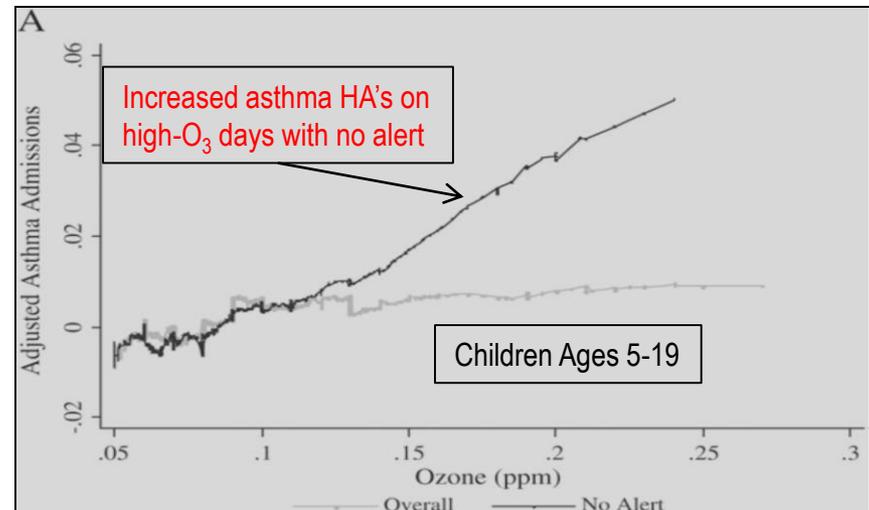
What Is Particle Pollution?
Are You at Risk?
How Can You Protect Yourself?

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

Sensor Concentration \neq Air Quality Index

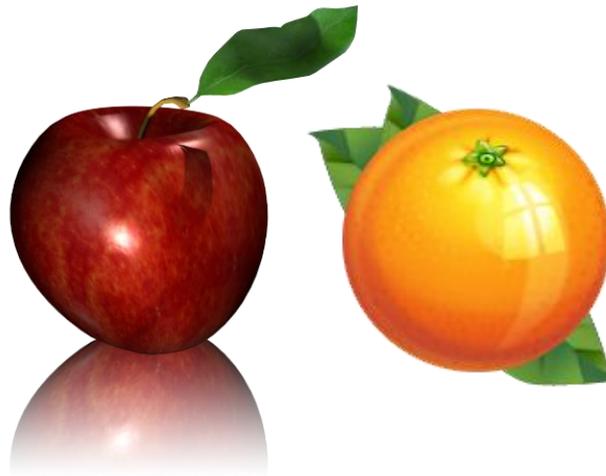


Sensor Reading

Concentration

**Short term
(e.g. 1 minute)**

**Data Quality
Unknown**



**Air Quality
Index**

**Index Value &
Color**

**Averaged (e.g.
8-hour, 24-
hour)**

**Data Quality
Assured**