

# **AIR POLLUTION AND HEALTH**

**MEDICAL  
EVIDENCE  
SUMMARY**



# Causes of Death in U.S.

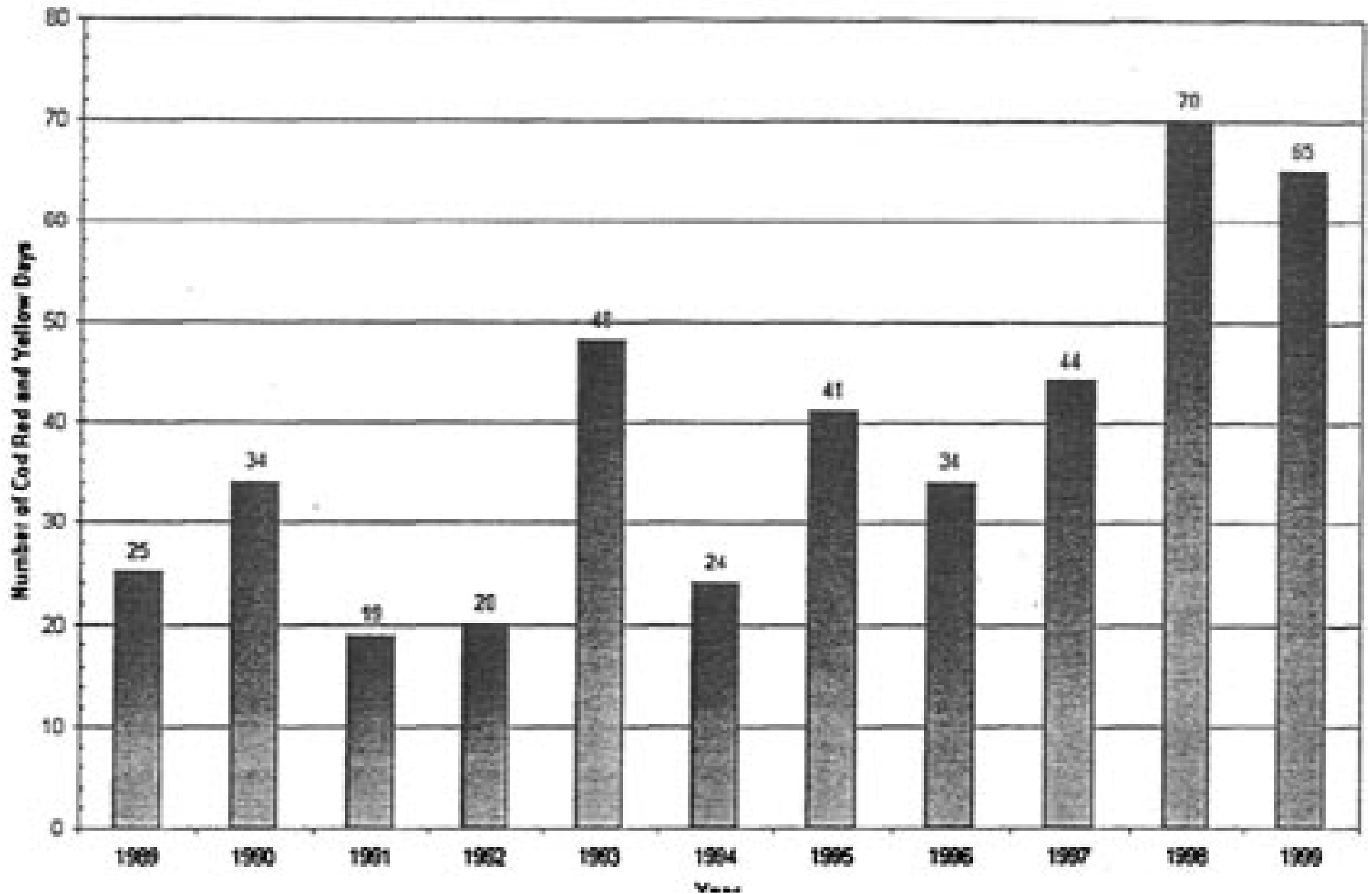
↓ 1. Cardiovascular Disease

↓ 2. Cancer

↑ 3. Lung Disease



**Figure 1. Unhealthy Air Days in North Carolina**



# **NC Medical Society Resolution**

**2001 House of Delegates unanimously adopted a resolution sponsored by the Buncombe Co. Medical Society, urging all branches of state government to work toward cleaner air because of the large public health impact of air pollution exposure.**



# 4 Main Pollutants

- **Ozone**
- **Particulates, especially PM 2.5**
- **Air-borne toxics**
- **Mercury**



# Who is at Risk?

- **Children**
- **Elderly**
- **Prior heart or lung disease patients**
- **Diabetics**
- **Persons who work/exercise outdoors**
- **Otherwise healthy adults and children**

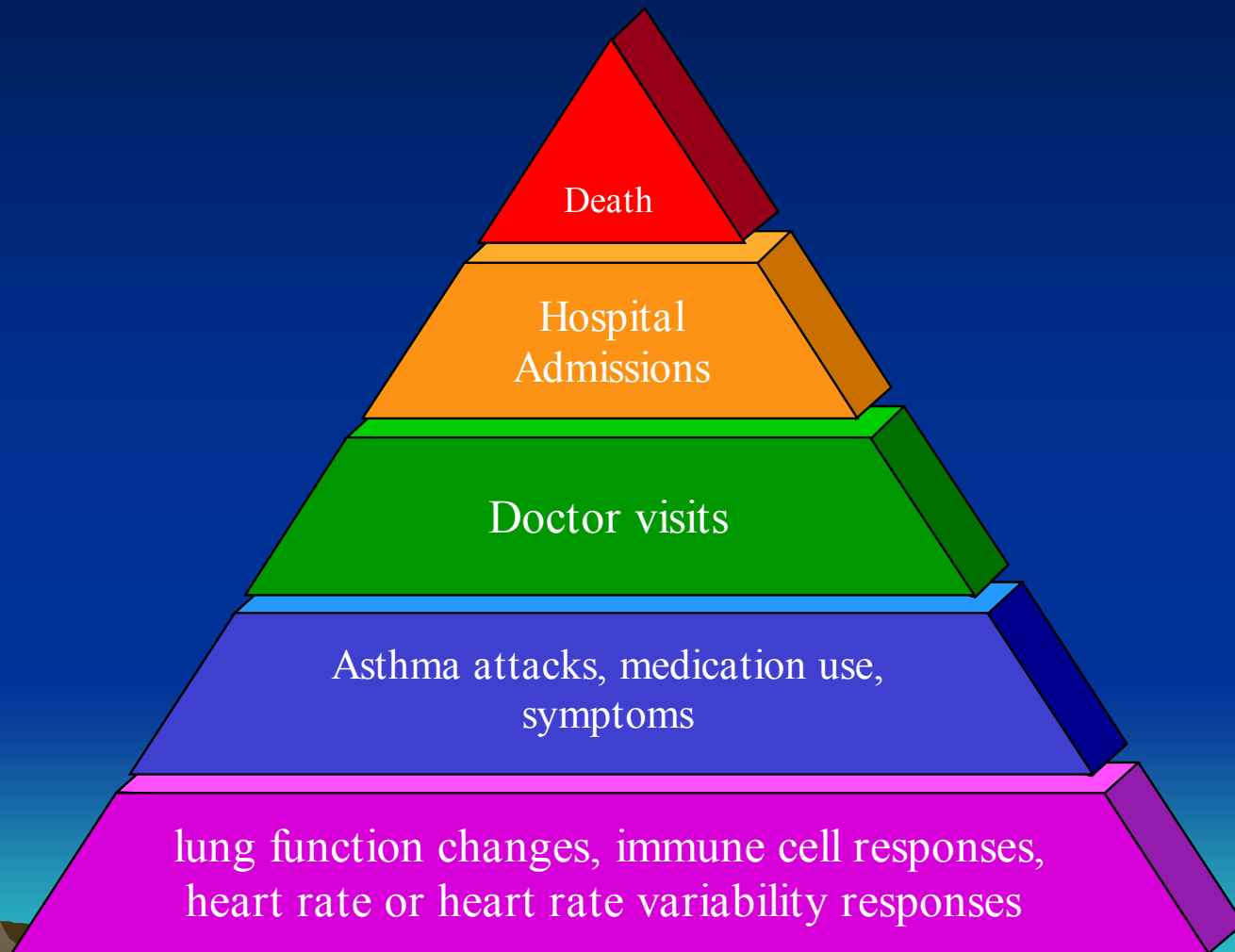


# Health Problems

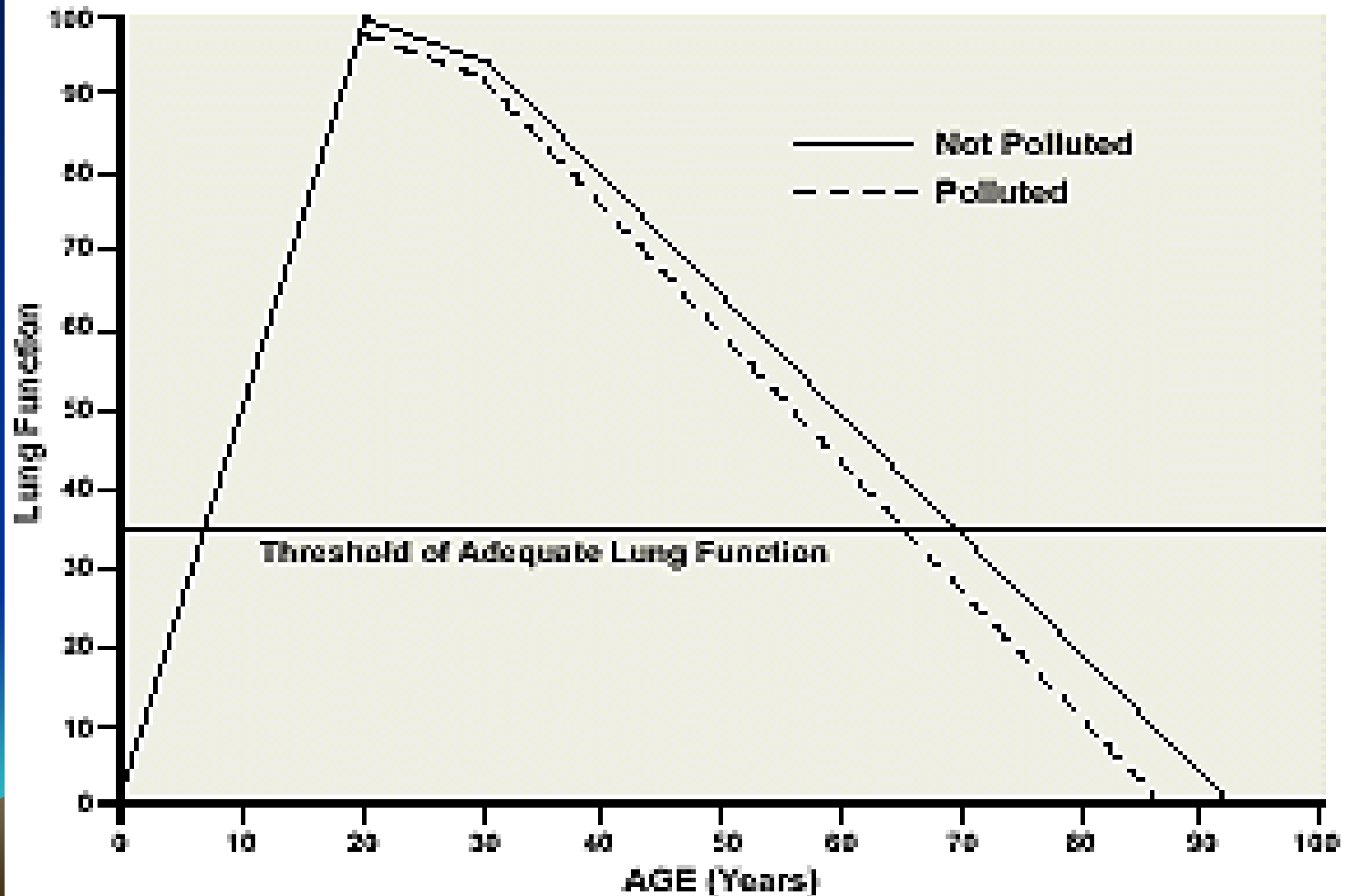
- Impaired fertility
- Birth Defects
- Asthma
- Emphysema
- Lung Cancer
- Heart attacks
- Premature Death



# “Pyramid of Effects”



# Schematic of Lung Function vs. Age Showing Loss of Life Expectancy



# Ozone

**Caustic gas**

**Highly irritating to lung linings**

**Sets off airway bronchospasm**

**Chronic lung damage**

**Damages infection fighting  
responses**

**Increases responses to allergens**



# **Ozone Effects**

**Causes asthma**

**Worsens existing asthma**

**Worsens allergy symptoms**

**Increases respiratory infections**

**Increases overall death rates**



# Childhood asthma

Increased by 55% from 1982-1996

#1 cause of hospitalization (< 18 yrs)

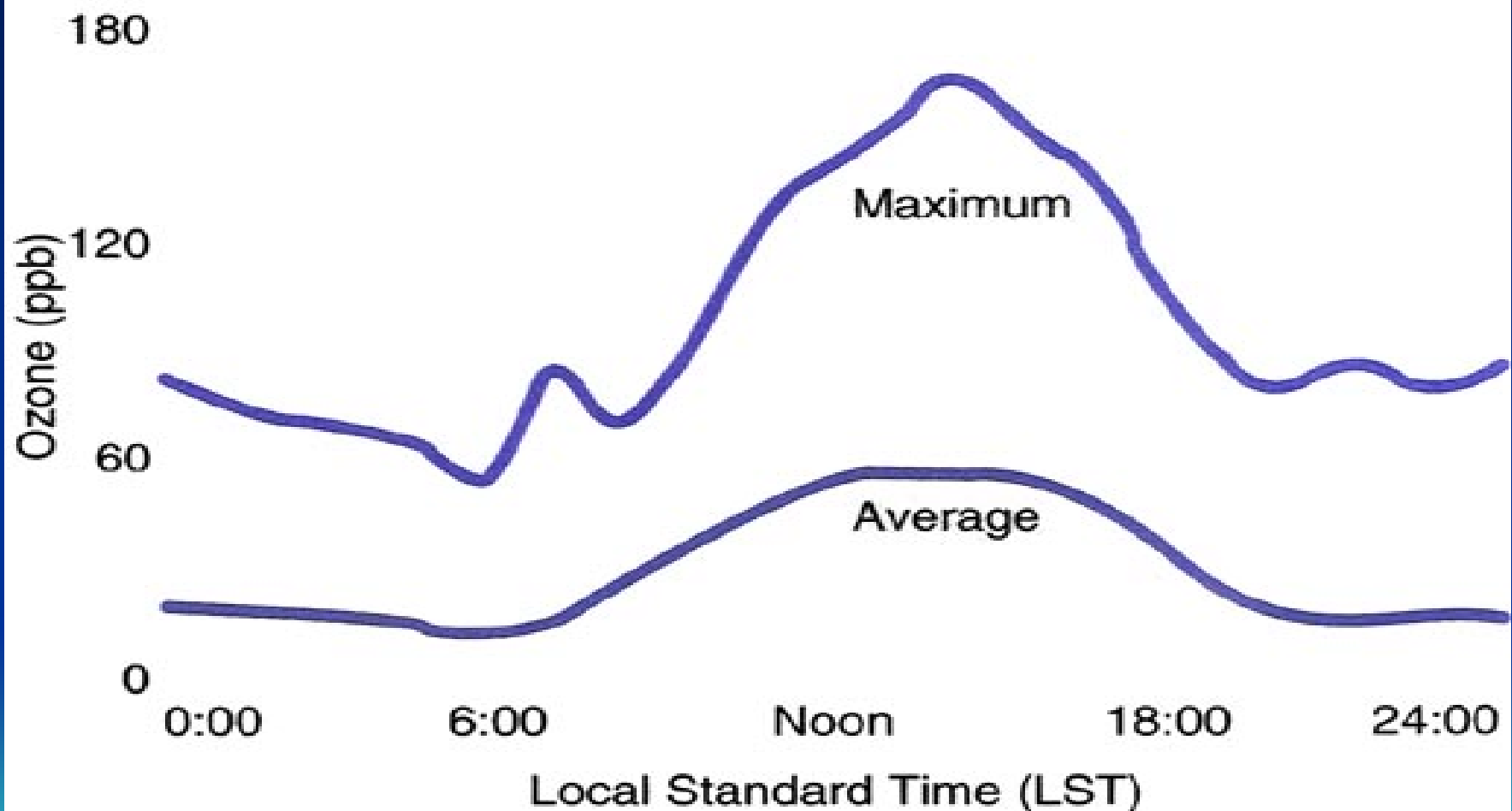
#1 cause lost school days (chronic illness )

#1 health care cost for childhood diseases

1/2 to 1/3 of NC asthma due to air pollution



**Figure 12.10. Typical Ozone Concentrations by Time of Day**



Source: U.S. Environmental Protection Agency. Data reflect all observations recorded at the Plaza Rd. site in Charlotte, 1981-89.

# **Asthma in exercising children exposed to ozone: a cohort study**

**Ozone exposure causes children to  
develop asthma**

**More time outdoors = More asthma**

**McConnell, et al. Lancet 2002; 359: 386-91**



# Eastern U.S. Summers

**Air Pollution causes an extra:**

**6,000,000 Asthma Attacks**

**159,000 ER Visits**

**53,000 Hospital Admissions**

**(Abt Associates, 1999)**



# Annual Asthma Costs

## NC 7<sup>th</sup> & 8<sup>th</sup> Graders:

**\$14 million**      **Hospitalizations**

**\$ 1.4 million**      **E.R. visits**

## All NC children:

**\$100 million**      **Add M.D. visits,  
prescription costs, wages lost by  
parents who miss work, and costs  
for other children's age groups**

# Emphysema and Pollution

## Increase in Hospitalizations Due to Increase of 10 mcg /m<sup>3</sup>

<u>Study city</u>	<u>Ozone</u>	<u>Particulates</u>
Birmingham, AL	0.6%	2.4%
Detroit, MI	1.2	4.0
Spokane, WA	2.6	3.4
Minneapolis, MN	0.6	5.0
APHEA (European Cities)	0.9	0.7

(Adapted from Anderson, et al.,1997)



# Ozone and Death Rates

Several studies of ozone exposure show an increase of 10 ppb ozone exposure leads to increases in death rates of:

**1.1%**      **APHEA Project 1997**

**0.4%**      **Thurston and Ito Meta-Analysis 1997**

**0.4%**      **Samet (20 Cities Study) 2000**



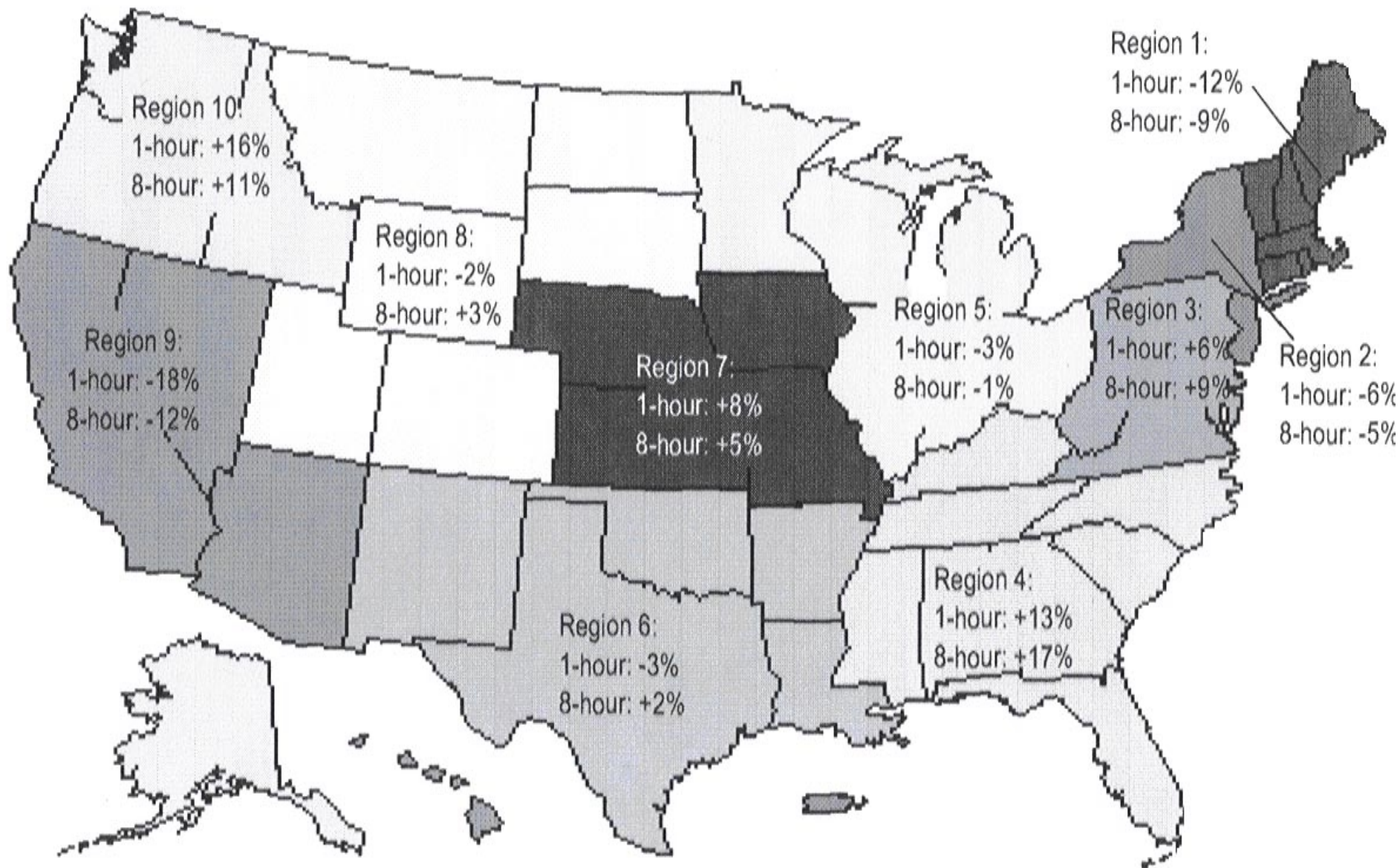
# Ozone Pollution Health Risks

## The ALA “Worst 25”

Atlanta	6 <sup>th</sup>
Knoxville	8 <sup>th</sup>
Charlotte	9 <sup>th</sup>
Raleigh-Durham	13 <sup>th</sup>
Nashville	18 <sup>th</sup>
Memphis	19 <sup>th</sup>
New York	20 <sup>th</sup>
Birmingham	21 <sup>st</sup>
Greensboro-Winston	21 <sup>st</sup>
Macon	24 <sup>th</sup>
Chattanooga	24 <sup>th</sup>



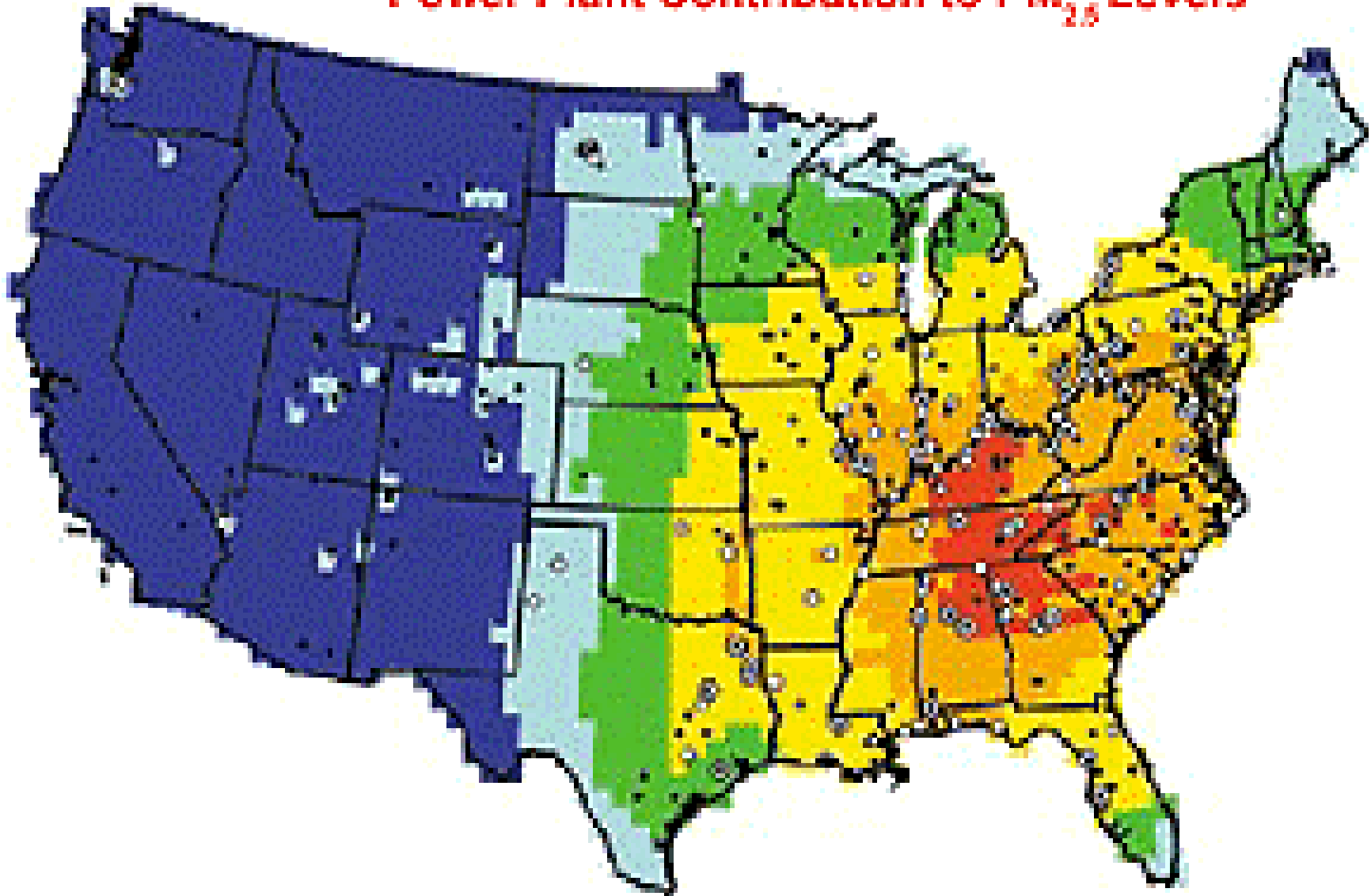
**Figure 7: Trends in the 2nd Highest Daily 1-Hour and 4th Highest Daily 8-Hour Ozone Concentration by EPA Region, 1989-1998**



Source: EPA, National Air Quality and Emissions Trend Report, 1998

# Particulate Pollution

Power Plant Contribution to  $PM_{2.5}$  Levels



# **Particulates (PM 2.5)**

**Penetrate deeply into lungs**

**Irritate lung linings**

**Stimulate immune system  
inflammatory proteins**

**Increase fibrinogen levels-increase  
blood clotting**

**Decrease heart rate responses**



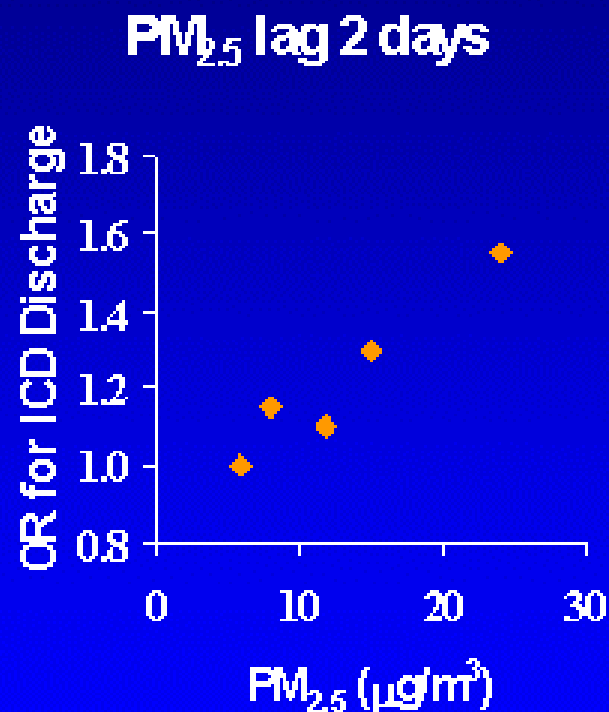
# Sudden Cardiac Deaths

- Leading cause of death in US
  - 350,000 deaths per year
  - Approximately 50% of cardiovascular deaths
- Often first sign of heart disease
- Ventricular arrhythmias most common causal pathway
  - Ventricular tachycardia
  - Ventricular fibrillation

## Air Pollution and Incidence of Cardiac Arrhythmias

*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)



# Lung Cancer, Cardiopulmonary Mortality and Long-term Exposure to Fine Particulate Air Pollution

For every increase in particulate exposure of  $10 \text{ mcg/m}^3$ , there was increased risk of:

- 4% All cause mortality
- 6% Cardiopulmonary mortality
- 8% Lung cancer mortality

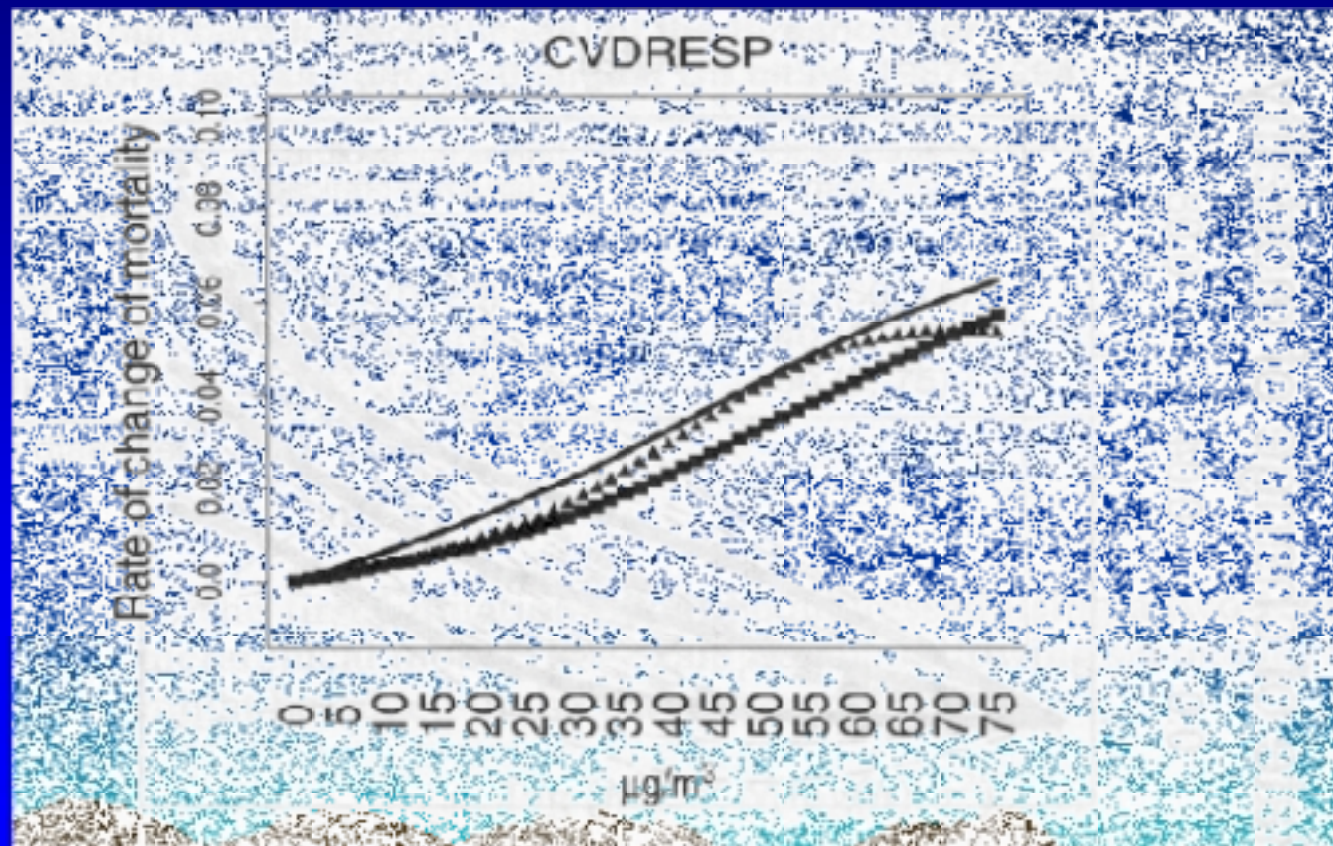
# Long-term Effects of Particulate Pollution Exposure

- Up to 4% of all US deaths
- 1 to 3 year drop in life expectancy
- (smokers lose ~4 years)
- PM 2.5 is more important
- No safe threshold
- Effects on healthy people as well



# Lack of Threshold Effect: Nowhere to hide

Daniels, NMMAPS, Am J Epidemiol 2000



# Area Cities at Risk >15 mcg/m<sup>3</sup> PM 2.5 Weighted Annual Mean

- Asheville = 15.1
- Atlanta = 21.4
- Charlotte = 17.2
- Greensboro = 17.8
- Greenville, SC = 16.5
- Johnson City, TN = 16.4
- Raleigh = 16.5

EPA data 2000



# **Southeast Region**

**33,000,000 people living in  
significant air pollution**

**11,000 excess deaths due to air  
pollution**

**\$20 billion in excess health care  
costs**



# Annual Deaths Due to Power Plant Particulates

#4	North Carolina	1800
#5	Florida	1740
#7	Georgia	1630
#8	Tennessee	1440
#10	Virginia	1240
#11	Alabama	1110
#14	Kentucky	997
#18	South Carolina	791



# Effects on Otherwise Healthy People

**Faster decline in lung function with age**

**Higher pneumonia and respiratory  
infection rates**

**Increased lung cancer rates similar to  
living with a smoker**

**Increased overall death rates**

**Higher asthma rates in adults**



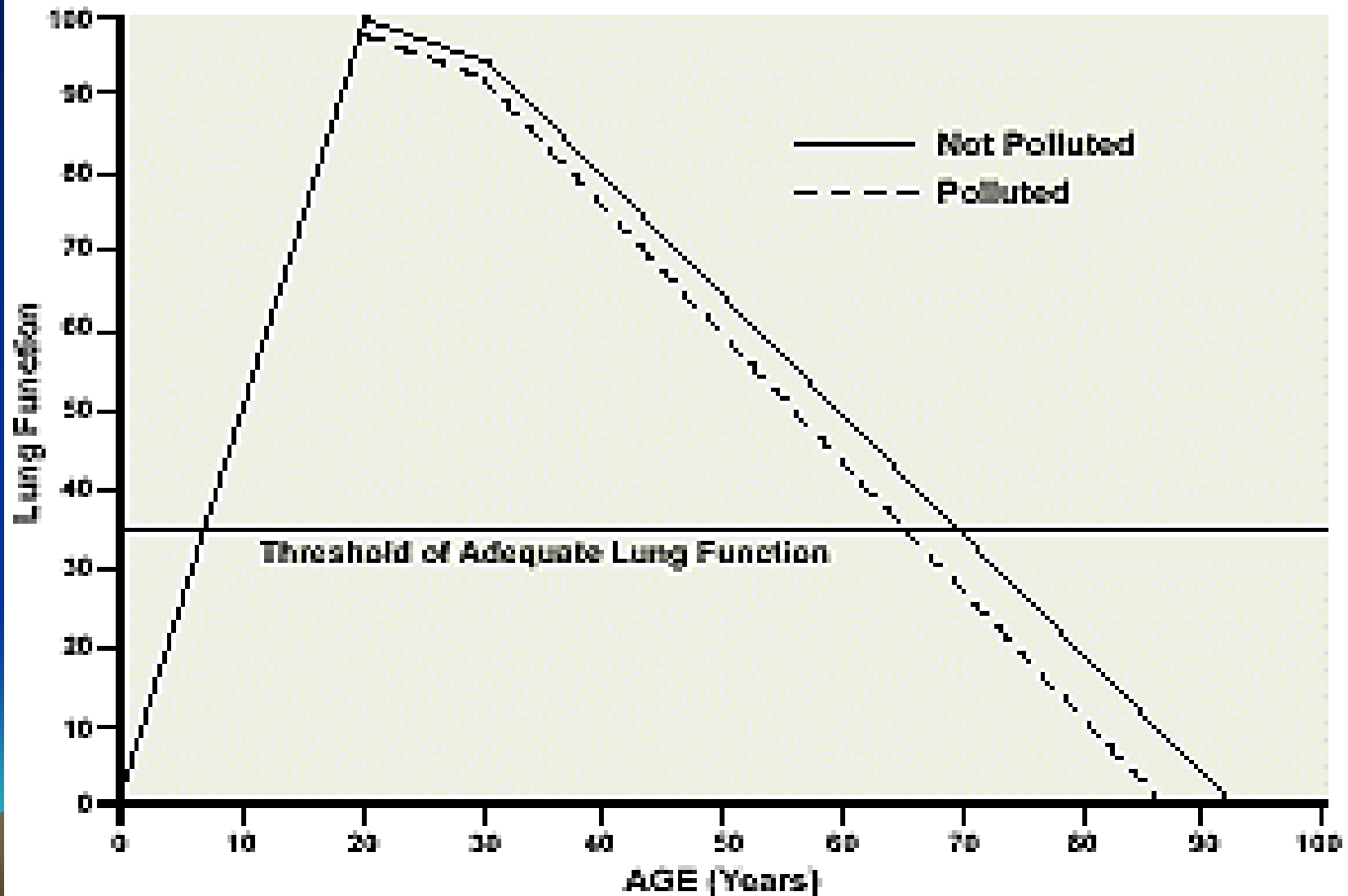
# Effects on Children

## --A Generation at Risk--

- Multiple birth defects-heart, neural tube
- Higher infant mortality
- More asthma
- Impaired lung development
- Premature emphysema
- Increased respiratory infections
- Higher health care expenditures



## Schematic of Lung Function vs. Age Showing Loss of Life Expectancy



# Results of Clean-up

**During 1996 Summer Olympics, reduced ozone levels due to transit system changes led to a significant drop in children's asthma.**

**After German reunification, pollution dropped and children's respiratory symptoms decreased dramatically.**

Friedman, M.S., et al. JAMA, V. 285, No. 7, 2001

Heinrich, J., et al., Am. J. Resp. and Crit. Care Med., V.161, 2000

# Cost Shifting-We all pay

- Health care costs not paid by the auto, trucking, oil and electric utilities that generate pollution
- Private insurance premiums
- Lost school revenue for absences
- Federal taxes for Medicare (especially for the elderly)
- State taxes for Medicaid (especially for children and disabled)
- County taxes for BCHD
- Hospital and health care providers pass on the costs of the uninsured

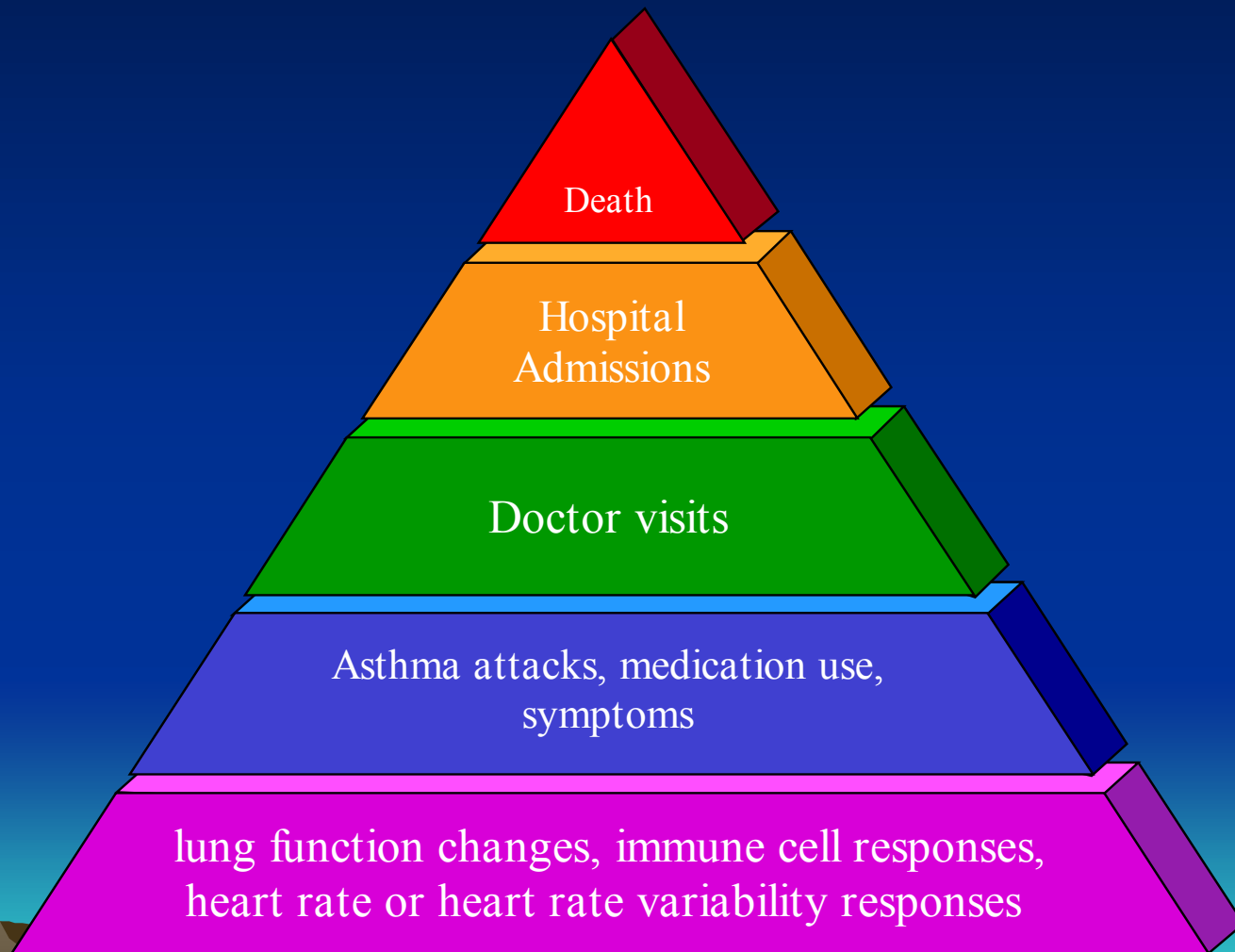


# **SAMI Data**

**Extremely limited health impact  
assessments**



# “Pyramid of Effects”



# RISK

Assumed vs. Imposed



# **Governmental Responses**

**Smokestacks legislation**

**Demand better solutions from DOT**

**Convert vehicle fleets, alternative  
and low sulfur fuels**

**Schools need bad air day response  
plans**

**Health Department input**



# Web Sites

- [www.lungusa.org](http://www.lungusa.org)
- [www.lungnc.org](http://www.lungnc.org)
- [www.healtheffects.org](http://www.healtheffects.org)
- [www.cleartheair.org](http://www.cleartheair.org)
- [www.cleanairtrust.org](http://www.cleanairtrust.org)
- [www.saminet.org](http://www.saminet.org)

# Medical Literature

- Multiple different types of studies
- Compare groups
- Bigger is better--more statistically powerful results
- Match the groups as closely as possible with one major difference
- The larger the groups, the more closely they can be matched
- Rigorous peer review by the editors of the journal before being published



# Health Effects Institute

- **Non-profit research consortium (1980)**
- **Joint funding from EPA and industry (power, auto, petroleum)**
- **Promote/fund unbiased research on the health effects of air pollution**
- **Over 100 reports/studies published**
- **International meetings/conferences with EPA, WHO, others**



# **HEI Perspectives, June 2001**

## **Report on Methods**

**After extensive review of the major medical studies to assure industry and policy groups about accuracy,**

**“The results are now available, and they indicate that epidemiologic evidence of PM’s effects on morbidity and mortality persists even when the alternative explanations have been addressed.”**



# Particulate Pollution and All Cause Mortality (PM10)

For combined heart and lung disease death rates, changes of PM10 particulate pollution of 10 mcg/m<sup>3</sup> led to increases in mortality of:

0.7% Schwartz, et al., 1994 (Six Cities Study)

1.0% Dockery and Pope, 1994 (American Cancer Society Study)

1.0% Confirmation reanalysis of the two above studies by HEI panel, 1996

0.4% APHEA Project (Air Pollution and Health: A European Approach) 1997

0.5% Fine Particulate Air Pollution and Mortality in 20 U.S. Cities (NEJM12/14/00, Samet et al.)



# Long-term Effects of Particulate Pollution Exposure

Spengler (1999) estimates 60,000 deaths/year are due to PM<sub>10</sub> particulate pollution, 4% of total U.S. death rate.

Pope (2000) shows chronic air pollution exposure to PM<sub>10</sub> particulates reduces life expectancy in polluted areas by several years. It is not just the already severely ill who are affected.

Wichmann (2000) is one of the first to show increased mortality (in Germany) due to PM<sub>2.5</sub> exposure.

Schwartz, et al. (1994) in the "Six Cities Study" found a 26% higher cardio-vascular mortality in polluted versus cleaner cities. (18 mcg/m<sup>3</sup> particulate difference.)

Pope, et al., (1994) in the ACS study followed 1.2 million people, showing a 17% increase in death due to exposure differences of 25 mcg/m<sup>3</sup>.

# Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution

- American Cancer Society's Cancer Prevention II study
- 1.2 million adults enrolled in 1982
- 500,000 adults matched to available air pollution data in U.S.
- Extensive risk factor questionnaires

# Lung Cancer... (Pope, et al)

- **Conclusion: Long-term exposure to combustion-related fine particulate air pollution is an important environmental risk factor for cardiopulmonary and lung cancer mortality**

# Effects on Otherwise Healthy People

Deters, et al. (1991) followed multiple populations in California showing larger decreases than expected in lung function among those who lived in the more polluted areas.

Abbey, et al., (1995) in the AHSMOG study of Seventh Day Adventists in California found an increase in respiratory diseases out of proportion to expected rates.

Abbey, et al., (1998) compared 1977 and 1997 lung function and saw a 6.3% decrease in Fev-1 for those who had 23 ppb greater average ozone exposures and 7% decreases due to higher PM10 exposures.

McDonnell (1999) discovered that higher ozone exposures led to a doubling of the risk of developing asthma among adult males.