

# **The Global Burden of Disease Due to Urban Air Pollution**

**Aaron Cohen**

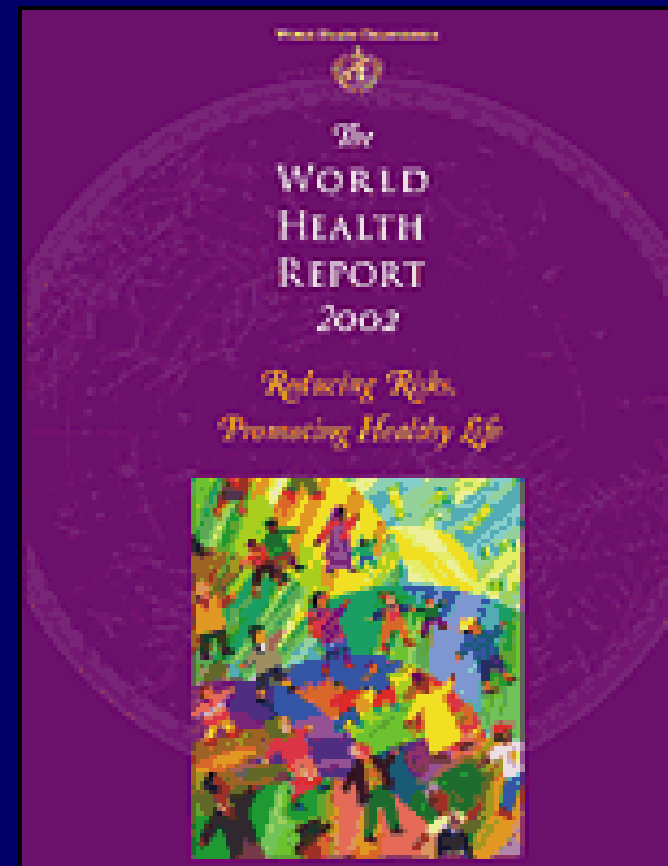
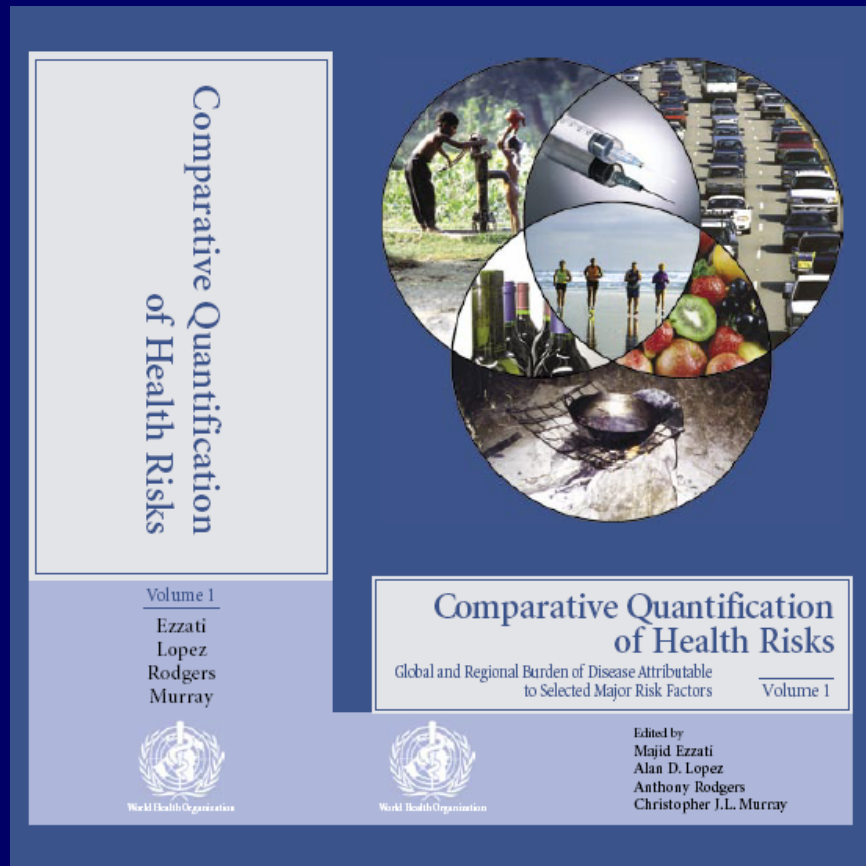
**Health Effects Institute**

**and**

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Global Health**

# CRA project and WHR 2002



# **The Global Burden of Disease Due to Urban Air Pollution**

- **Estimating the Global Burden of Disease**
- **Magnitude and distribution of the attributable burden**
- **Major sources of uncertainty**
- **Estimating the avoidable burden**

# Risk factors in CRA

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## **Child & maternal under-nutrition**

Childhood and maternal underweight  
Iron deficiency  
Vitamin A deficiency  
Zinc deficiency

## **Other nutrition-related risks & inactivity**

High blood pressure  
High cholesterol  
Overweight and obesity  
Inadequate fruit and vegetable intake  
Physical inactivity

## **Addictive substances**

Smoking and oral tobacco  
Alcohol  
Illicit drugs

## **Sexual and reproductive health risks**

Unsafe sex  
Non-use and ineffective use of contraception

## **Environmental risks**

Unsafe water, sanitation, and hygiene  
Urban air pollution  
Indoor smoke from solid fuels  
Lead exposure  
Climate change

## **Occupational risks**

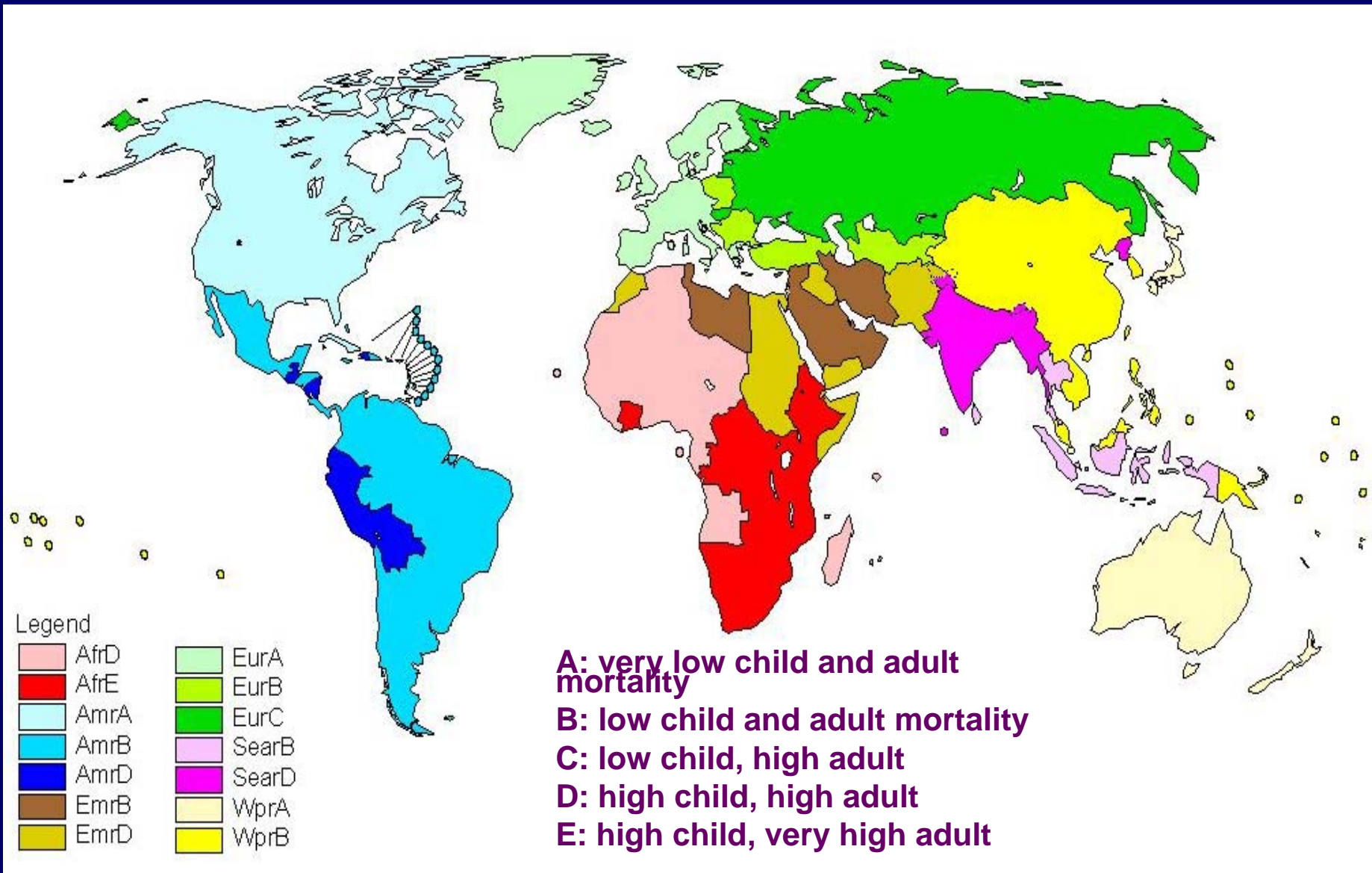
Risk factors for injury  
Carcinogens  
Airborne particulates  
Ergonomic stressors  
Noise

## **Other selected risks to health**

Contaminated health care injections  
Child sexual abuse

## **Distributions of risks by poverty**

# 14 WHO mortality sub-regions



# Basic CRA framework and goals

## Risk factor levels

- current distribution
- counterfactual distribution(s)

## Risk factor-disease relationships

- risk accumulation
- risk reversal

## Disease burden

**Attributable burden in 2000**  
**Avoidable burden in 2010 & 2020**

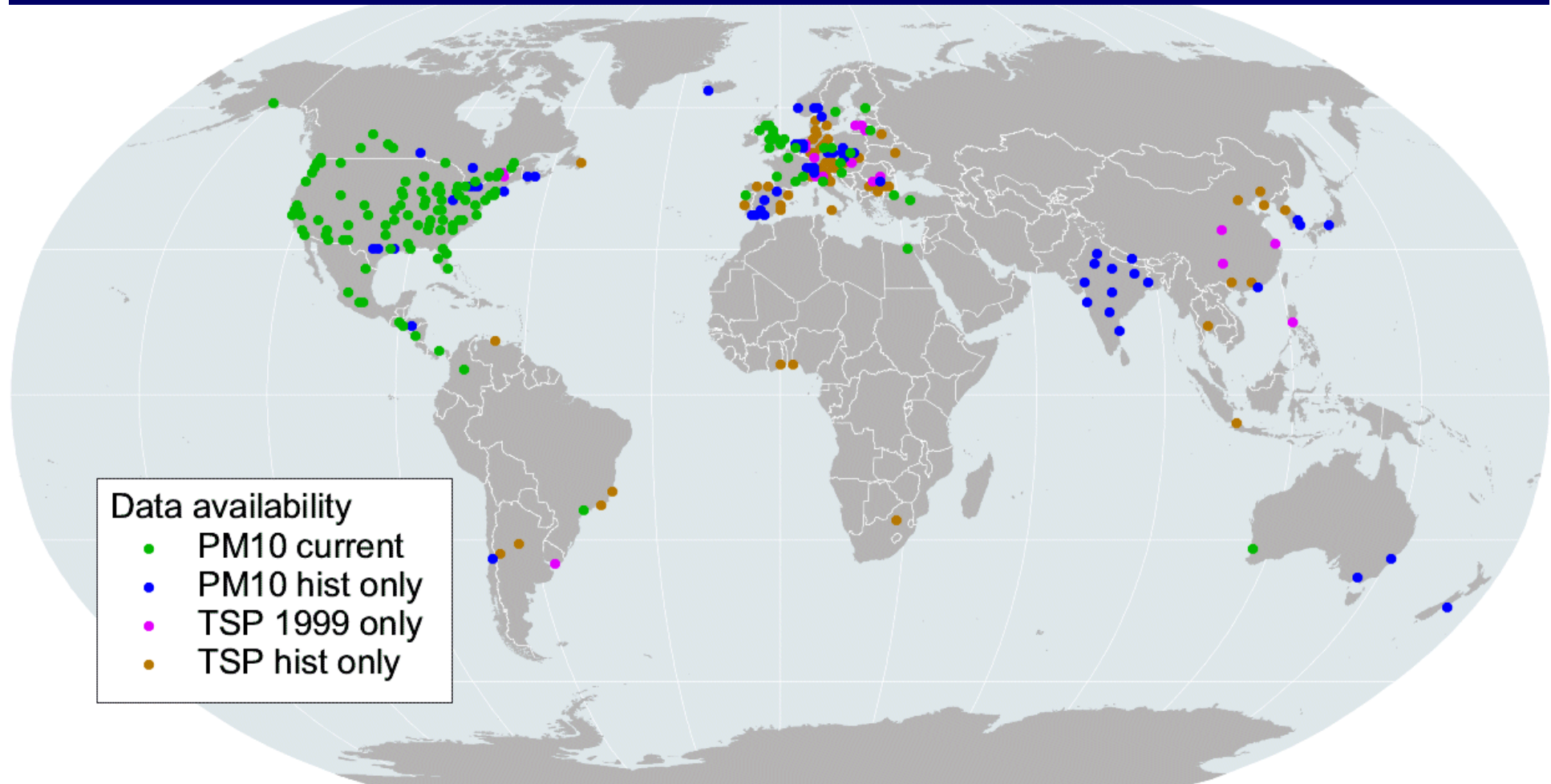
# Mortality and Burden of Disease

- **Mortality = Numbers of Deaths**
- **Burden = Disability Adjusted Life Year *or* DALY**
- **DALY = YLL + YLD**
  - *years of life lost because of premature death (YLLs)*
  - *years of life lived with disability (YLDs)*
  - **one DALY = one lost year of healthy life**

# **Applying the CRA Methods to Urban Air Pollution**

- **Specification of risk factor levels and counterfactuals**
- **Choice of risk factor-disease relationships**
- **Calculation of disease burden**

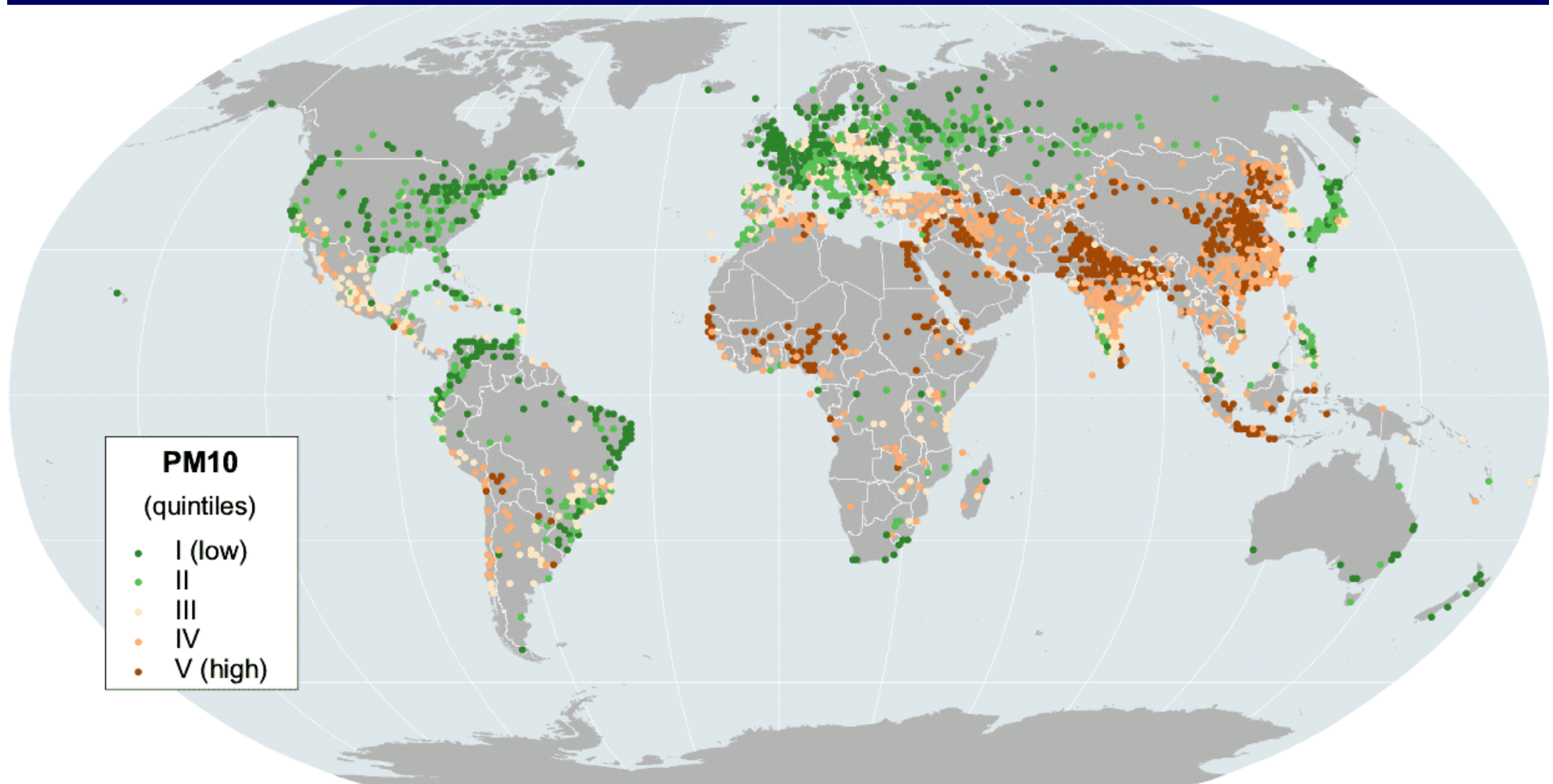
# Availability of Exposure Data at Fixed Monitoring Sites in Residential Areas



# **Determinants of Ambient Concentration of PM**

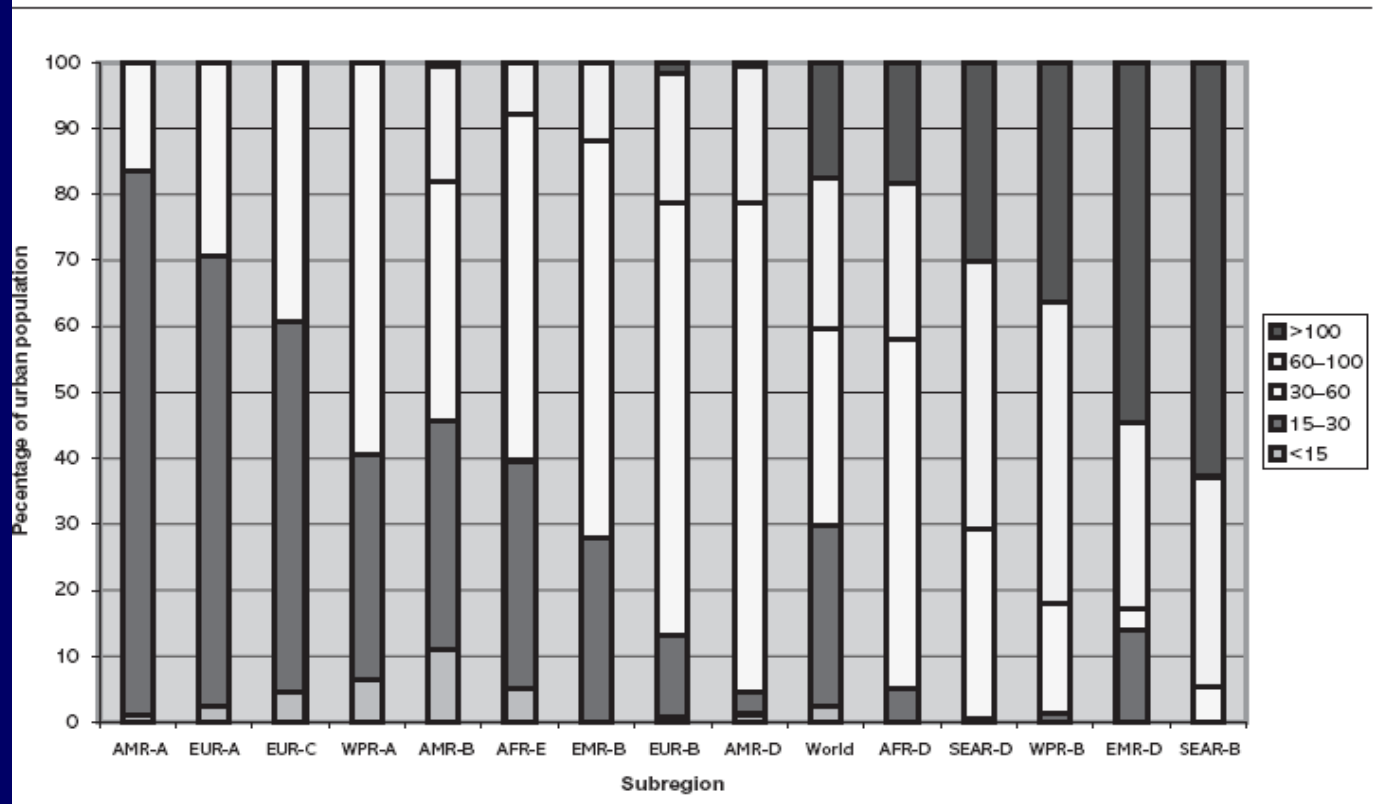
- **Anthropogenic factors**
  - **Emissions / economic activity**
  - **Pollution abatement policies**
  - **Technology / knowledge**
- **Natural /geo-climatic factors**
  - **Direct sources**
  - **Dissipative / dispersive factors**

# Estimated PM<sub>10</sub> Concentration in World Cities (pop ≥ 100,000)



# Population Distribution of Estimated $PM_{10}$ Levels for 3200 Cities

**Figure 17.3** Distribution of the urban population according to estimated concentrations of  $PM_{10}$  in cities with populations of >100 and in national capitals, by subregion



**American Cancer Society II Cohort  
500 000 adults followed 1982 – 1998**

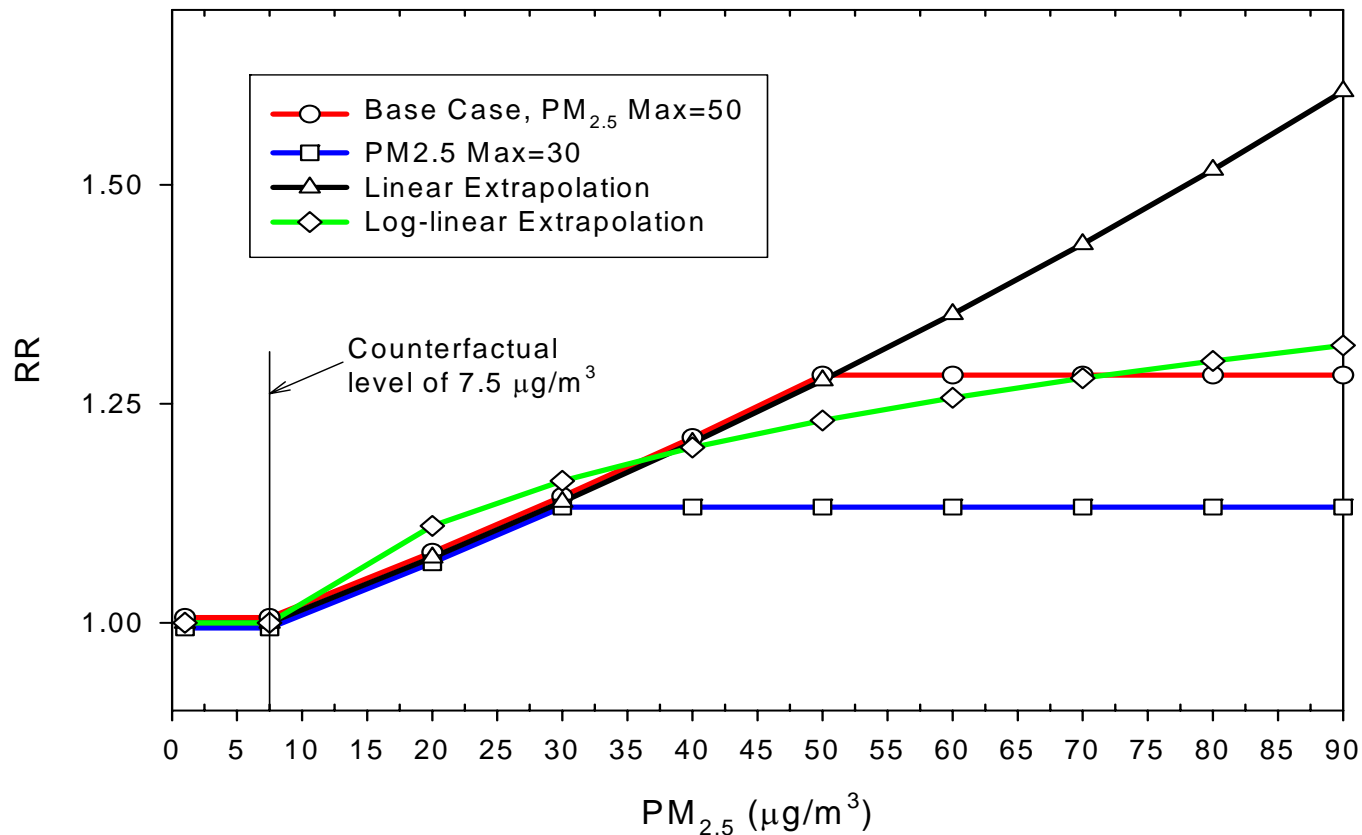
**(Pope et al JAMA 2002)**

<b>RR per 10<math>\mu</math>g/m<sup>3</sup> PM<sub>2.5</sub> 1979-83</b>		
	<b>RR</b>	<b>95% CI</b>
<b>Cardiopulmonary</b>	<b>1.06</b>	<b>1.02-1.10</b>
<b>Lung Cancer</b>	<b>1.08</b>	<b>1.01-1.16</b>

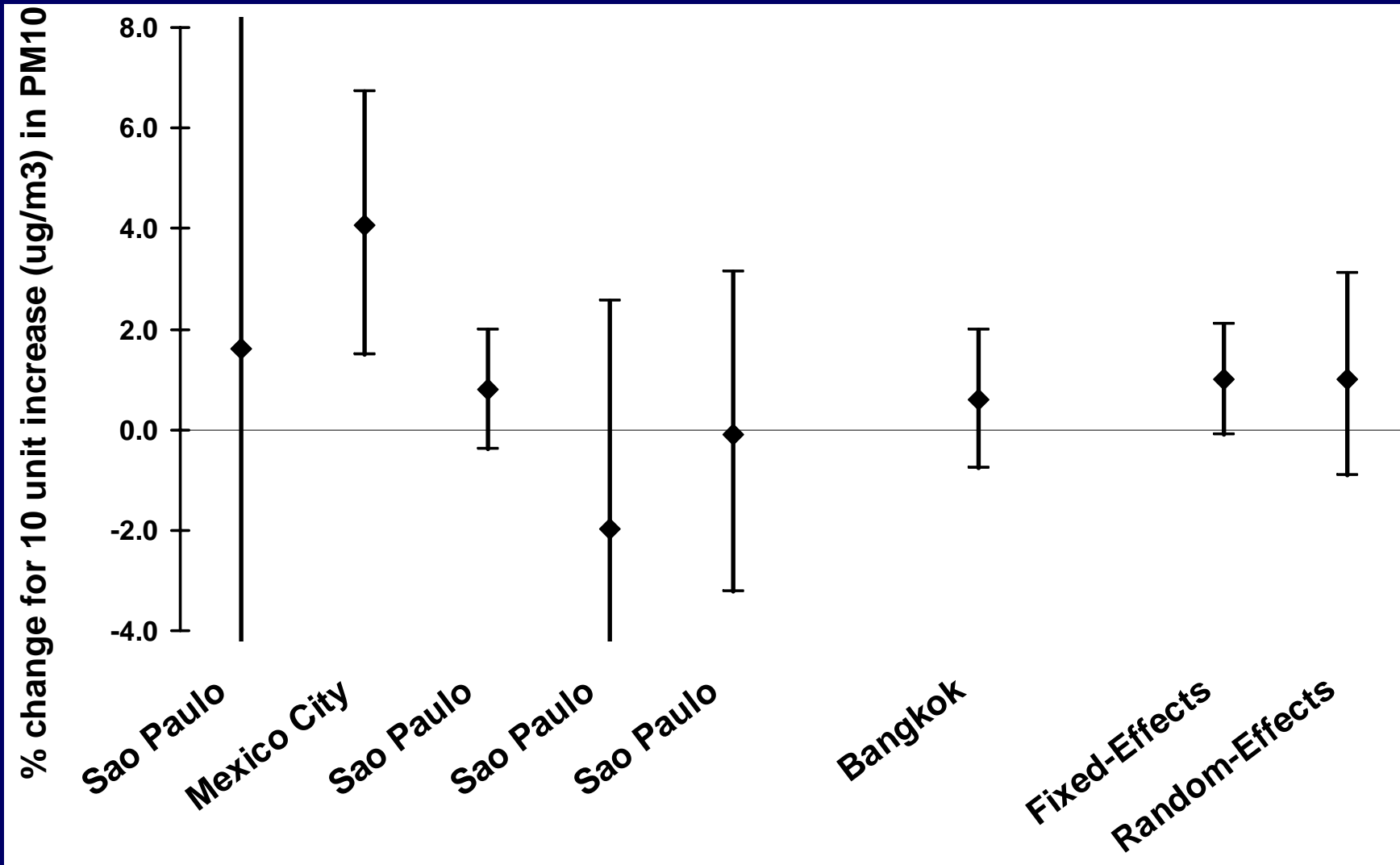
**Random effects Cox proportional hazards model controlling for age, sex, race, smoking, education, marital status, body mass, alcohol, occupational exposure and diet**

# Alternative Scenarios for Burden of Disease Estimation for Urban Air Pollution

Alternative concentration-response curves for cardiopulmonary deaths



# Percent change in mean daily number of child and infant deaths associated with 10 units of particles



# Estimation of attributable deaths and DALYs

## 1. Calculate region specific relative risk

$$RR_{2.5} = \exp [CR * (X - 7.5)]$$

*where CR is slope of the C-R function ( $\beta$  coefficient) and X is regional population weighted mean PM.*

## 2. Calculate Attributable Fraction (AF)

$$AF = P(RR-1) / [ P(RR-1)+1]$$

*where P is proportion exposed, i.e. proportion living in cities*

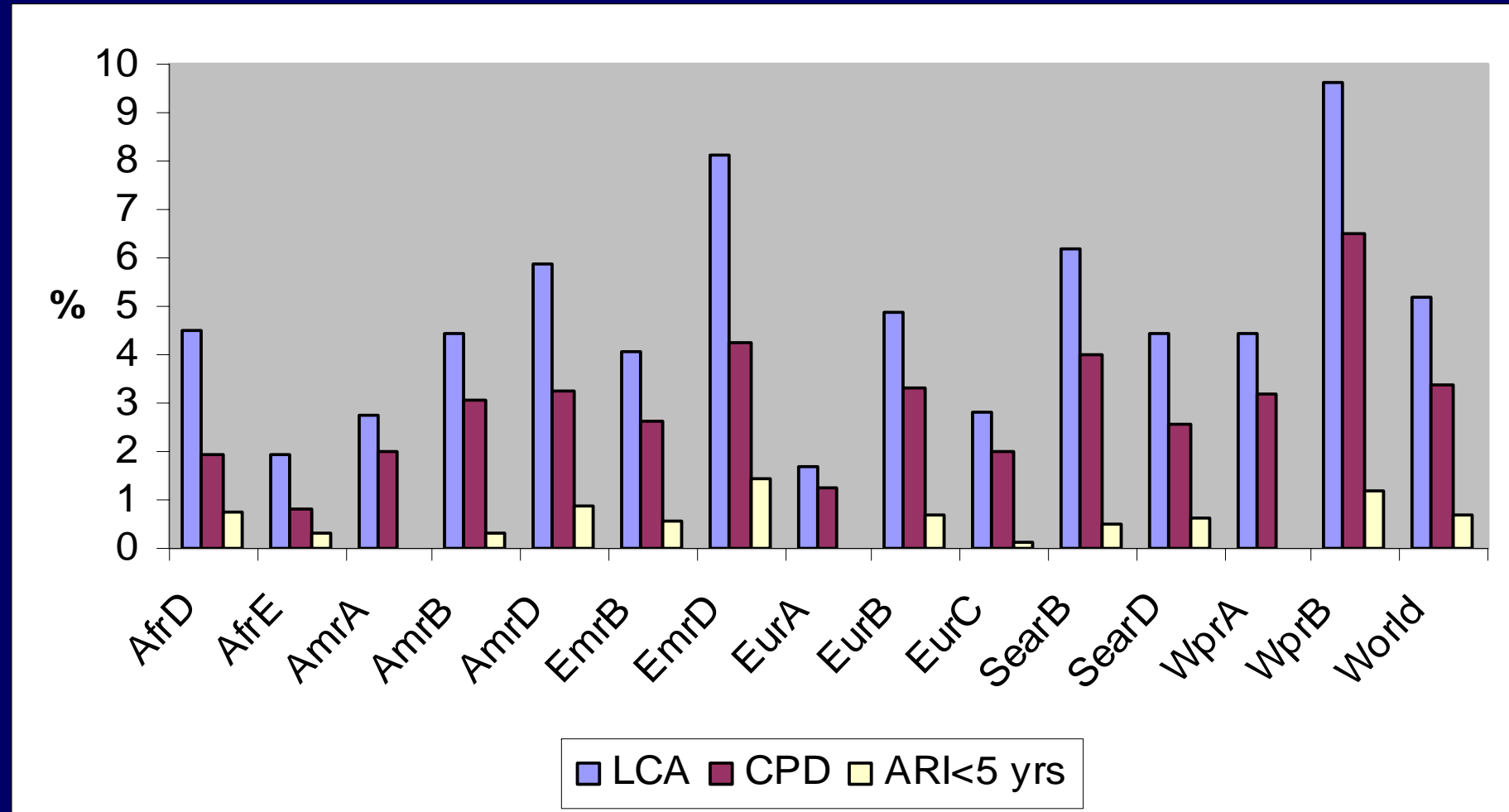
## 3. Calculate attributable deaths and DALYs

**(AF \* regional totals)**

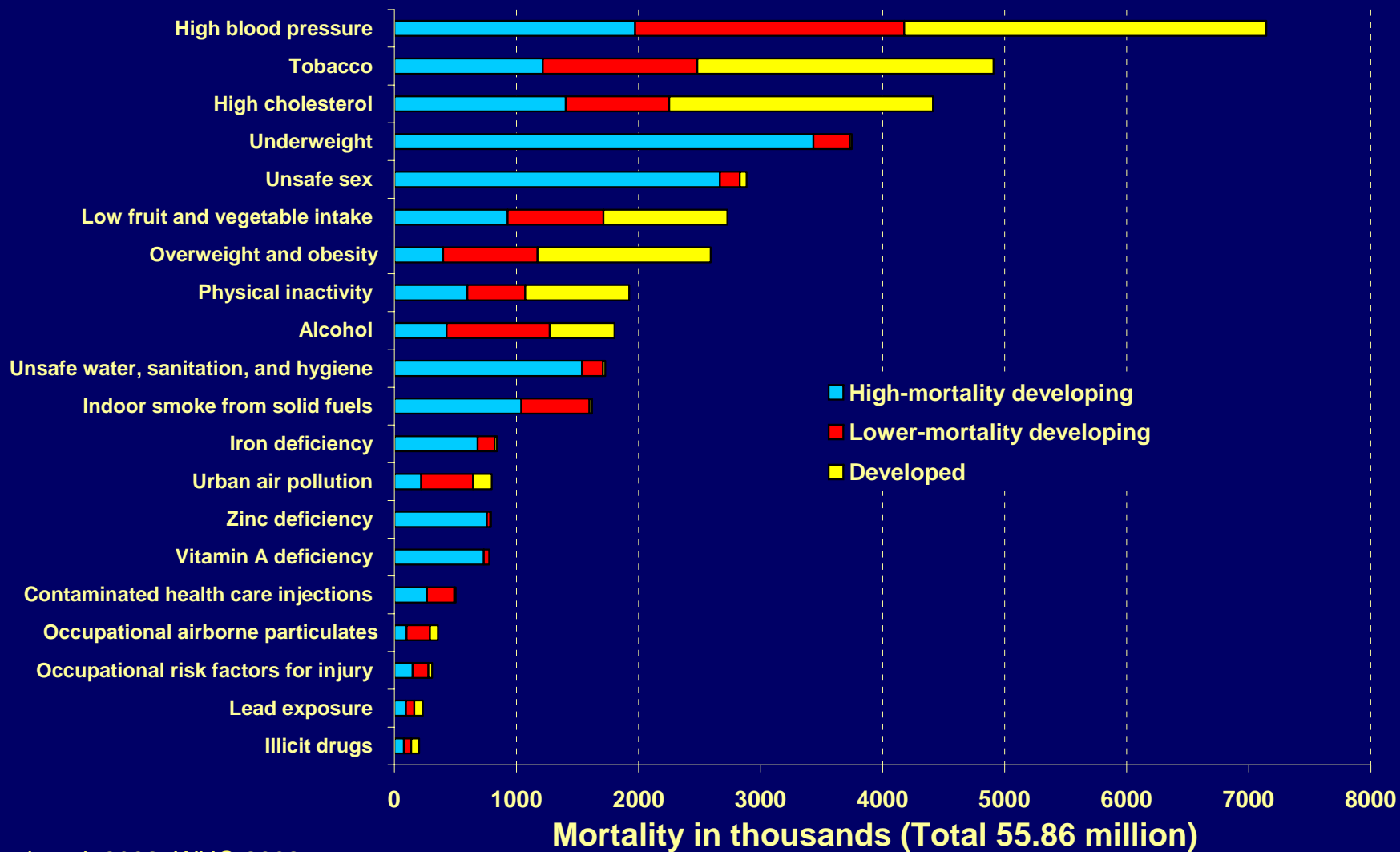
# Estimated Burden of Urban Air Pollution Worldwide (95% confidence intervals)

	<b>AF (%)</b>	<b>Deaths (x 10<sup>3</sup>)</b>	<b>YLL (x 10<sup>3</sup>)</b>
<b>CPD</b>	3 (1, 6)	712 (245, 1,107)	4,666 (1,695, 7,700)
<b>Lung Cancer</b>	5 (1, 9)	62 (10, 114)	572 (92, 1,063)
<b>ARI (&lt;5 yr.)</b>	1 (-1, 3)	26 (-24, 66)	863 (-799, 2,228)

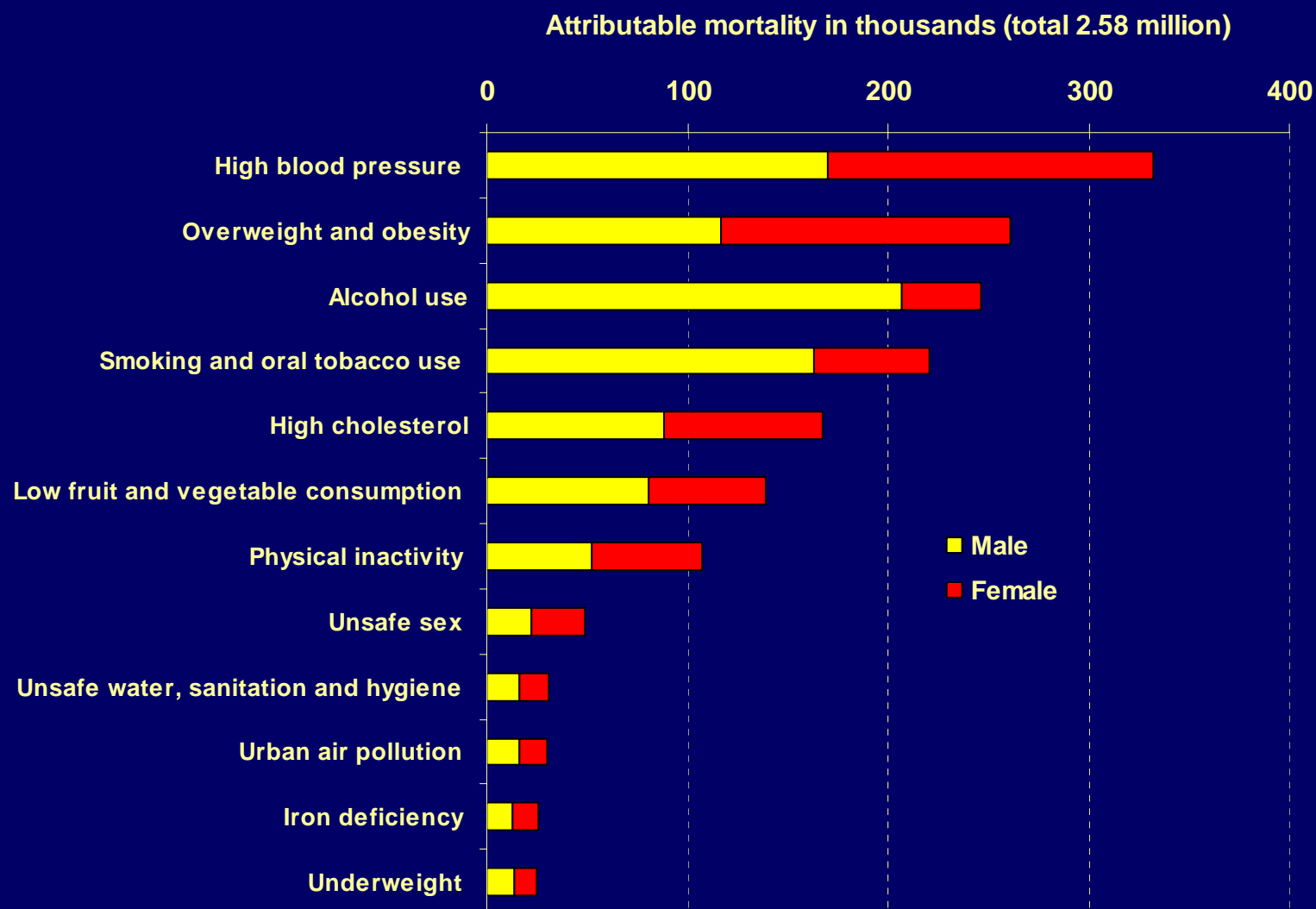
# Fraction of Deaths Attributable to Urban Air Pollution by Region



# Mortality attributable to leading risk factors



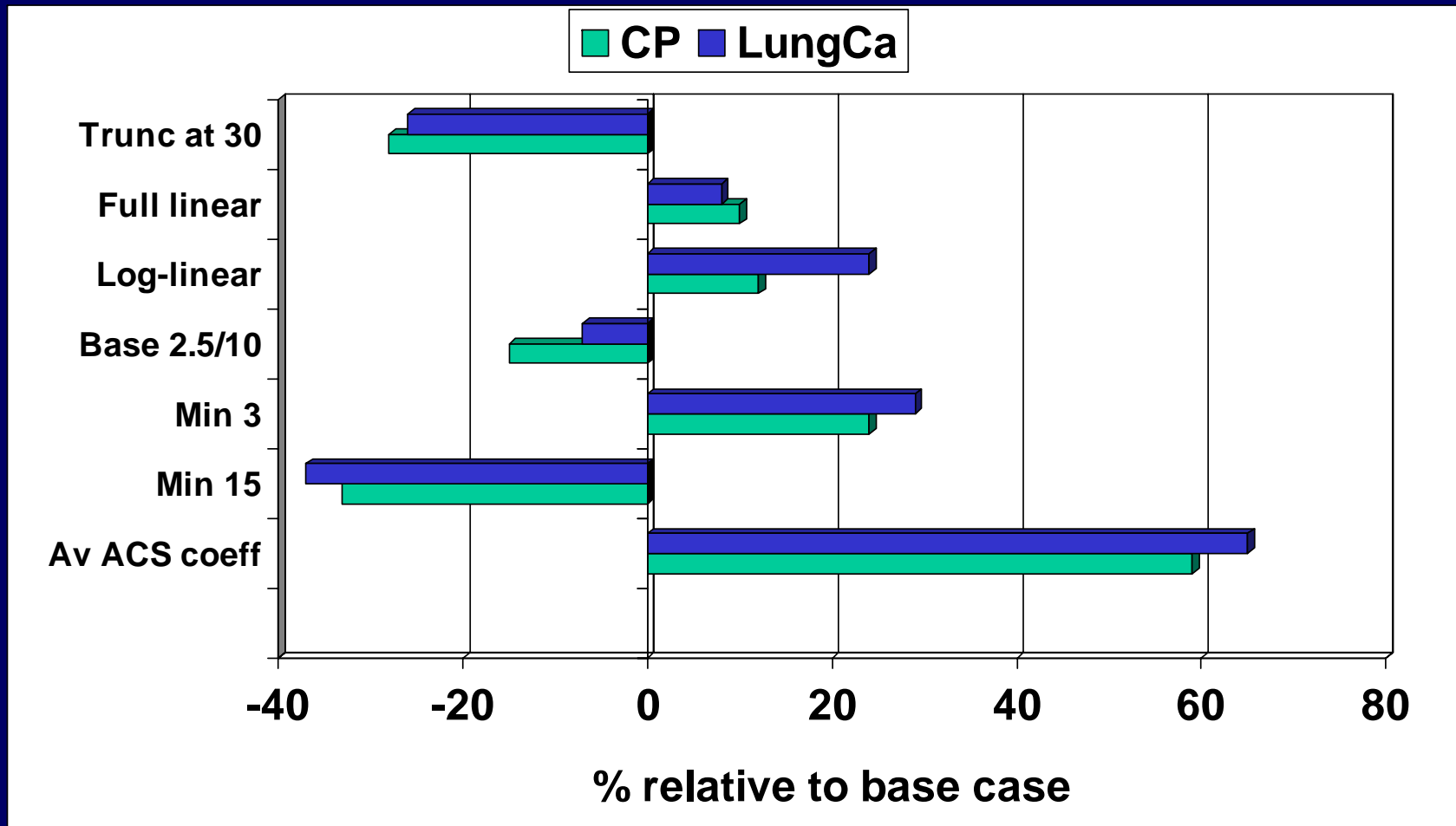
# AMR-B attributable mortality



# Uncertainties that we quantified

- **Sampling variability**
- **Choice of  $PM_{2.5}/PM_{10}$**
- **Choice of concentration-response function: coefficients and extrapolation**
- **Choice of counterfactual of level**
- **YLDs vs. YLL**
- **Cities under 100,000 K**

# Sensitivity of Attributable Mortality Estimates



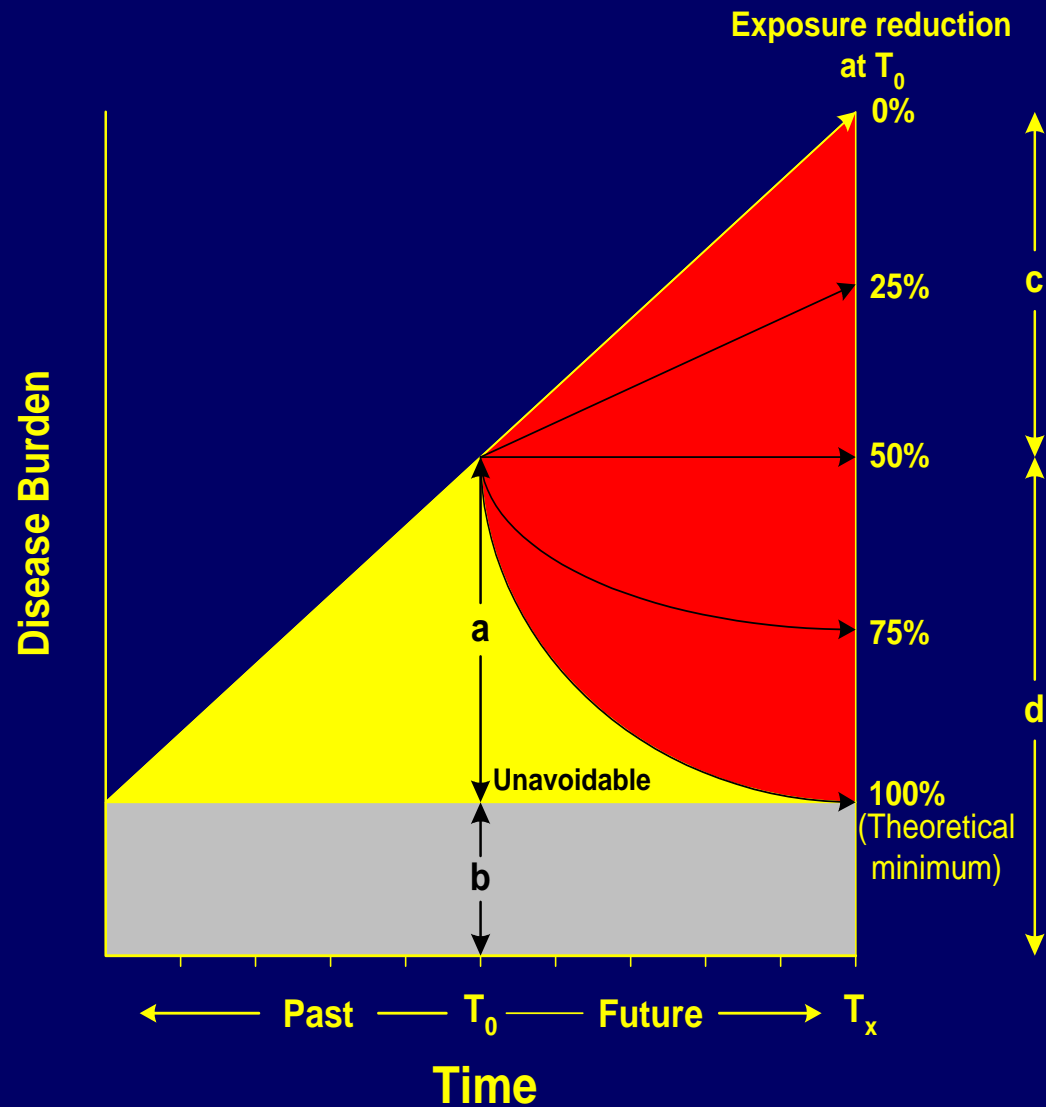
## **Uncertainties that we did not quantify**

- **No estimates of YLDs for some potentially important health outcomes, e.g., LBW, asthma morbidity**
- **No estimates for potentially important pollutants, e.g., ozone**
- **Effects of exposure at finer spatial scales (e.g., due to proximity to vehicular traffic)**

# Summary results

- **Substantial disease burden associated with risk factors such as under-nutrition, poor water and sanitation, and indoor air pollution remain, especially in the poorest developing countries**
- **Simultaneously risks from a number of factors such as smoking, alcohol, and obesity are becoming increasingly global**
- **Some risks, like urban air pollution and lack of contraception are major causes of burden in specific regions**
- **The burden of disease due to urban air pollution is likely to have been underestimated**

# Attributable and avoidable burden

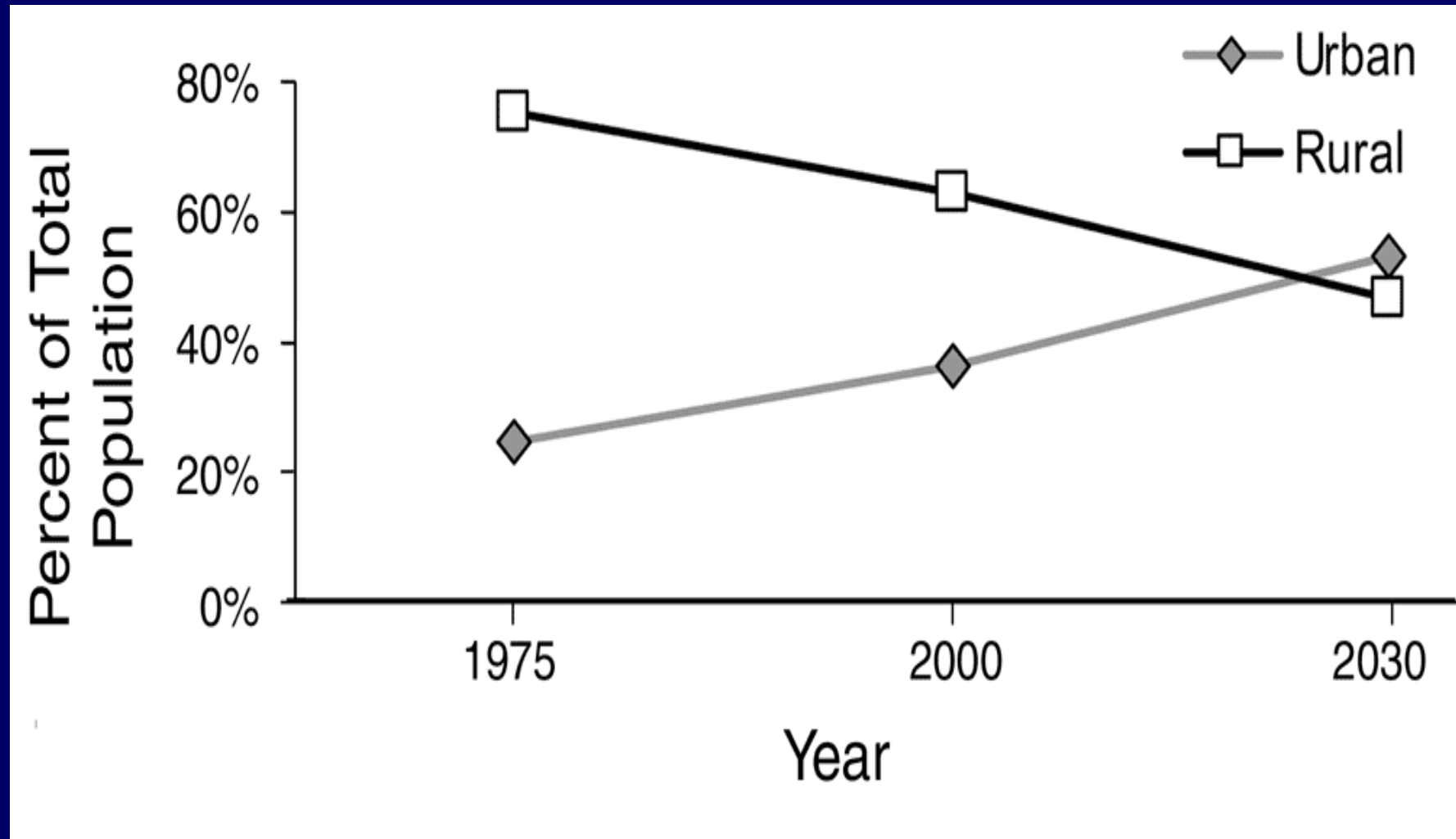


# **What determines the health effects of air pollution as economies grow?**

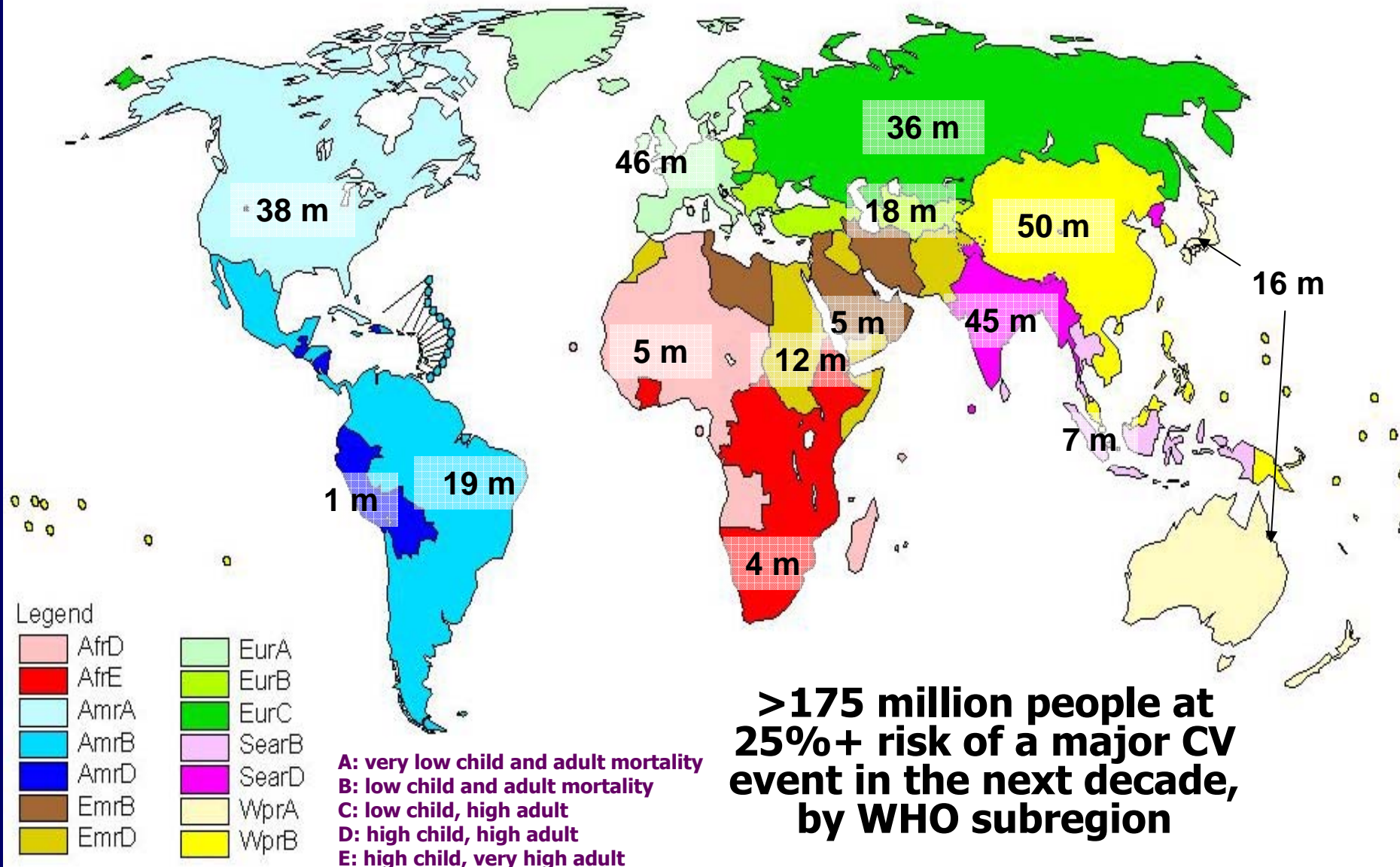
- ✓ Number of people in cities**
- ✓ Sources of air pollution**
- ✓ Total pollution**
- ✓ Susceptibility**

# An Increasingly Urban Population

(data from UN/UN Centre for Human Settlements 1995-2002)

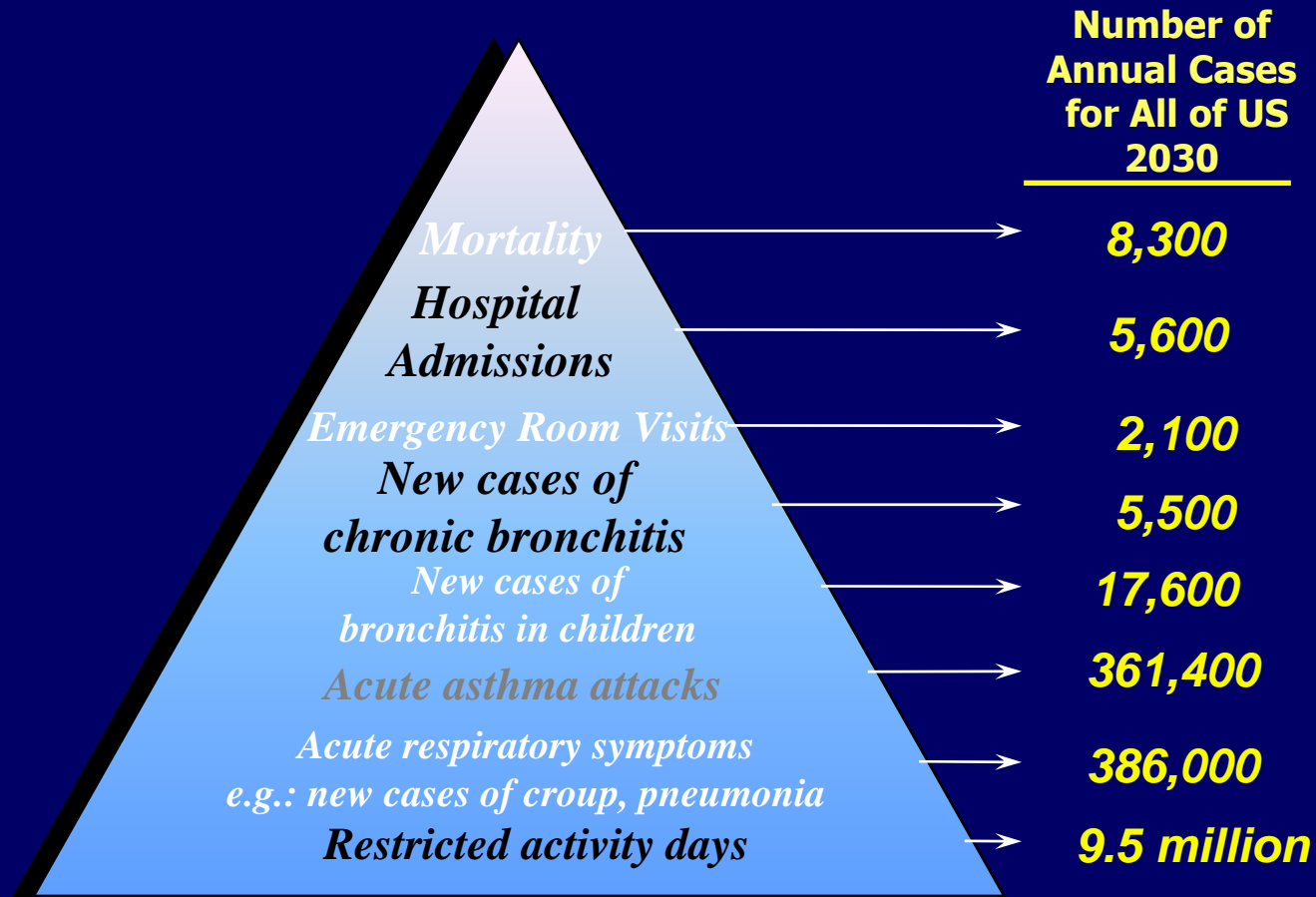


# Number of people at high CV risk globally in 2000 (A Rogers 2005)



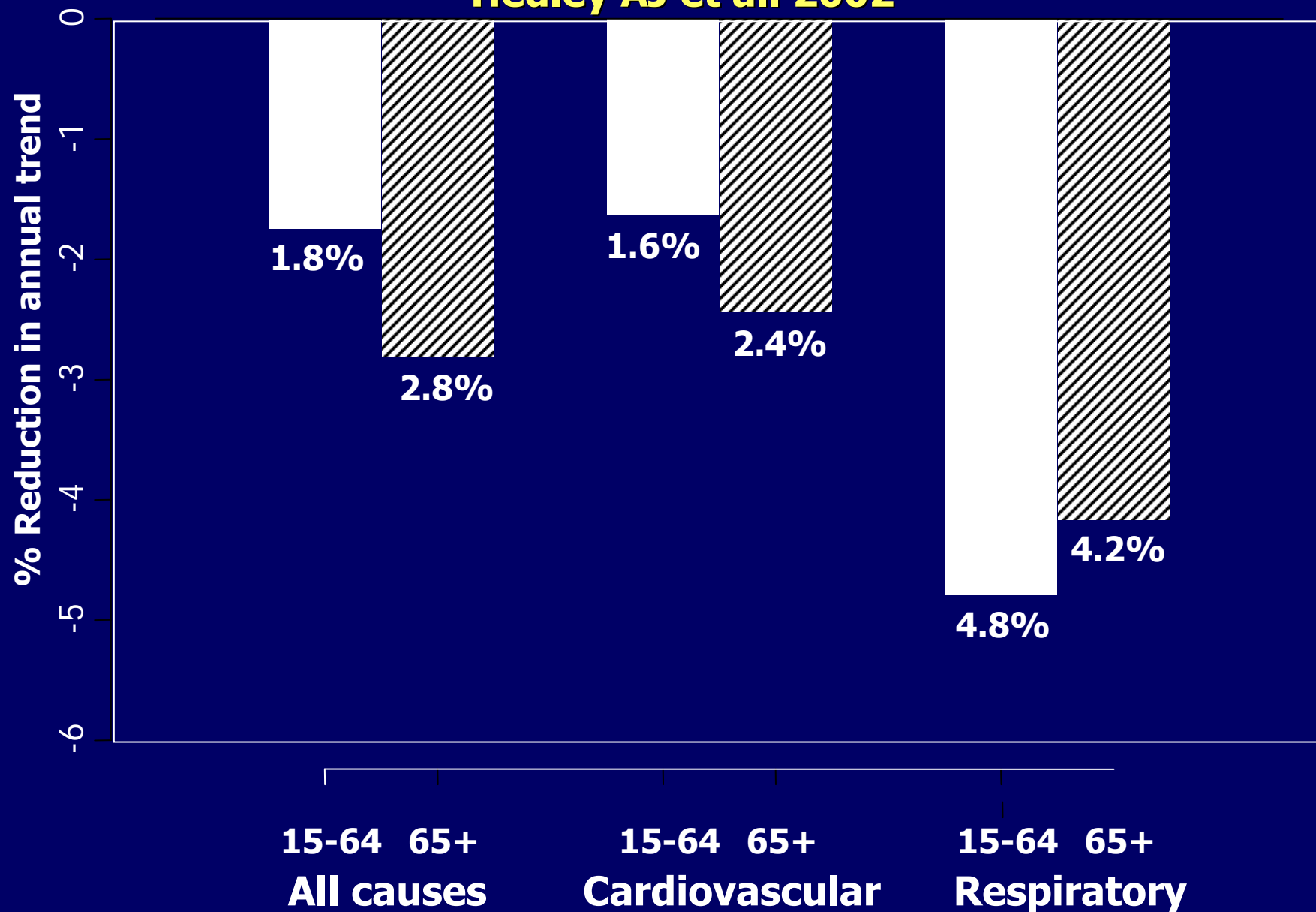
# Estimates of benefits

(Source: US EPA RIA, 2000)



# Reductions in deaths after sulphur restriction in Hong Kong 1990

Hedley AJ et al. 2002



**Obrigado**

**¡Gracias!**

**Thank You!**

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