Health Impacts of Air Pollution: International Trends and Issues

Dietrich H. Schwela

Stockholm Environment Institute at York University, York, UK

Sub-regional Workshop

“Better Air Quality for North Africa”

23-25 November 2009

Hotel Ramada Plaza, Tunis

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dieter.schwela@sei.se

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- Major ambient air pollutants
- Particle characteristics
- PM, SO_2, NO_2, O_3 concentrations
- Pyramid of health effects
- Outdoor-indoor excess death estimates
- PM, O_3, NO_2 excess risks
- SO_2 intervention study
- WHO air quality guidelines
- CAFÉ cost-benefit analysis
- Way forward for North African countries

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dieter.schwela@sei.se

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Major ambient air pollutants

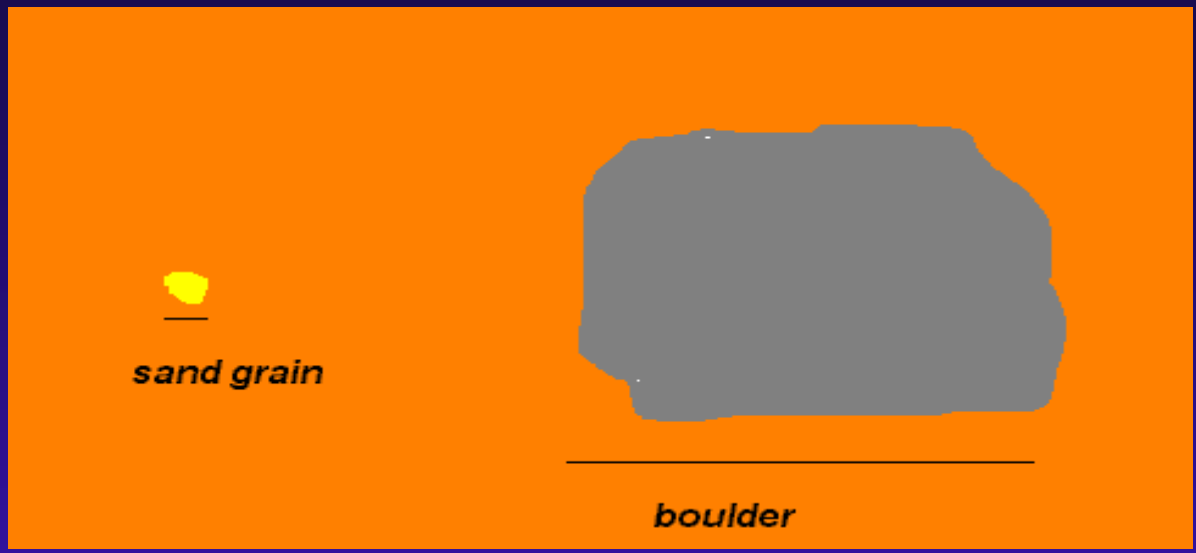
- **Particulate matter (PM)**
  - Inhalable particles (PM_{10})
  - Coarse particles ($PM_{10-2.5}$)
  - Fine particles ($PM_{2.5}$)
  - Ultrafine particles ($PM_{0.1}$)

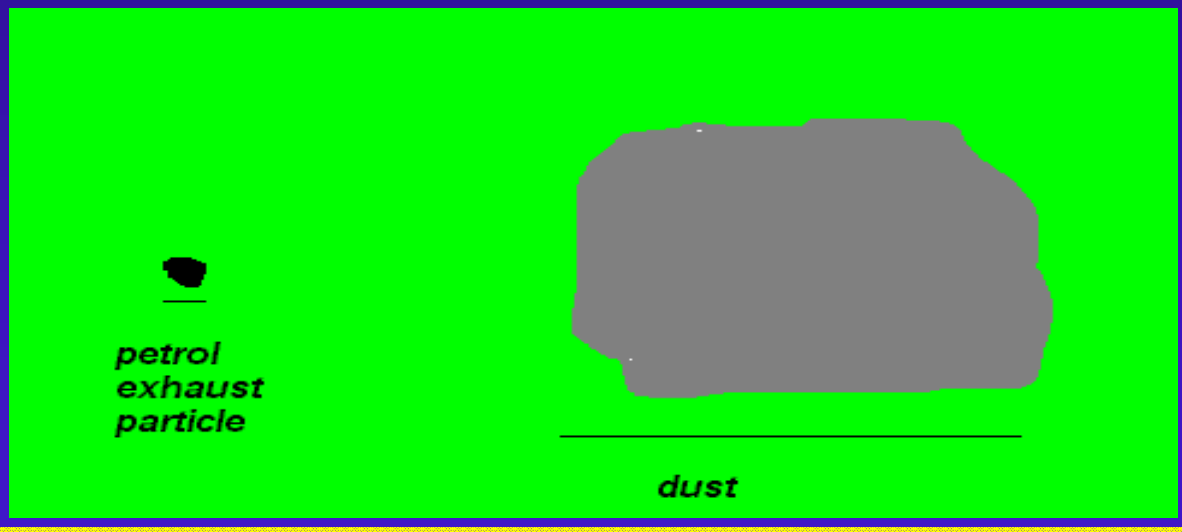
QuickTime™ and a
decompressor
are needed to see this picture.

- **Gases**
  - Oxides of nitrogen
  - Ozone
  - Sulphur dioxide
  - Carbon monoxide
  - Carbon dioxide
  - Methane
  - Nitrous oxide

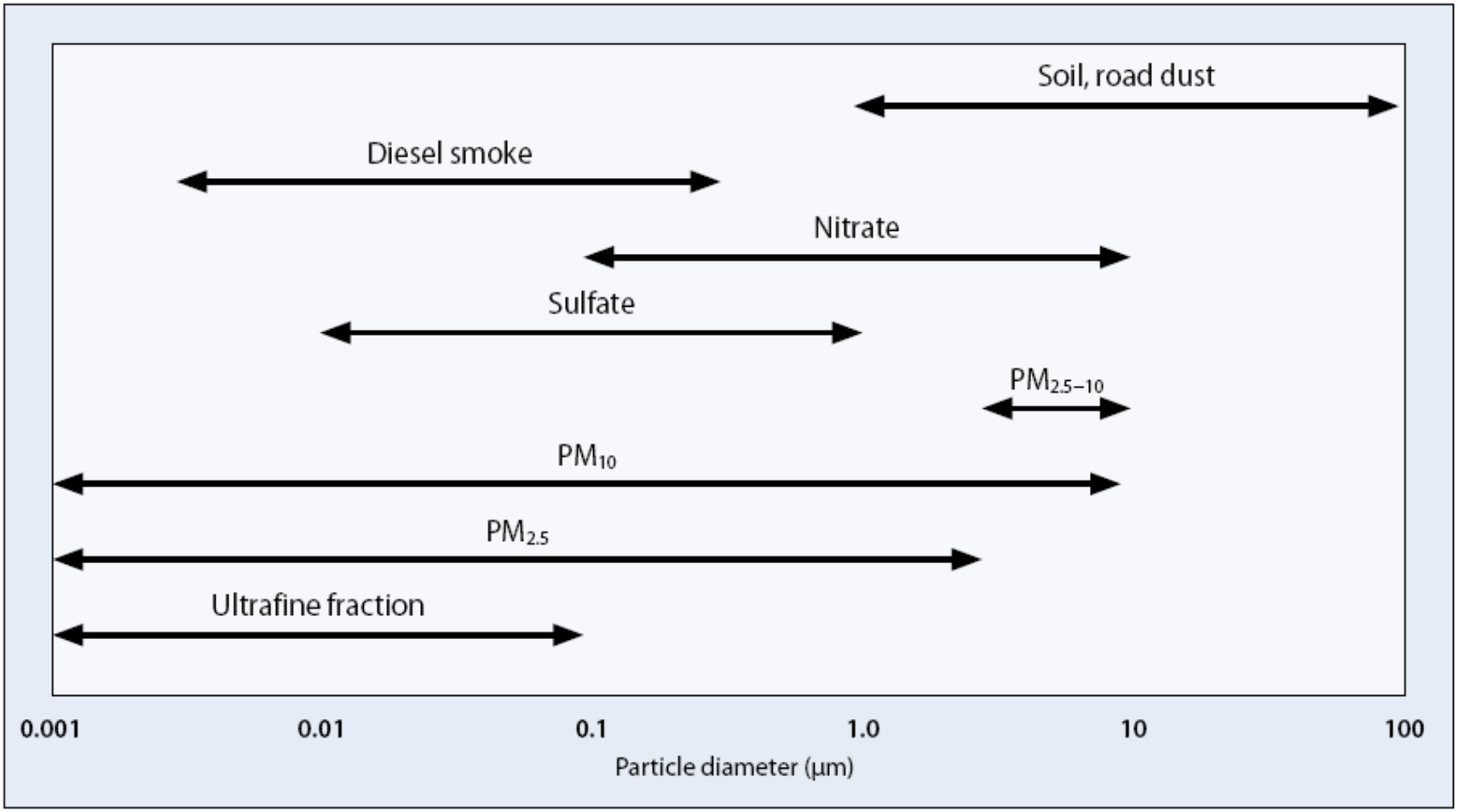
dieter.schwela@sei.se

Physical properties of particles: size



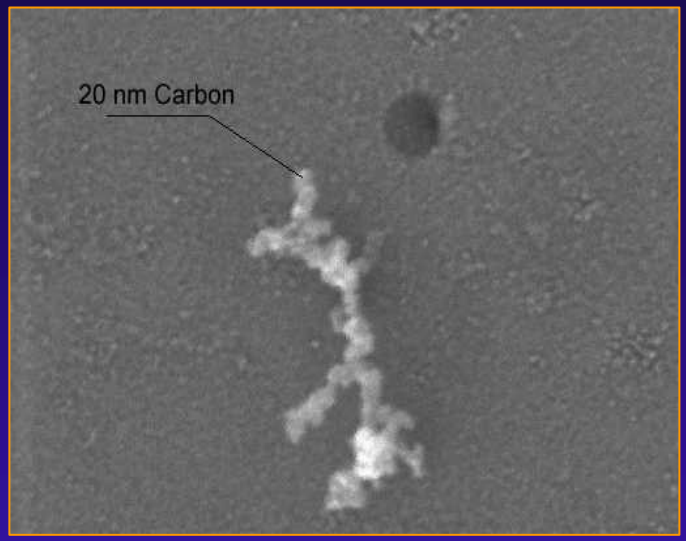


Size range of suspended particles



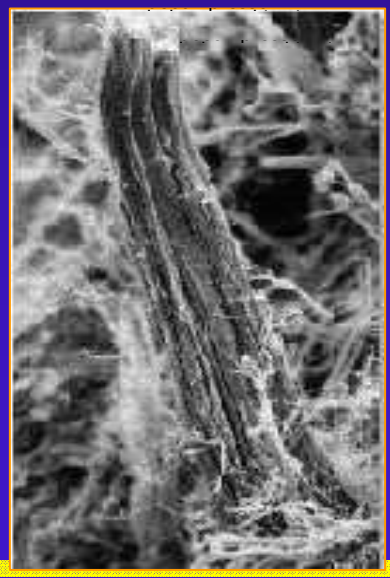
Source: WHO 2006

Physical properties of particles: shape



Petrol car exhaust particles

Asbestos fibre particle



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Ranges of annual mean PM_{10}, NO_2 and SO_2 and 1-hour maximum O_3 concentrations [$\mu g/m^3$]

Region	PM_{10}	NO_2	SO_2	O_3
Africa	40-150	35-65	10-100	120-300
Asia	35-220	20-75	6-65	100-250
Australia/NZ	28-127	11-28	3-17	120-310
Canada/USA	20-60	35-70	9-35	150-380
Europe	20-70	18-57	8-36	150-350
Latin America	30-129	30-82	40-70	200-600

Source: WHO 2006

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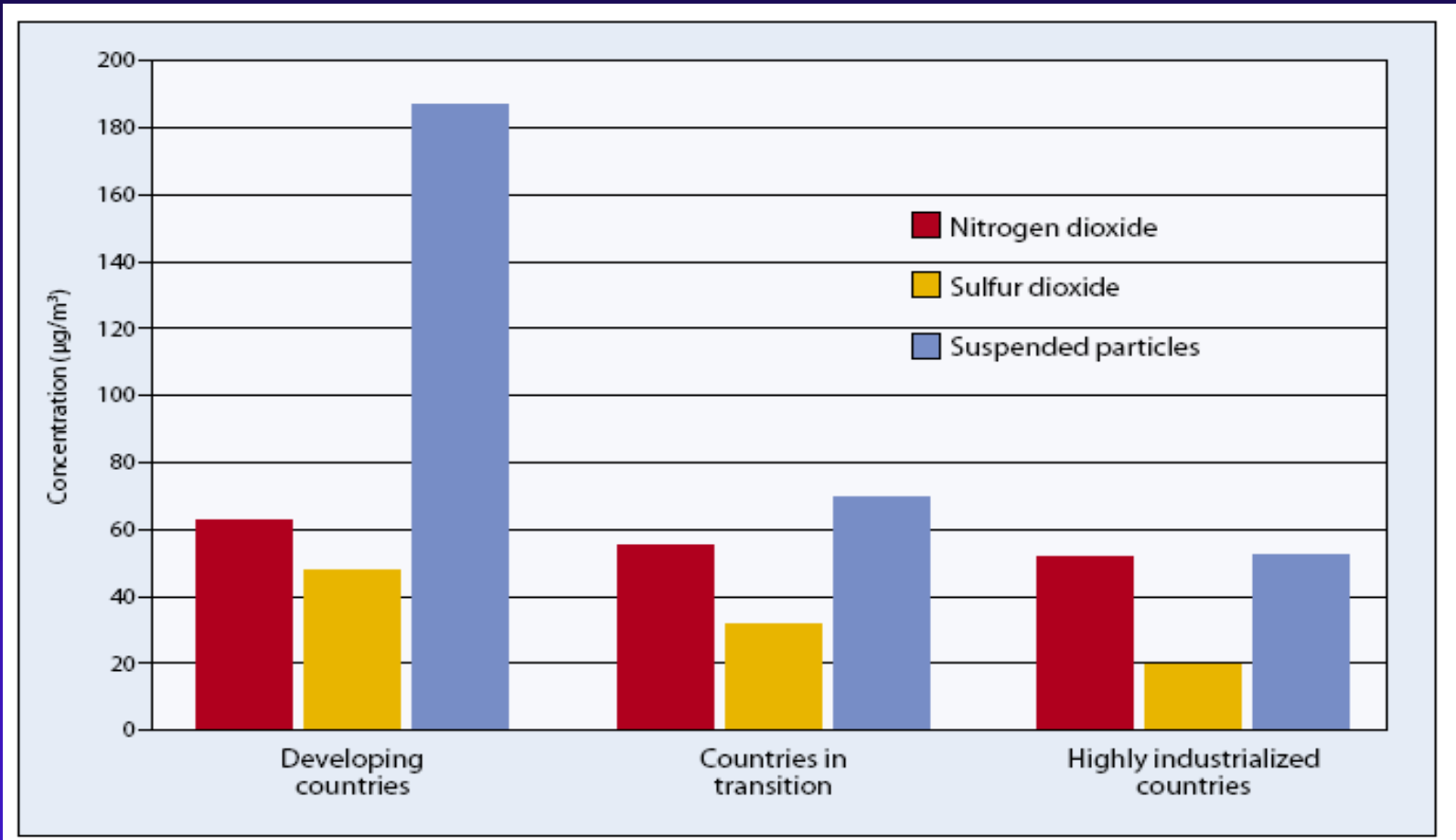
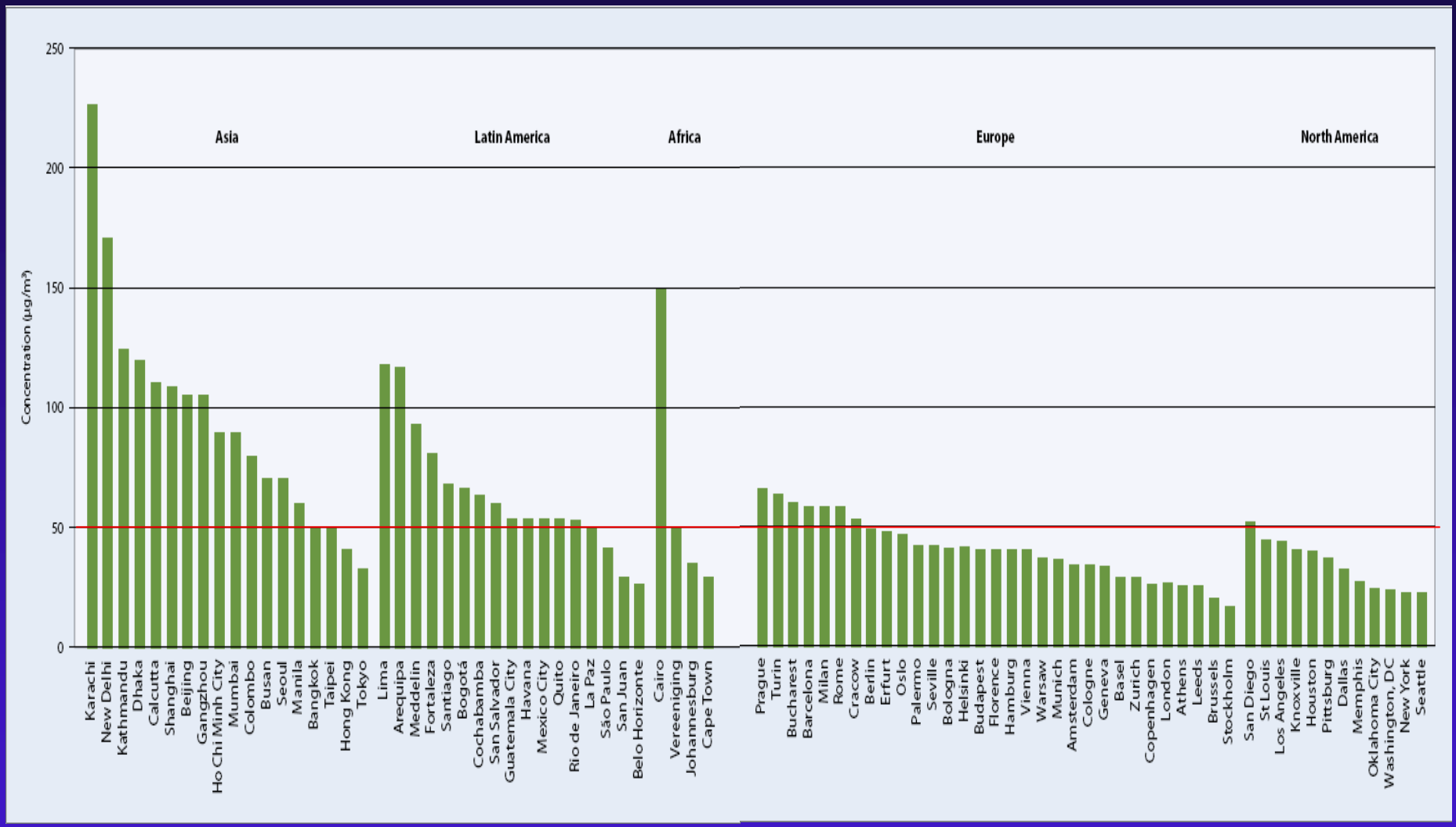
Typical annual mean concentrations for NO_2, SO_2, and PM_{10}



Source: UNCHS 2001

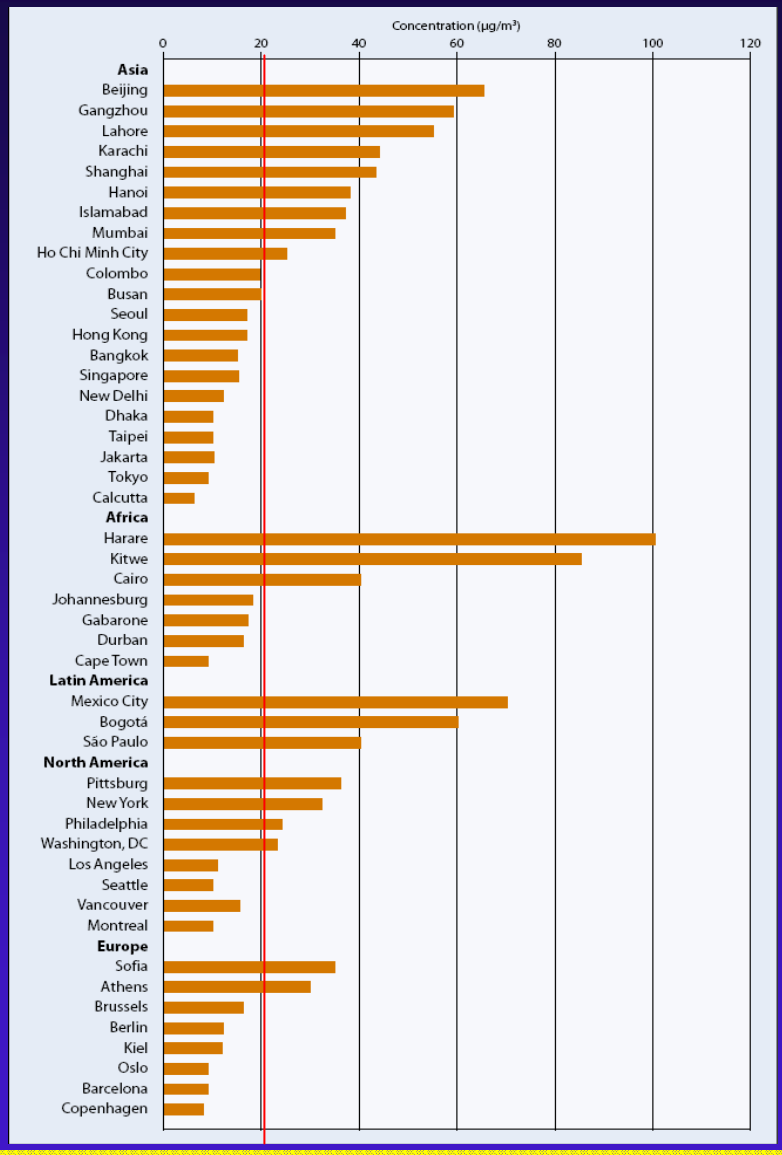
Annual mean PM_{10} concentrations in selected cities



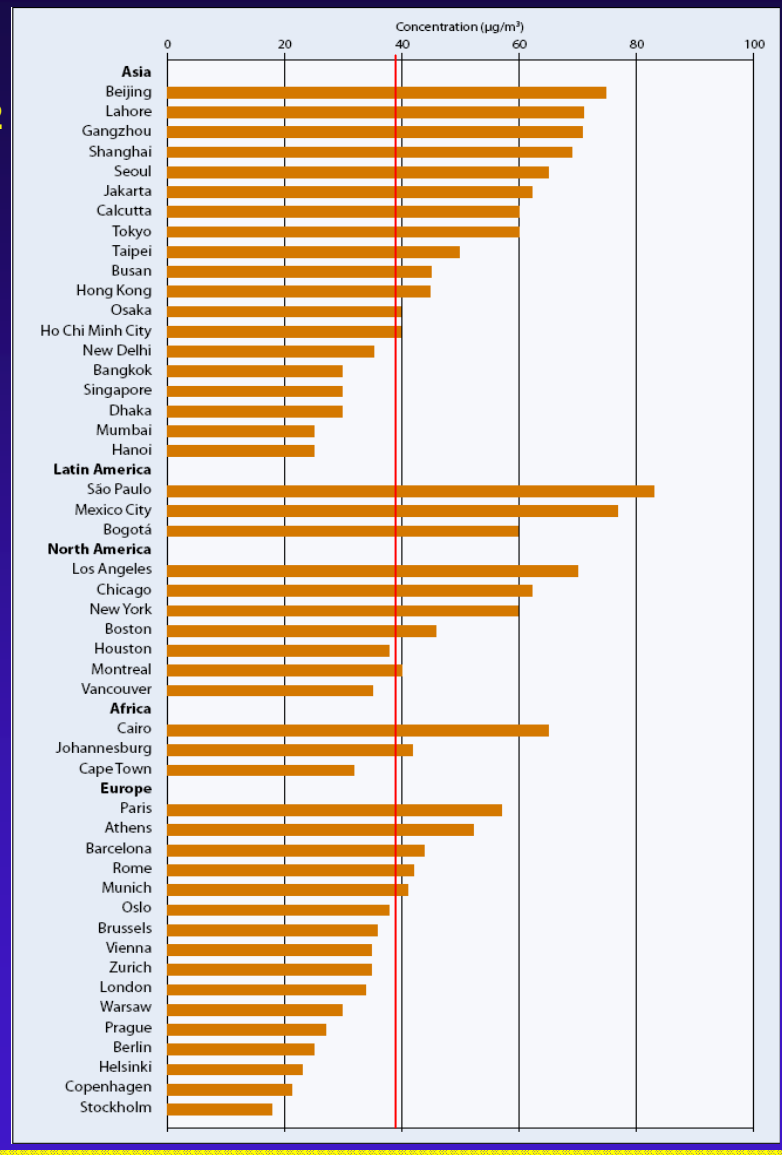
Source: WHO 2006

Annual concentrations 2000-2005

SO_2



NO_2



Source: WHO 2006

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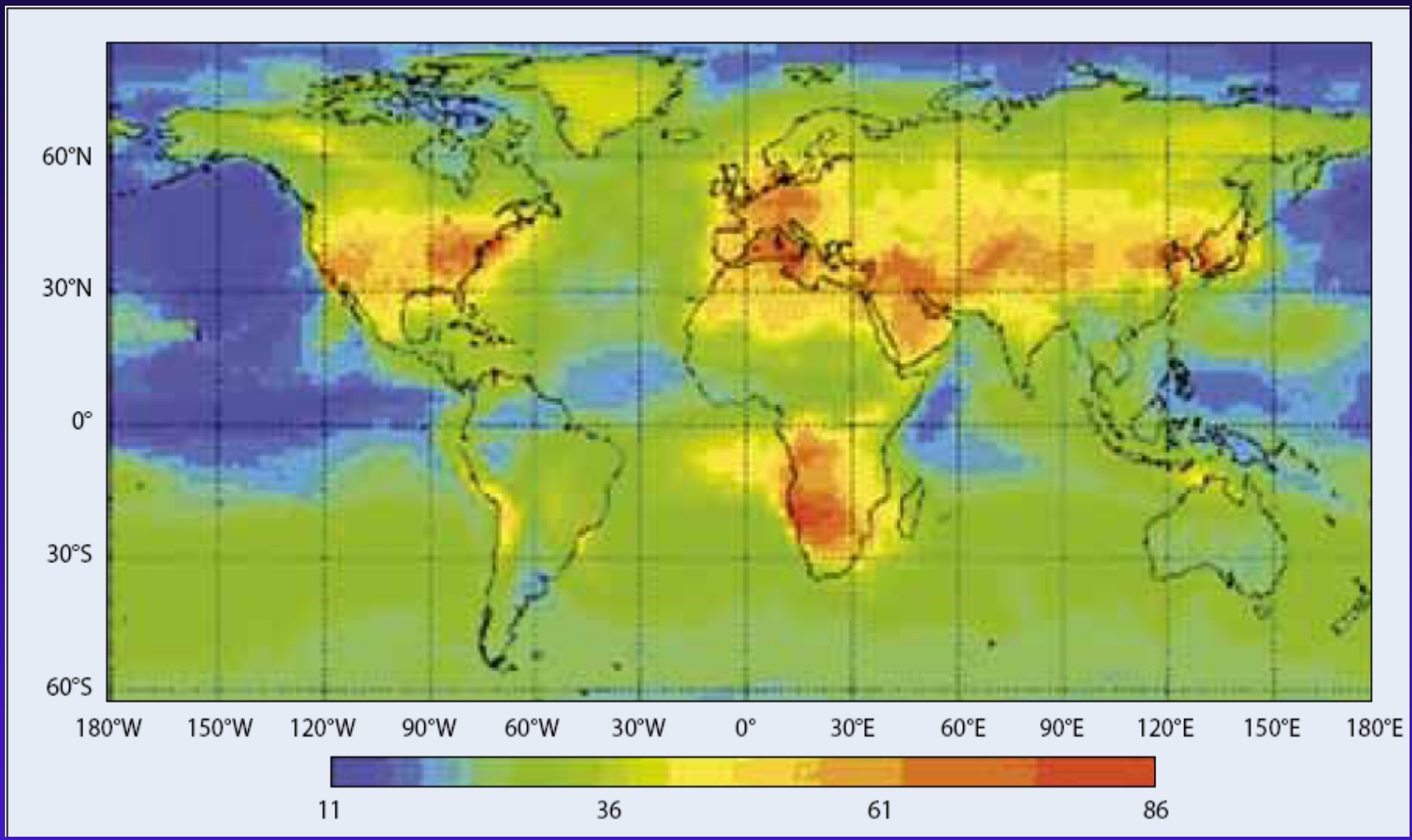
Mean afternoon ozone concentrations, July



Source: Harvard University 2006

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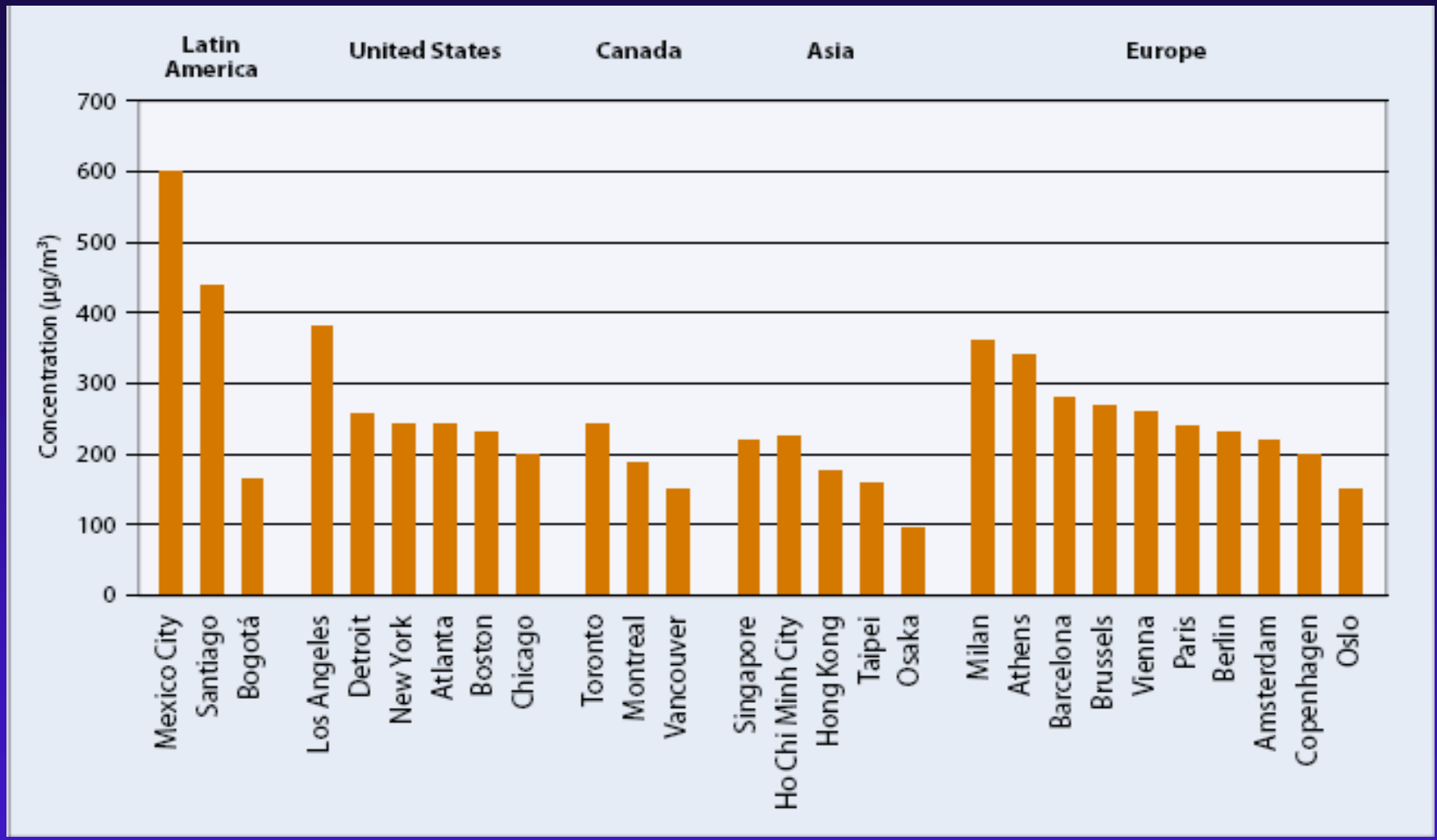
Maximum one-hour ozone concentrations



Source: WHO 2006

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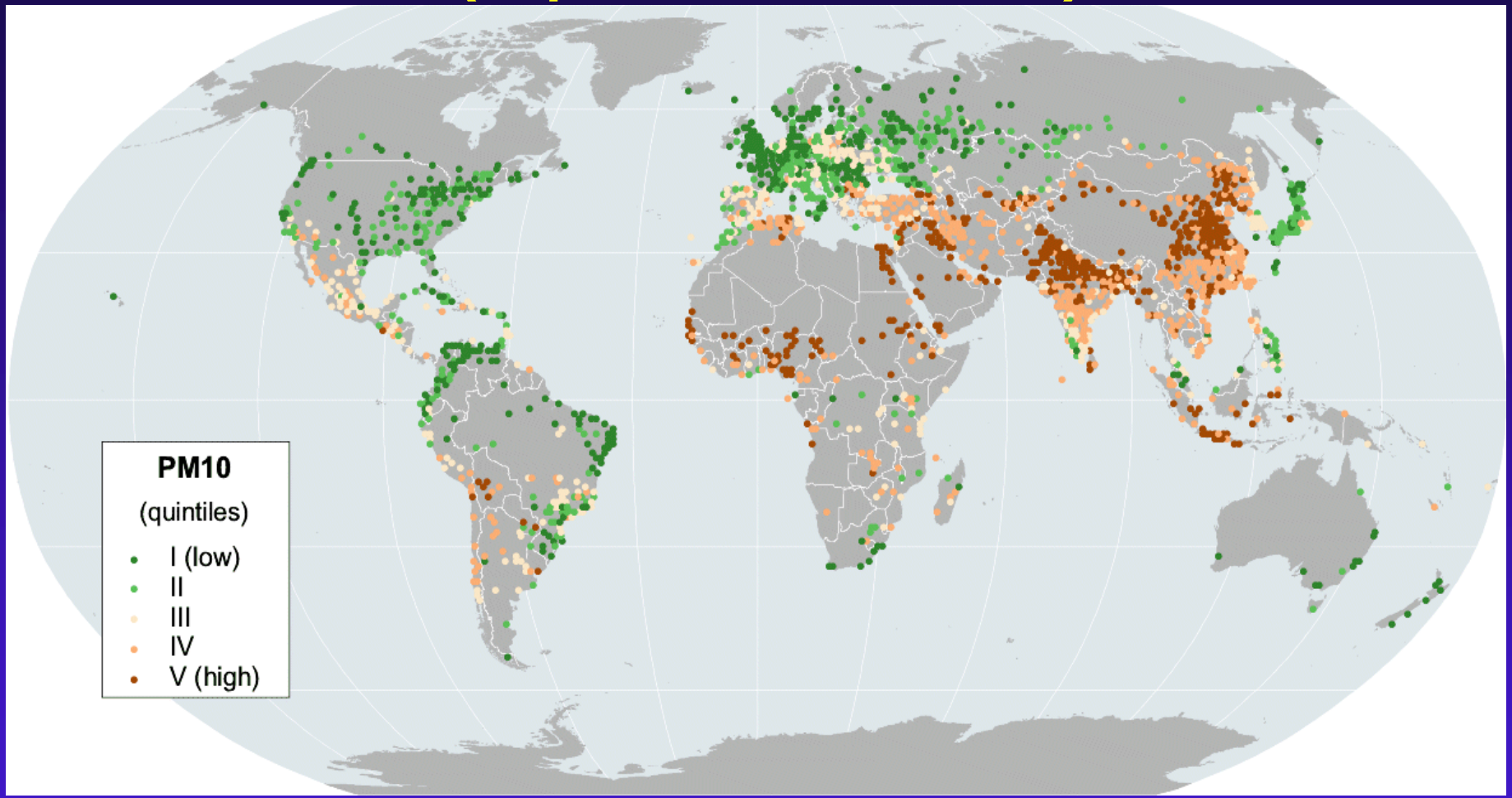
Estimated PM_{10} Concentration in World Cities (Population $\geq$ 100,000)



Source: Cohen et al. 2004

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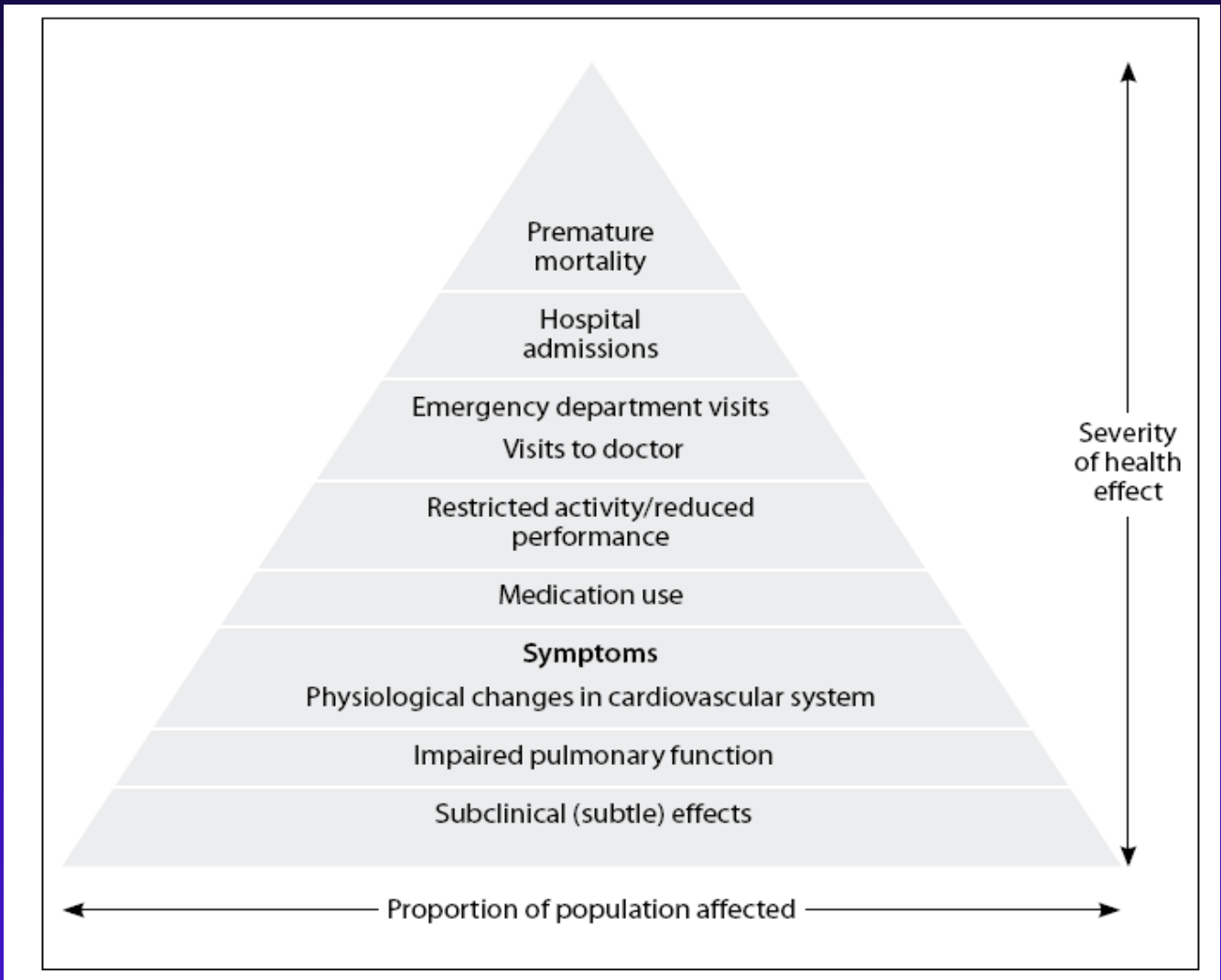
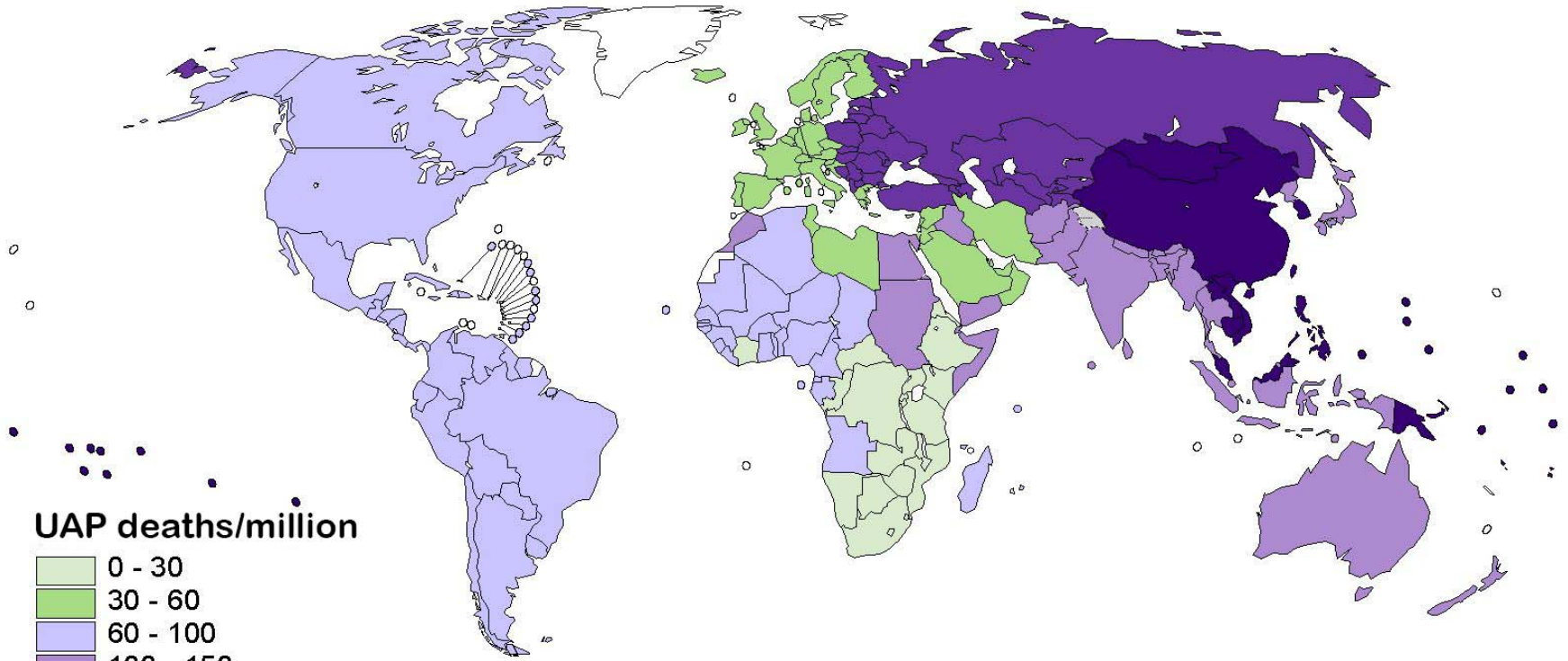
Pyramid of health effects associated with air pollution



Source: ATS 2000

Deaths from urban air pollution

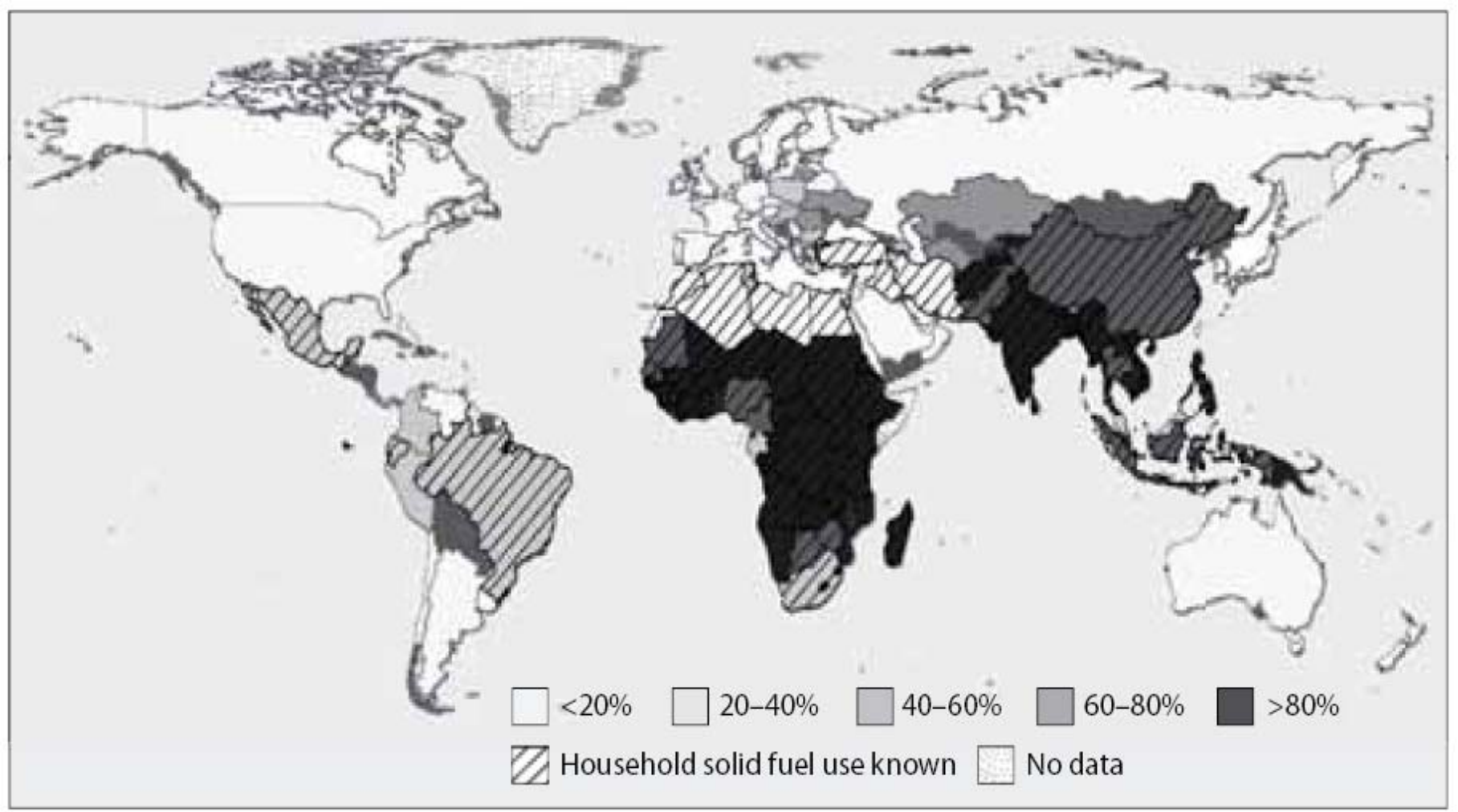


Estimates by WHO sub-region for 2000 (WHO World Health Report, 2002).
The boundaries shown on this map do not imply the expressionof any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

WHO estimates of premature death (WHO, 2006)

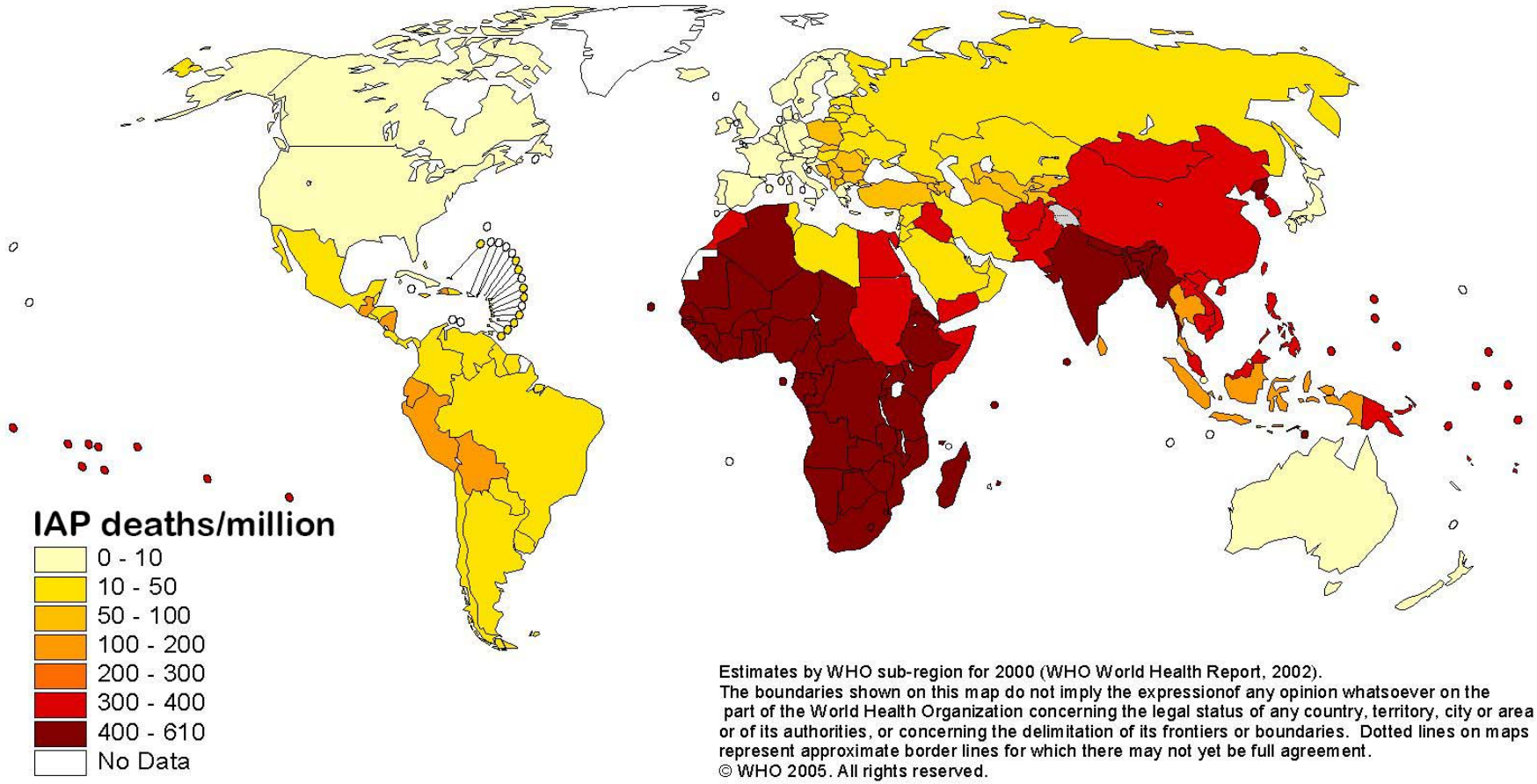
Country	Outdoor air pollution	Indoor air pollution
Algeria	1,900	400
Egypt	15,000	700
Libyan Arab Jamahirya	1,600	99
Mauritania	200	2,300
Morocco	700	600
Tunisia	700	100
Western Sahara	No estimate	No estimate

Household solid fuel use 2000



Source: WHO 2004

Deaths from indoor smoke from solid fuels



Estimates by WHO sub-region for 2000 (WHO World Health Report, 2002).
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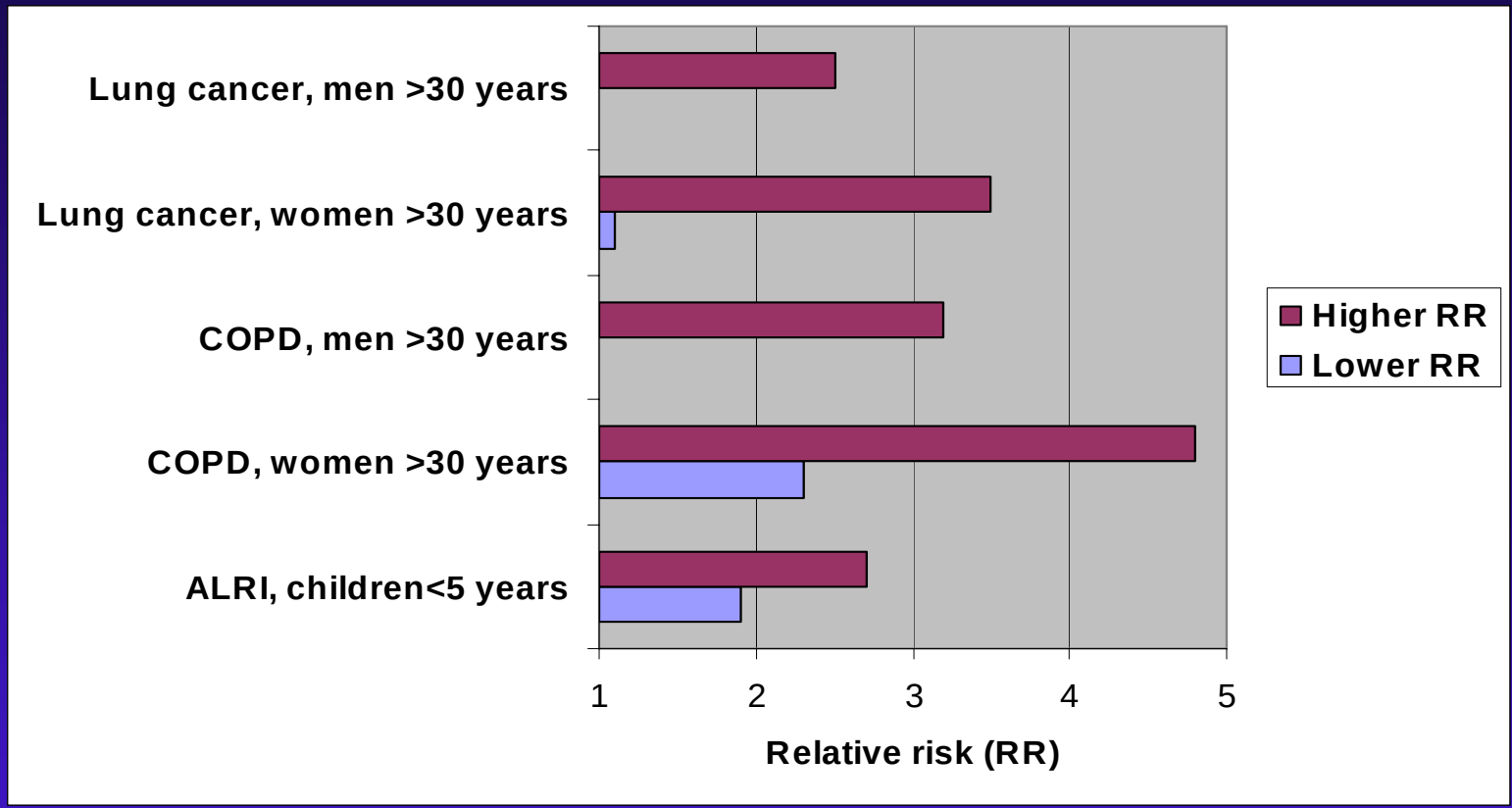
Relative risk for developing health impact due to exposure to solid fuel use



Smith et al. 2004

ALRI = Acute lower respiratory infections
COPD = Chronic obstructive pulmonary disease

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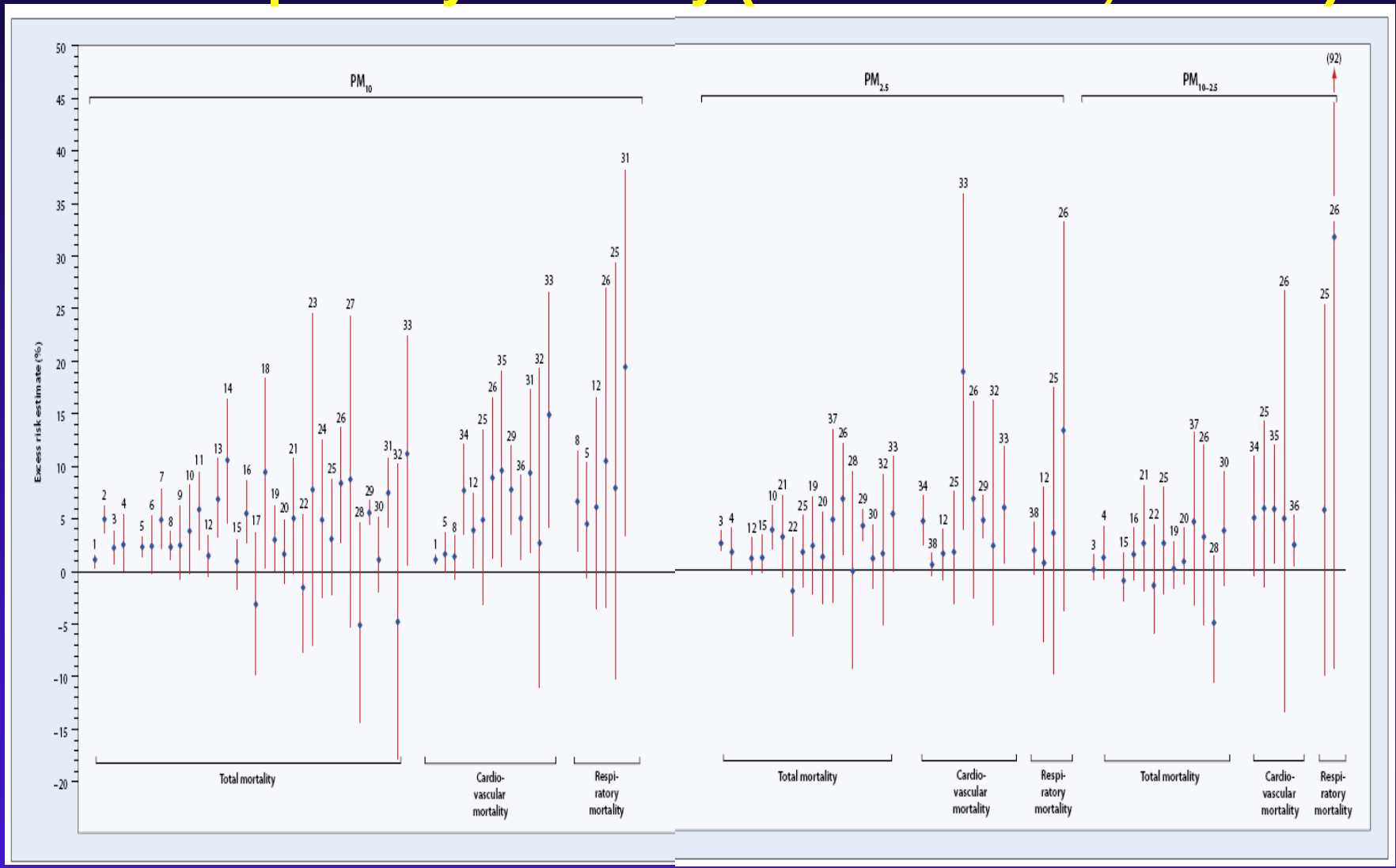
PM excess risk for total non-accidental, cardiovascular and respiratory mortality (United States, Canada)



Source: US EPA 2005

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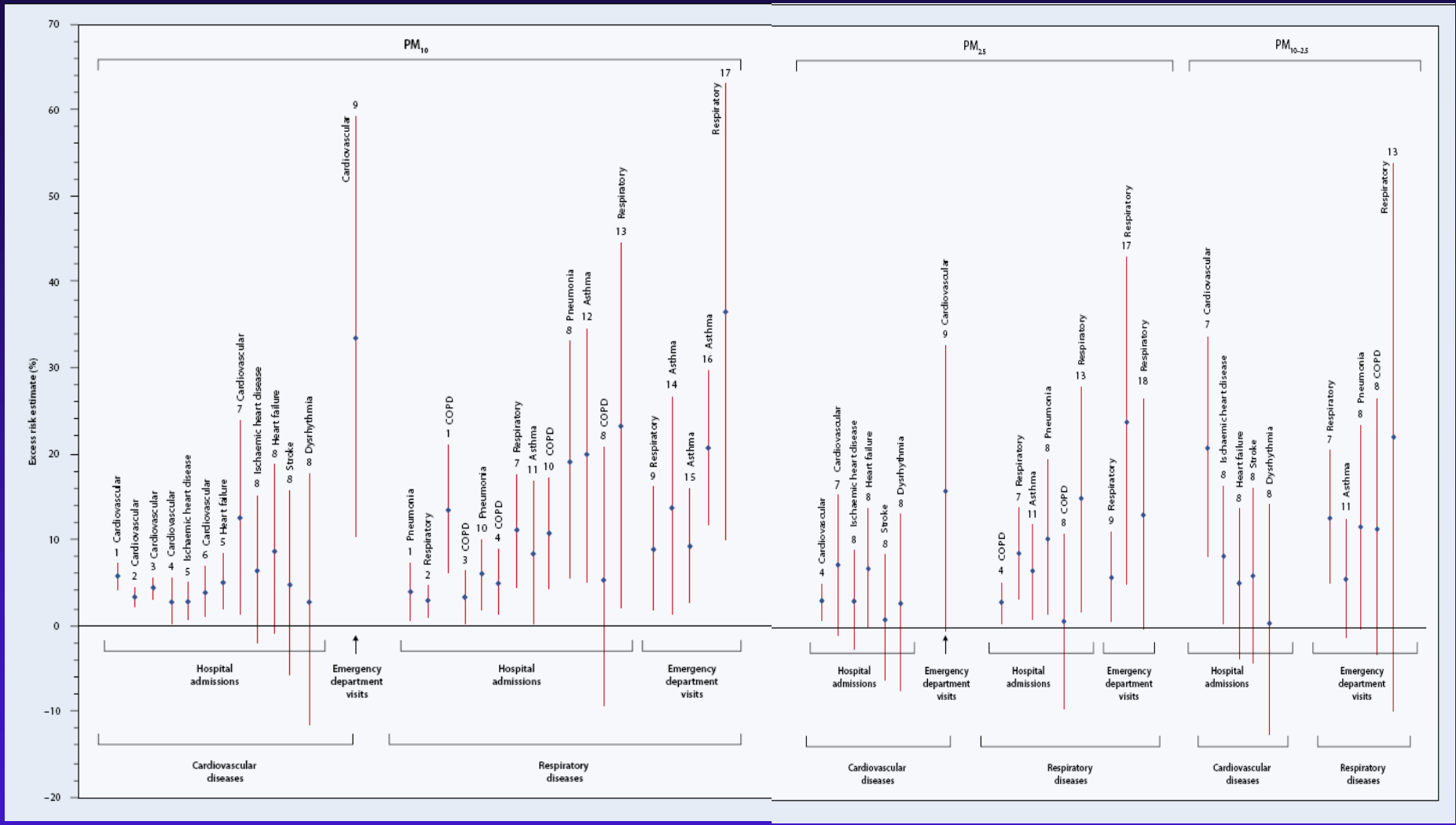
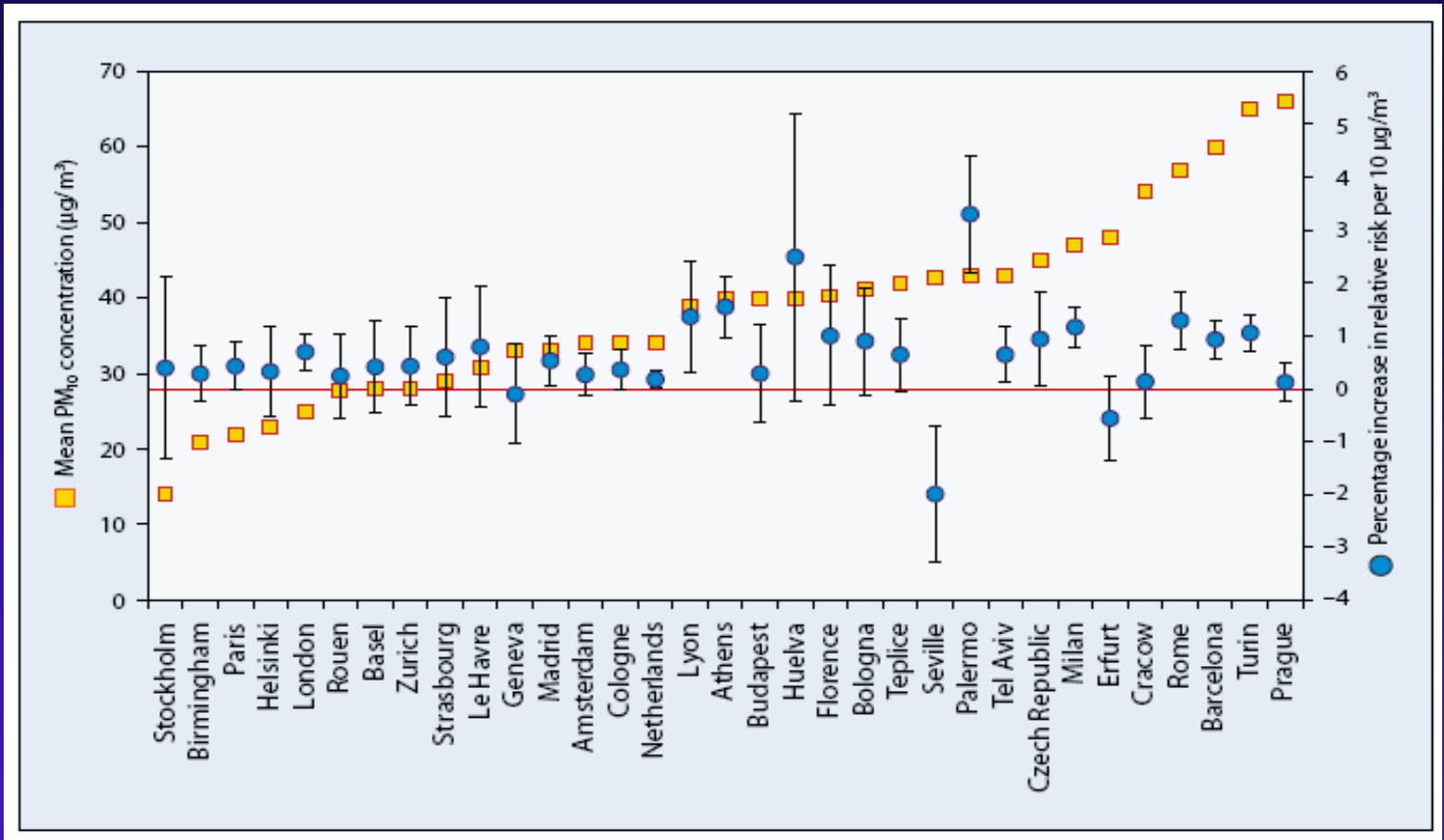
PM excess risk for hospital admissions / emergency department visits for cardiovascular and respiratory diseases (USA, Canada)



Source: US EPA 2005

Percentage increase of all-cause mortality associated with PM_{10} in European cities



Source: Anderson et al. 2004

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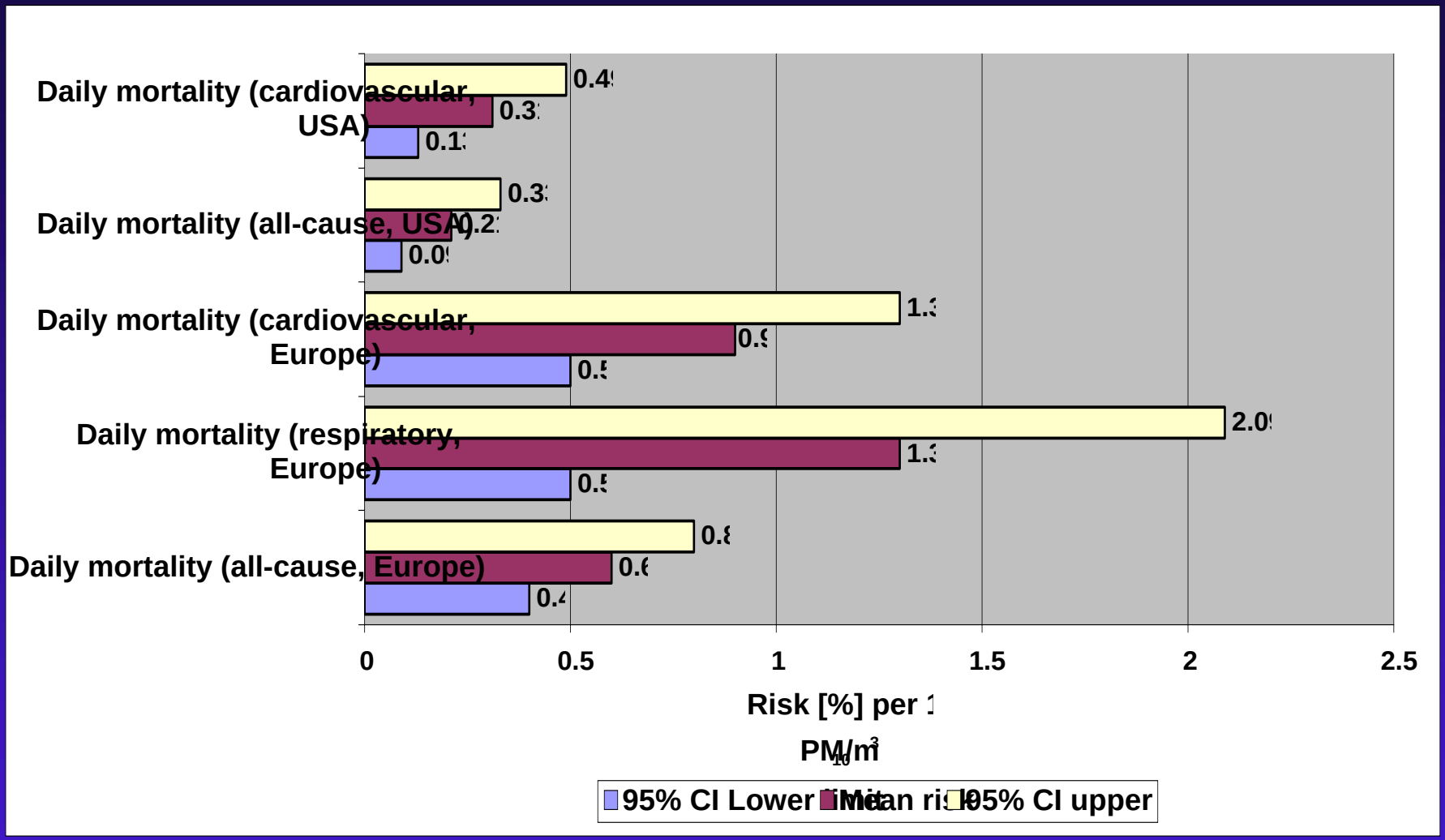
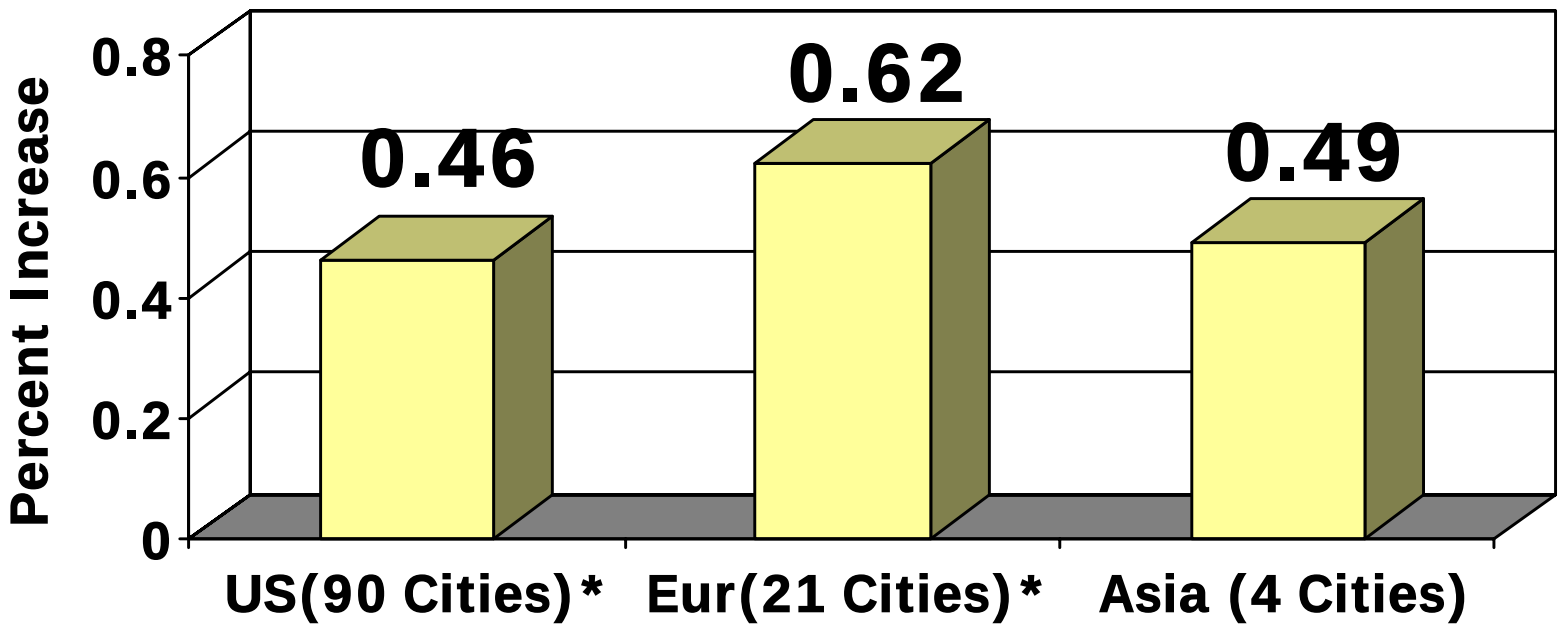
Daily mortality risk estimates for PM_{10} exposure



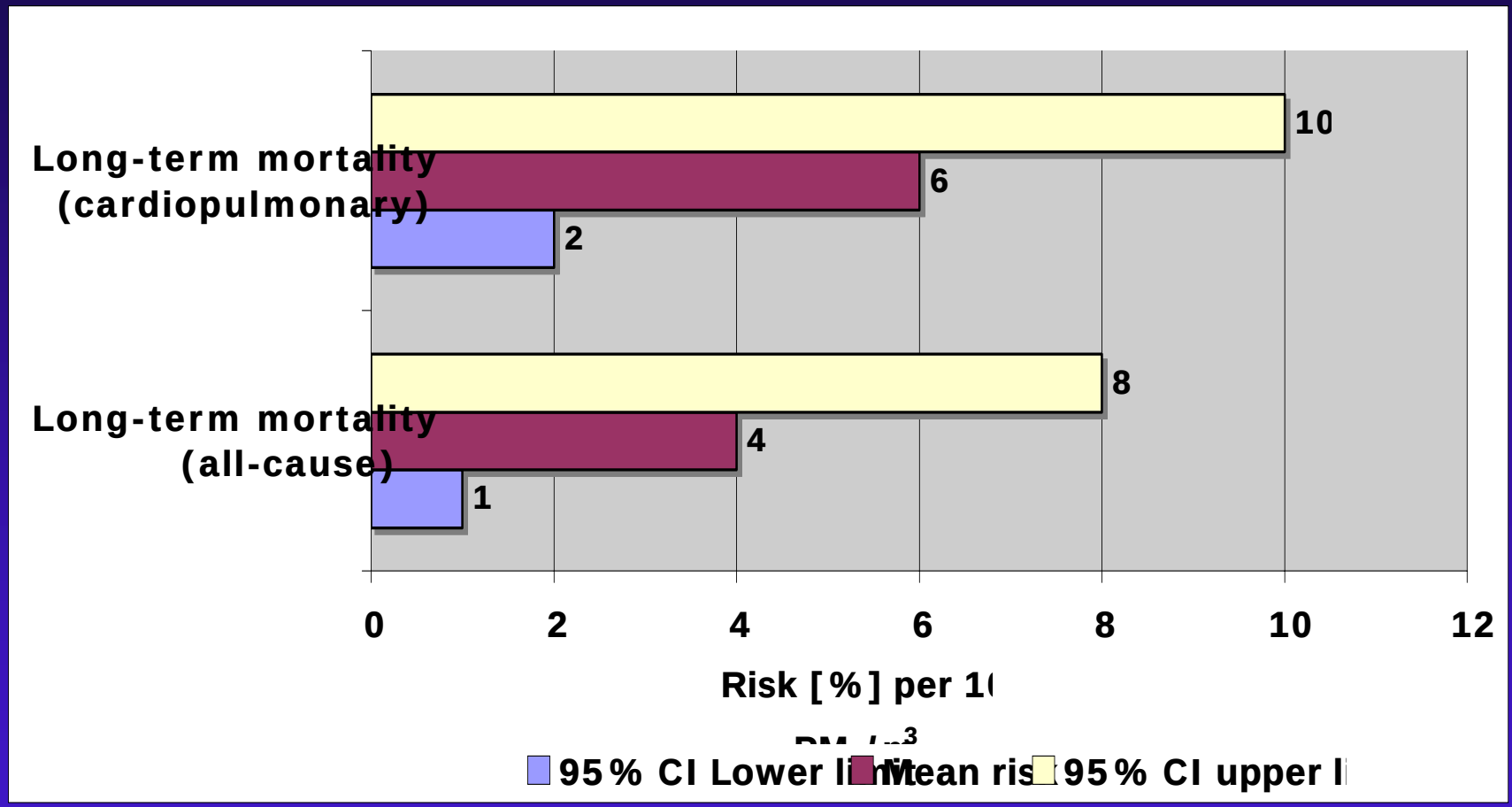
Source: WHO 2006

Daily mortality in Asian, North American and European cities with PM_{10} % increase of 10 μ g/m^3



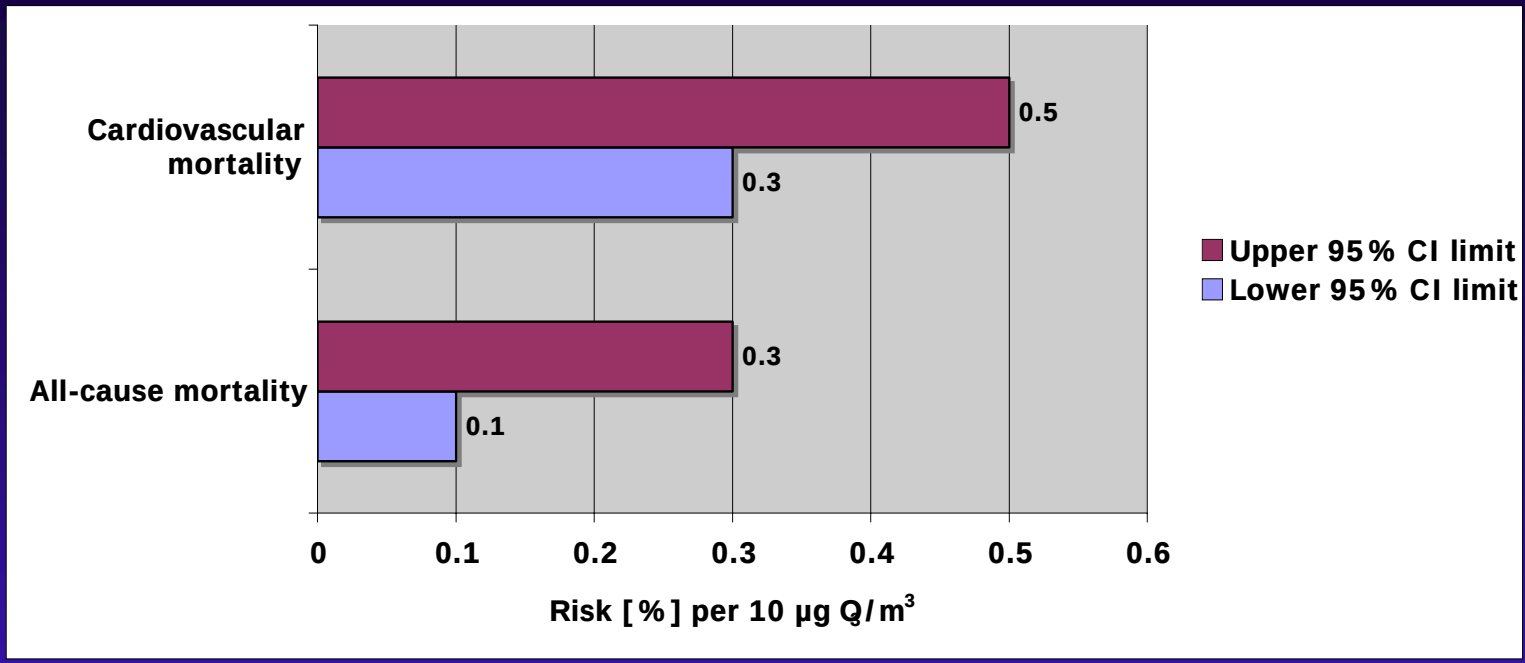
Source: HEI 2004

Long-term mortality risk estimates for PM_{10} exposure in North American cities

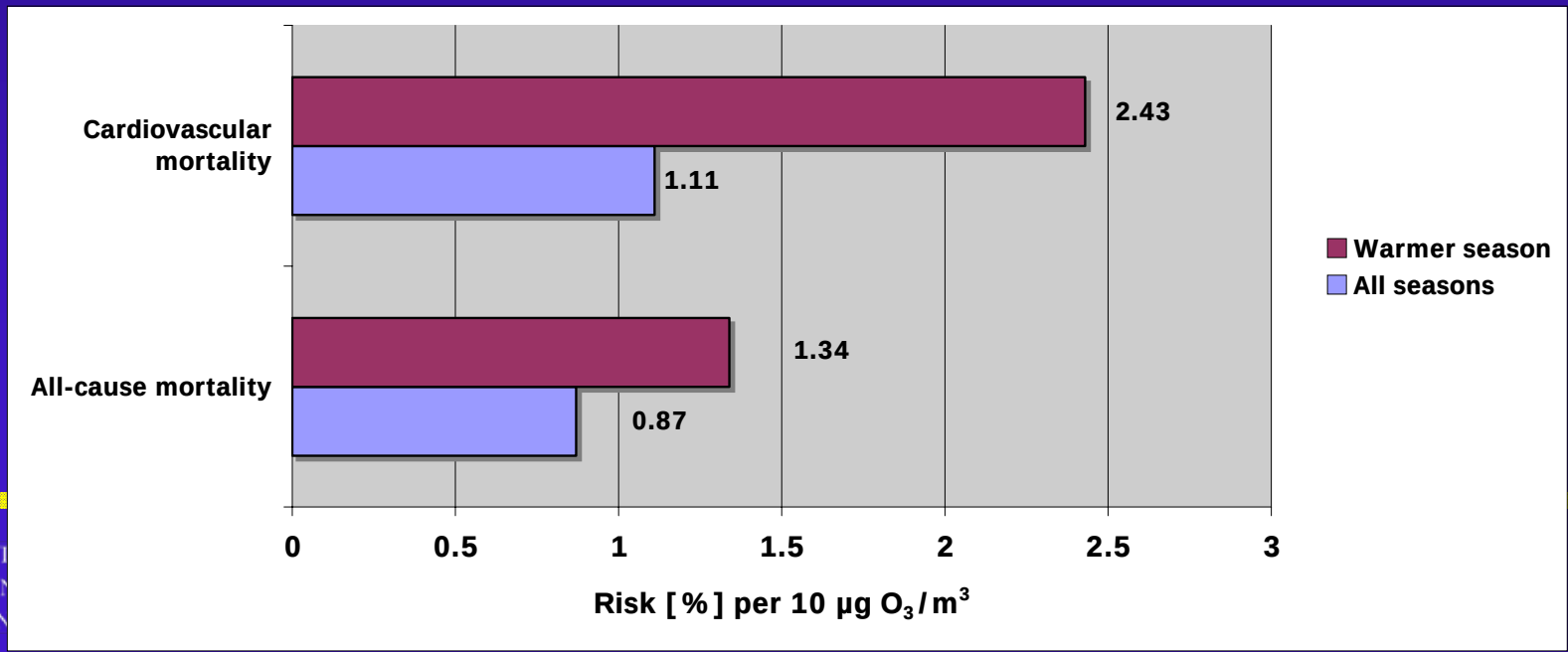


Source: WHO 2006

Short-term mortality risk per 10 μg O_3 / m^3 increase

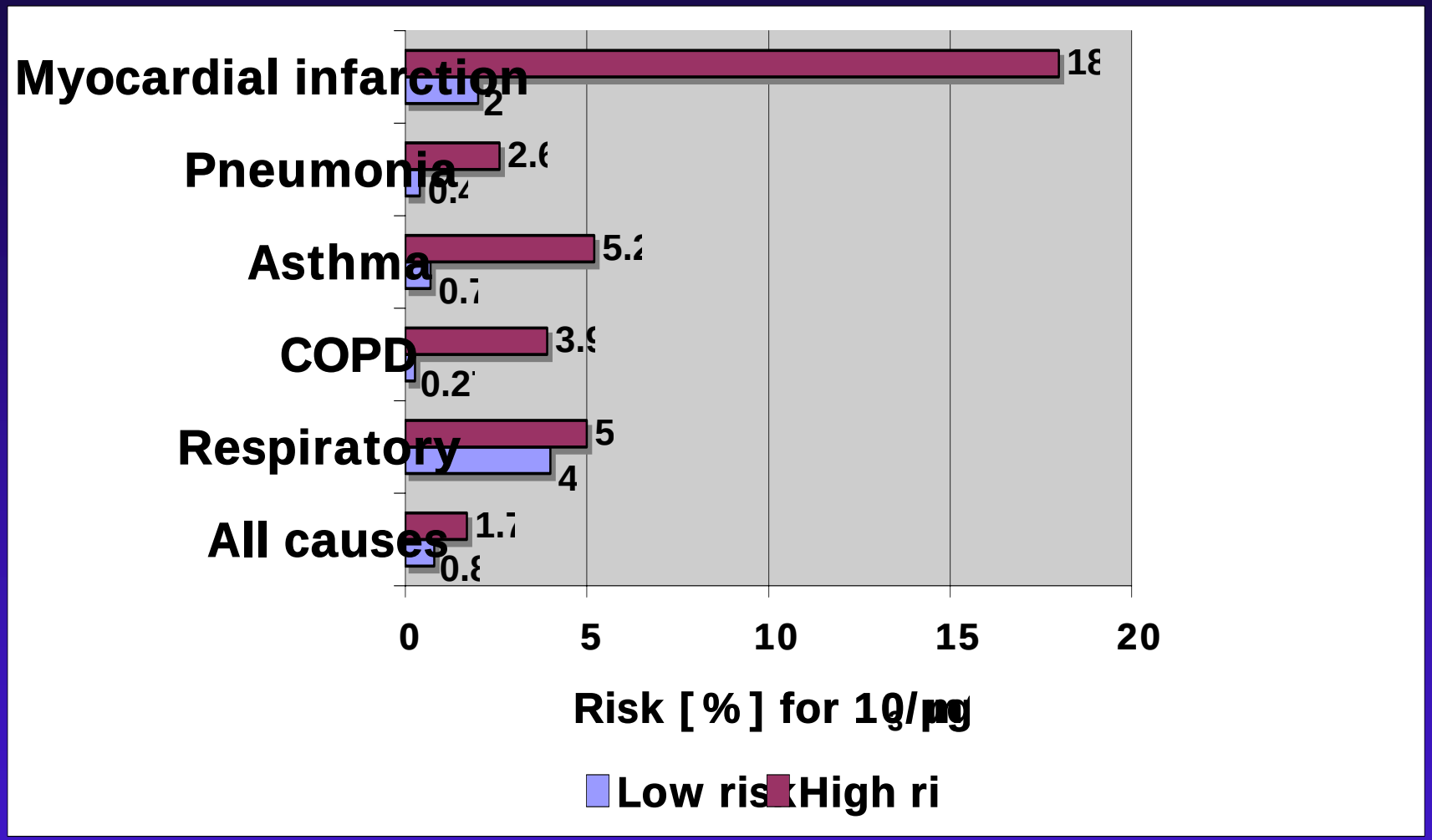


Anderson et al 2004



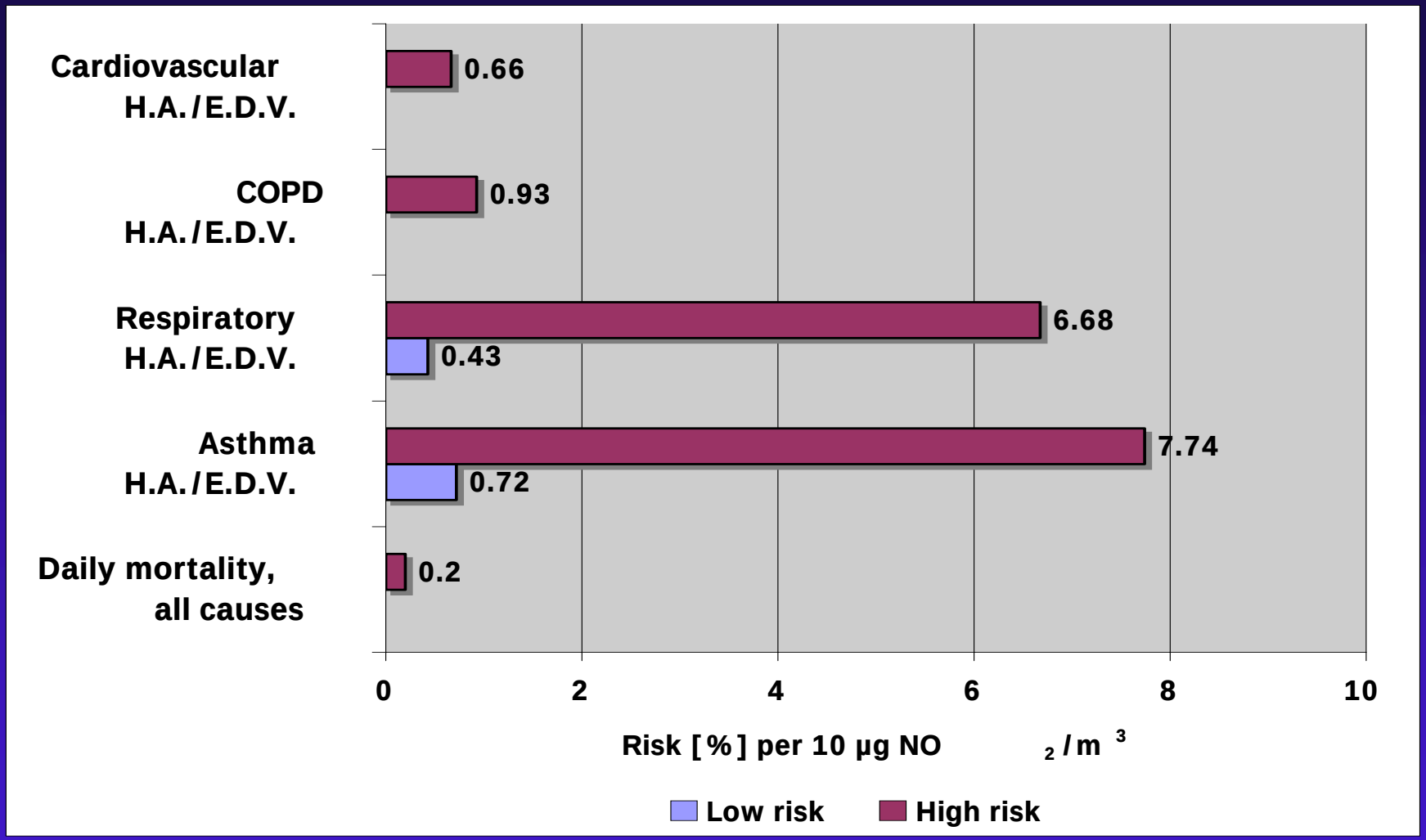
Bell et al 2005

Risk of hospital admissions with 10 μg O_3 / m^3 increase



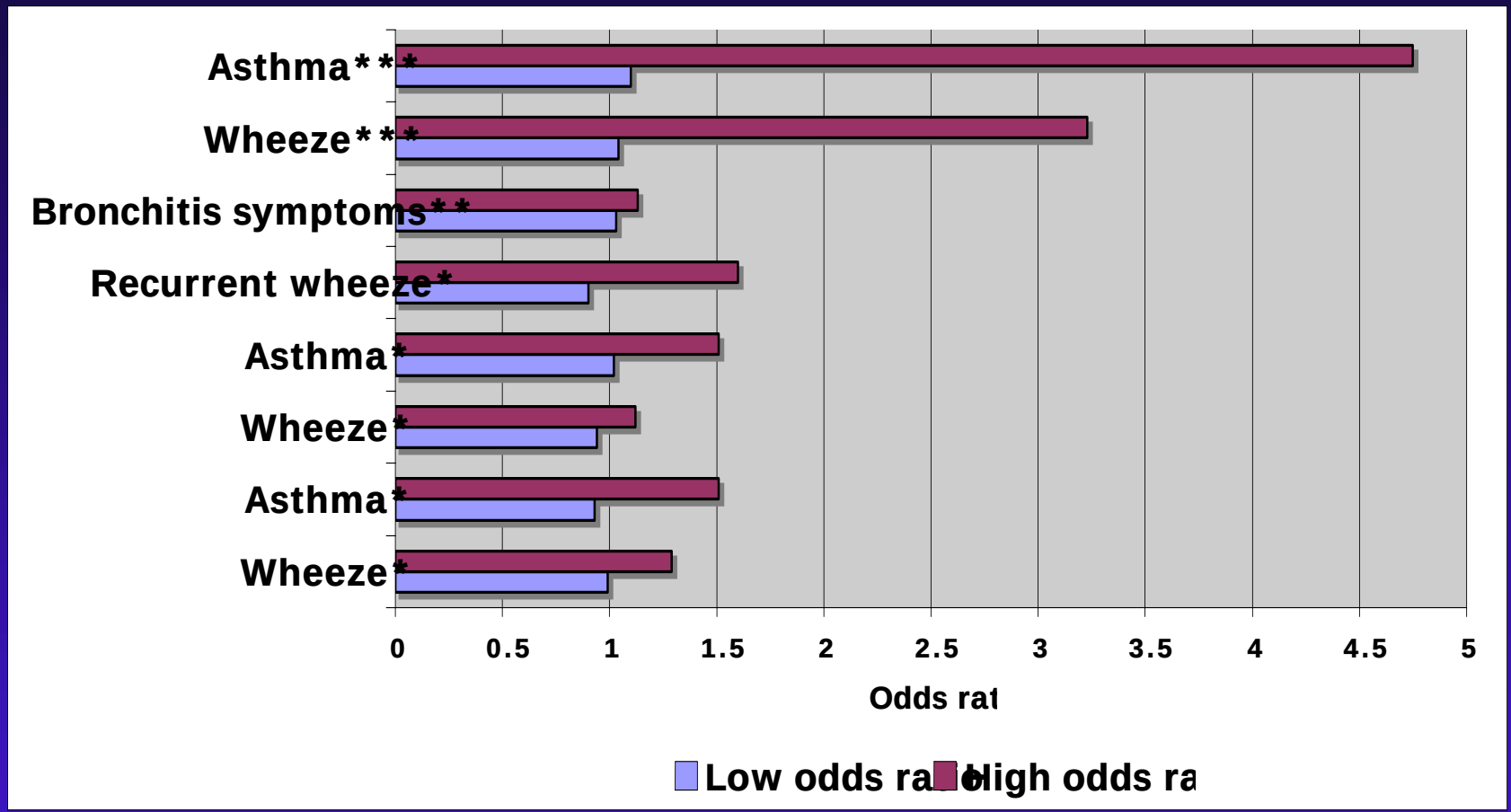
WHO 2006

Short-term risks per 10 μg NO_2 / m^3



WHO 2006

Odds ratios for long-term exposure to NO_2



* Infants < 2 years; NO_2 concentration ≈ 20 μg/m³; Europe

** Pupils 9-13 years; NO_2 concentration ≈ 2 μg/m³; USA

*** Pupils 9-10 years; NO_2 concentration ≈ 20 μg/m³; Japan

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Hong Kong air quality intervention 1990

Before

After

Kwai Tsing

On July 1st 1990 the Environmental Protection Department restricted the sulfur content of fuel to 0.5% by weight

dieter.schwela@sei.se

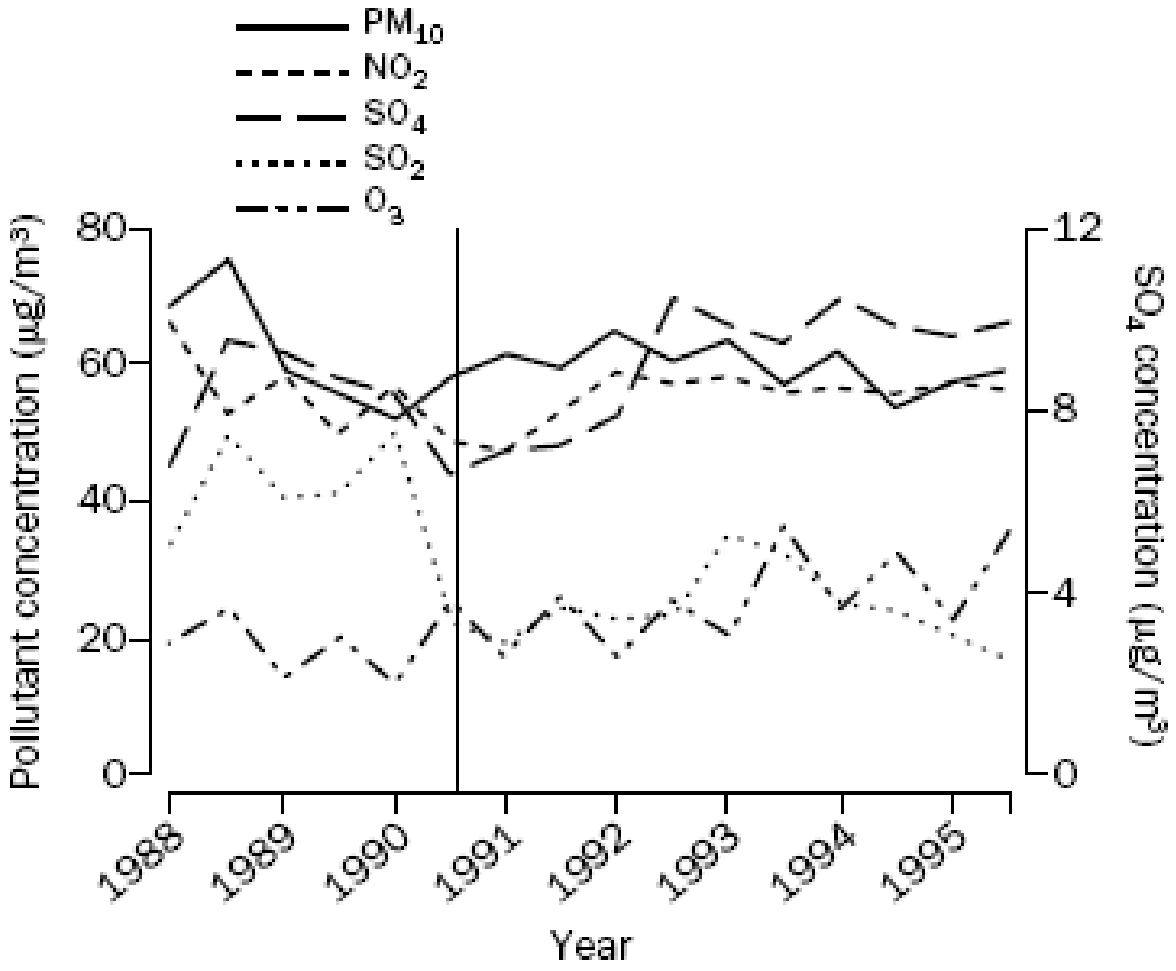


Figure 1: **Average of pollutant concentrations at five monitoring stations**

Vertical line represents date of introduction of fuel regulation.

Intervention study in Hong Kong

After intervention, SO_2 levels declined 50%: from 44 to 21µg/m^3

- **A reduction in SO_2 leads to an immediate reduction in death**
  - **All causes decrease 2.1% (about 600 deaths per year associated with 10268 person-years of life per year)**
  - **Respiratory causes decrease 3.9%**
  - **Cardiovascular causes decrease 2.0%**

- **Average gain in life expectancy per year of exposure to the lower SO_2 concentration level:**
  - **Females: 20 days**
  - **Males: 41 days**
  - **SO_2 consistently associated with mortality, PM_{10} associated with mortality only marginal**

Hedley AJ et al. Lancet 2002, 360: 1646-1652

dieter.schwela@sei.se

WHO air quality guideline values 2006 (2000)

Pollutant	Averaging time	AQG value 2006 (2000) [µg/m³]
$PM_{2.5}$	1 year	10
	24 hours (99-percentile)	25
PM_{10}	1 year	20
	24 hours (99-percentile)	50
O_3	8 hours, daily maximum	100 (120)
NO_2	1 year	40
	1 hour	200
SO_2	24 hours	20 (125)

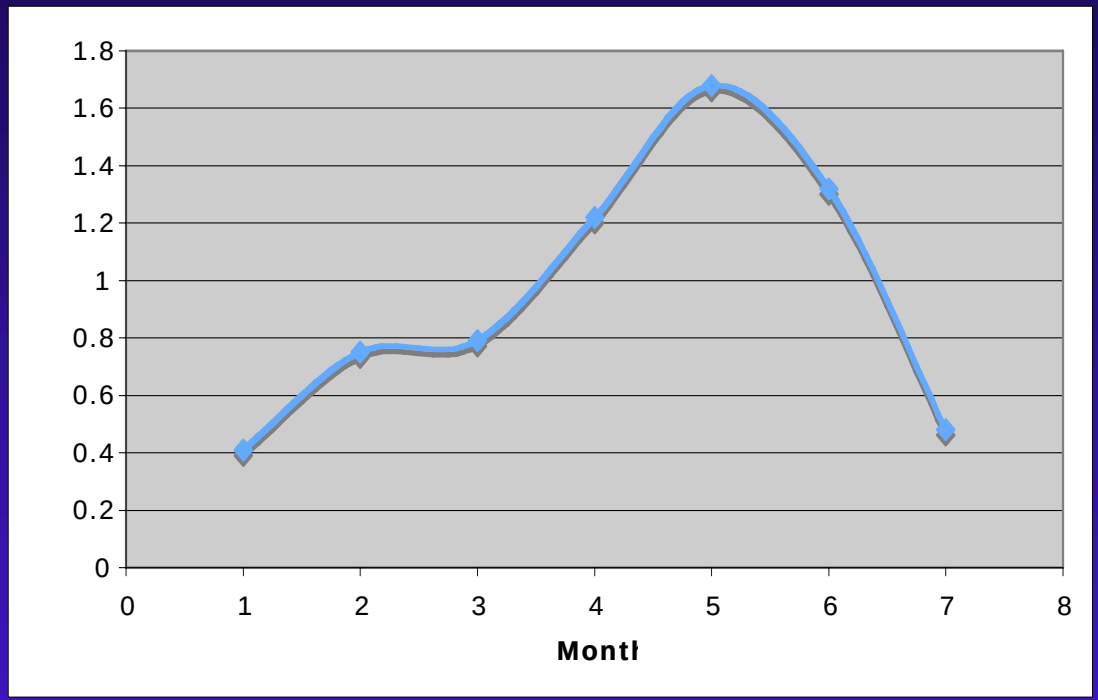
dieter.schwela@sei.se

Health impacts of air pollution in North African countries

Country	Observed/reported health impacts
Algeria	Increase of number of out-patient visits for respiratory reasons
Egypt	Asthma, respiratory diseases, chronic bronchitis, heart disease, cancer
Libya, A, J.	
Mauritania	
Morocco	Asthma
Tunisia	Cancer from Ra indoor exposure

dieter.schwela@sei.se

Benzo[a]pyrene concentrations around a waste deposit in Oued Smar, 13 km east of Algiers, August 2002 - February 2003



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decompressor
are needed to see this picture.

Unit risk BaP: $8.6 \cdot 10^{-5}/(ng/m^3)$

Source: Ladji et al., 2007

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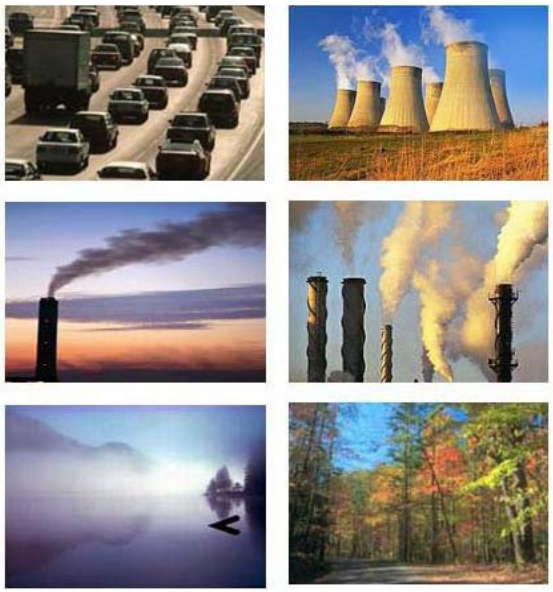
CAFE CBA: Baseline Analysis 2000 to 2020



April 2005

Service Contract for Carrying out Cost-Benefit Analysis of Air Quality Related Issues, in particular in the Clean Air for Europe (CAFE) Programme

End point	Pollutant
Acute Mortality	O_3
Respiratory hospital admissions	O_3
Minor Restricted Activity Days (MRADs)	O_3
Respiratory medication Use (Children)	O_3
Respiratory medication Use (Adults)	O_3
Cough and LRS (children)	O_3
Chronic mortality *	PM_{10}
Infant mortality	PM_{10}
Chronic bronchitis	PM_{10}
Respiratory hospital admissions	PM_{10}
Cardiac hospital admissions	PM_{10}
Restricted activity days (RADs)	PM_{10}
Respiratory medication Use (children)	PM_{10}
Respiratory medication Use (adults)	PM_{10}
LRS (including cough) among children	PM_{10}
LRS among adults with chronic symptoms	PM_{10}

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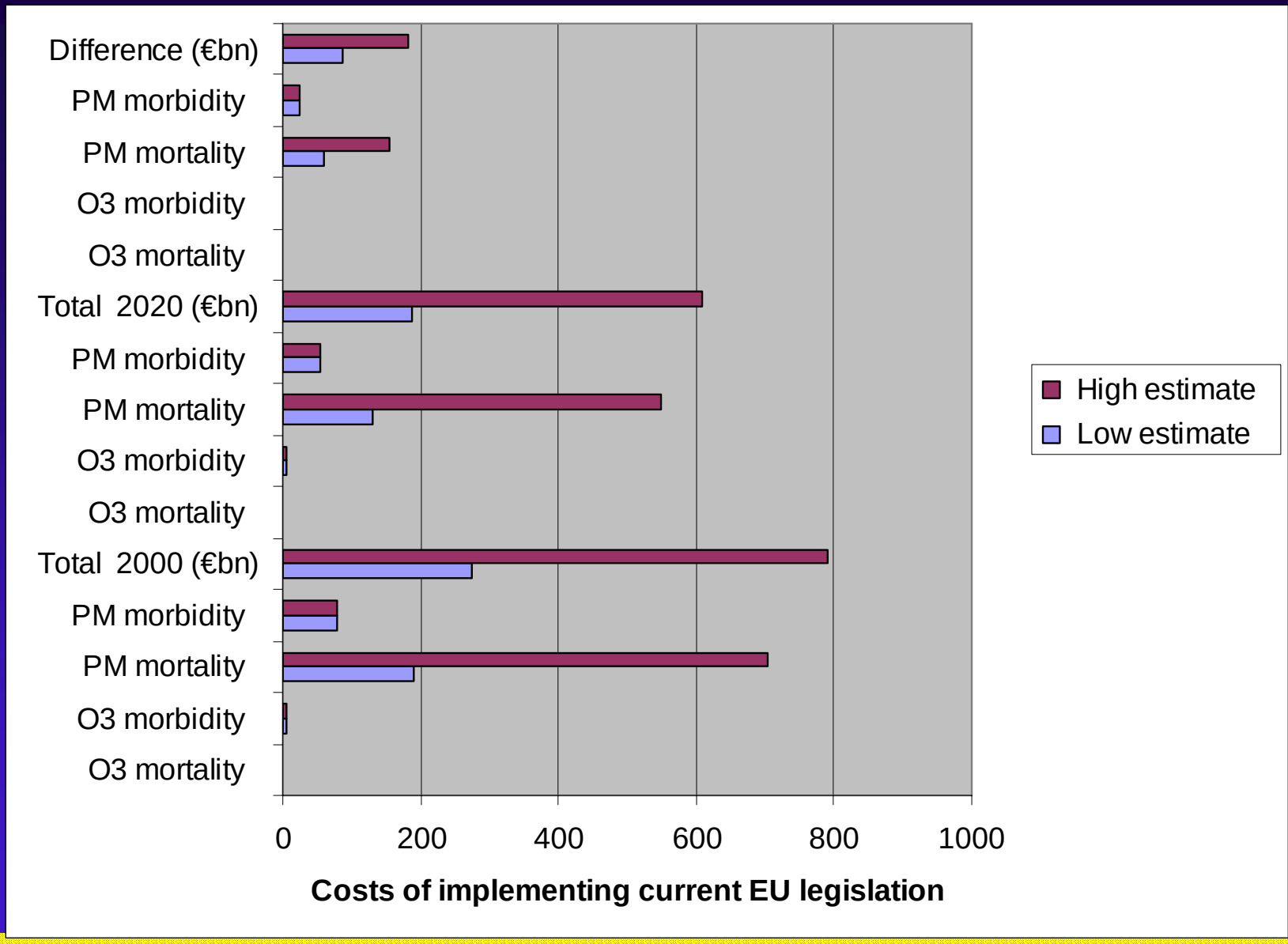
Difference (€bn)
PM morbidity
PM mortality
O3 morbidity
O3 mortality
Total 2020 (€bn)
PM morbidity
PM mortality
O3 morbidity
O3 mortality
Total 2000 (€bn)
PM morbidity
PM mortality
O3 morbidity
O3 mortality
0
200
400
600
800
1000
High estimate
Low estimate
Costs of implementing current EU legislation

Another example of health costs:

Quah and Boon (2003) estimated the economic costs of air pollution using exposure-response relationships relating mortality and morbidity due to particulate matter to amount to

US$ 3,662 million,

in 1999, corresponding to

4.3 per cent

of Singapore's GDP.

dieter.schwela@sei.se

Way forward for North African countries

Policy makers should

- **recognize that there exist substantial risks of excess mortality and morbidity from exposure to PM, O_3, NO_2, and SO_2**
- **not ignore the link between economic development, environment and health**
- **not ignore the environment in pursuit for economic progress**

As we approach the 21st century, it is imperative that we change our general attitude towards the environment, … deal seriously with these problems and enforce environmental laws and regulations strictly, without reluctance and hesitation.

Hosny Mubarak, 1997

dieter.schwela@sei.se

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dieter.schwela@sei.se

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