# Urban Air Pollution and Health

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**and**

**Swiss School of Public Health+**

Chairperson Swiss Commission on Air Hygiene

## Smog episodes:

Reflexion of light and warm radiation,
warming of atmosphere

⟶ Inversion

Urban mix of pollutants: PM, NOx ,CO, Ozon
$SO_2$ affect health of population

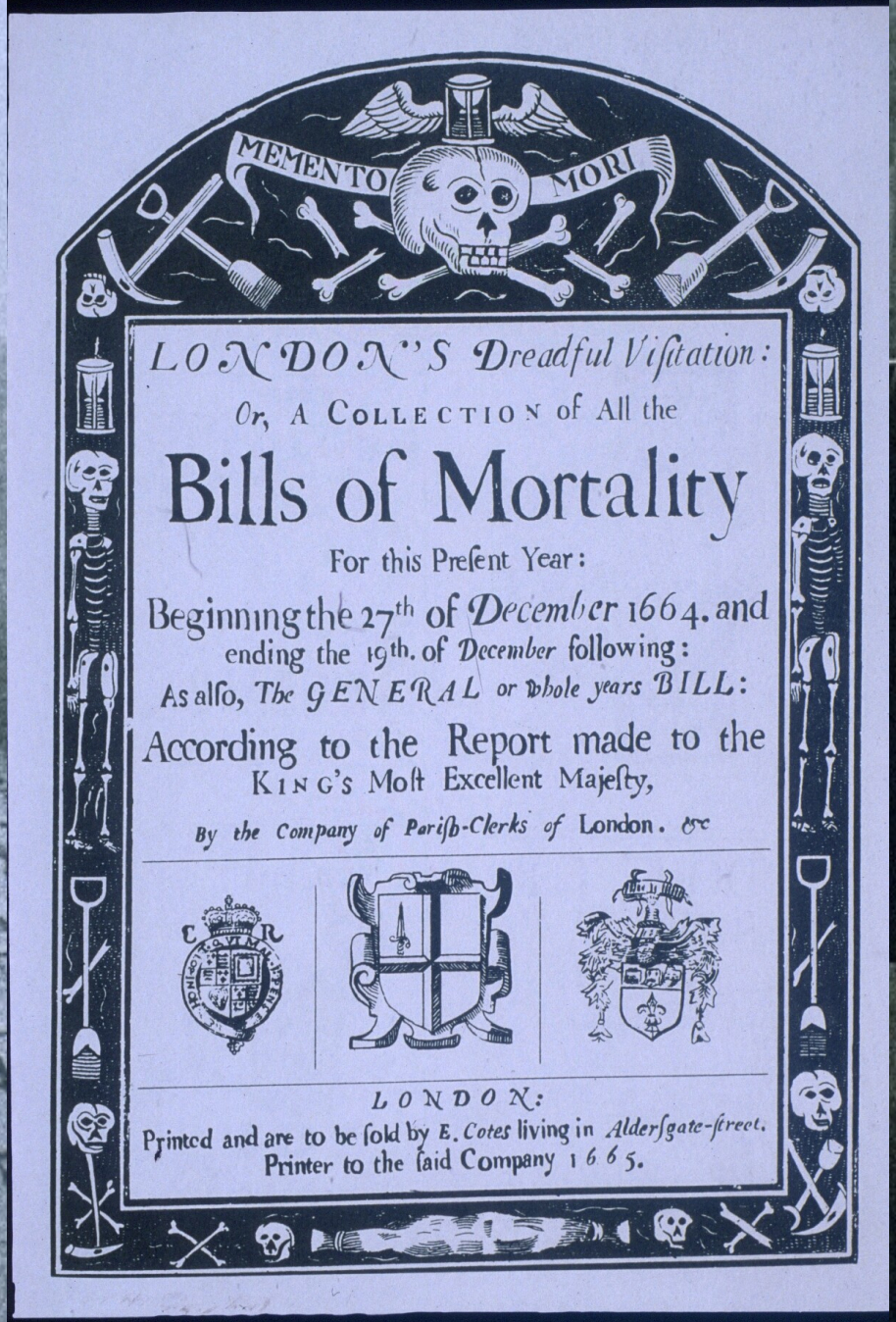
Arnold Böcklin: Die Pest

Kunstmuseum Basel


IVECO
IVECO


London 1952

London 1952




LONDON'S Dreadful Viſitation:

Or, A COLLECTION of All the

# Bills of Mortality

For this Preſent Year:

Beginning the 27th of December 1664. and ending the 19th. of December following:

As alſo, The GENERAL or Whole years BILL:

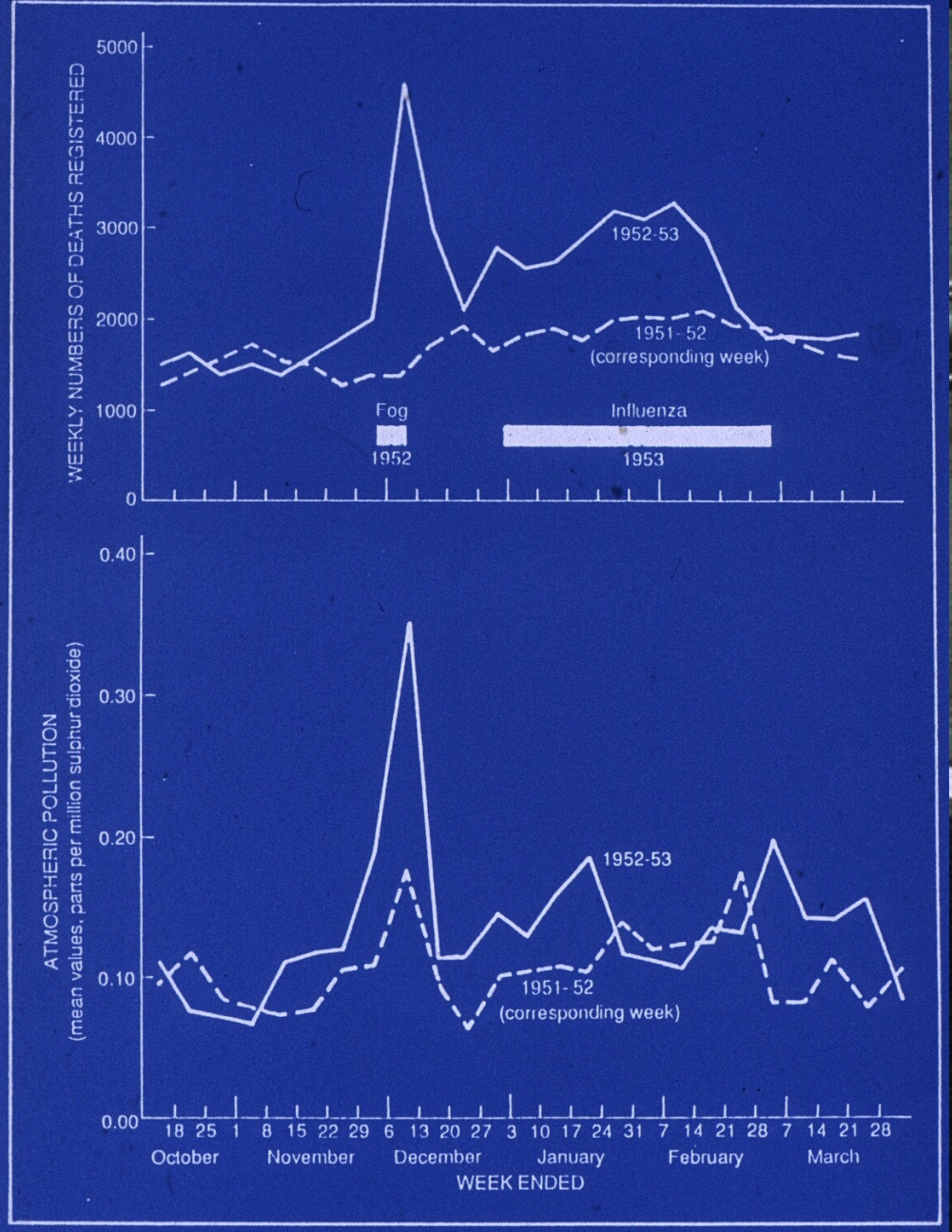
According to the Report made to the KING'S Moſt Excellent Majeſty,

By the Company of Pariſh-Clerks of London. &c

LONDON:

Printed and are to be ſold by E. Cotes living in Alderſgate-ſtreet. Printer to the ſaid Company 1665.

London 1952

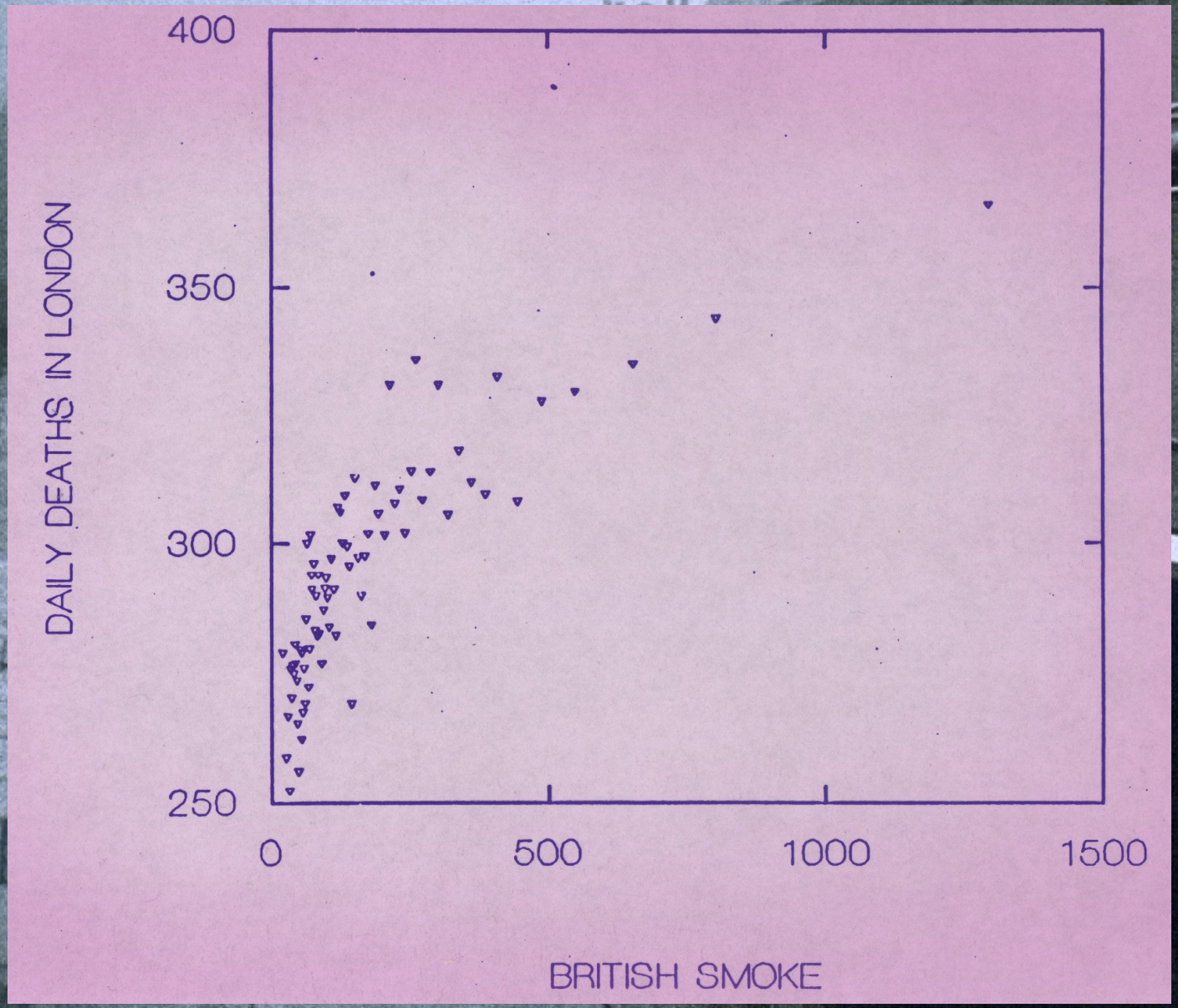



*(From Morris JN: Uses of Epidemiology, 2nd edt. Edinburgh: Livingstone, 1964, p 200.)*

# The Consequence

- Clean Air Act removed visible particulates and Sulfur Dioxide
- Invisible gaseous pollutants and smaller particulates increased

London 1952



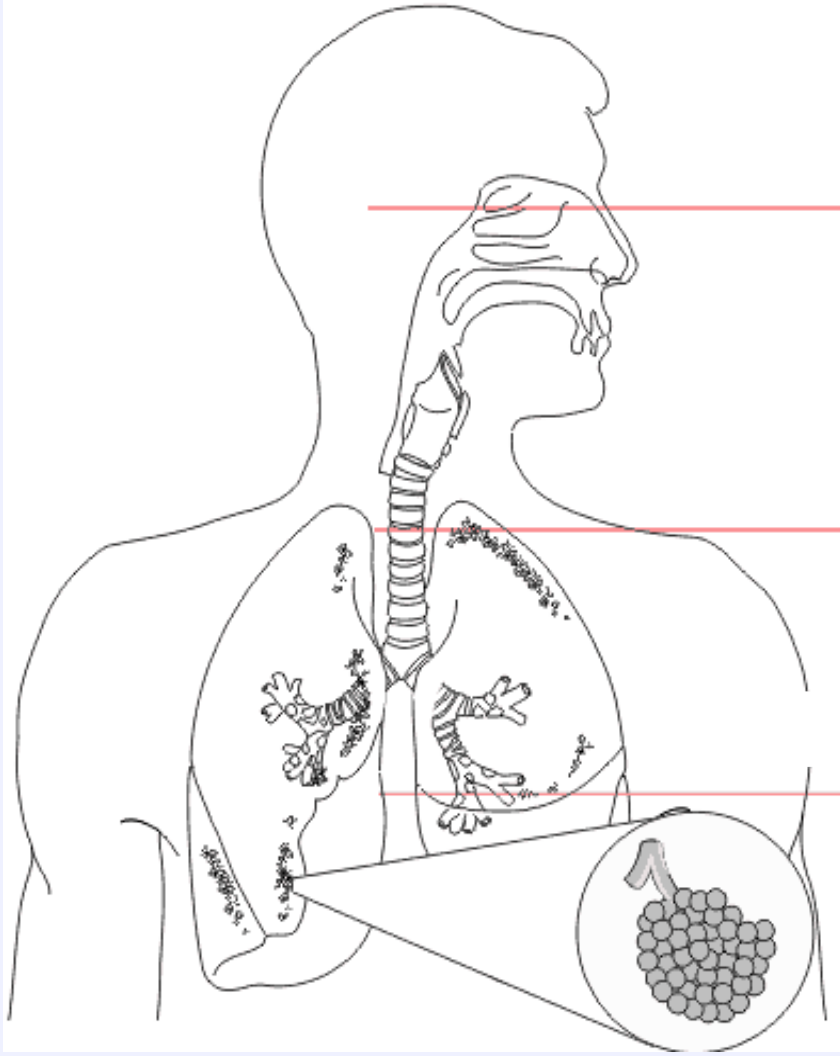

Reanalysis
Schwartz 1989

Studies on short term health effects of urban air pollution now concentrated on effects of particulates with a diameter of less than 10 µm

Arnold Böcklin: Die Pest

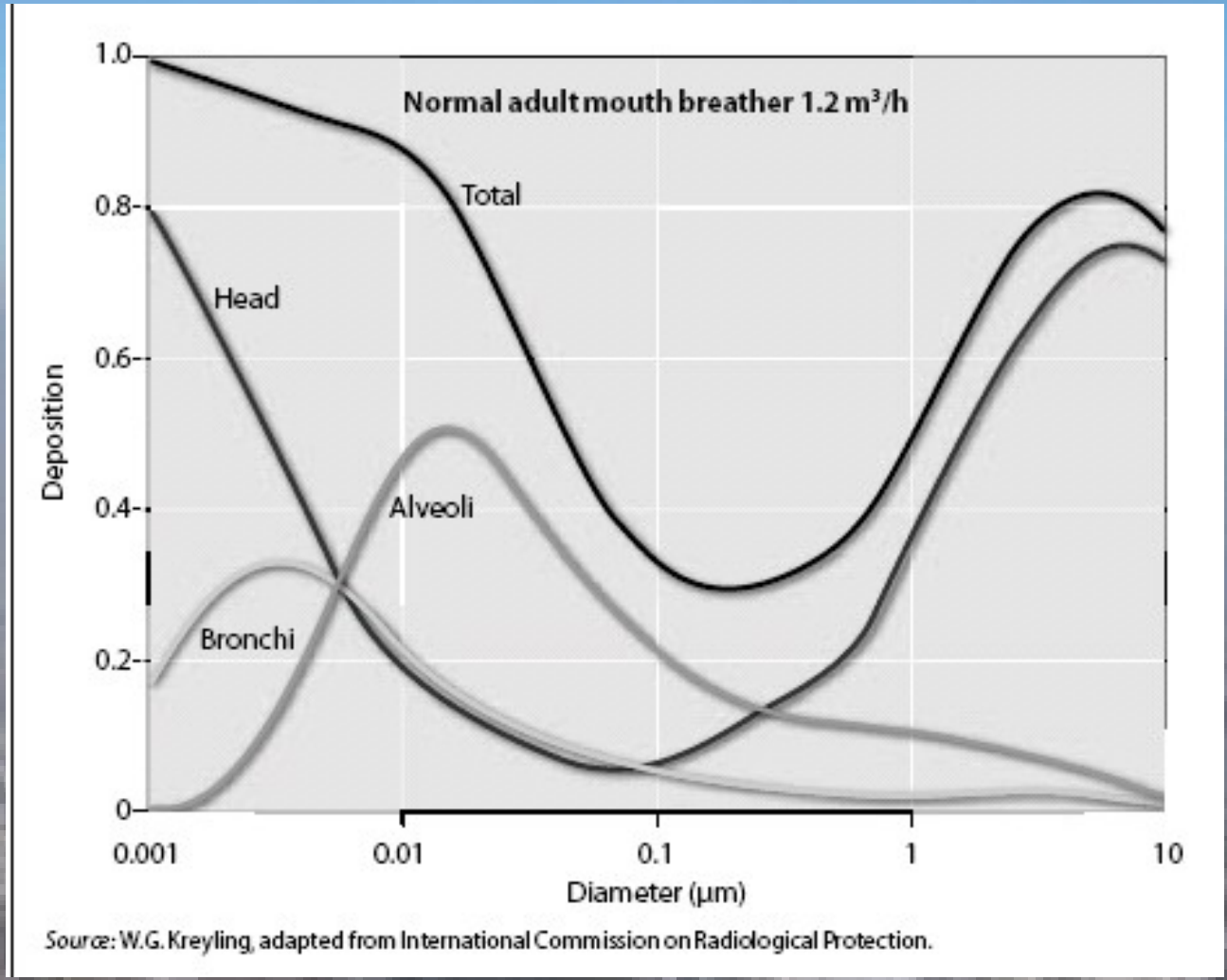
Kunstmuseum Basel

# Deposition of particles in different parts of the respiratory system

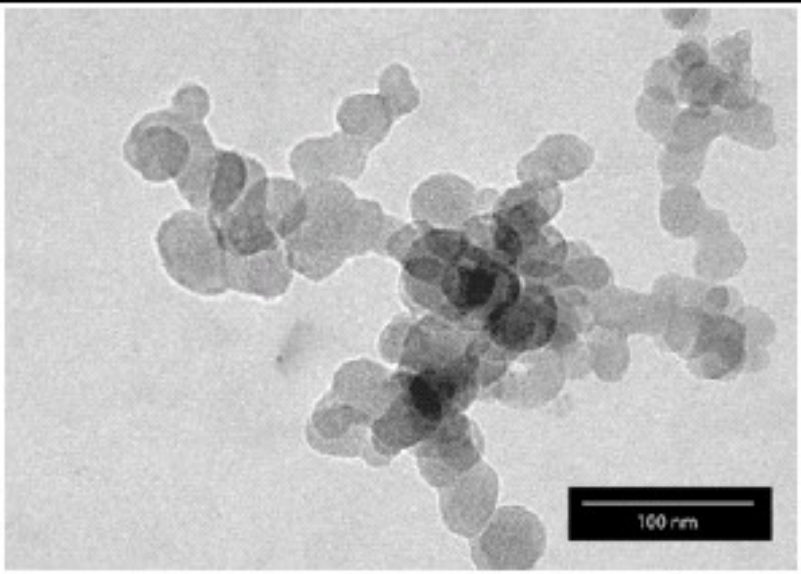


| | Particle size µm |
|---|---|
| Nose and throat | 5-10 |
| Upper airways | 3- 5 |
| Bronchi | 2 -3 |
| Bronchiols | 1-2 |
| Alveoli | 0,1-1 |

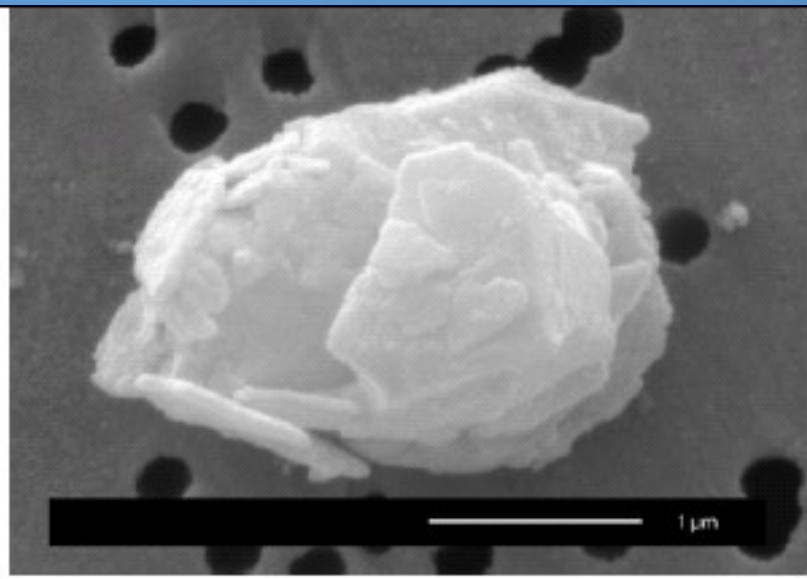
# Deposition of particles in different parts of the respiratory system

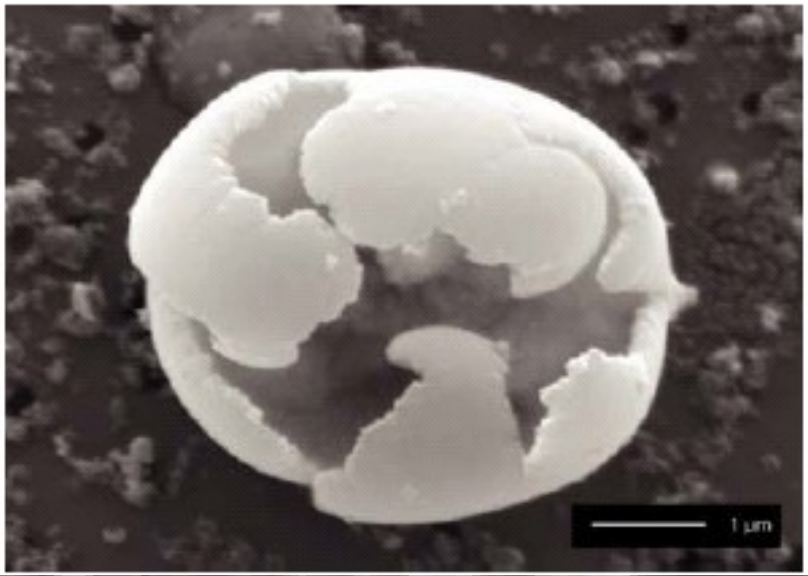



Source: W.G. Kreyling, adapted from International Commission on Radiological Protection.

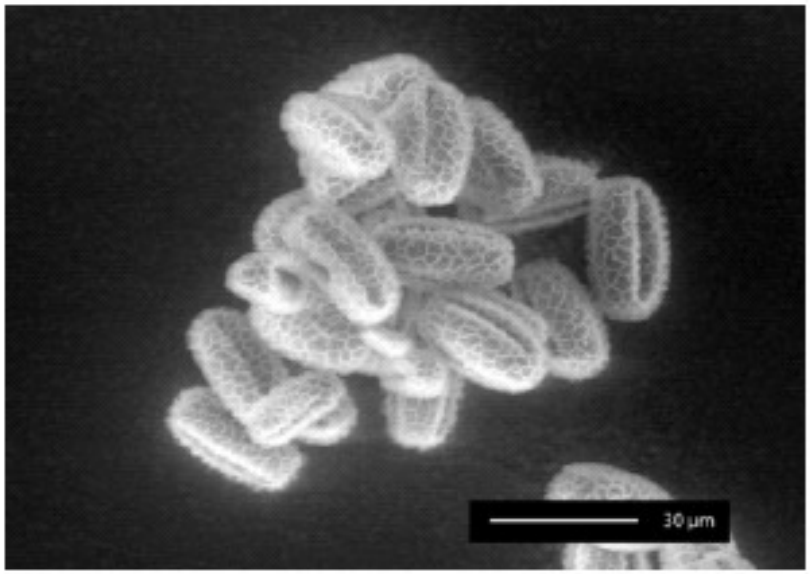



b)



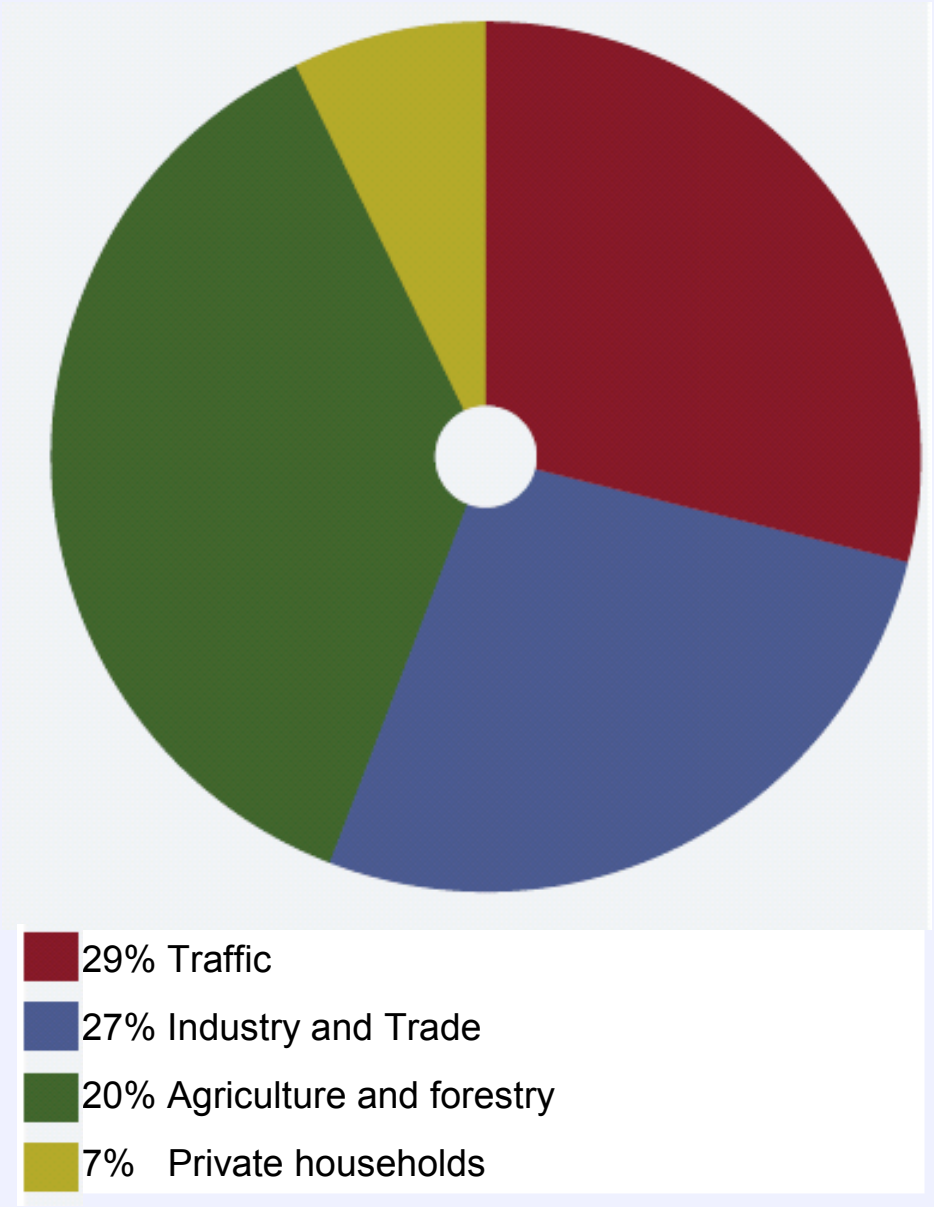

d)





Summer Smog: Ozone, Particulates ,
Nitrogen Dioxide :
The “Culprits”

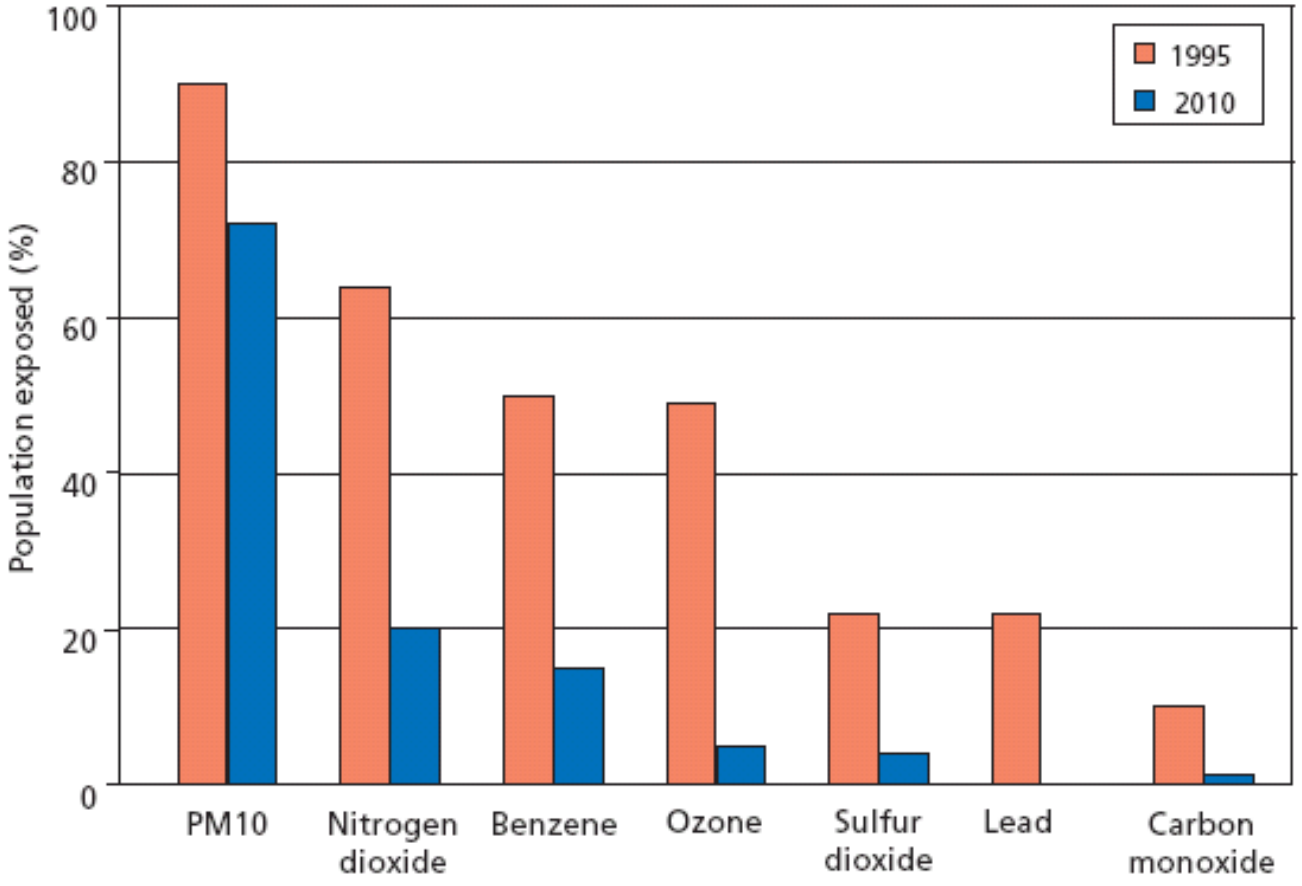
# Sources of PM 10 in Switzerland



Construction work –mainly in urban areas

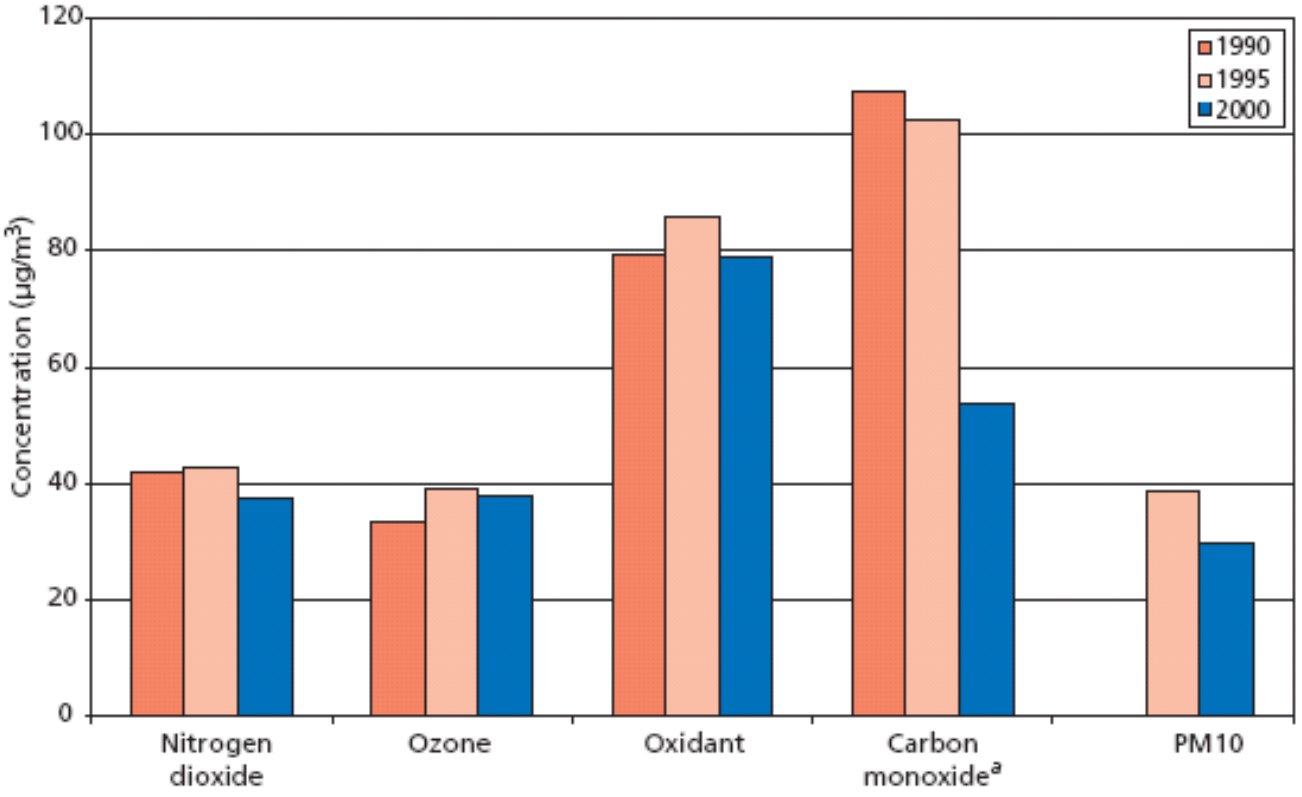
# The Population Exposure

Fig. 2.6. Percentage of urban population in Europe living in background areas exposed to pollutant levels not in compliance with EU standards, 1995 and 2010 (projected)




*Source:* EEA (2001).

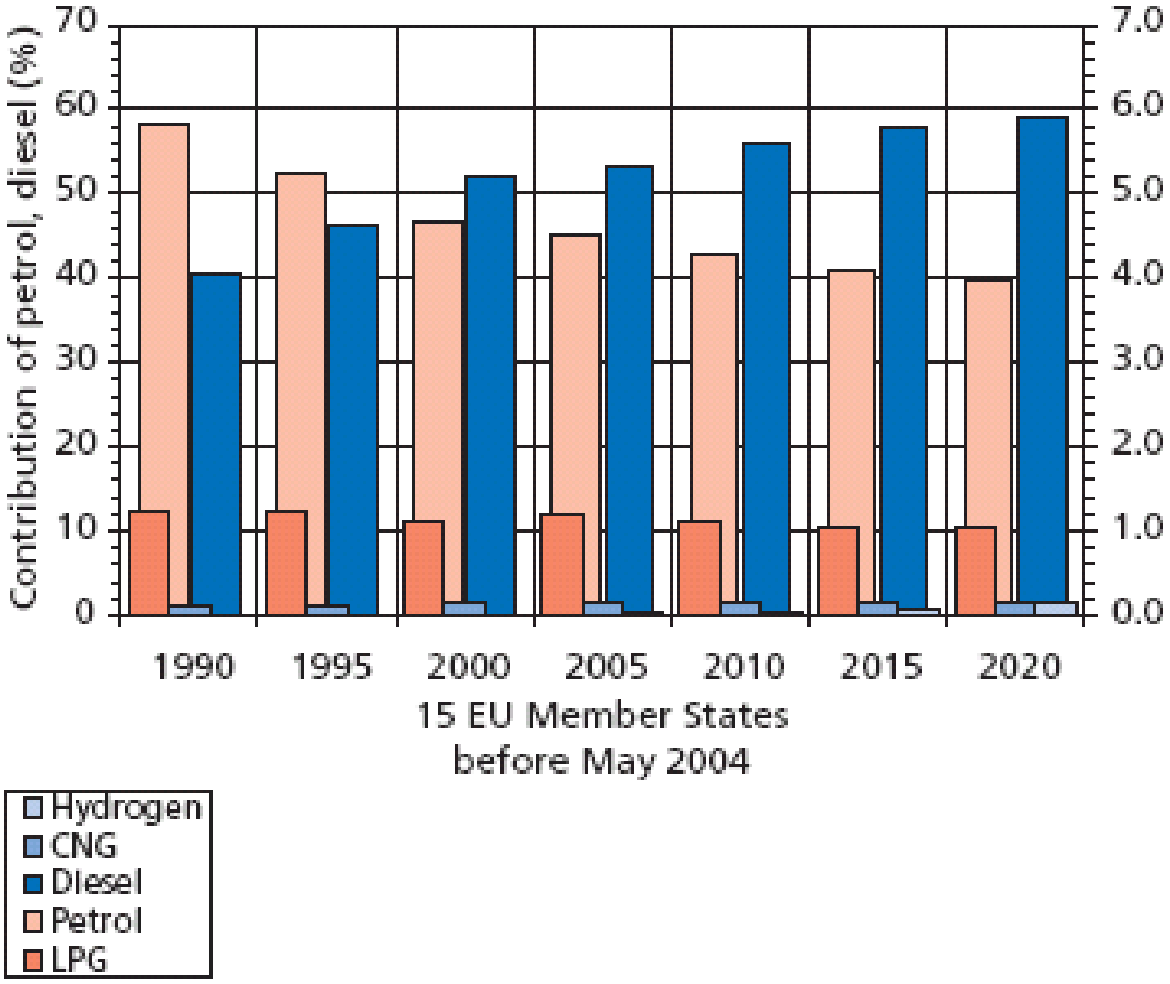
Fig. 2.5. Annual average concentrations of nitrogen dioxide, ozone, oxidant, carbon monoxide and PM10 at urban background locations in Athens, Berlin, London, Utrecht and Prague, 1990, 1995 and 2000




[a] The scale for carbon monoxide extends to 1000, so carbon monoxide concentrations are presented in tens of µg/m³.

*Source:* ETC/ATC (2003).

# Development of contribution of different sources

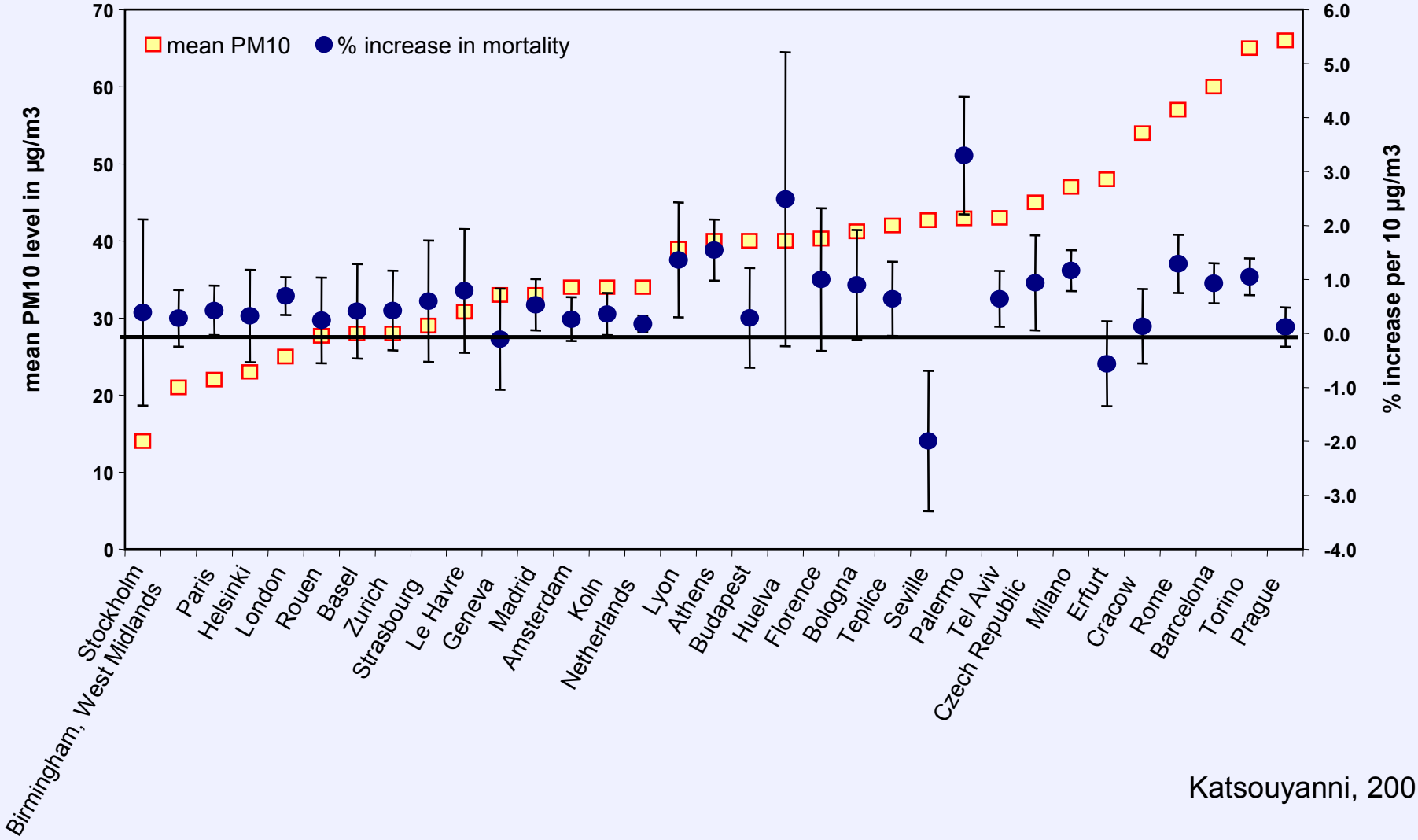



*Note.* LPG = liquified petroleum gas; CNG = compressed natural gas.

*Source:* CAFE (2002).

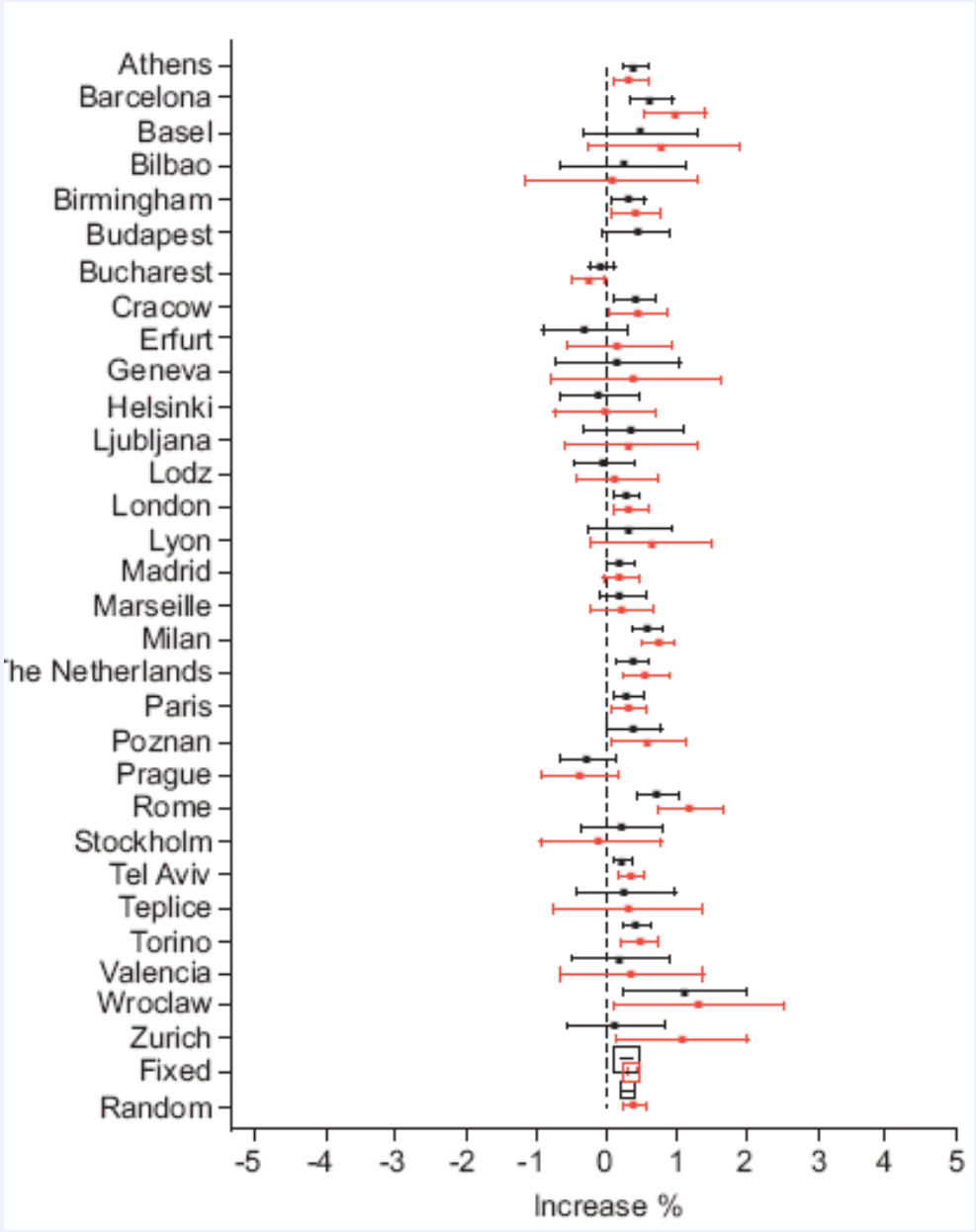
# Short Term Effects of Urban Air Pollution on Health

# Short-term Increase in Particulates and Mortality in European Cities
## APHEA Study




Katsouyanni, 2001

# Short-term Increase in Nitrogen Dioxide and Total Mortality in European Cities
## APHEA Study




Samoli 2006

# Lag between Increase in Nitrogen Dioxide and Total Mortality in European Cities APHEA Study

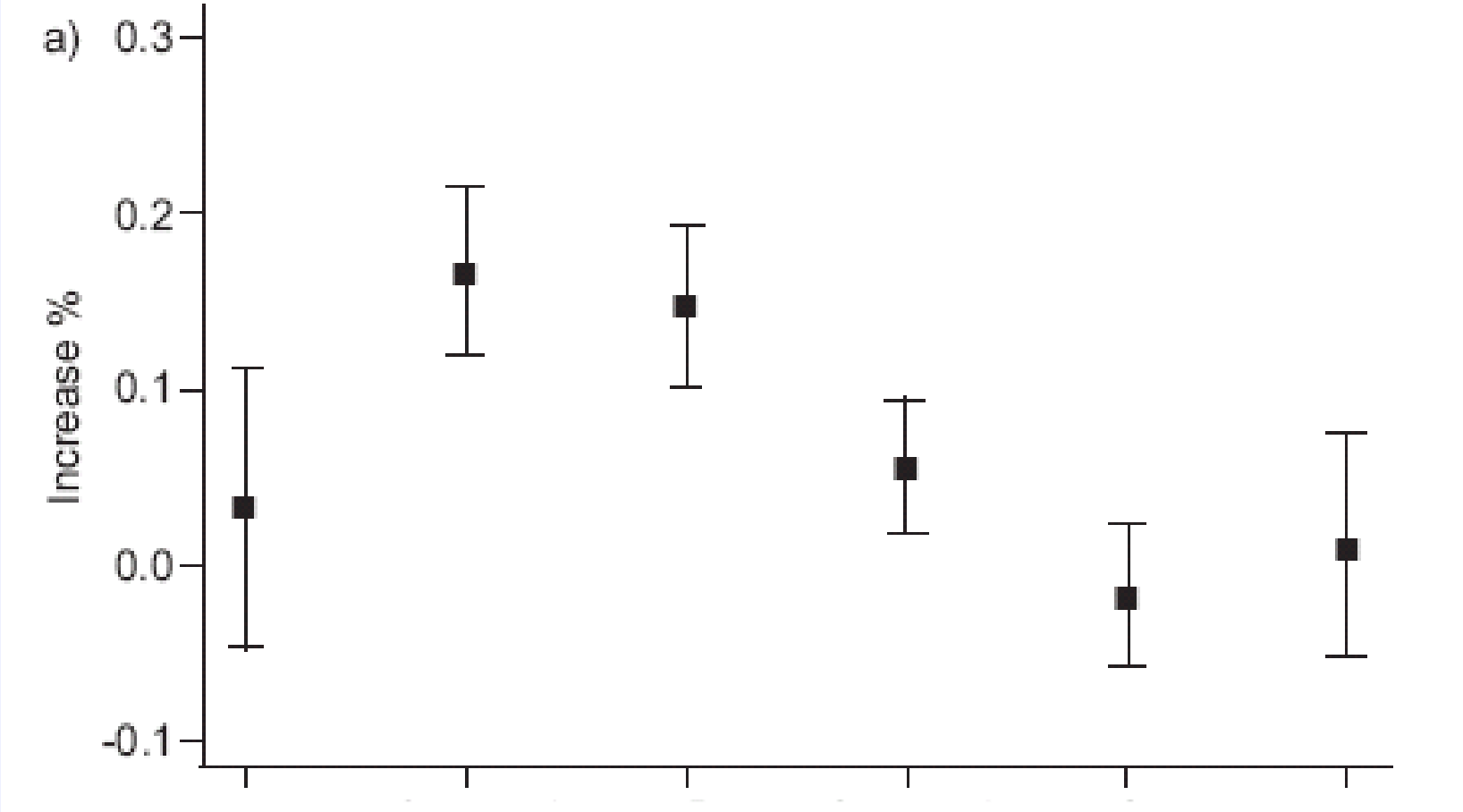



**FIGURE 4.** Shape of the association of a) total / mortality with nitrogen dioxide over 6 days (lags 0–5) summarised over all cities using a cubic polynomial distributed lag model.

Samoli ,2006

# Long Term Effects of Urban Air Pollution on Health

**American Cancer Society Cohort**

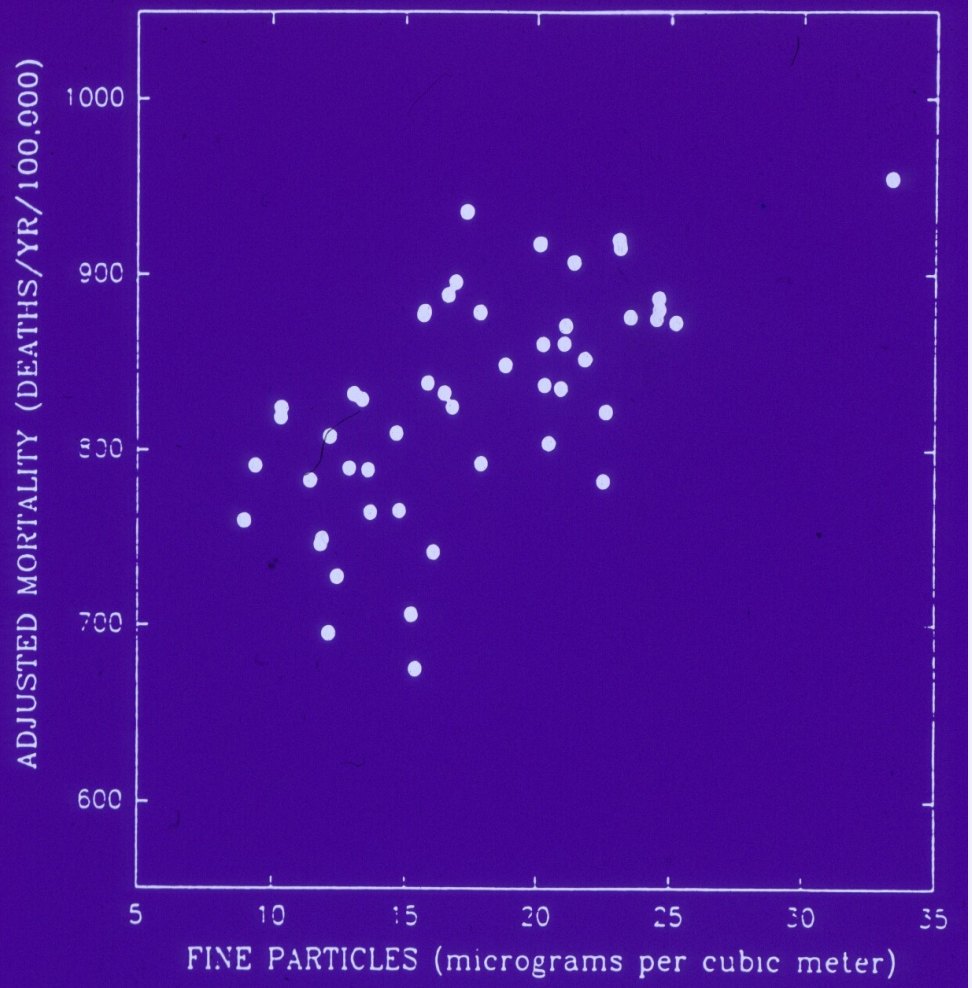
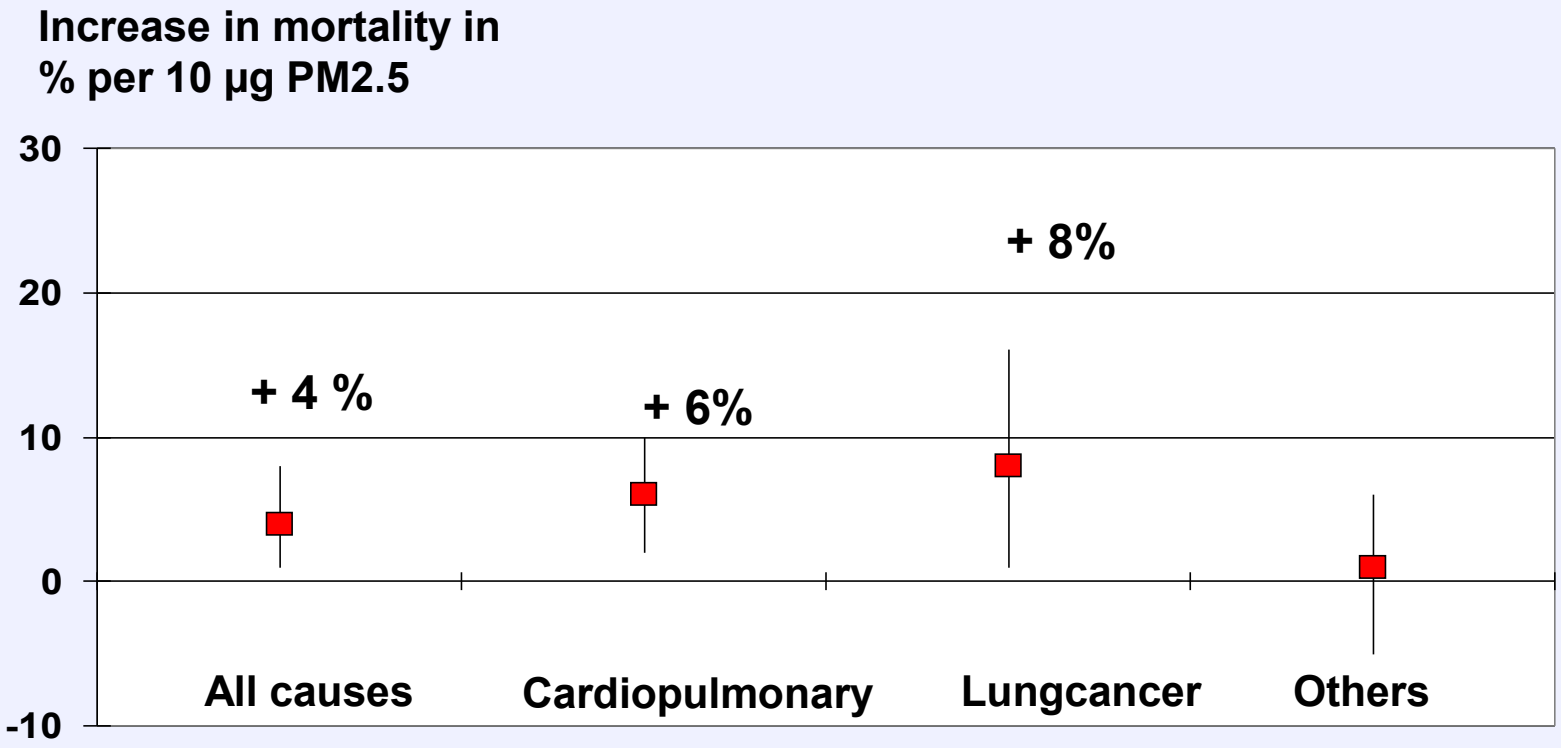



*Figure 2.* Age-, sex-, and race-adjusted population-based mortality rates for 1980 plotted against mean fine particulate air pollution levels for 1979 to 1983. Data from metropolitan areas that correspond approximately to areas used in prospective cohort analysis.

Pope 1995

# Long- term Mortality and Air Pollution

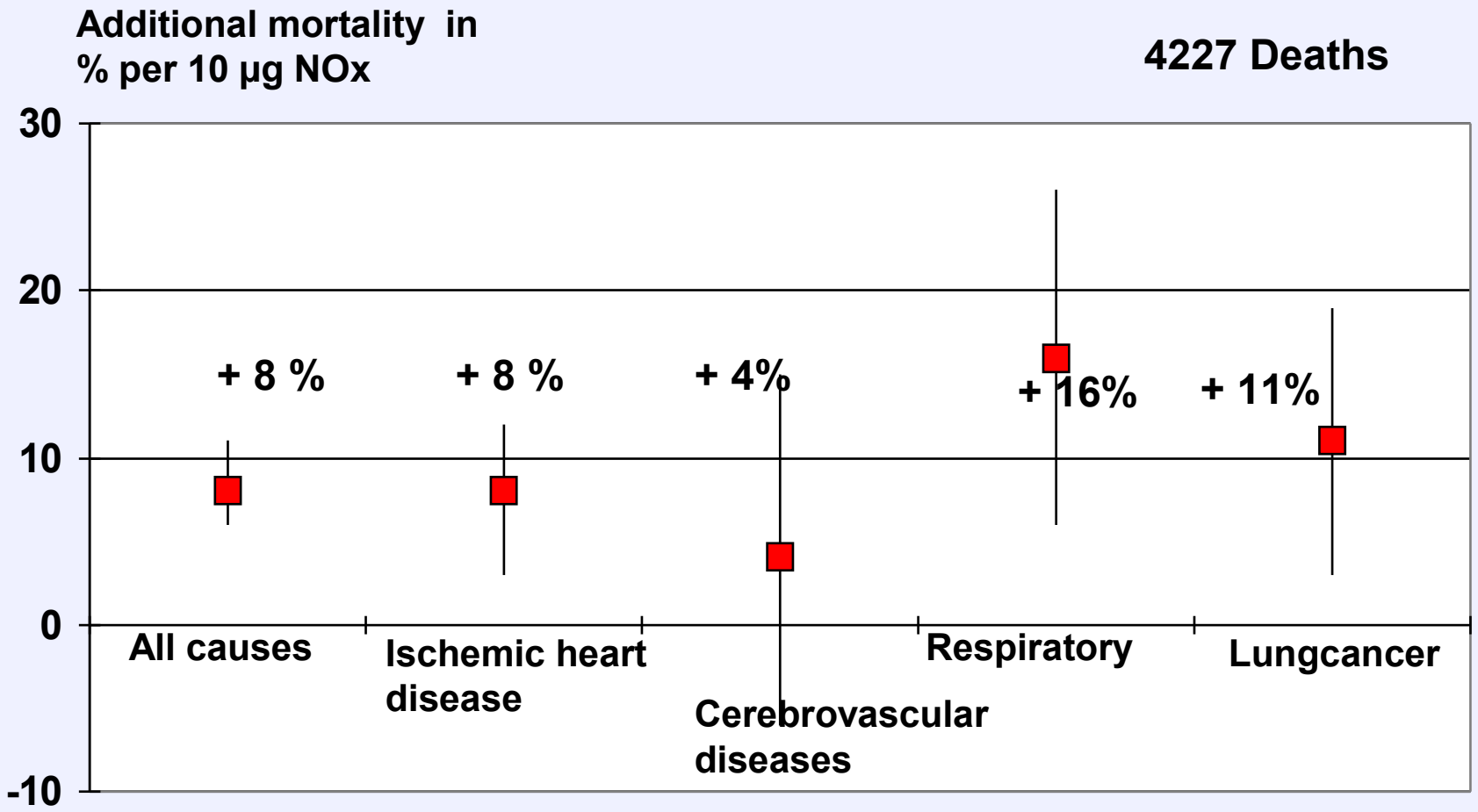
## 500‘000 persons of the american cancer study , 1982-1998




Pope 2002

# Longterm Mortality and Air Pollution

## in a Cohort of 16‘200 Men in Oslo, 1972-1998




Nafstad 2004

# Swiss Study on Air Pollution and Lung Diseases in Adults

# SAPALDIA – study design


| Baseline | Longitudinal | | Cohort Study |
|---|---|---|---|
| 8 Areas<br>Interview<br>Lung function<br>Methacholine<br>Skin prick test<br>Total IgE<br>Endex CO<br>9‘651 Participants<br>Age 18-60 | Diary<br>Peakflow<br>3‘500 | Address update and mortality follow-up | 8 Areas<br>Interview<br>Lung function/<br>Methacholine<br>Heart rate variablity<br>Blood pressure<br>Establishment of biobank<br>Endex CO<br>8‘047 Participants<br>Age 29-71 |

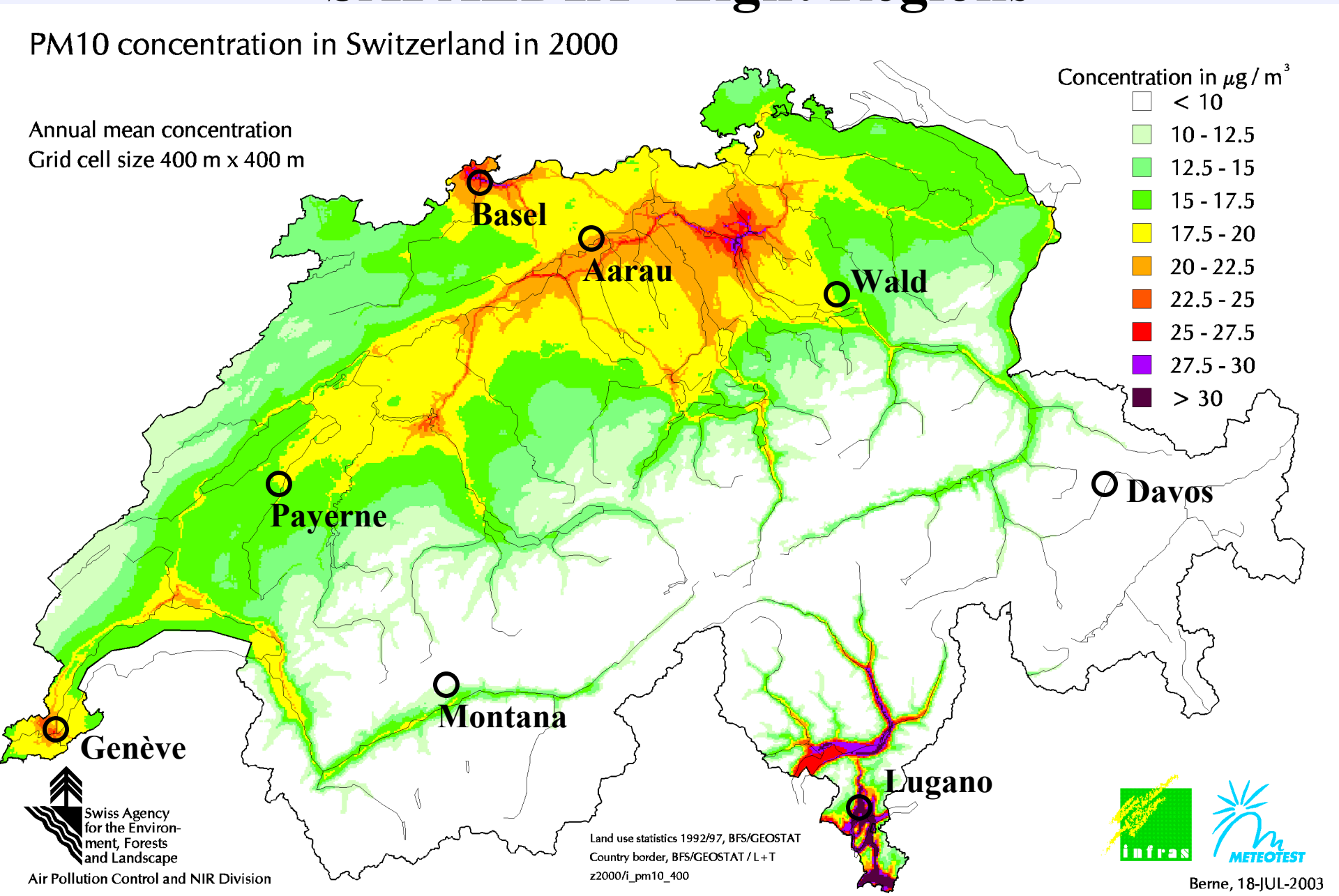
NO2 ,SO2
TSP, CO
Ozone
Meteo

PM2.5

PM10

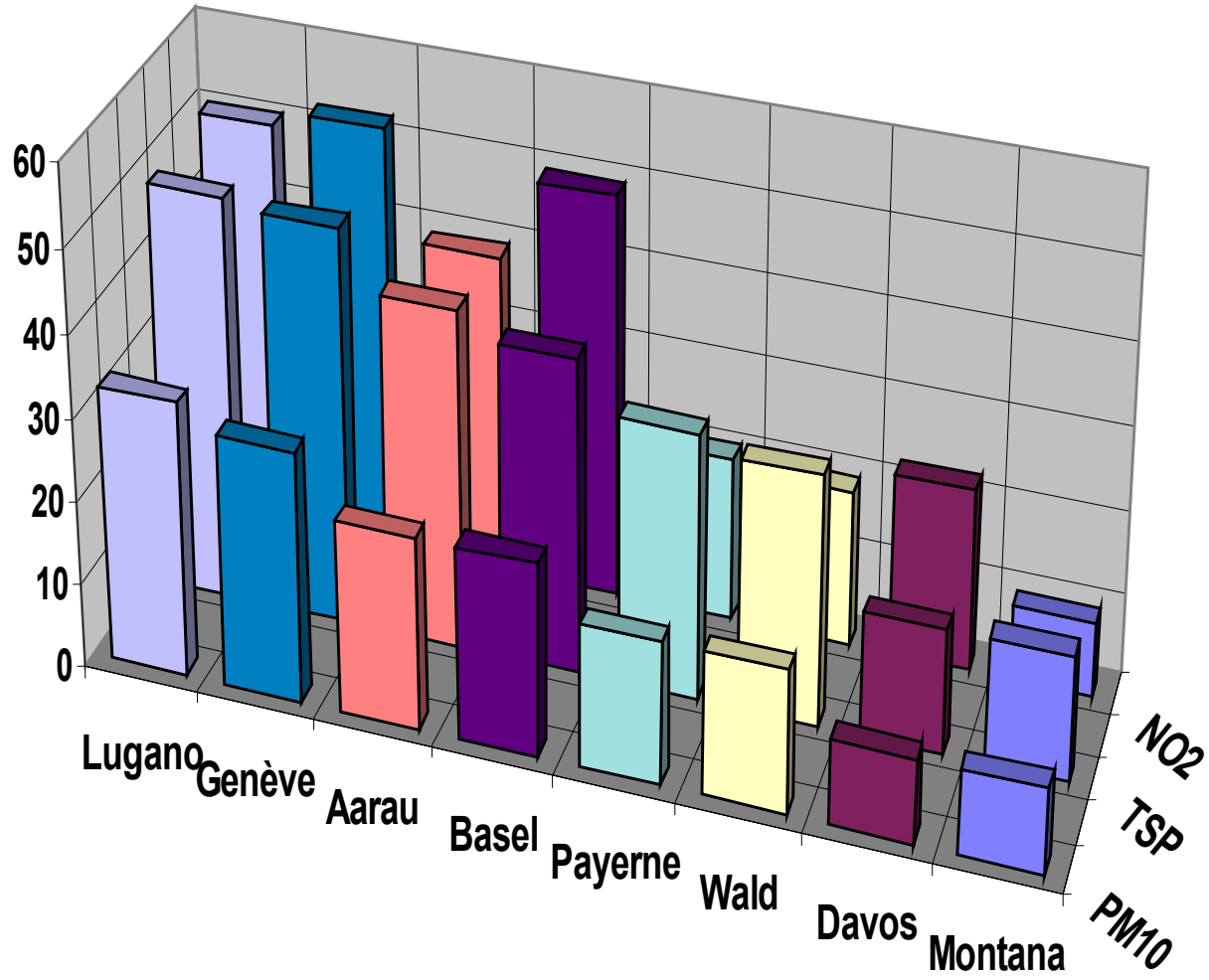
1991 | 92/93 | 95/97/99 | 2002

# SAPALDIA –Eight Regions



# Air Pollution Levels in SAPALDIA

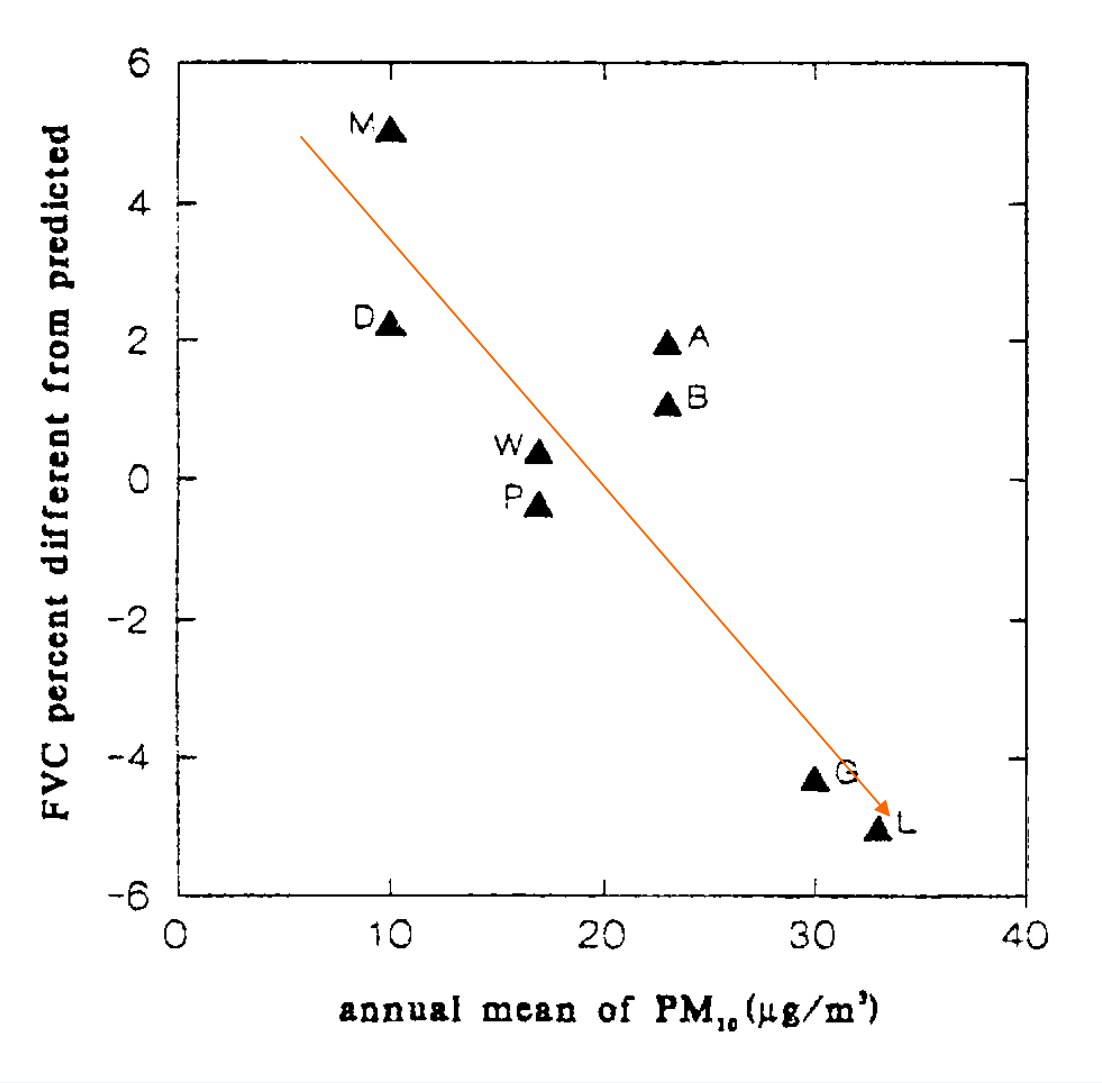
## 1991-1993; annual mean ug/m3



# Lung Function in Adults SAPALDIA

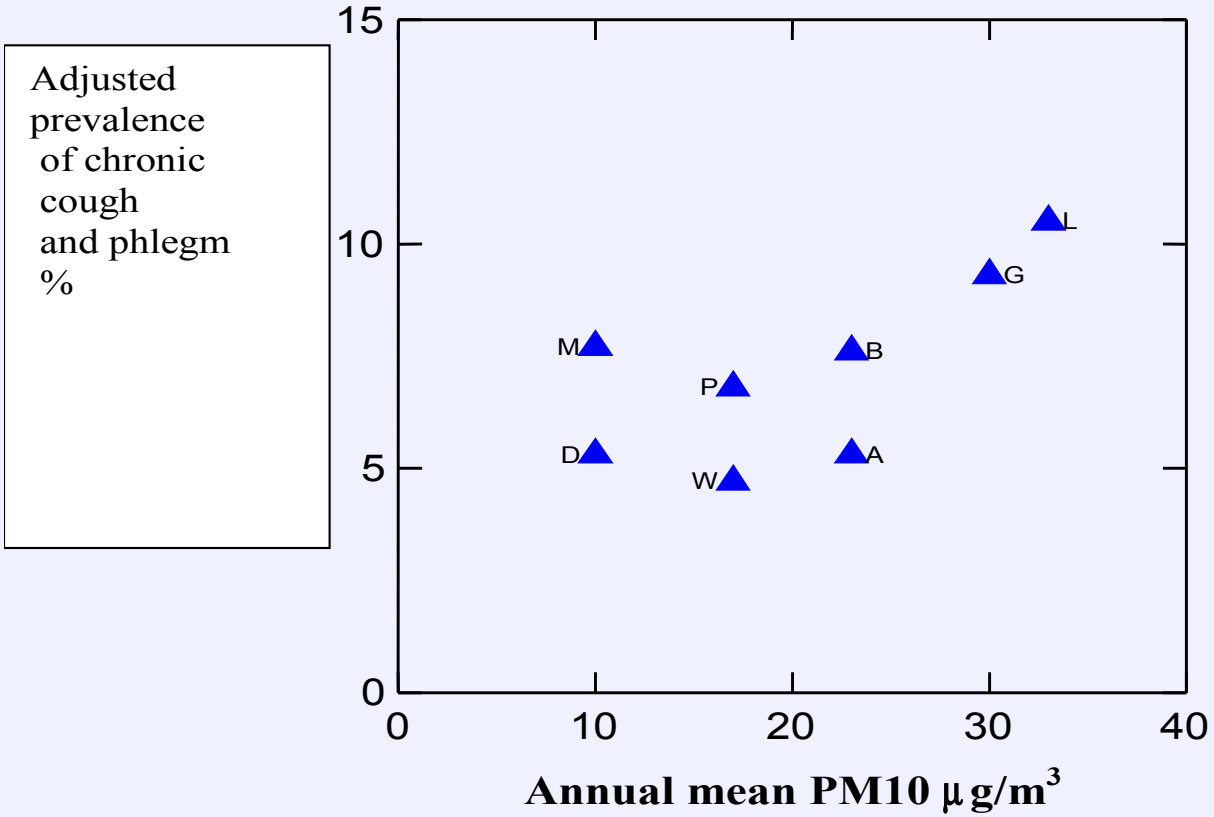
# Skin Prick Test

# Annual mean PM10 and Forced Vital Capacity (FVC) in adults (SAPALDIA)



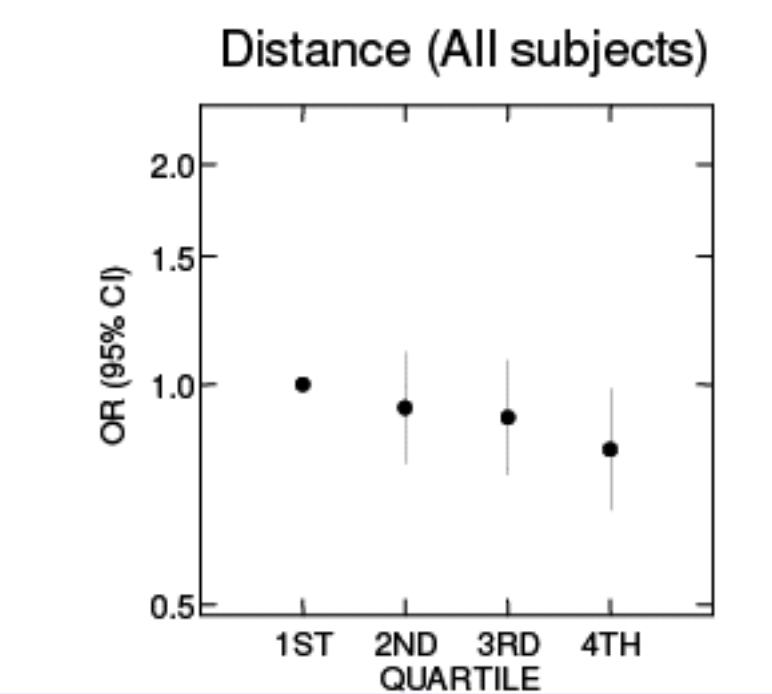

Ackermann-Liebrich , AJRCCM 1997

# Annual Mean PM10 and Adjusted Prevalence of Chronic Cough SAPALDIA




Zemp 1999

# Distance to Main Roads and Reported Breathlessness



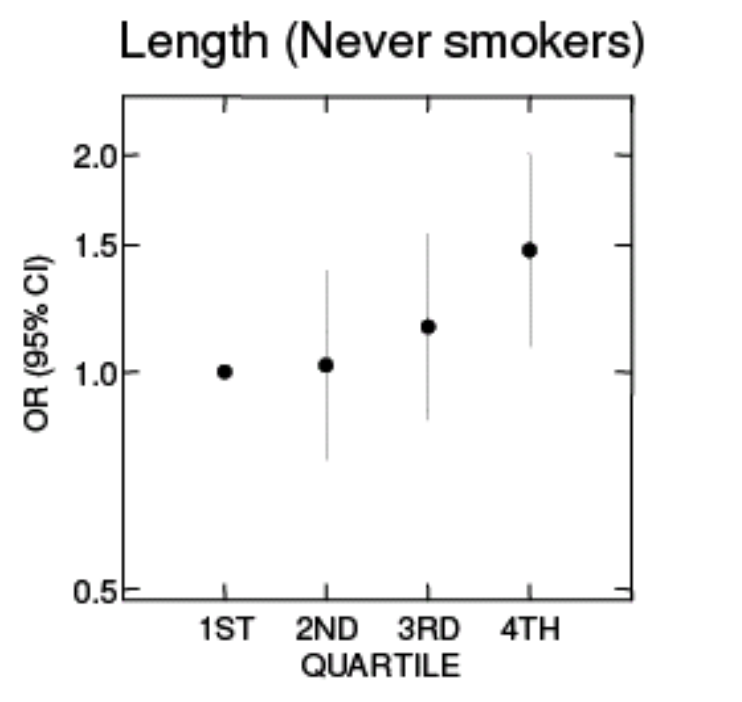



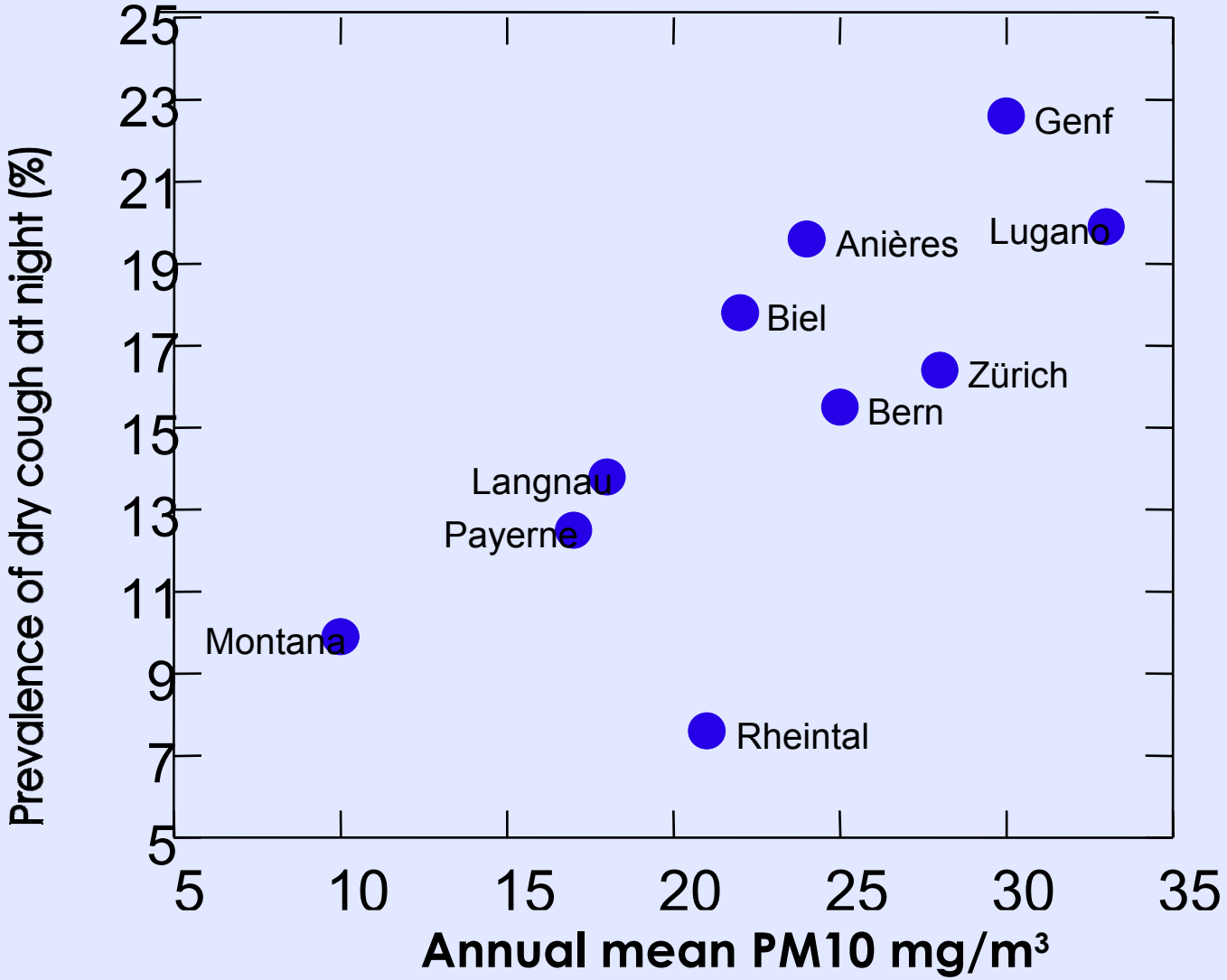

**FIGURE 1.** Adjusted odds ratios * (and 95% CI) for reported attacks of breathlessness by quartiles of "distance to the closest main street" † (top) and by quartiles of "length of main street segments around the home address" ‡ (bottom) for the entire sample and for never smokers (the lowest quartile category serving as the reference)

Bayer ,AmJ Epi in print

SAPALDIA

# Acute bronchitis in children and annual mean PM1

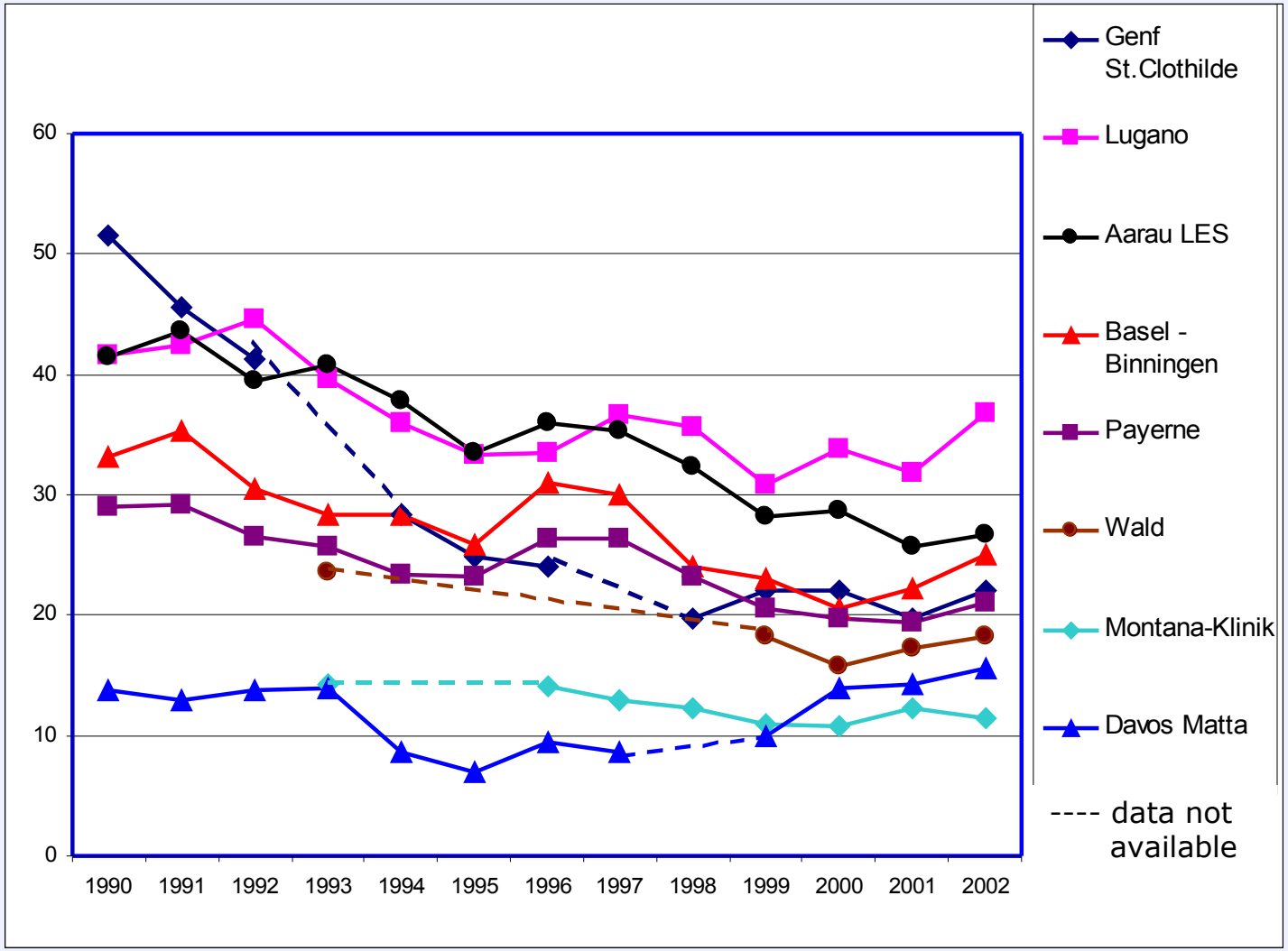
## The SCARPOL Study




C. Braun-Fahrländer: A JRCCM 1997


Cleaner Air

# 12-Year course of PM10 [µg/m³] in the SAPALDIA areas




**Methods:** Digitel HiVol sampling**.** Data before 1997 converted from TSP (Geneva, Lugano, Basel, Payerne, Davos) and Harvard-data (Wald, Montana)

**Stations:** Geneva: St. Clothilde ; Lugano: Lugano NABEL; Aarau: Aarau Luftelektrische Station; Basel: Basel-Binningen NABEL; Payerne: Payerne NABEL; Wald (Zurich): Wald-Spital; Davos: Davos-Matta; Montana: 1990-1998 Montana-Clinic, since 2002 Montana-Village.

# Assignment of individual concentrations of PM10

**PM10** – suspended particulate matter in the respirable range and marker of combustion related anthropogenic pollution

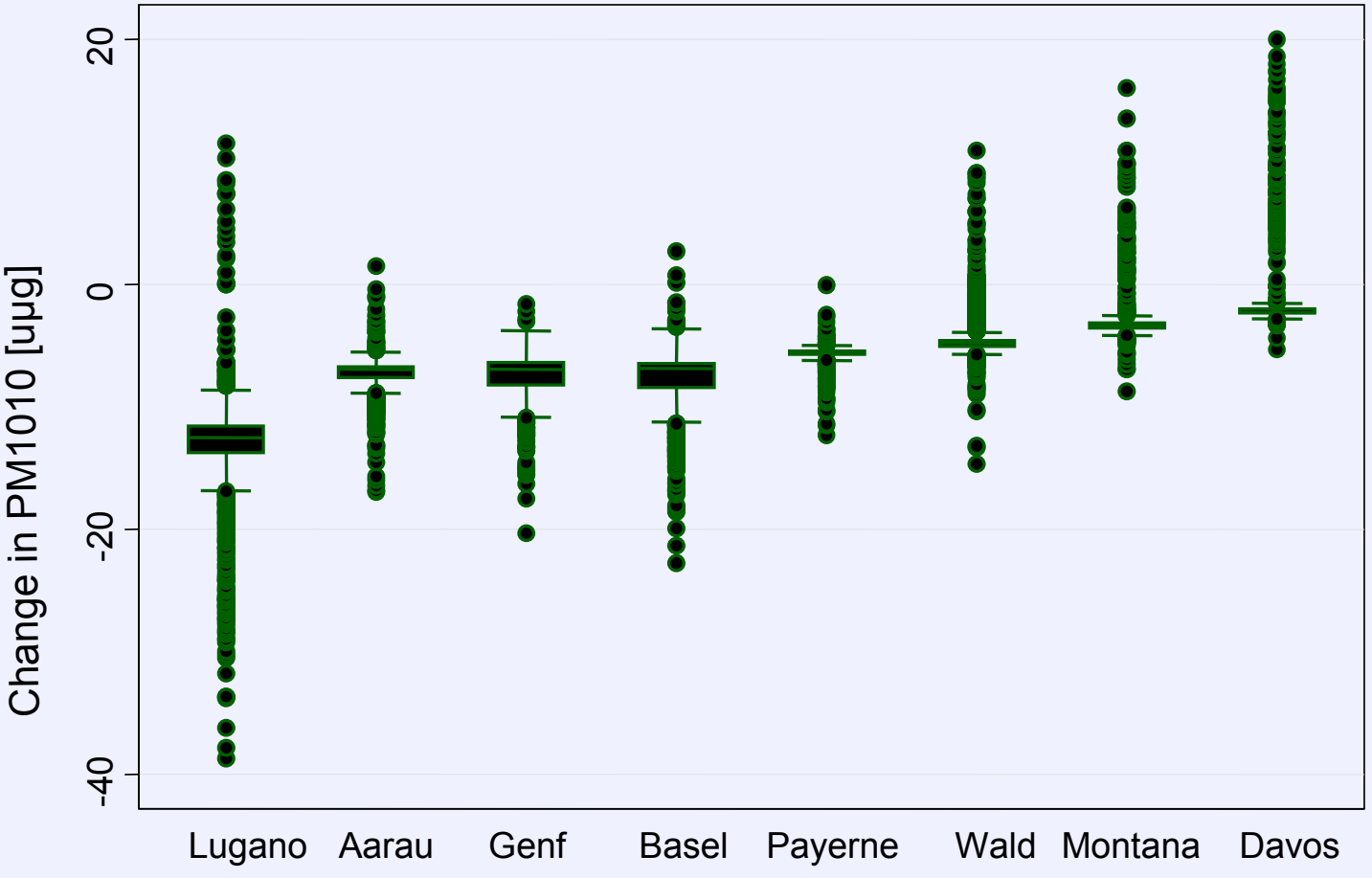
**Modelled** PM10 concentrations based on emission inventories, dispersion and transfer factors to resolution of **200x200m** validated with monitoring data

SAPALDIA participant **addresses in 1991 and 2002 geocoded**

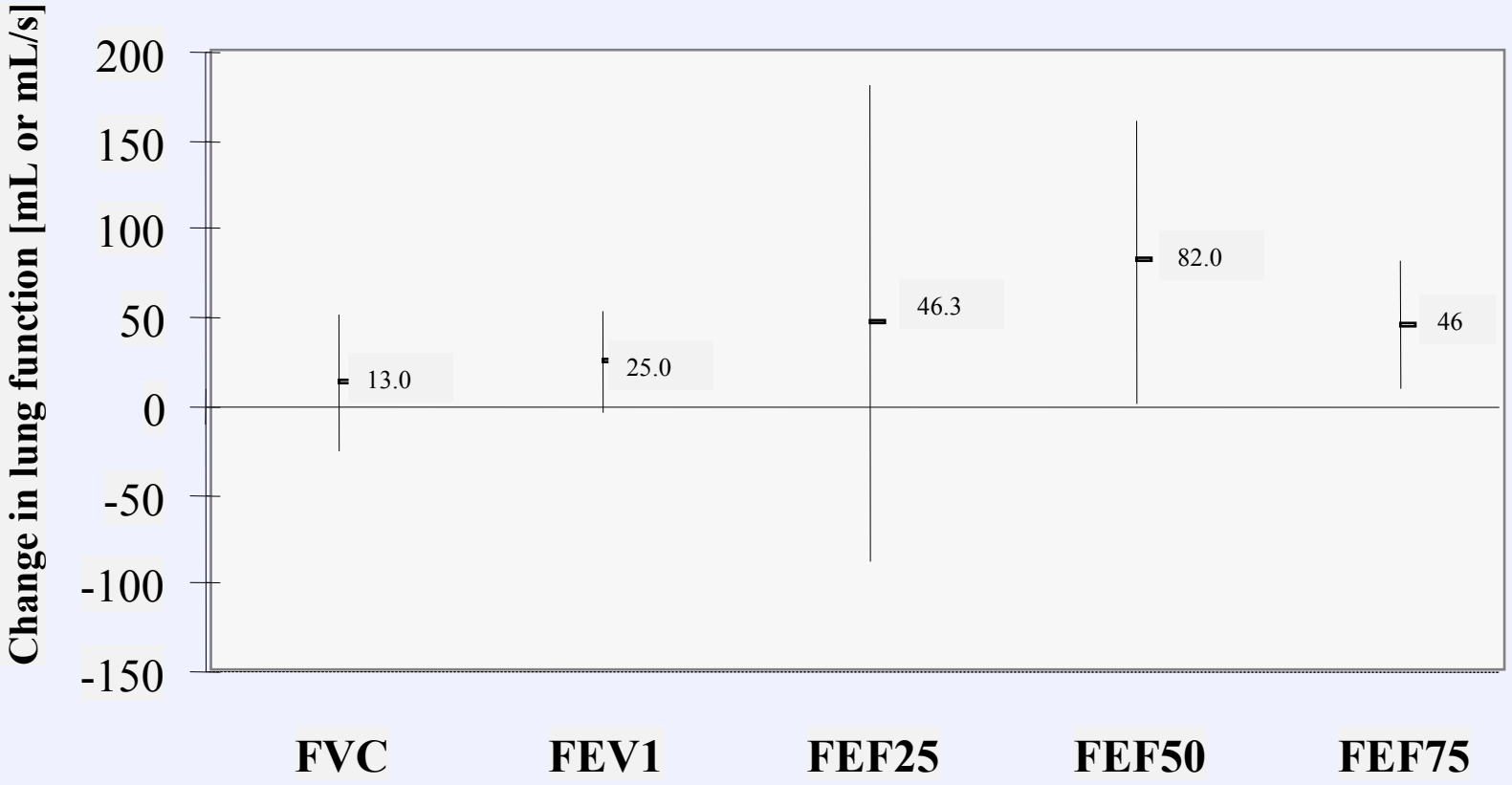
Assignment of **individual concentrations** of PM10

**Exposure term: Concentration in 2002- concentration in 1991**

# Change in PM10 by area, 2002 – 1991



# Adjusted mean change in lung function per 10ug/m3 decrease in in PM10



# Decrease of Air Pollutants and decrease of symptoms in children

## SCARPOL

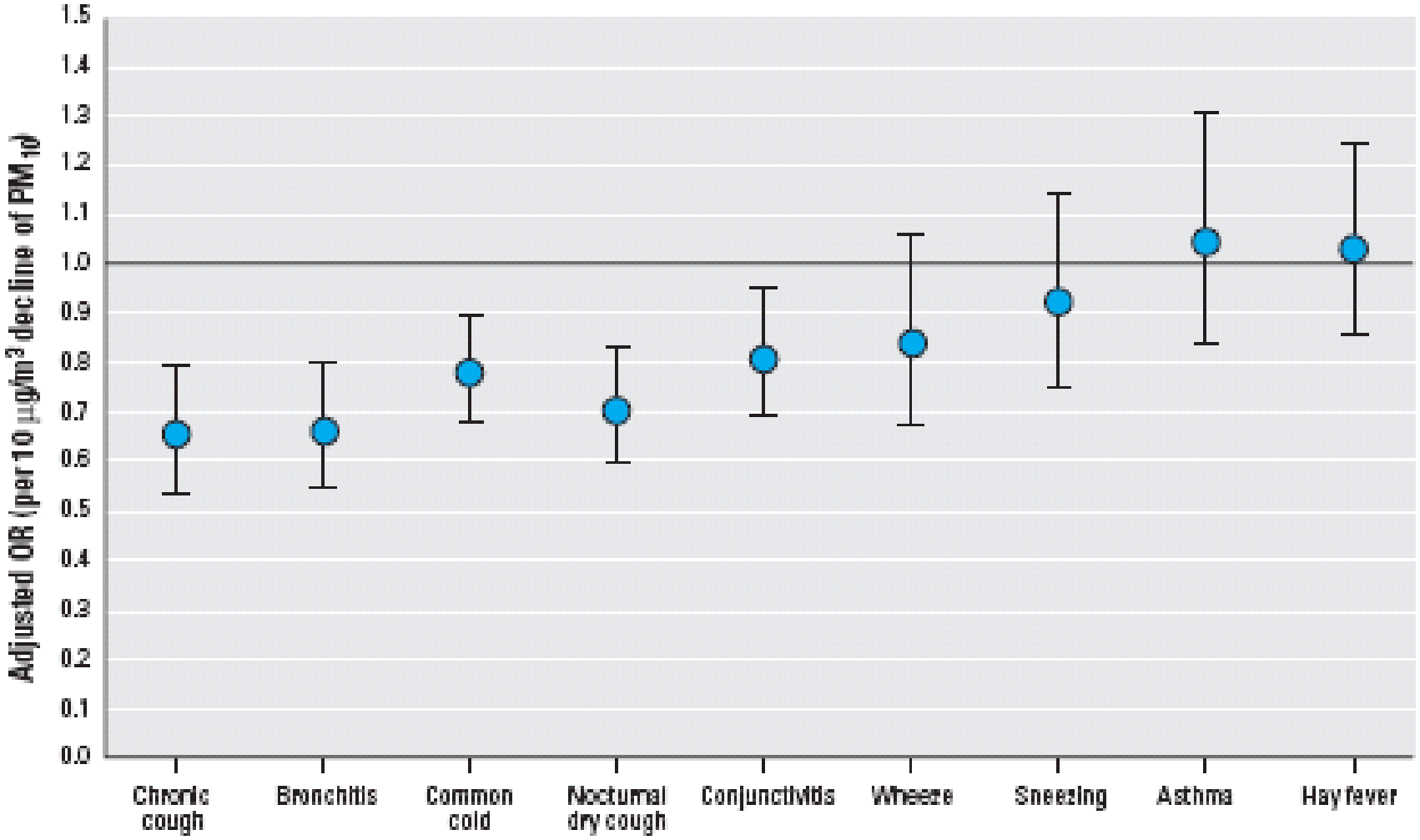



**Figure 2.** Adjusted ORs[a] and 95% CIs of symptoms and respiratory diseases in SCARPOL associated with a decline of 10 µg/m³ $PM_{10}$ levels.

Bayer 2005


And Politicians?

# European Parliament

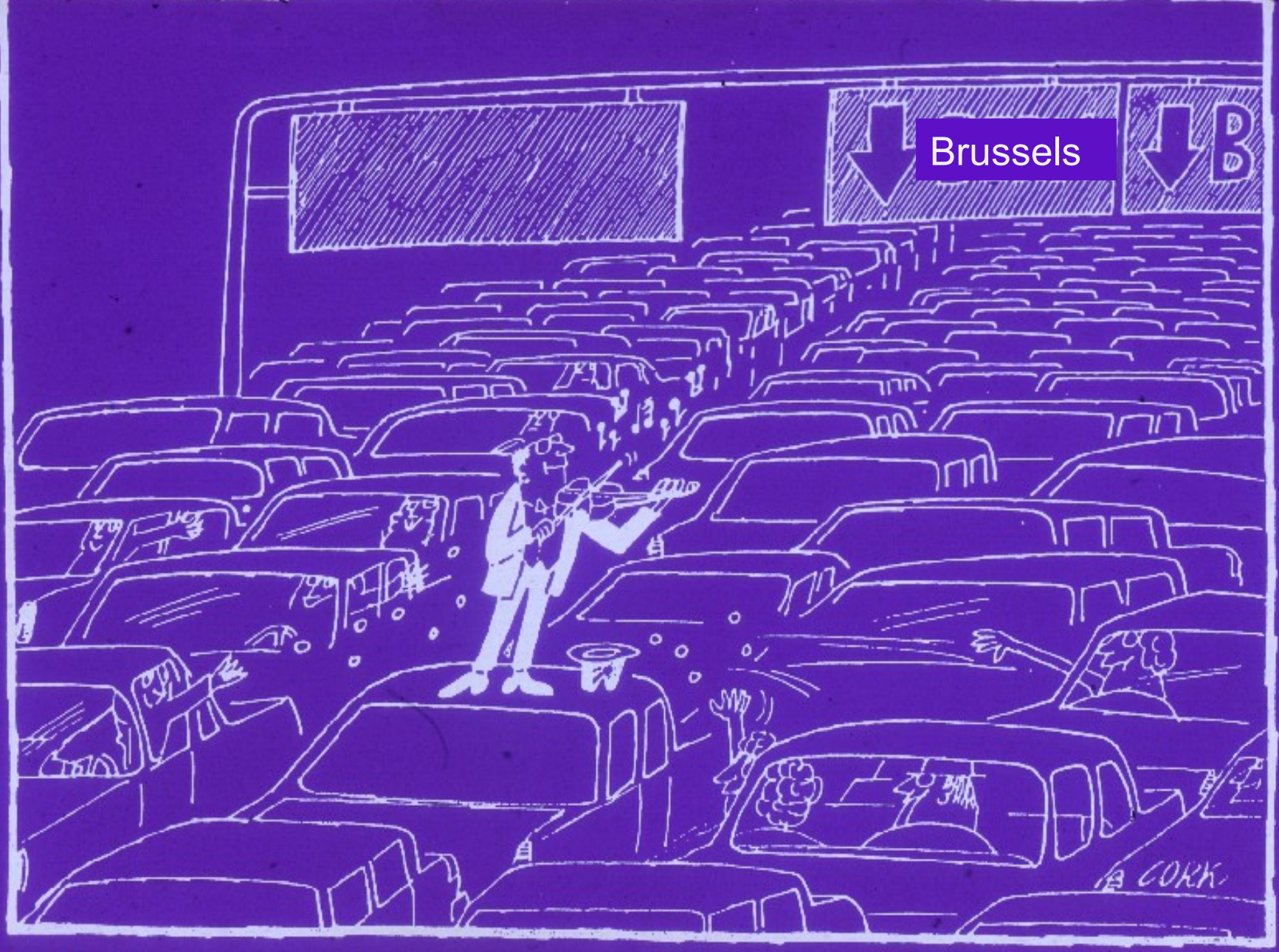
Air pollution with particulate matter (PM) claims an average of 8.6 months from the life of every person in the European Union (EU),
but Germans lose more: 10.2 months of life in the year 2000.

Council Directive 99/30/EC sets down limit values for PM10: 50 µg/m3 for the 24-hour average and 40 µg/m3 for the annual average.
Current policies to reduce emissions of air pollutants by 2010 are expected to save 2.3 months of life for the EU population and 2.7 months of life for the population of Germany. This is the equivalent of preventing 80 000 premature deaths and saving over 1 million years of life in the EU; the corresponding figures for Germany are about 17 000 premature deaths and over 240 000 years of life (see Fact sheet EURO/04/05 of 14 April 2005).

STRASBOURG (Parlement européen), 26 sept 2006 (AFP) - Le Parlement européen s'est prononcé mardi pour de nouvelles normes en matière de pollution atmosphérique par les microparticules, auxquelles les scientifiques attribuent chaque année près de 360.000 décès prématurés dans l'Union européenne.
Mais ce vote de première lecture a été aussitôt dénoncé comme "inacceptable" par le Commissaire européen à l'Environnement, Stavros Dimas, qui a déploré que les eurodéputés préconisent dans le même temps une mise en oeuvre moins contraignante de ces normes.
Les députés suggèrent de réduire les plafonds de concentration des microparticules issues de la combustion industrielle, des moteurs automobiles et du chauffage urbain.
Ils proposent ainsi de fixer le seuil de concentration des particules de moins de 10 microns (PM10) de diamètre à 33 microgrammes par mètre cube en moyenne annuelle à partir de 2010, et celui des particules de moins de 2,5 microns, réputées les plus nocives, à 20 microgrammes.

STRASBOURG (Parlement européen), 26 sept 2006 (AFP) –
The European Parliament proposes to the Ministers a standard value for PM10 of 33 micrograms per cubic meter for an annual mean to be introduced by 2010 and of 20 micrograms for PM 2.5

Proposed guidelines from WHO:
20 micrograms per cubic meter for PM10 and 10 for PM2.5




*Die Zukunftsmusik kann nur «weniger Verbrennungsmotoren» heissen.*

The future tunes can only  be called “less combustion engines”


Thank you for your attention

# Acknowledgments


- **SAPALDIA Team**

  ***Senior scientific team*** Ph. Leuenberger (p) co-dir and U. Ackermann-Liebrich (e) co-dir

  J.C. Barthélémy (c), W. Berger (g), R. Bettschart (p)A. Bircher (a), K. Blaser (a), G. Bolognini (p), O. Brändli (p), M. Brutsche (p), L. Burdet (p), S.H. Downs (e/s), M. Frey (p), JM. Gaspoz (c), M.W. Gerbase (p), D. Gold (e/c/p), W. Karrer (p), R. Keller (p), B. Knöpfli (p), N. Künzli (e/exp), A. Morabia (e), U. Neu (exp), L. Nicod (p), A.P. Perruchoud (p), M. Pons (p), N.M. Probst Hensch (e/g), Th. Rochat (p), E. Russi (p), C. Schindler (s), P. Schmid-Grendelmeyer (a), J. Schwartz (e), F. Schwarz (p), P. Straehl (exp), JM. Tschopp (p), A. von Eckardstein (?), J.P. Zellweger (p), E. Zemp Stutz (e)

  ***Scientific team at coordinating center*** L. Bayer-Oglesby (exp), S.H.Downs (e/s), D. Felber Dietrich (c), M. Imboden (g), D. Keidel (s), P. Städele-Kessler (s), M.W. Gerbase (p, gology, (c) cardiology, (cc) clinical chemistry, (e) epidemiology, (exp) exposure, (g) genetic and molecular biology, (m) meteorology, (p) pneumology, (s) statistics

  ***Scientific team at local study sites***C. Burrus, D. Felber Dietrich, U. Egermann, M.W. Gerbase, R. Gimmi, A. Kick, N. Lutz, R Keller

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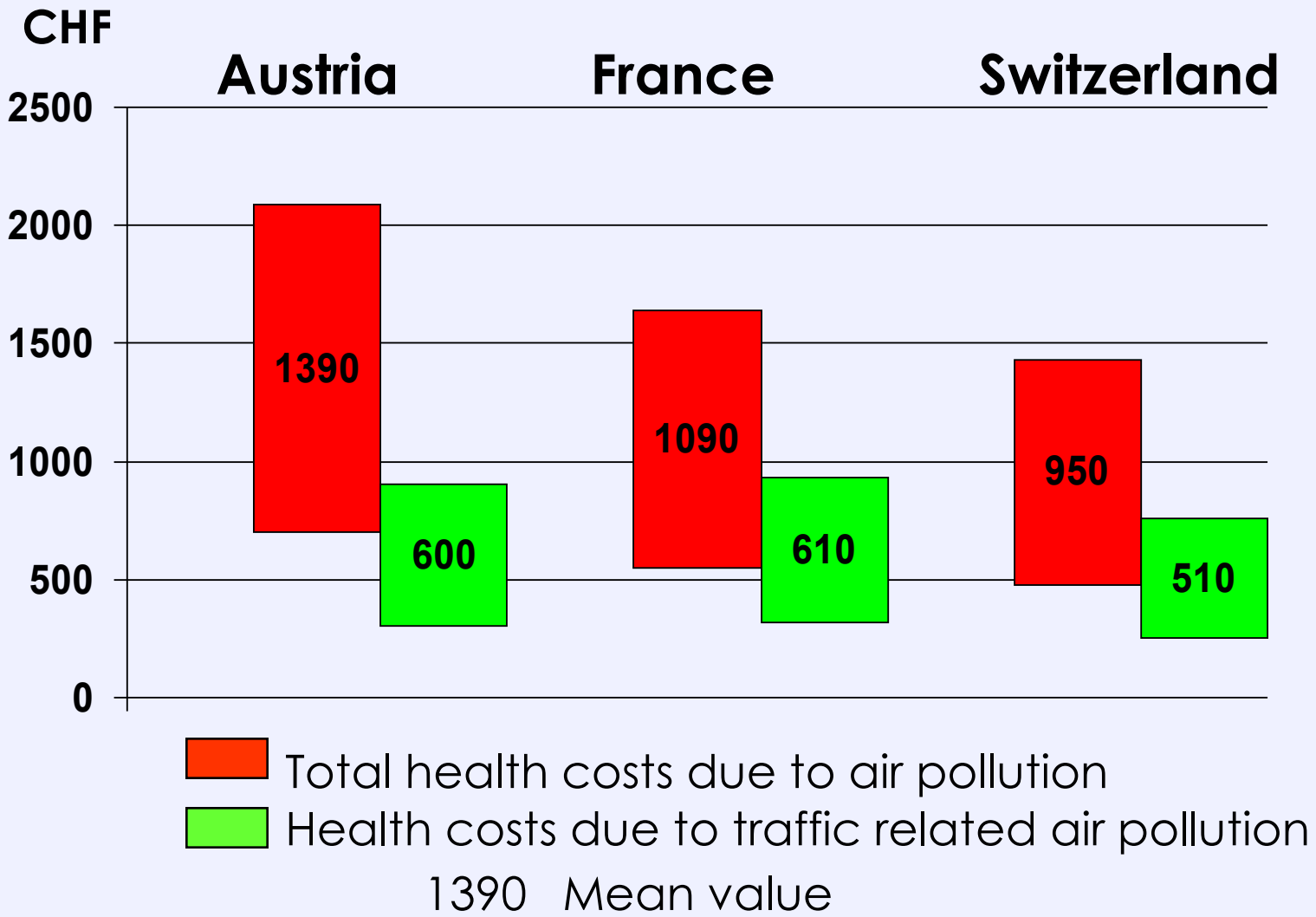
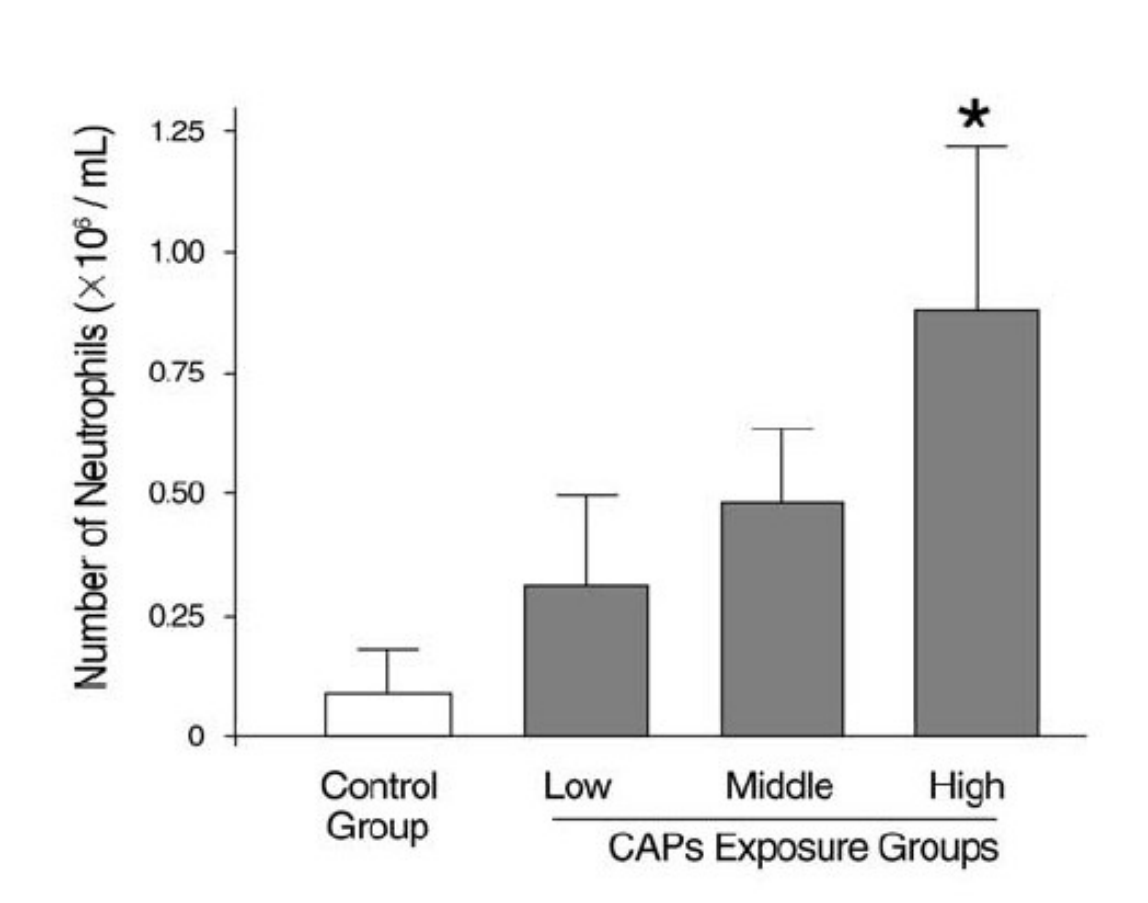
  SAPALDIA Basel is part of the European Community Respiratory Health

# Per capita health costs due to air pollution



# Experimental exposure with PM2.5

**8 persons in air, 30 persons 2 h with 3, 47, 107, 206 PM2.5 µg /m3**




**Neutrophil counts in BAL, 18h after exposure**

**Holgate 2002, HEI**

# Experimental exposure with PM2.5

**8 persons in air, 30 persons 2 h with 3, 47, 107, 206 mikrogramm PM2.5/m3**

## Authors conclusions:

„modest degree of airway inflammation as judged by lavage,.. not reflected in biopsies tissues from proximal airways“

## Conclusion HEI review

„a consistent pattern of inflammation after exposure to a variety of PM mixtures.... has not emerged to date.

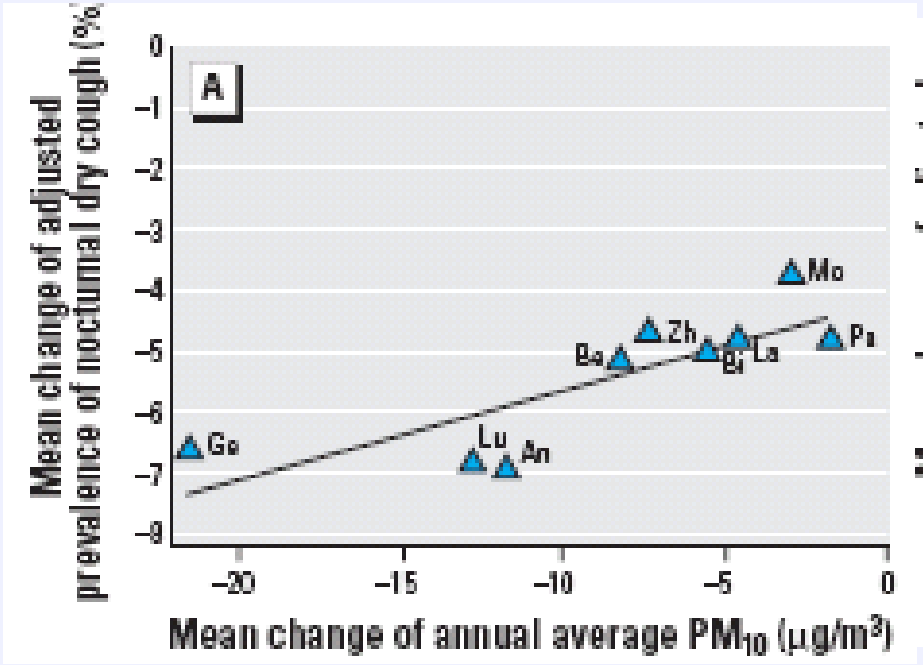
In part, this may be due to different experimental approaches and to measuring different inflammatory markers at different times after exposure.“

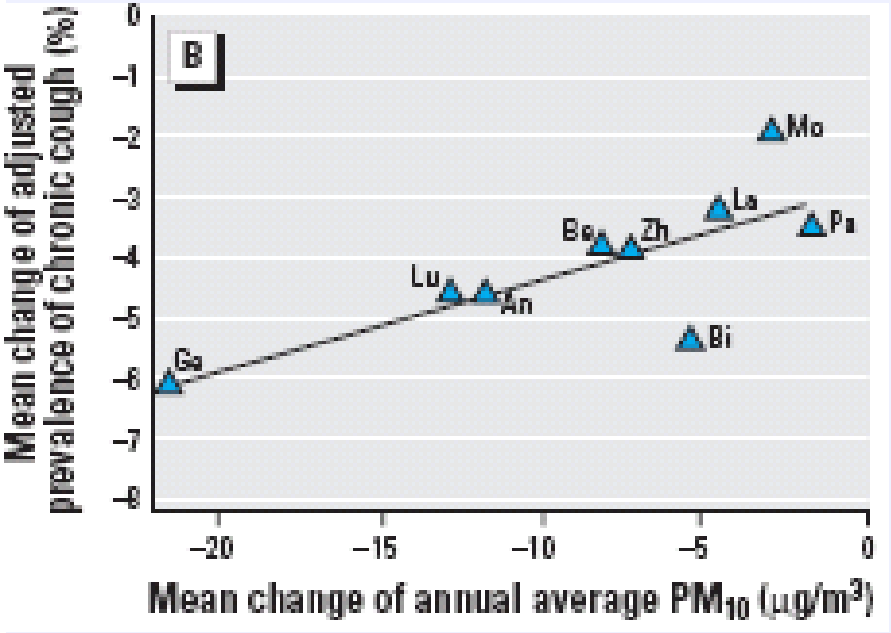
**HEI, Holgate 2002**

# Short term increase in mortality per increase in pollutant levels

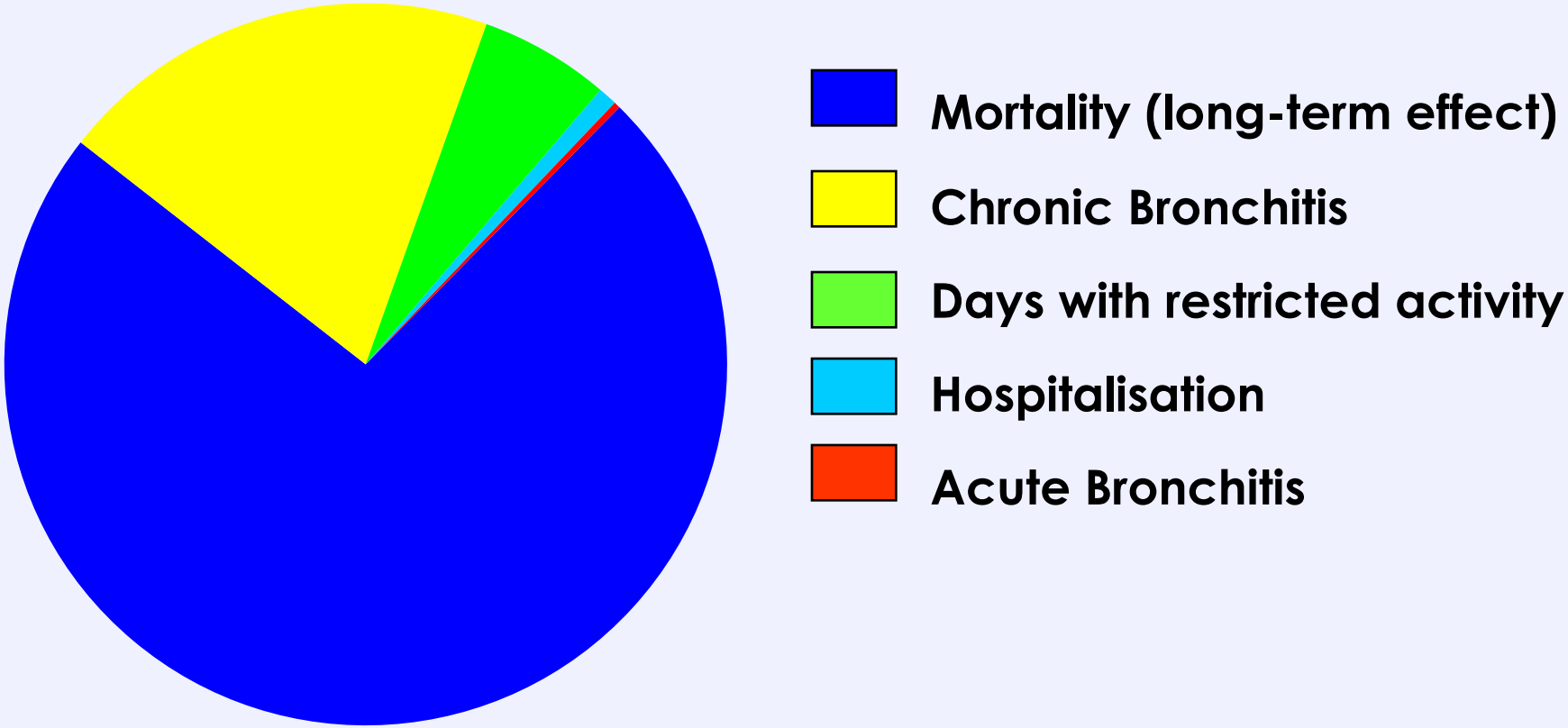
| | Per 10 µg PM10/m3 | Per10 µg Ozone/m3 (8 h mean) |
|---|---|---|
| All causes | 0.6% | 0.3% |
| Respiratory deaths | 1.3% | 0 |
| Cardiovascular deaths | 0.9% | 0.4% |

Metaanalysis WHO


A
Mean change of adjusted prevalence of nocturnal dry cough (%)
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
Mo
Zh
Ba
Bi
La
Pa
Ga
Lu
An
−20
−15
−10
−5
0
Mean change of annual average PM10 (μg/m3)


B
Mean change of adjusted prevalence of chronic cough (%)
0
−1
−2
−3
−4
−5
−6
−7
−8
Mo
La
Ba
Zh
Pa
Lu
An
Bi
Ga
−20
−15
−10
−5
0
Mean change of annual average PM10 (μg/m3)

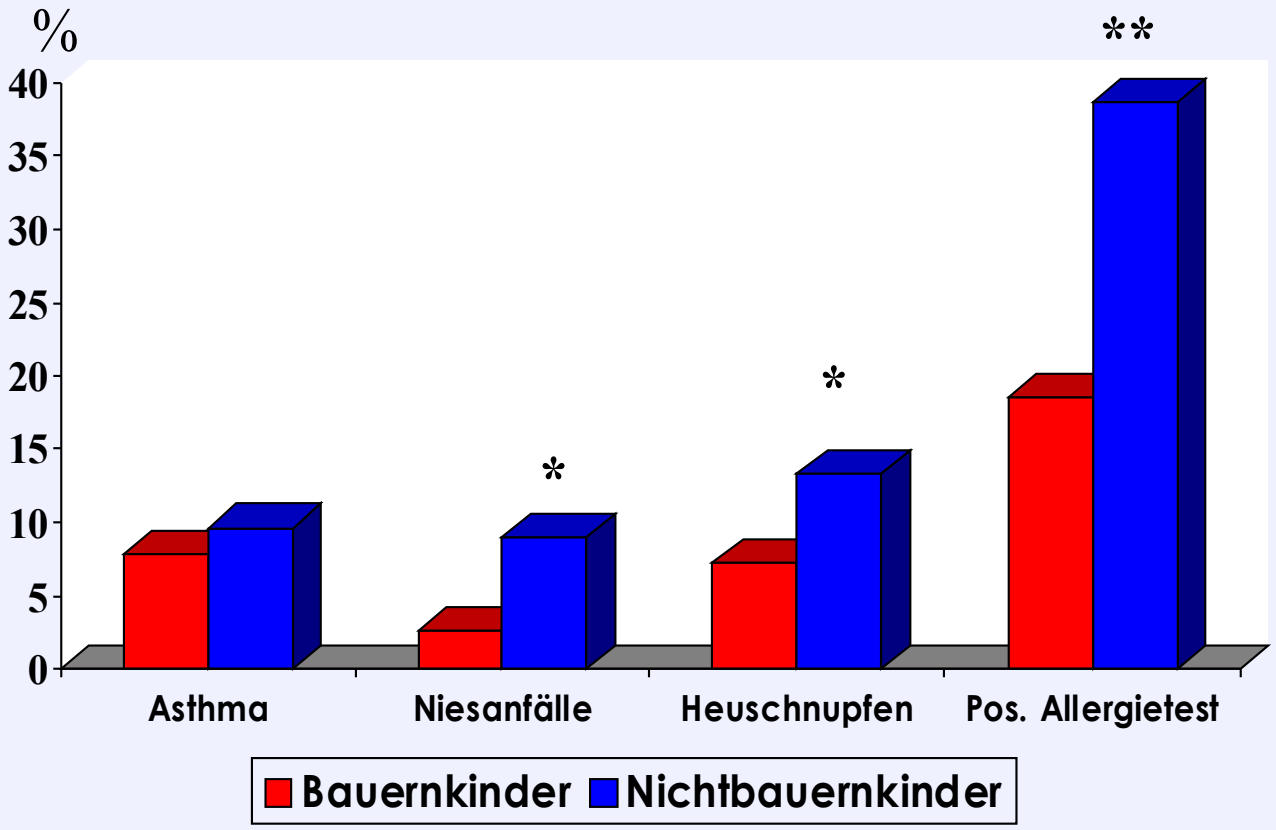
# Traffic related health costs



Dans le projet de directive initial, la Commission européenne suggérait des seuils respectivement de 40 et de 25 microgrammes pour ces particules.
Tout en se félicitant que les députés soient allés plus loin que lui sur ce point, M. Dimas a dit sa déception que "certains points essentiels" de son projet aient été en revanche affaiblis.
Plaidant pour plus de flexibilité dans le respect de ces normes, les eurodéputés proposent ainsi d'accorder des dérogations temporaires au moment de l'entrée en vigueur de la directive dans les zones ou agglomérations qui n'arrivent pas à respecter les critères en matière de polluants.
Ils proposent aussi d'autoriser les dépassements jusqu'à 55 jours par an des limites journalières de concentrations de PM10, au lieu de 35 actuellement.

Ce projet de directive, sur lequel les ministres européens de l'Environnement doivent à leur tour plancher le 23 octobre, a également été très critiqué par des spécialistes de l'environnement et des maladies respiratoires.
La nouvelle directive risque de ralentir ou d'interrompre "les efforts futurs tendant à contrôler les sources de pollution", selon un texte rendu public déb

# Allergiehäufigkeit bei Bauern und Nichtbauernkindern in der Schweiz




* = p<0.05, ** = p<0.01

Braun-Fahrländer et al. Clin Exp Allergy 1999; 29: 28-34

% Zunahme der Spitaleinweisungen wegen Asthma nach einer Zunahme von 10µg/m³

$NO_2$ und $O_3$ an den vorangehenden Tagen