Acute effecten van luchtverontreiniging

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Inhoud

- Historische aspecten
- Acute sterfte en luchtverontreiniging
- Acute respiratoire symptomen en interventies

Rapport Firket

Mijlpaal in de geschiedenis van luchtvervuiling

- eerste wetenschappelijk bewijs dat luchtvervuiling sterfte en ziekte kon veroorzaken
- identificatie van de mechanismen van “winter smog”
  - ✓ temperatuursinversie
  - ✓ verbranding van steenkool: SO_2 + fijne roetdeeltjes (+ Zn)
- identificatie van personen “at risk”
- voorspelling van latere catastrofen

Medical observations

- 60 fatalities on 4 & 5 December

Jemeppe-s/Meuse	9	Seraing	12
Flémalle-Grande	5	Yvoz-Ramet	7
Flémalle-Haute	9		
Engis	14	Clermont	0
Amay	4	Ombret	0
Ampsin		0	
Huy	0	Hermalle-s/-Huy	0

- 10.5 times “normal mortality”

Medische waarnemingen

Wie was aangetast?

- Vooral ouderen, astmalijders, hartpatiënten & verzwakten, zelfs indien binnen gebleven
- toch ook wie voorheen gezond was
- ook kinderen

- vee ook aangetast (tenzij naar de heuvels weg gebracht)

Besluit rapport Firket

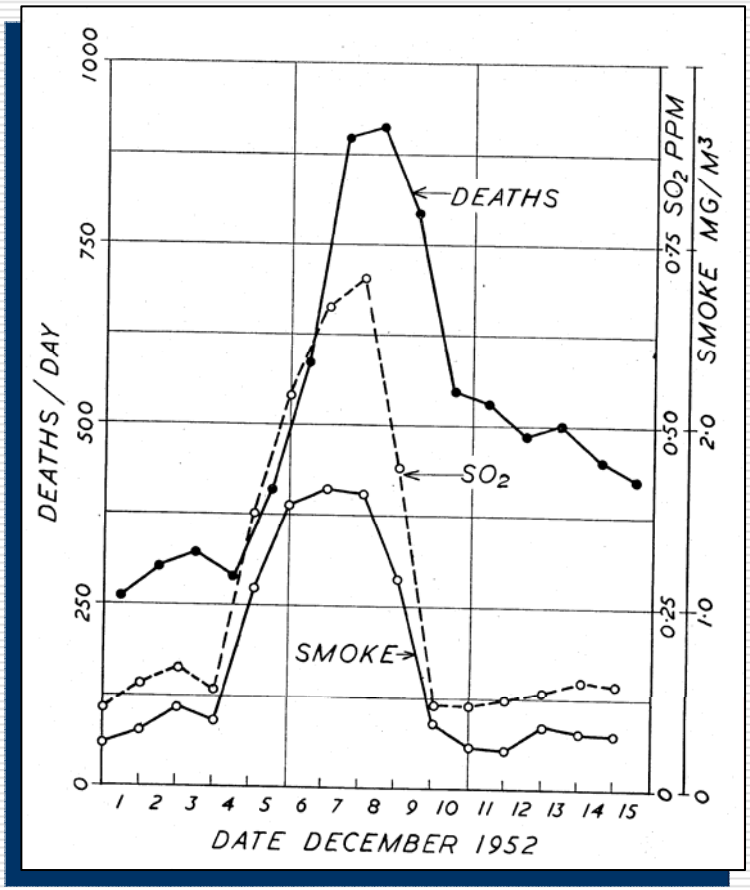
“Si les mêmes conditions se trouvent réunies, les mêmes accidents se reproduiront”

Onder dezelfde voorwaarden zijn dezelfde gevolgen te verwachten.

“Si un désastre survenait à Londres dans des conditions analogues on aurait à déplorer 3.179 morts immédiates”

Een soortgelijke catastrofe zou in Londen leiden tot 3.179 onmiddellijke doden

London Fog, *5-9 december 1952*



Wilkins E.T. ***Journal of the Royal Sanitary Institute*****, 1954, 74, 1-21**

“Winter smog”

“Traditionele luchtverontreiniging”

“Reducing-type air pollution”

“London smog”

- verbranding van steenkool en zwavelrijke brandstof ⮜ SO_2 + roetdeeltjes
- temperatuursinversie

laatste jaren ↓ in industriële wereld

“Zomer smog”

Fotochemische luchtverontreiniging

“Oxidizing-type air pollution”

“Los Angeles smog”

- industrie, verkeer ➚ NO_x en koolwaterstoffen
- onder invloed van zonlicht (via complexe fotochemische reacties) ➚ vorming van O_3 en andere secundaire polluenten, inclusief fijne partikels ➚ *“summer haze”*

Ozon

- warme (windstille) zomerdagen
- progressieve vorming en opstapeling
  - in de loop van de dag
  - transport over grote afstanden
- ozon is zeer reactief
  - concentraties in stad < buiten stad !
  - geen verhoogde concentratie binnenshuis

Ozon

- Goede penetratie in de luchtwegen
- symptomen van irritatie (≠ astma)
- voorbijgaande daling in longfunctie (-10%)
- ontsteking van kleine luchtwegen (“bronchiolitis”)
- grote individuele verschillen in gevoeligheid !
- dosis-afhankelijk
  - concentratie x duur (>150 ppb x 1-2 h)
  - inspanning

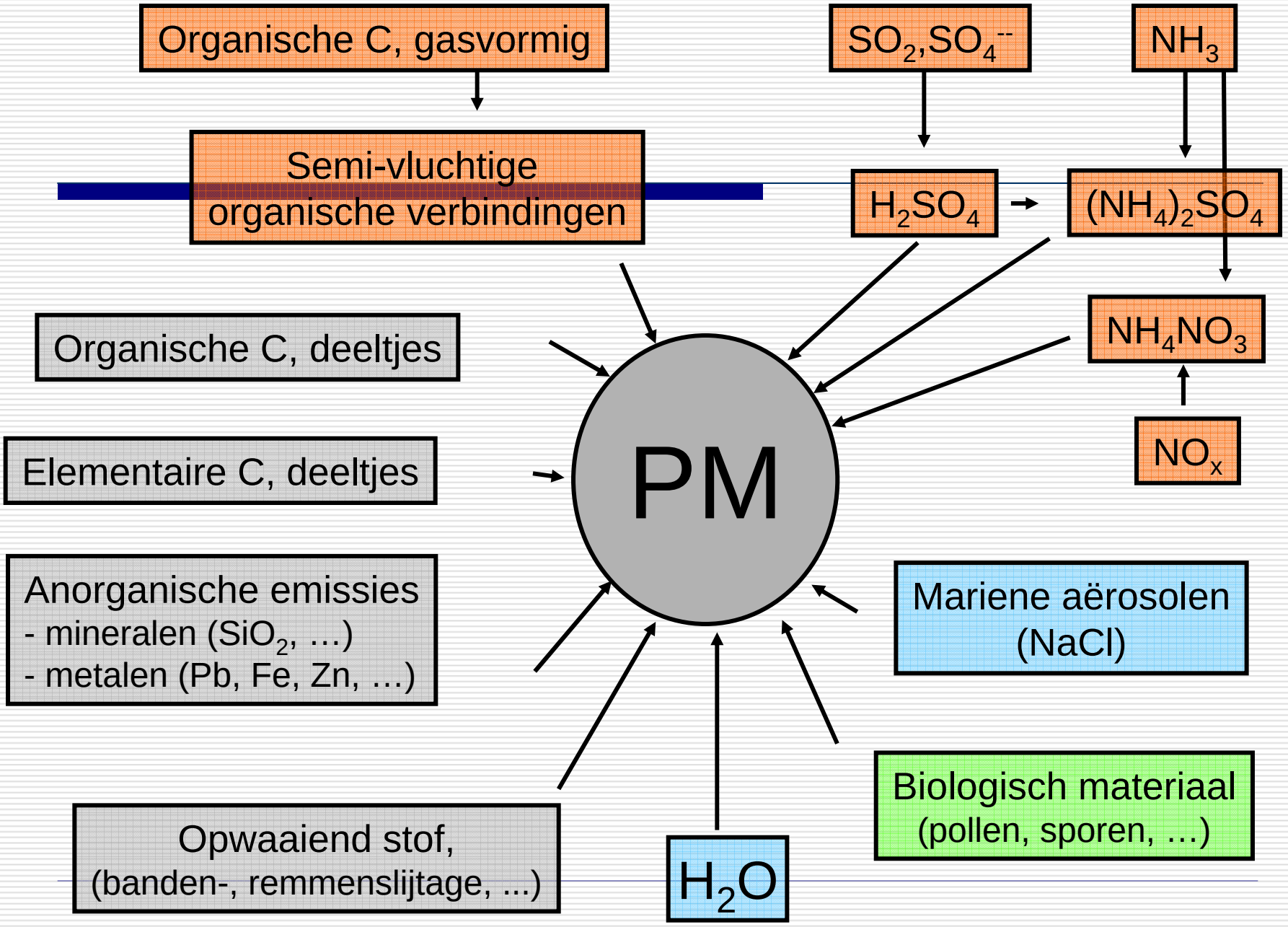
  ! effect in expositiekamers < veldstudies

Partikels

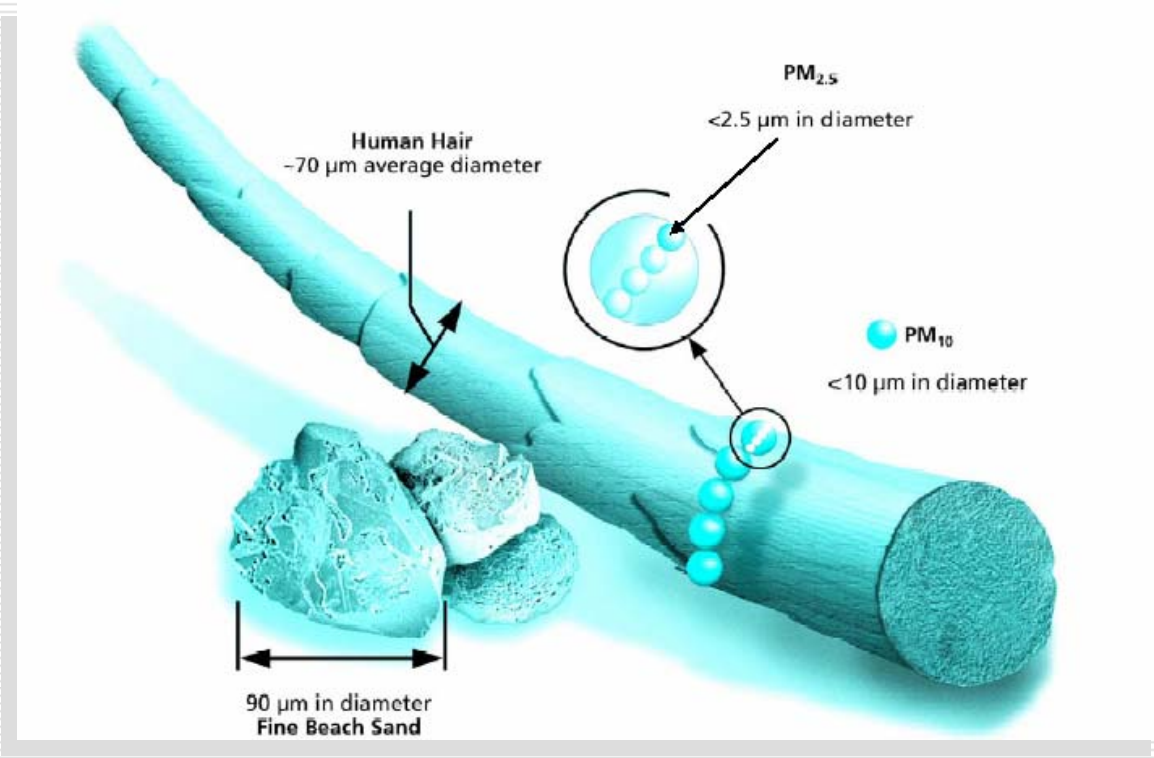
Zwevend stof

Suspended "particulate matter" (PM)

- mengsel van uiteenlopende samenstelling en origine
  - primaire emissie van stofdeeltjes
  - secundaire vorming uit (gasvormige) precursoren
- deeltjes ingedeeld volgens grootte


Organische C, gasvormig
Semi-vluchtige organische verbindingen
SO_2,SO_4^{--}
NH_3
H_2SO_4
$(NH_4)_2SO_4$
NH_4NO_3
NO_x
Organische C, deeltjes
Elementaire C, deeltjes
Anorganische emissies
- mineralen (SiO_2, …)
- metalen (Pb, Fe, Zn, …)
PM
Mariene aërosolen (NaCl)
Biologisch materiaal (pollen, sporen, …)
Opwaaiend stof, (banden-, remmenslijtage, ...)
H_2O

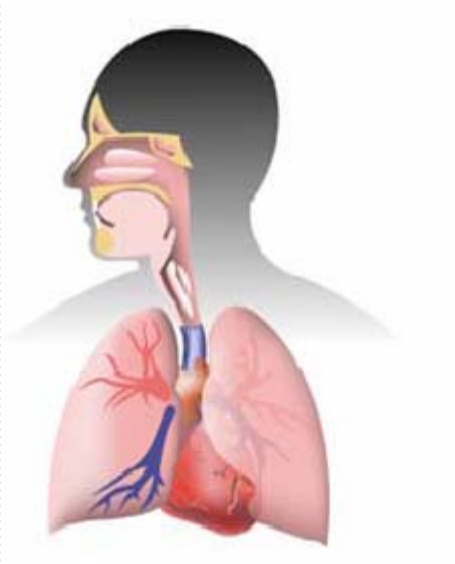
Particulate matter (1)



From: EPA, US Environment Protection Agency

Particulate matter (2)

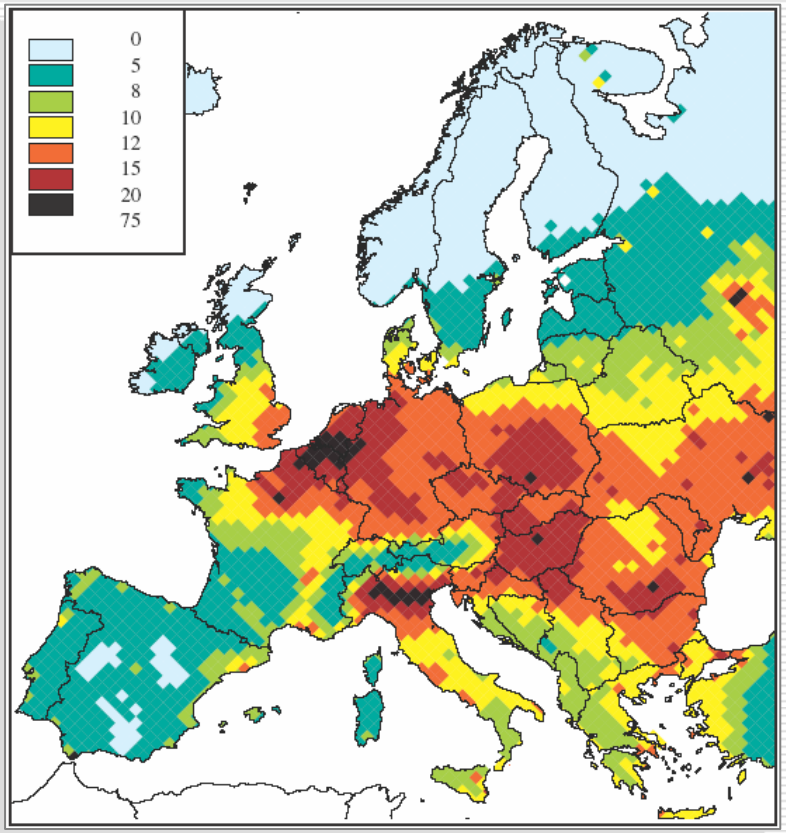
- Larger particles (>PM_{10}) deposit in the upper respiratory tract.



- Small particules penetrate deep into the lungs

- Deposited particules may accumulate, react, or be cleared.

$PM_{2.5}$ gradient* in Europe



***2002, mean annual $PM_{2.5}$ gradient**

From: International Institute for Applied Systems Analysis

Background

- Most of the previous studies assumed that the association between daily mortality and PM_{10} is constant over the study period.

- Because of the complex temperature and air pollution relation, simple adjustment for confounding may be inadequate.

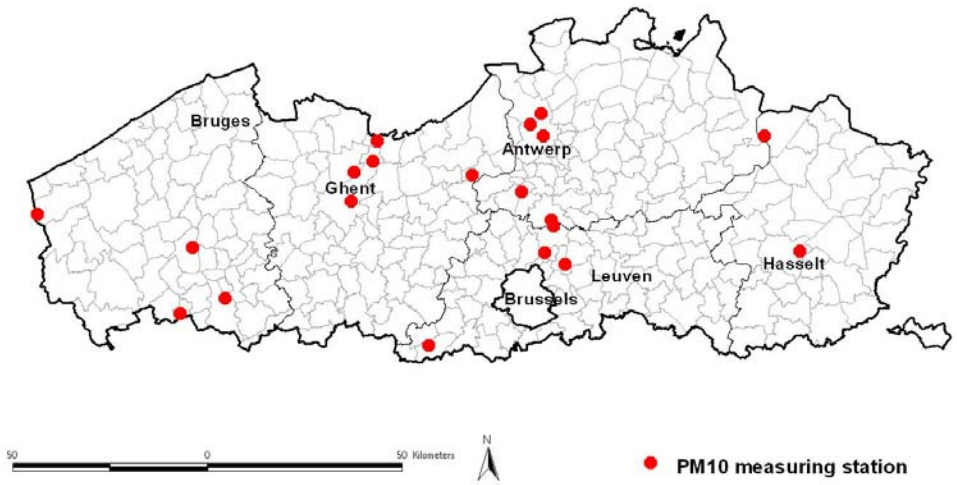
Research questions

- What is the impact of temperature and season on mortality and PM_{10}?
- Is the impact of PM_{10} on mortality independent of outdoor temperature?
- Is the association between mortality and PM_{10} the same in all seasons?

Methods

- Daily time series of mortality, temperature and air pollution data for Flanders, Belgium for the period 1997-2003.
- Accidental deaths were excluded.
- Mean number of daily deaths by quartiles of PM_{10}.
- Stratification by season or quintiles of temperature.

Monitoring sites representing background PM_{10} levels



Bron: IRCEL

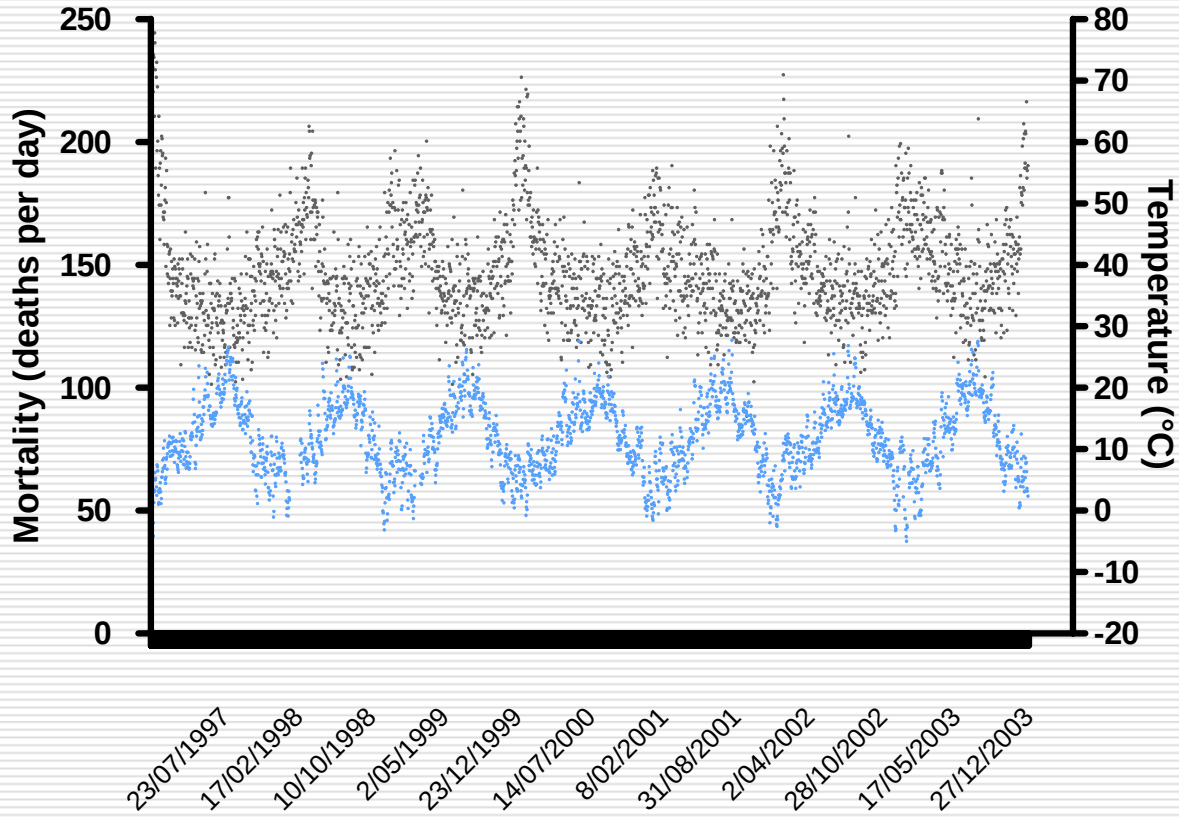
The impact of temperature on mortality and PM_{10}

Mortality and PM_{10} across the seasons

	Winter	Spring	Summer	Autumn
Daily mortality, n	166.8 (0.71)	144.3 (0.71)	133.4 (0.74)	144.2 (0.71)
Cardiovascular mortality, n	66.0 (0.35)	57.1 (0.35)	51.4 (0.35)	57.2 (0.35)
Respiratory mortality, n	25.3 (0.25)	17.4 (0.25)	13.5 (0.26)	16.1 (0.25)
PM_{10}, $\mu g/m^3$	43.3 (0.88)	39.5 (0.88)	37.7 (0.91)	37.2 (0.88)
Temperature, °C	5.7 (0.17)	13.2 (0.16)	18.3 (0.17)	9.4 (0.16)

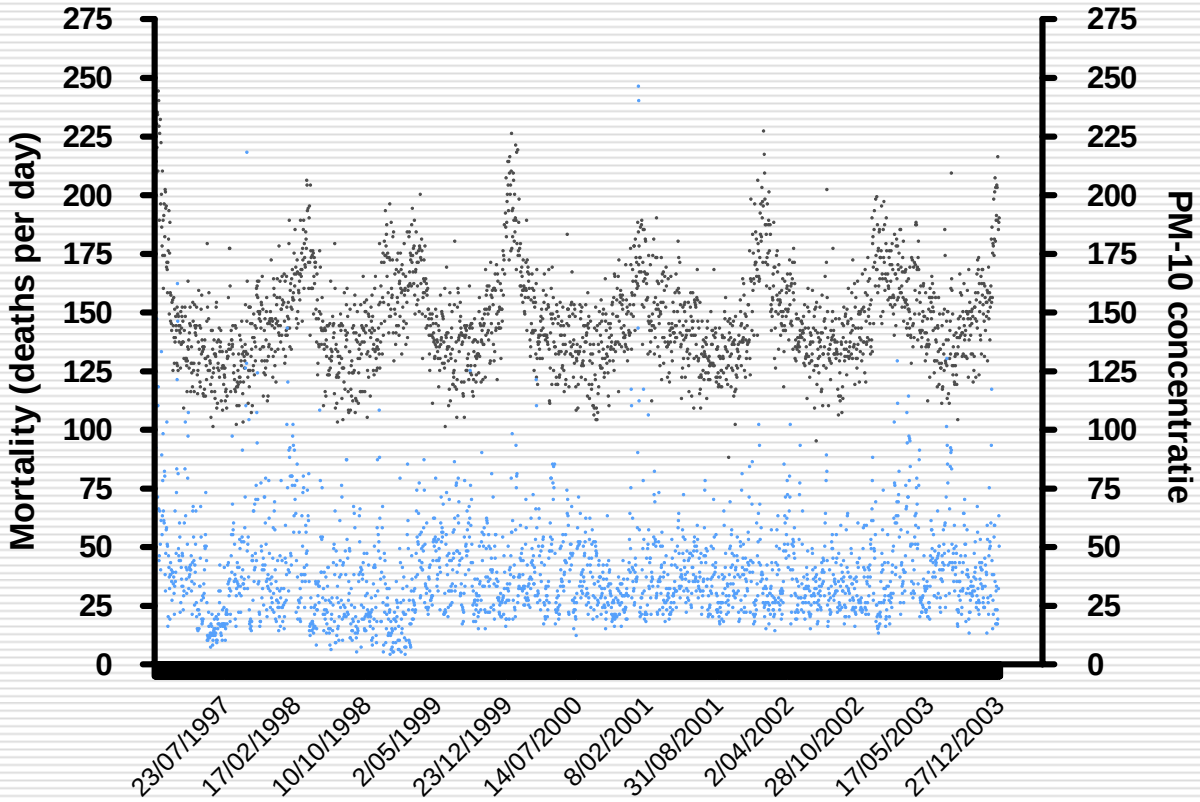
Mean (SD)

Variation in daily mortality and temperature, 1997-2003*



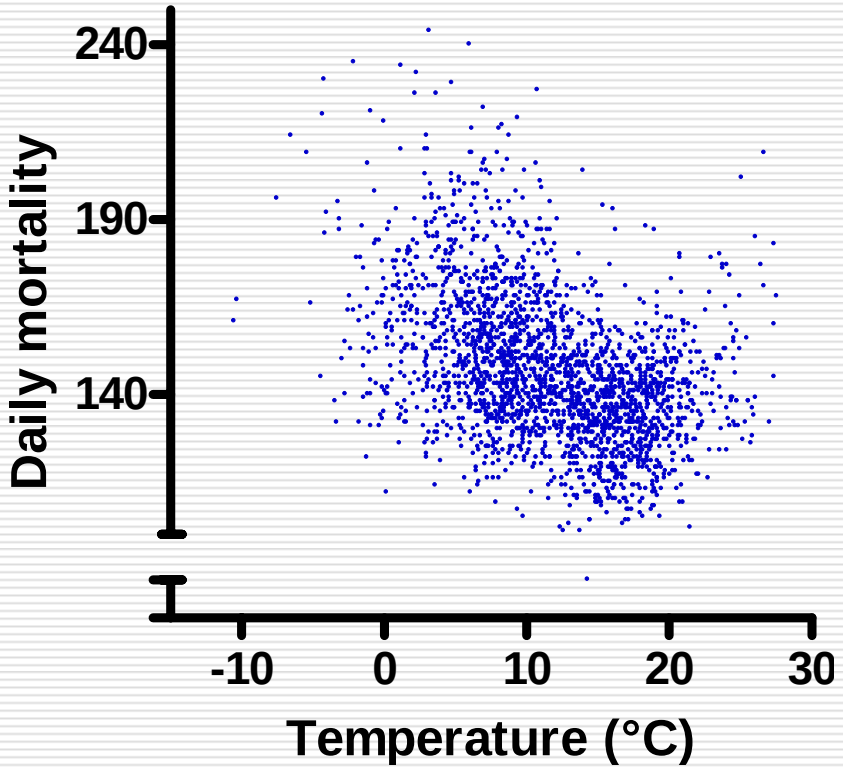
*non-traumatic death (n = 354 357)

Variation in daily mortality and PM_{10} 1997-2003*

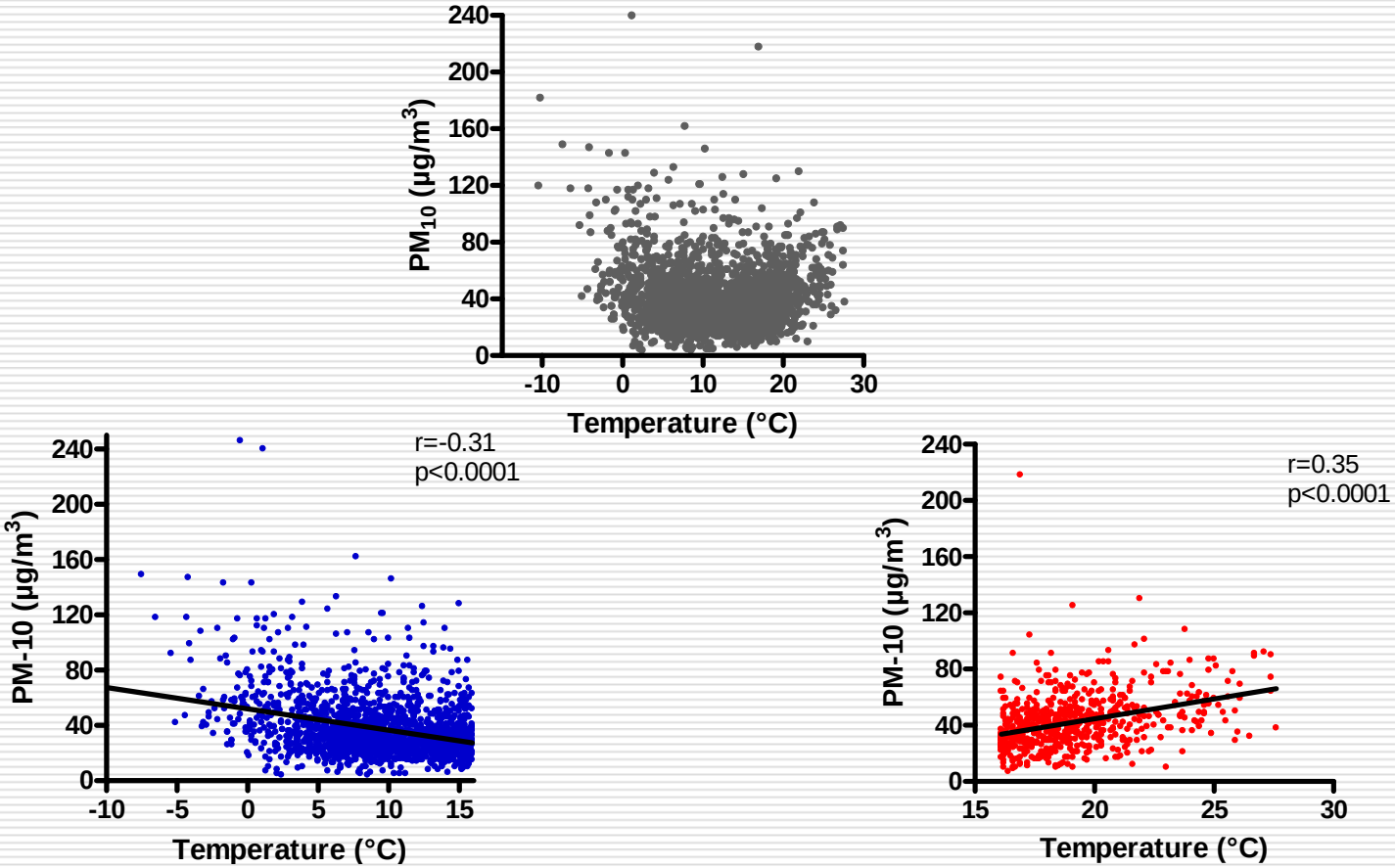


*non-traumatic death (n = 354 357)

Mortality and outdoor temperature

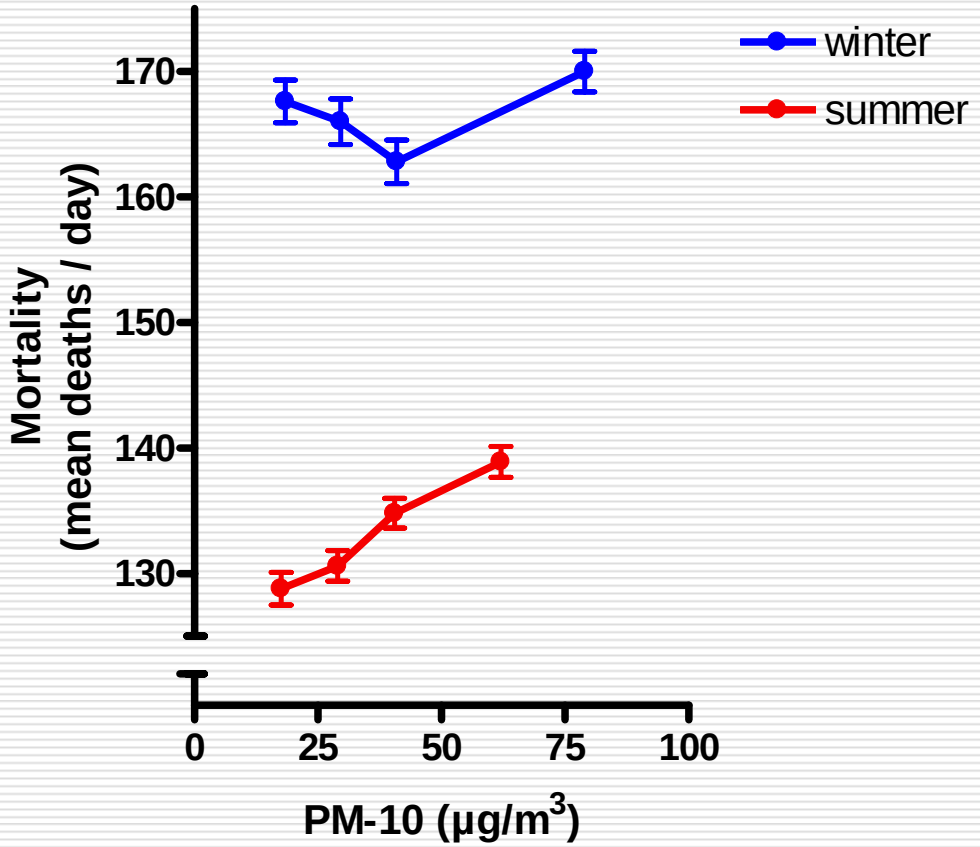


PM_{10} and outdoor temperature



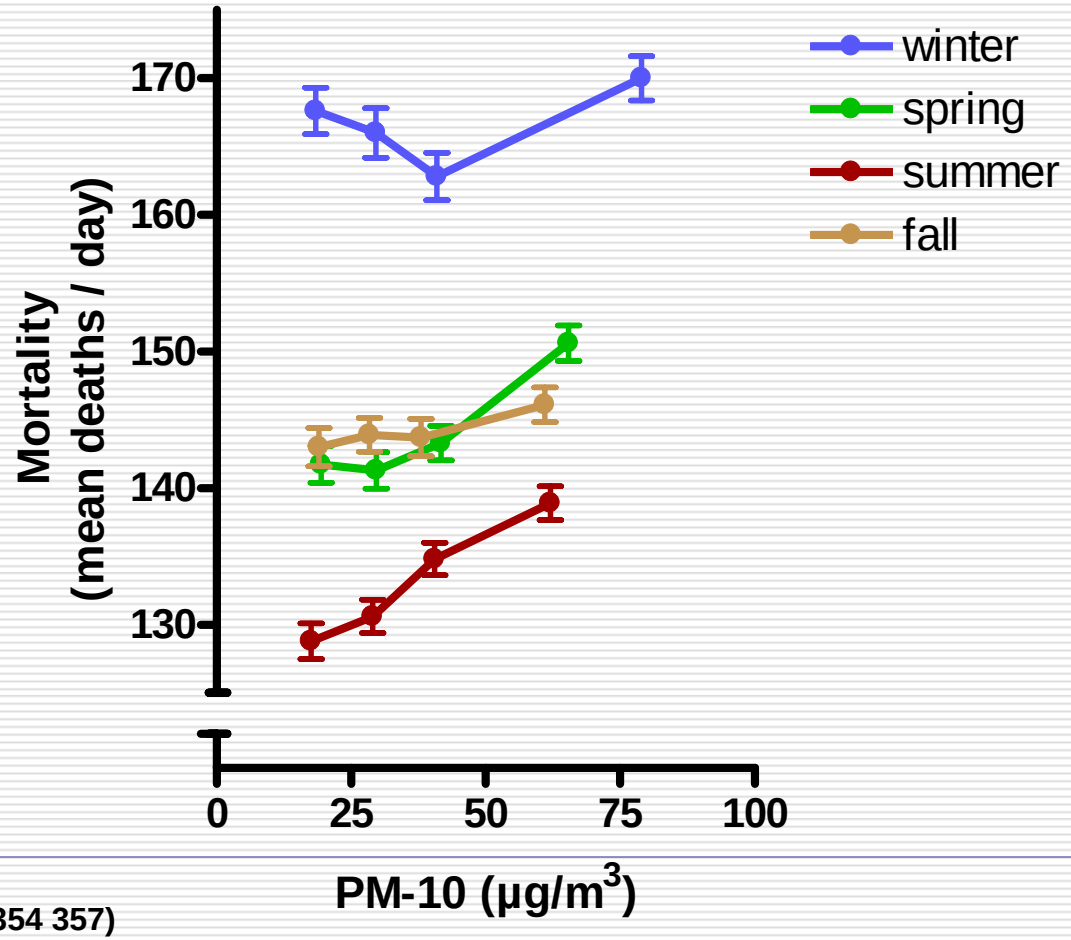
The impact of PM_{10} on mortality

Mean daily mortality by season specific quartiles of PM_{10}



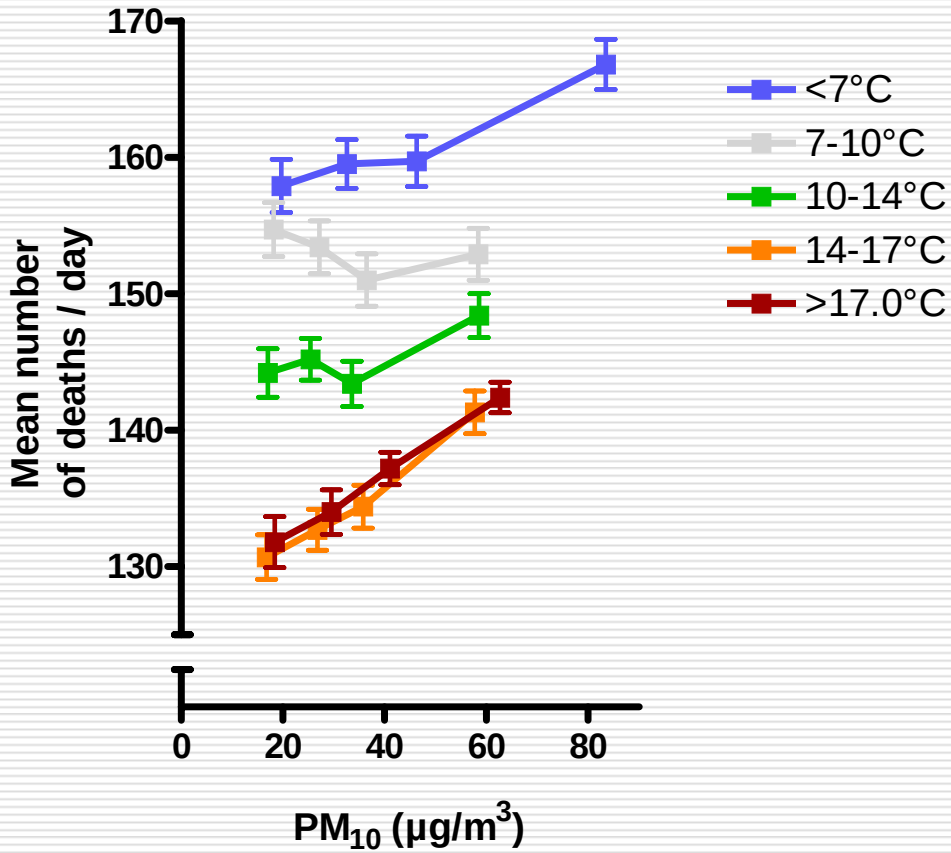
Non-traumatic deaths (n = 354 357)

Mean daily mortality by season specific quartiles of PM_{10}



Non-traumatic deaths (n = 354 357)

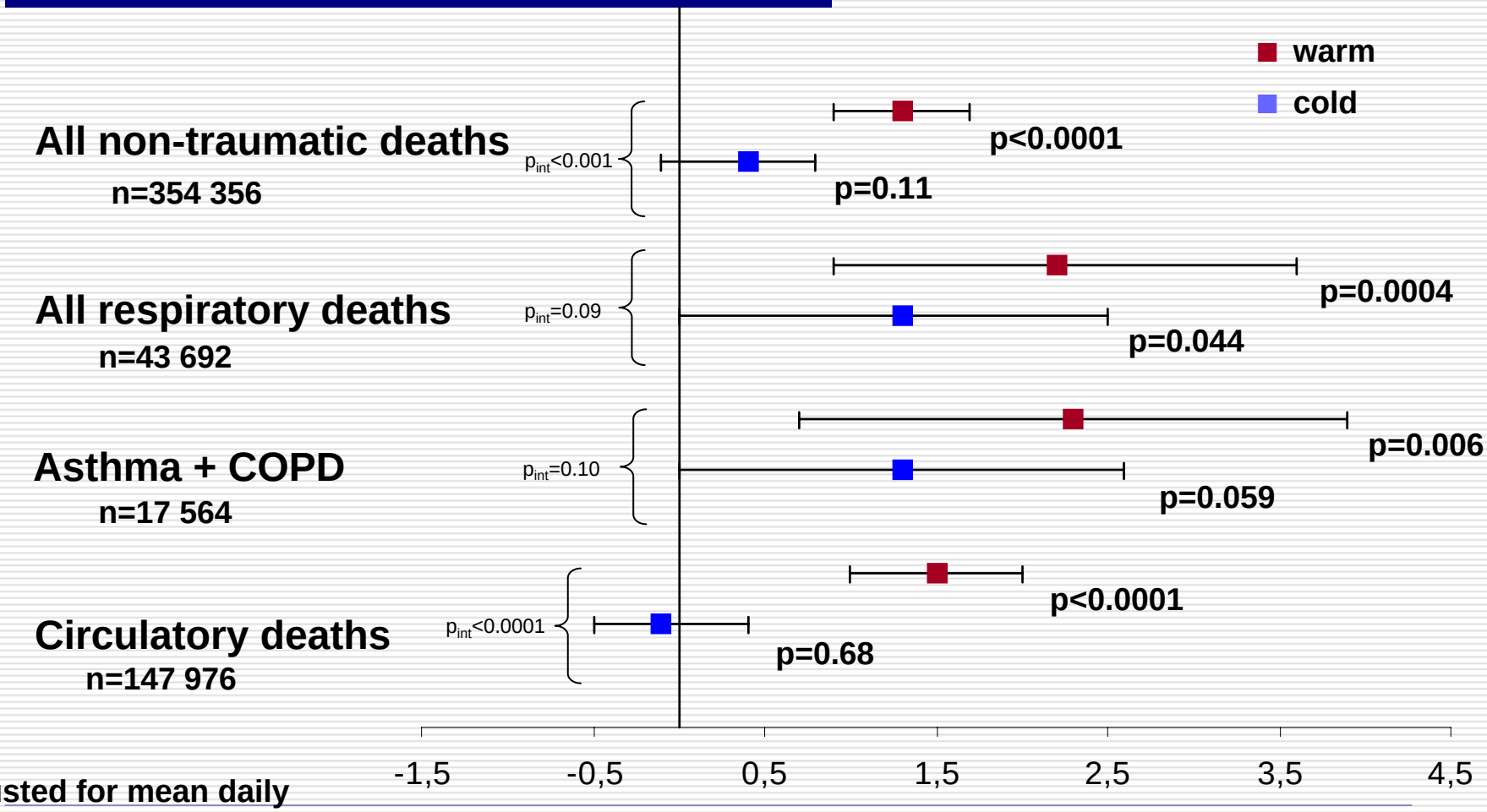
Mean daily mortality by temperature* specific quartiles of PM_{10}



Non-traumatic deaths (n = 354 357)

*temperature categories based on quintiles.

Percentage increase in daily mortality per each increase of 10 µg/m³ PM_{10}*



*adjusted for mean daily temperature of the same and the preceding day.

Sensitivity analysis

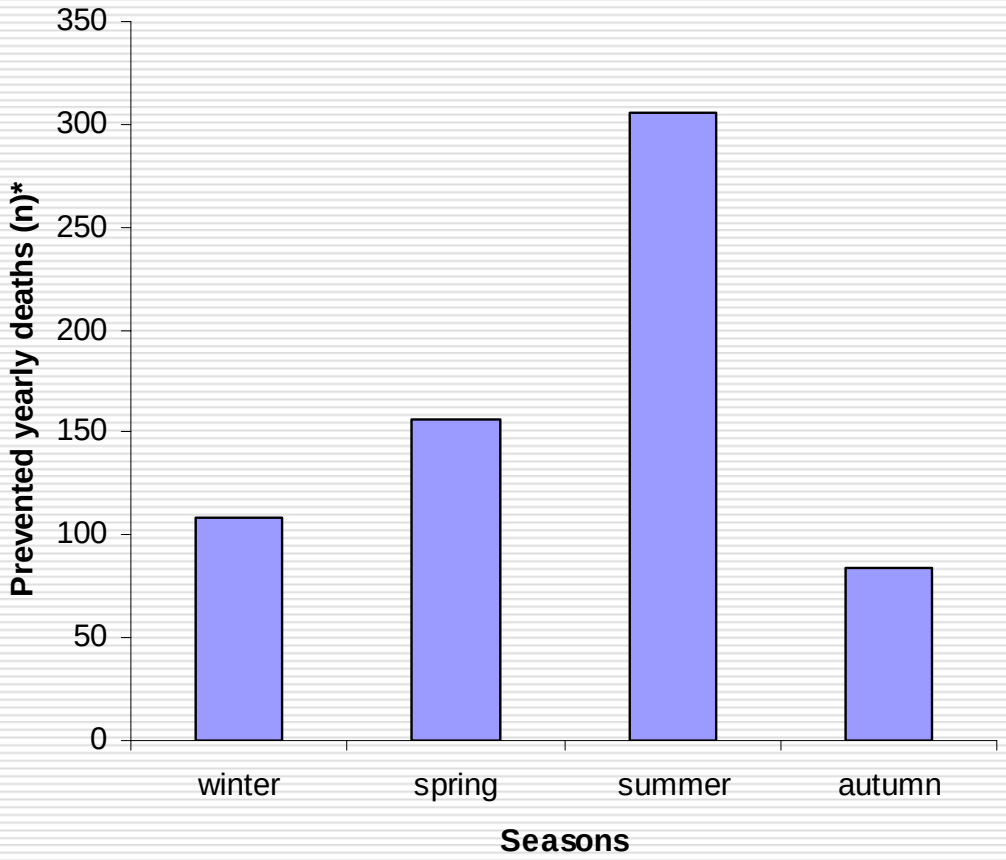
Age classes	Mean age	Mean daily mortality*	+10 µg/m^3 (95% CI)	*p*
<55	43	10	0.49 (-0.61 to 1.5%)	0.39
55-65	61	12	1.53 (0.57 to 2.46%)	0.0017
>65	81	116	1.29 (0.84 to 1.74)	<0.0001

*Mortality (ICD<800) data Flanders (1997-2003) during the warmer period of the year (April to September).

Conclusions

- The association between mortality and PM_{10} concentration is complex and depends largely on outdoor temperature.
- We observed a threshold during the winter period and on days with a mean outdoor temperature of less than 10°C.

Perspectives



*If mean daily PM_{10}-levels had not been exceeded 20 µg/m^3.

How can we explain the seasonal influence on the mortality - air pollution association?

- The PM_{10} toxicity may vary by season.
- Higher relative effects in summer as a result of more time spent outdoors.
- The PM_{10} effect on mortality in winter could be swamped by the more powerful effect of cold spells on mortality.

“Interventies”

Pope C.A. Respiratory disease associated with community air pollution and a steel mill, Utah Valley. *Am.J. Publ.Health* 1989, 79, 623-8

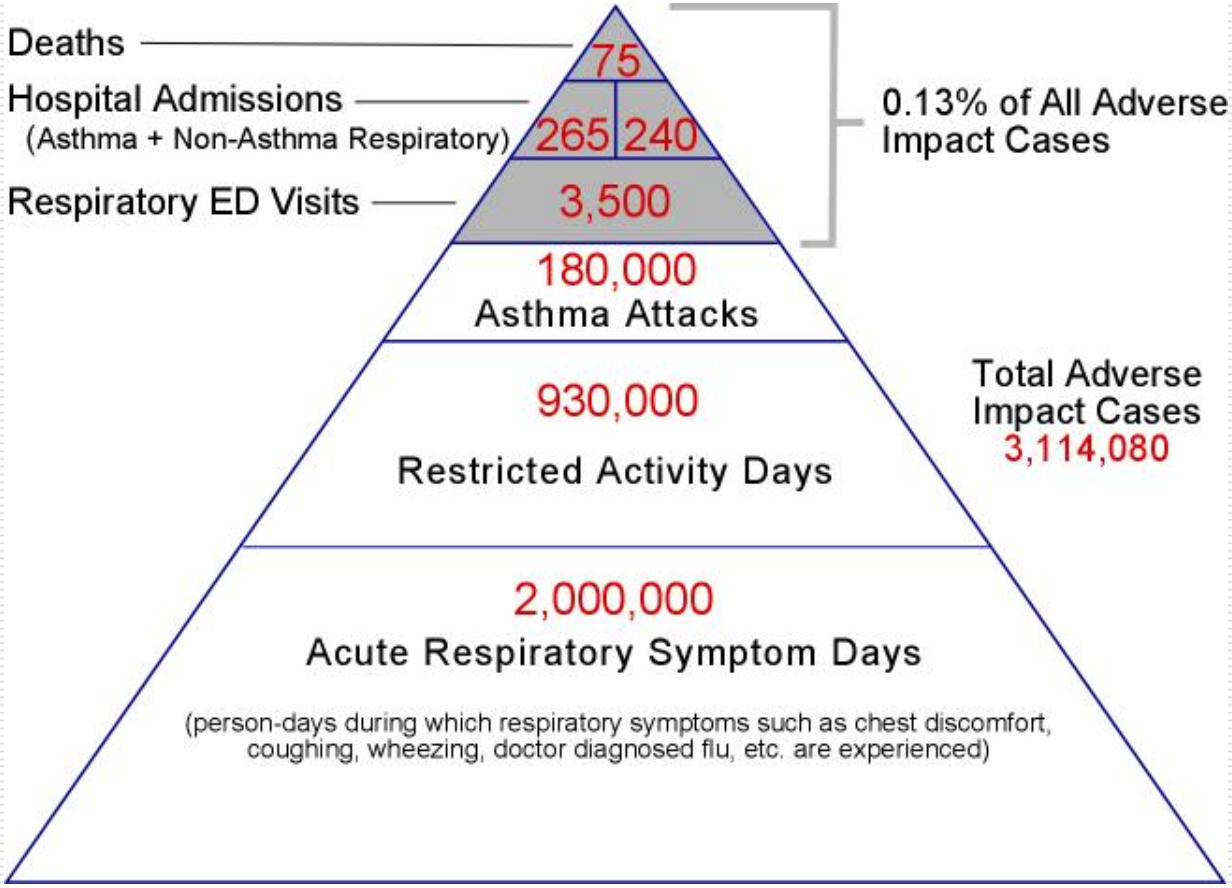
- strike in 1986-87
- PM_{10} ($\mu g/m^3$): 90 $\rightarrow$ 51 (mean)
  365 $\rightarrow$ 113 (high)
- 50% fewer hospital respiratory admissions in children

“Interventies”

Friedman *et al*. Impact of changes in transportation and community behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma. *JAMA*, 2001, 285, 897-905

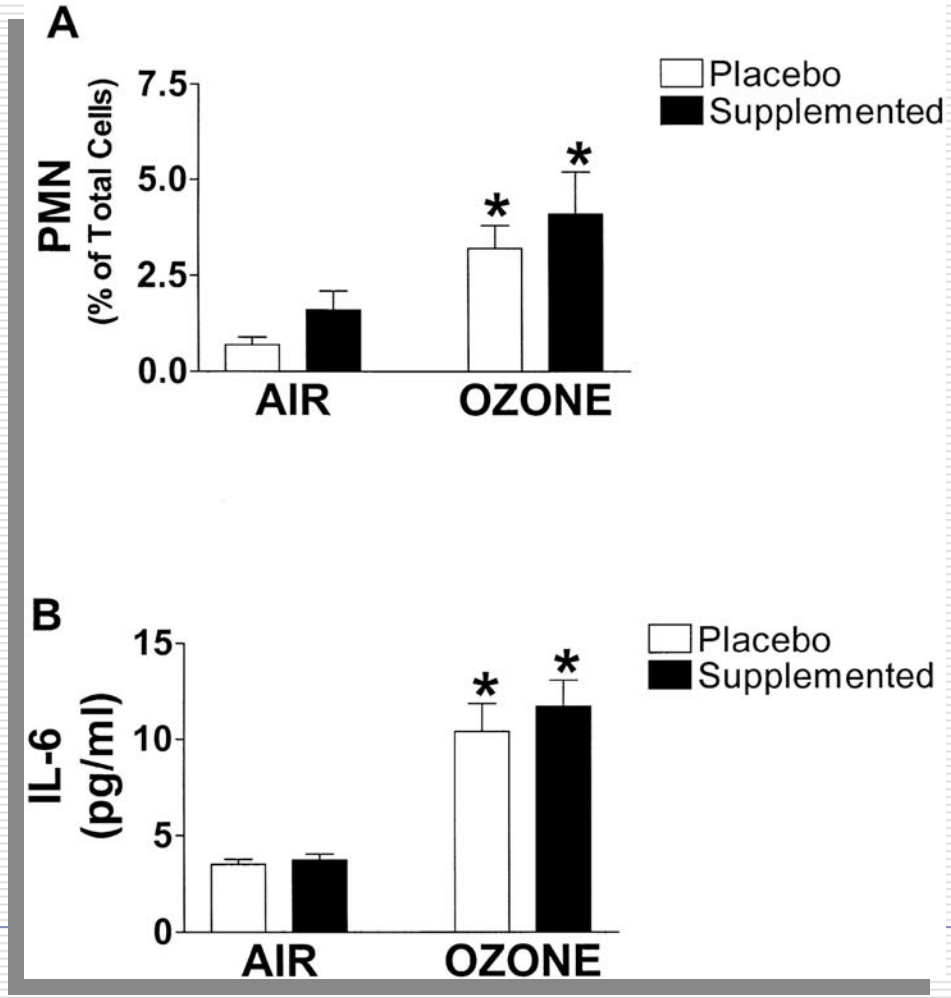
- peak morning traffic counts: -22.5%
- peak daily O3 : 81.3 ppb $\rightarrow$ 58.6 ppb
- mean daily PM10 : 36.7 $\rightarrow$ 30.8 µg/m3
- asthma acute care events: -41.6%

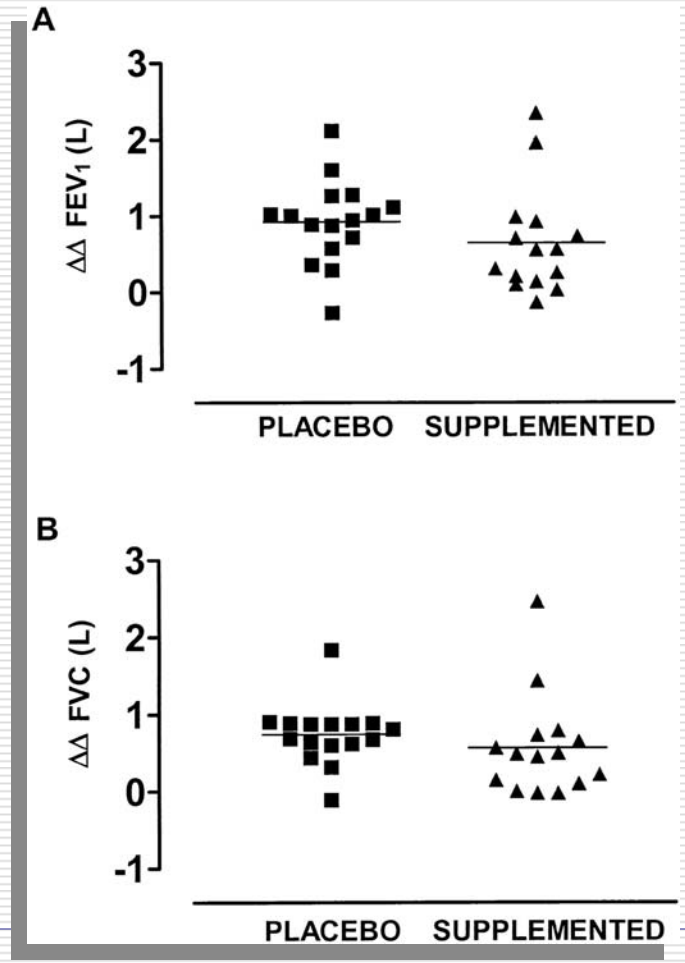
“Tip of the Iceberg”



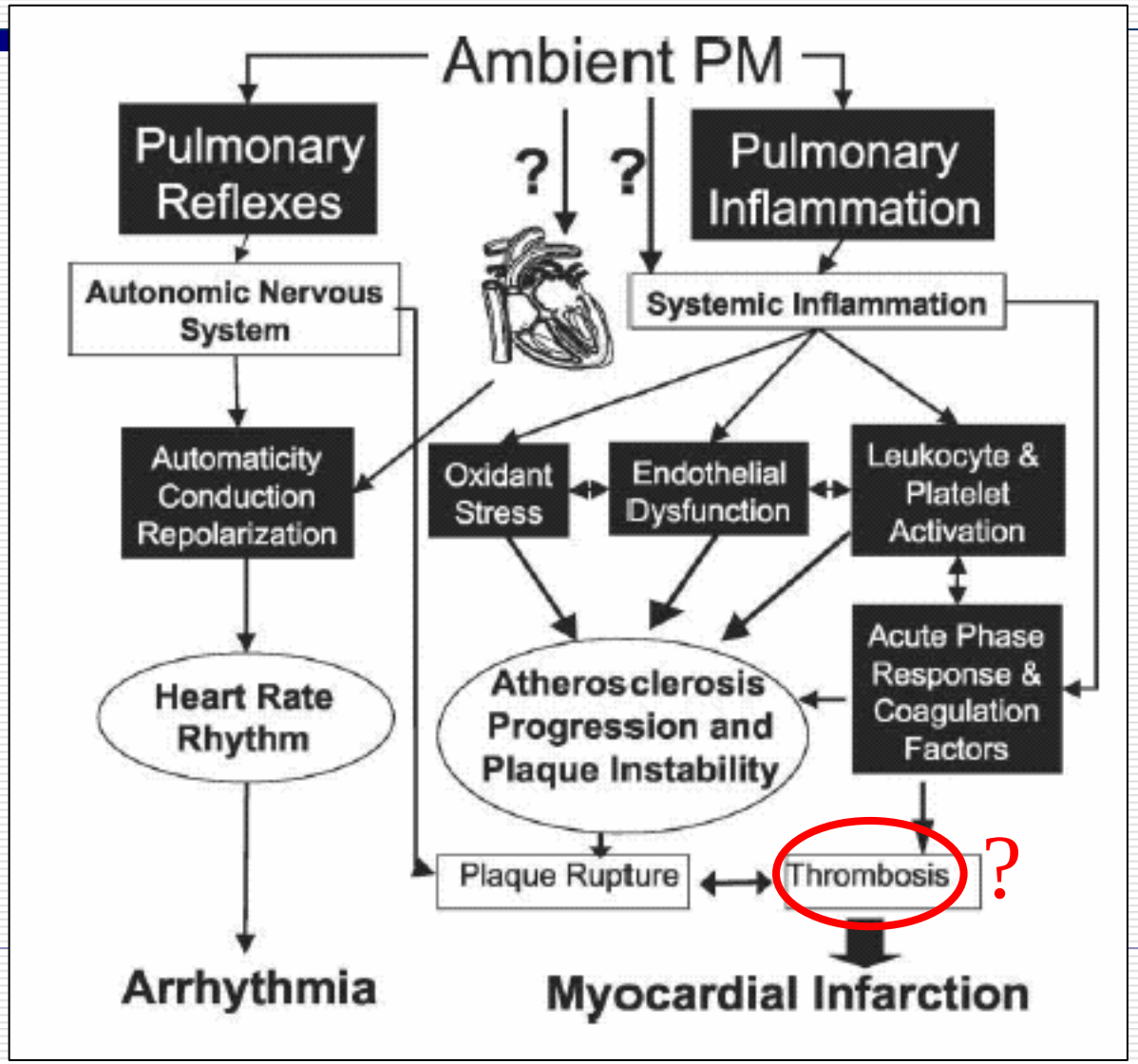
Adverse health effects that could be avoided every year by meeting the US EPA's daily maximum ozone standard (80 ppb 8-hr) in New York. Figure sections not drawn to scale. From Thurston 1997.

Interventions Vitamin E




A
ΔΔ FEV1 (L)
3
2
1
0
-1
PLACEBO
SUPPLEMENTED
B
ΔΔ FVC (L)
3
2
1
0
-1
PLACEBO
SUPPLEMENTED

Brook RD *et al*. Air pollution and cardiovascular disease. A statement for health- care professionals from the expert panel on population and prevention science of the American Heart Association. *Circulation* 2004 (June 1); 109: 2655-71



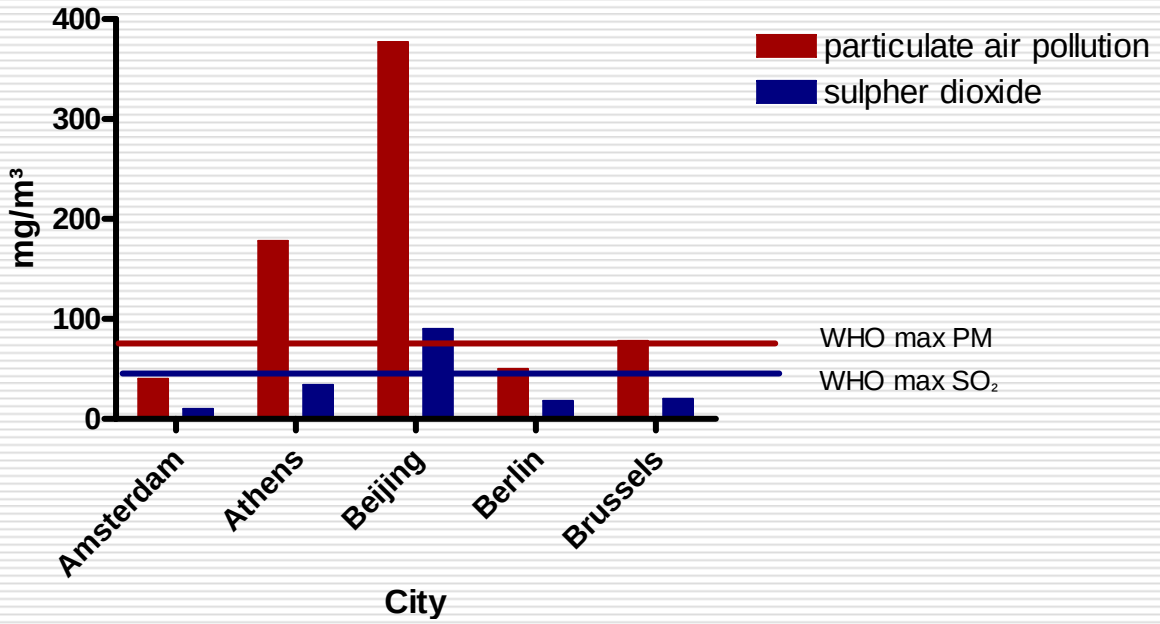
DOI:10.1111/j.1365-2125.2004.02044.x

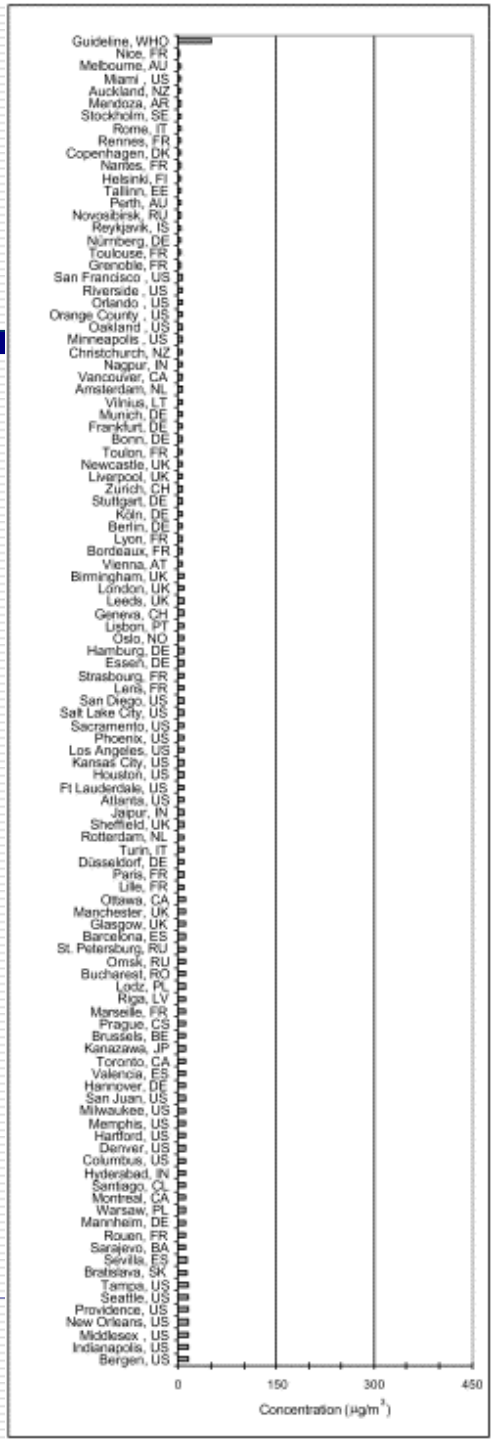
British Journal of Clinical Pharmacology

Professional athletes suffering from familial hypercholesterolaemia rarely tolerate statin treatment because of muscular problems

H. Sinzinger & J. O'Grady*

Wilhelm Auerswald Atherosclerosis Research Group (ASF) Vienna, Institute for Diagnosis and Treatment of Atherosclerosis and Lipid Disorders (ATHOS), Vienna, Austria


400
300
200
100
0
mg/m³
particulate air pollution
sulpher dioxide
WHO max PM
WHO max SO₂
Amsterdam
Athens
Beijing
Berlin
Brussels
City


Guideline, WHO
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Melbourne, AU
Miami , US
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Helsinki, FI
Tallinn, EE
Perth, AU
Novosibirsk, RU
Reykjavik, IS
Nürnberg, DE
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Grenoble, FR
San Francisco , US
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Vancouver, CA
Amsterdam, NL
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Munich, DE
Frankfurt, DE
Bonn, DE
Toulon, FR
Newcastle, UK
Liverpool, UK
Zurich, CH
Stuttgart, DE
Köln, DE
Berlin, DE
Lyon, FR
Bordeaux, FR
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Salt Lake City, US
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Los Angeles, US
Kansas City, US
Houston, US
Ft Lauderdale, US
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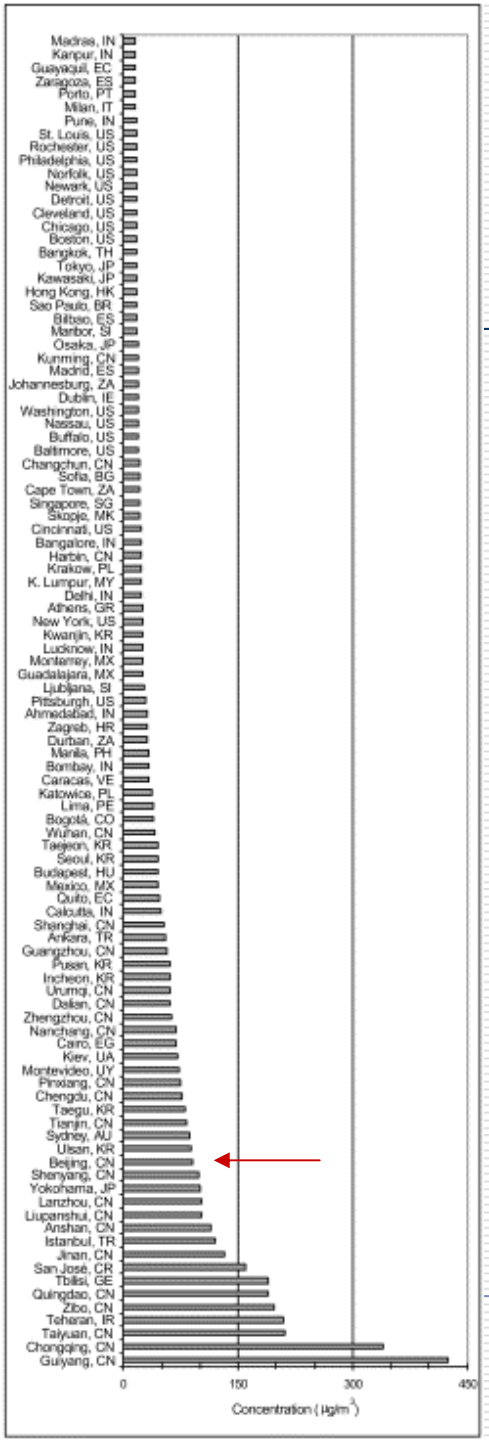
Sarajevo, BA
Seville, ES
Bratislava, SK
Tampa, US
Seattle, US
Providence, US
New Orleans, US
Middlesex , US
Indianapolis, US
Bergen, US
0
150
300
450
Concentration (µg/m3)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Chicago, US
Boston, US
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Kawasaki, JP
Hong Kong, HK
Sao Paulo, BR
Bilbao, ES
Maribor, SI
Osaka, JP
Kunming, CN
Madrid, ES
Johannesburg, ZA
Dublin, IE
Washington, US
Nassau, US
Buffalo, US
Baltimore, US
Changchun, CN
Sofia, BG
Cape Town, ZA
Singapore, SG
Skopje, MK
Cincinnati, US
Bangalore, IN
Harbin, CN
Krakow, PL
K. Lumpur, MY
Delhi, IN
Athens, GR
New York, US
Kwanjin, KR
Lucknow, IN
Monterrey, MX
Guadalajara, MX
Ljubljana, SI
Pittsburgh, US
Ahmedabad, IN
Zagreb, HR
Durban, ZA
Manila, PH
Bombay, IN
Caracas, VE
Katowice, PL
Lima, PE
Bogotá, CO
Wuhan, CN
Taejeon, KR
Seoul, KR
Budapest, HU
Mexico, MX
Quito, EC
Calcutta, IN
Shenghai, CN
Ankara, TR
Guangzhou, CN
Pusan, KR
Incheon, KR
Urumqi, CN
Dalian, CN
Zhengzhou, CN
Nanchang, CN
Cairo, EG
Kiev, UA
Montevideo, UY
Pinxiang, CN
Chengdu, CN
Taegu, KR
Tianjin, CN
Sydney, AU
Ulsan, KR
Beijing, CN
Shenyang, CN
Yokohama, JP
Lanzhou, CN
Liupanshui, CN
Anshan, CN
Istanbul, TR
Jinan, CN
San José, CR
Tbilisi, GE
Qingdao, CN
Zibo, CN
Teheran, IR
Taiyuan, CN
Chongqing, CN
Guiyang, CN
0
150
300
450
Concentration (µg/m3)

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