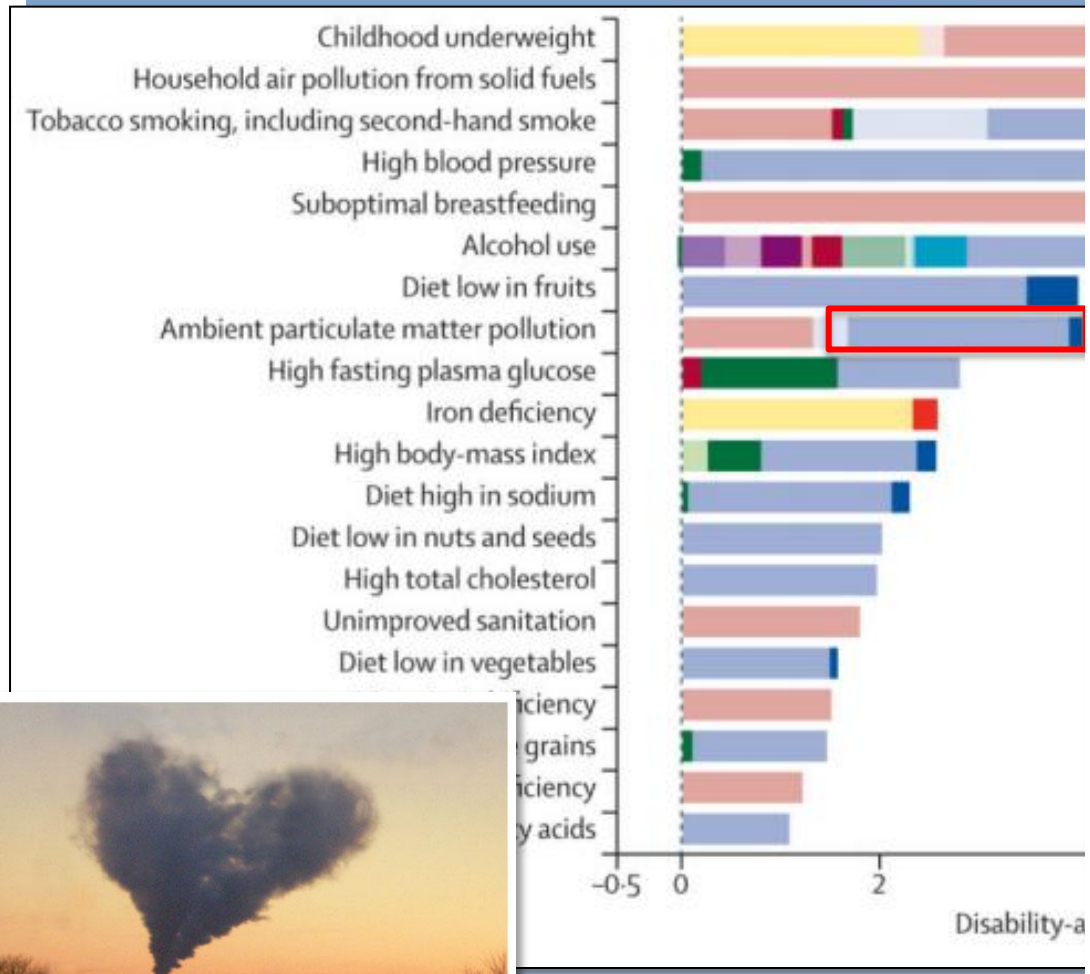
Environmental hazards – air pollution and noise as novel risk factors

Tommaso Gori

University Medical Center Mainz

Pollution

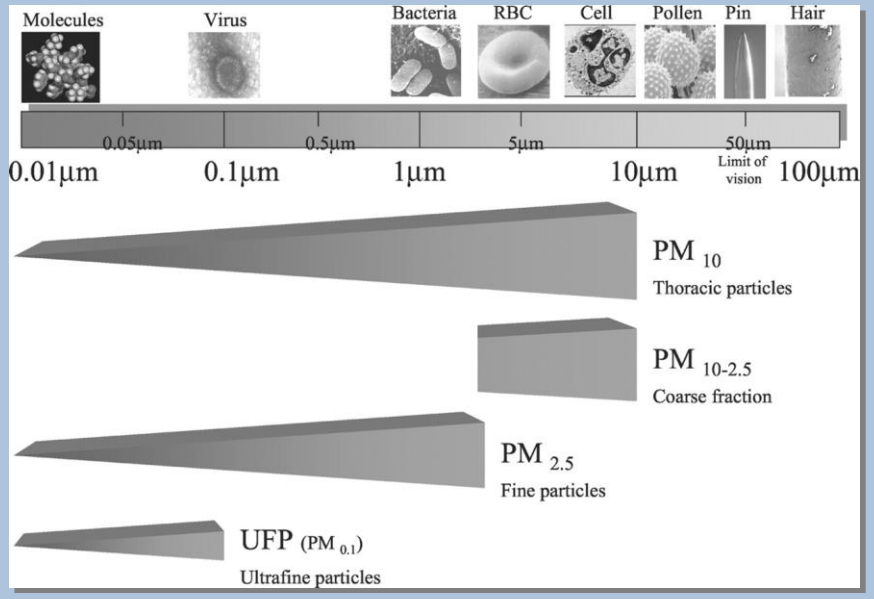


	Disability-adjusted life-years (%)
Physiological risk factors	
High blood pressure	53%
High total cholesterol	29%
High body-mass index	23%
High fasting plasma glucose	16%
Alcohol use	33%
Tobacco smoking, including second-hand smoke	31%
Dietary risk factors and physical inactivity	
Diet low in nuts and seeds	40%
Physical inactivity and low physical activity	31%
Diet low in fruits	30%
Diet low in seafood omega-3 fatty acids	22%
Diet low in whole grains	17%
Diet high in sodium	17%
Diet high in processed meat	13%
Diet low in vegetables	12%
Diet low in fibre	11%
Diet low in polyunsaturated fatty acids	9%
Diet high in trans fatty acids	9%
Diet high in sugar-sweetened beverages	2%
Air pollution	
Ambient particulate matter pollution	22%
Household air pollution from solid fuels	18%
Other environmental risks	
Lead exposure	4%

Global Burden of Disease Study 2012, Lancet

Pollution

- Airborne particulate matter (PM)
- Ozone
- Nitrogen dioxide (NO2)
- Volatile organic compounds (benzene)
- Carbon monoxide (CO)
- Sulphur dioxide (SO2)

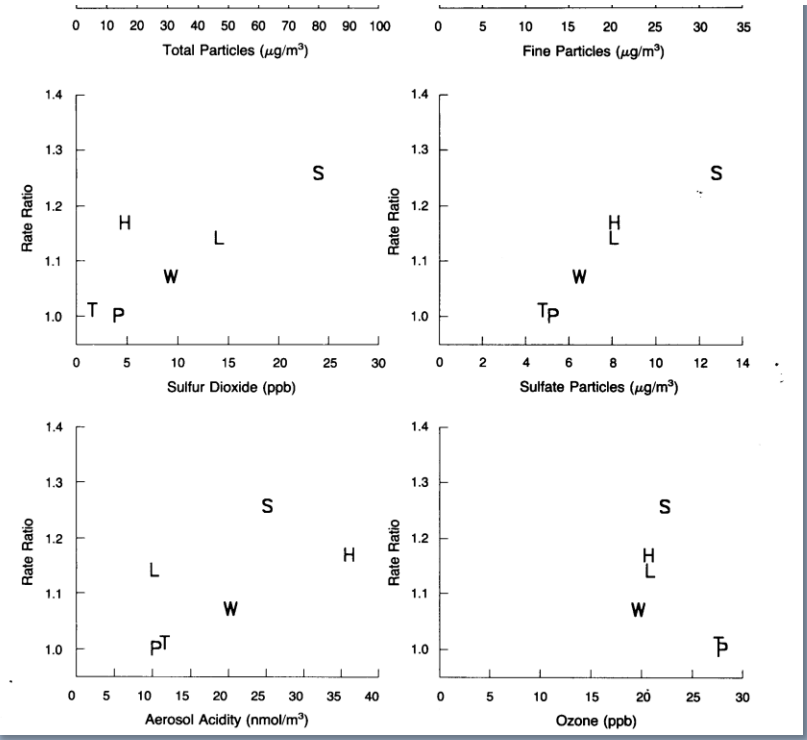


- Road traffic
- Power generation
- Industrial sources
- Residential heating

Six-cities and APHEA studies: HR 1.26-1.97

The Temporal Pattern of Respiratory and Heart Disease Mortality in Response to Air Pollution

Antonella Zanobetti,[1] Joel Schwartz,[1] Evi Samoli,[2] Alexandros Gryparis,[2] Giota Touloumi,[2] Janet Peacock,[3] Ross H. Anderson,[3] Alain Le Tertre,[4] Janos Bobros,[5] Martin Celko,[6] Ayana Goren,[7] Bertil Forsberg,[8] Paola Michelozzi,[9] Daniel Rabczenko,[10] Santiago Perez Hoyos,[11] H. Erich Wichmann,[12] and Klea Katsouyanni[2]



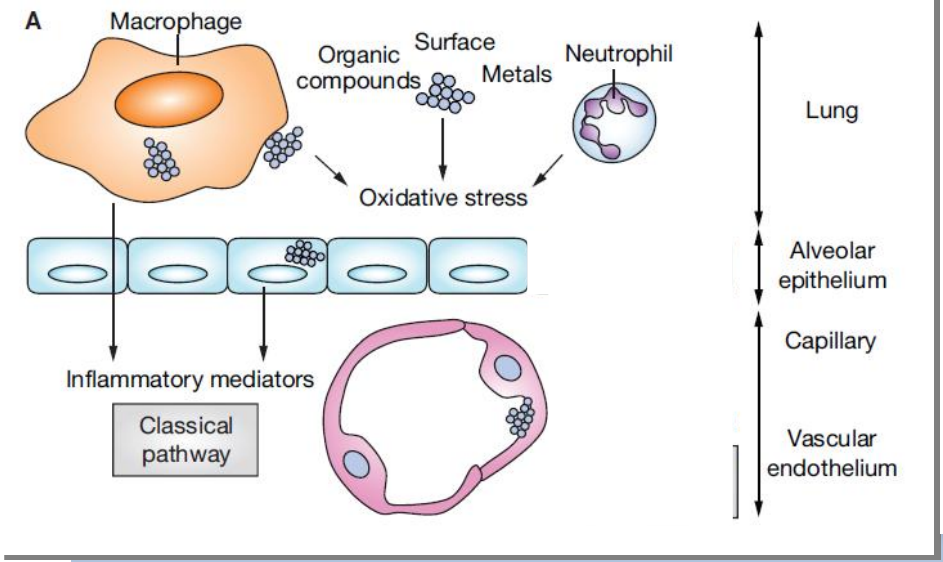
Not the result of harvesting

(mortality displacement, or advancement of death by no more than a few days for severely ill individuals)

N Engl J Med 1993;329:1753–1759

Mechanistic insight

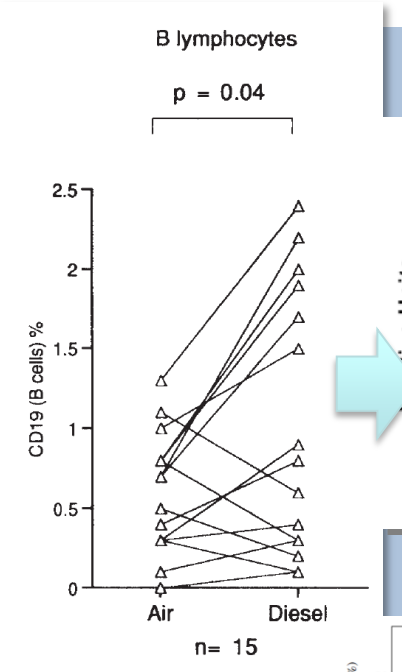
Classical pathway



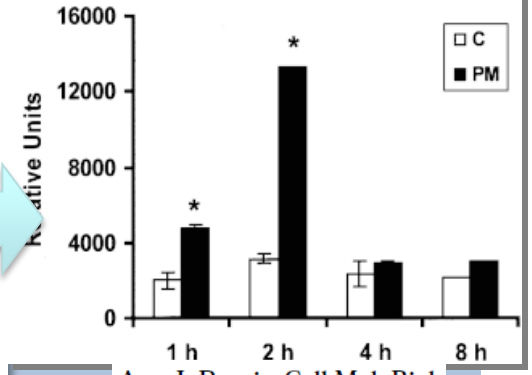
Mills Nat Clin Pract 2009

Particulate air pollution and acute health effects

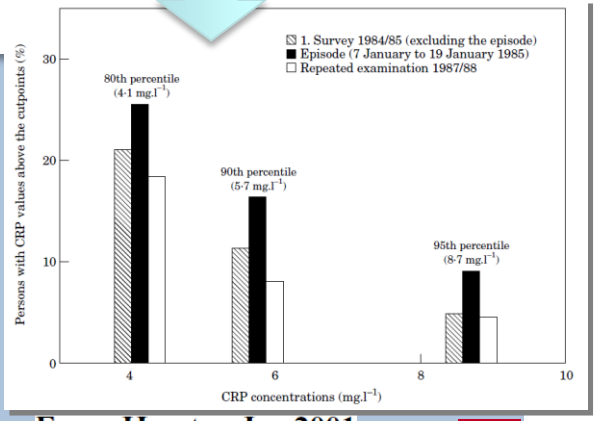
Lancet 1995



AM J RESPIR CRIT CARE MED 1999;



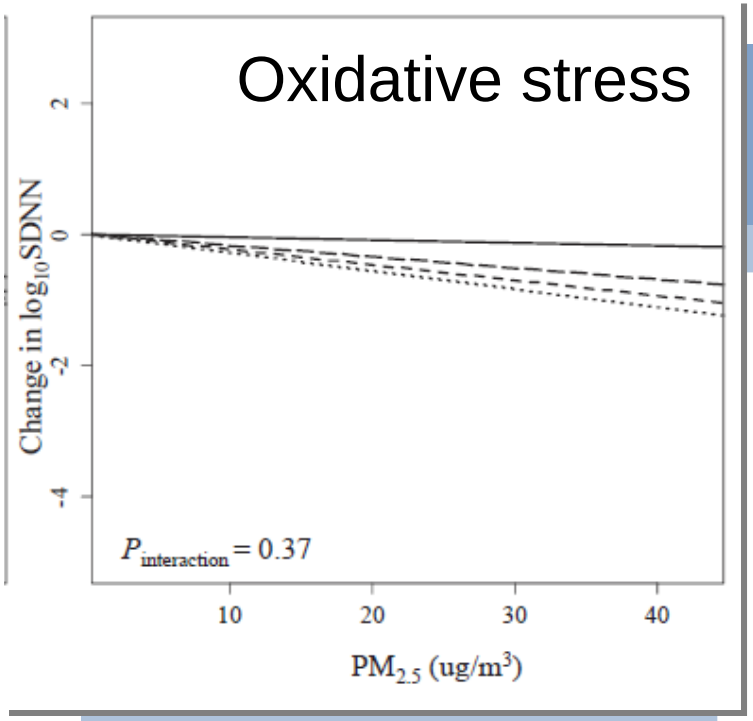
Am. J. Respir. Cell Mol. Biol.

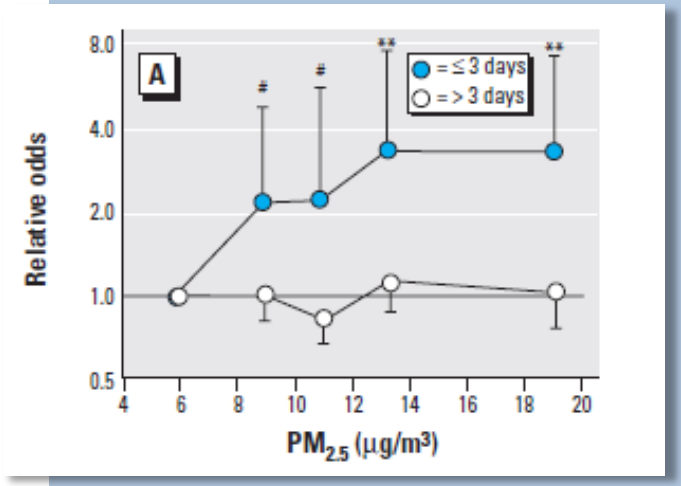


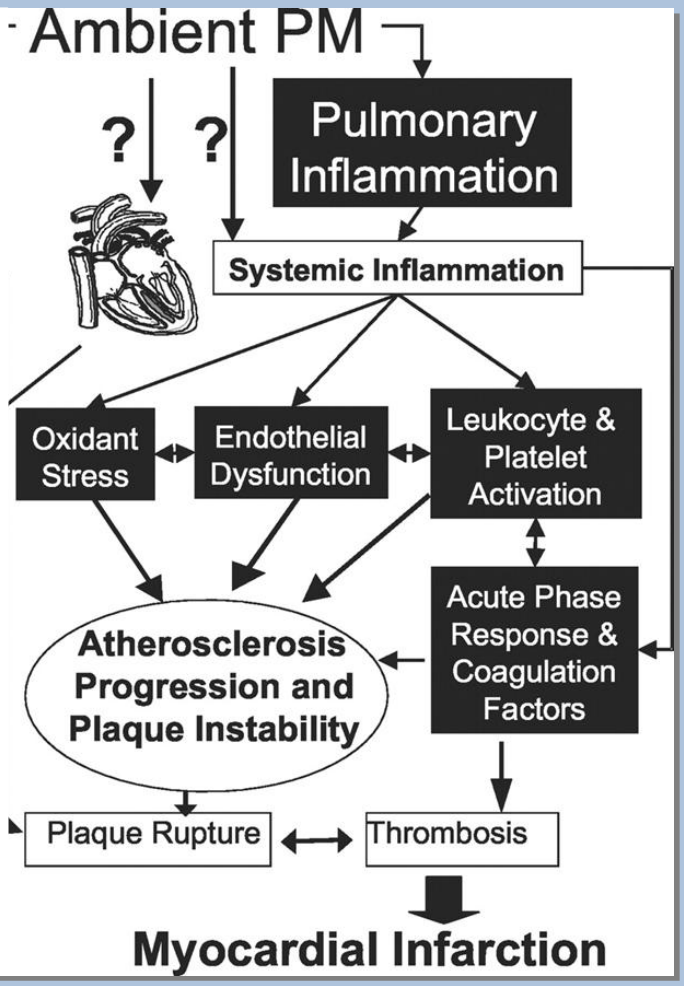
Eur Heart J 2001

- CRP
- Plasma fibrinogen
- Plasma viscosity
- Adhesion molecules

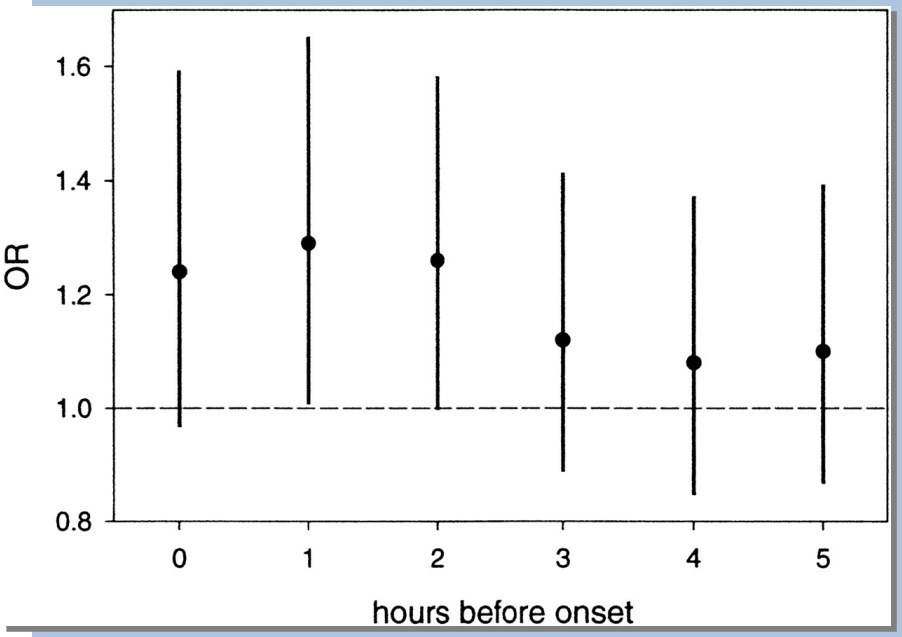
Oxidative stress

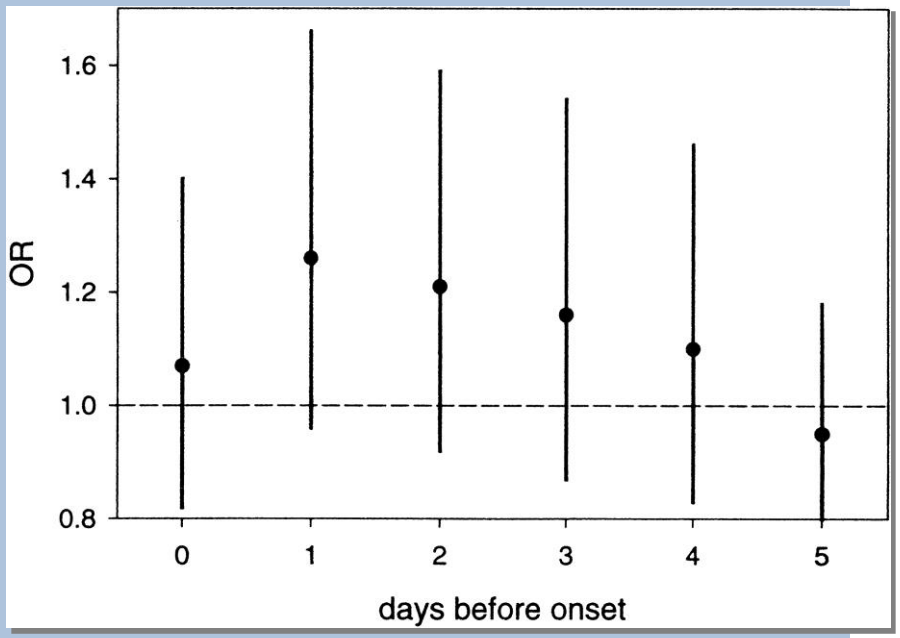






„Reverse preconditioning“

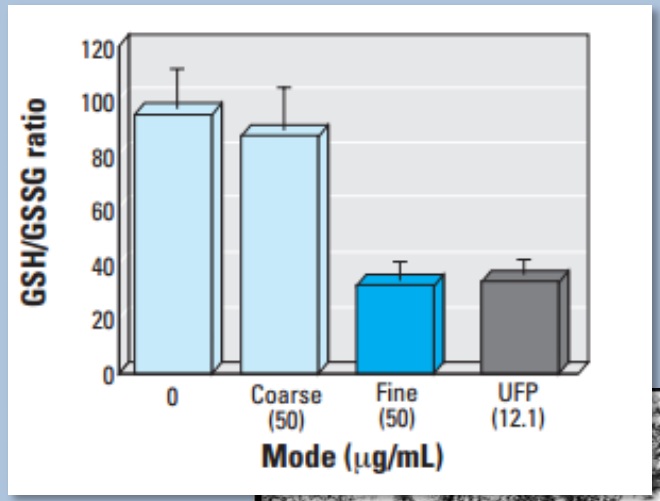


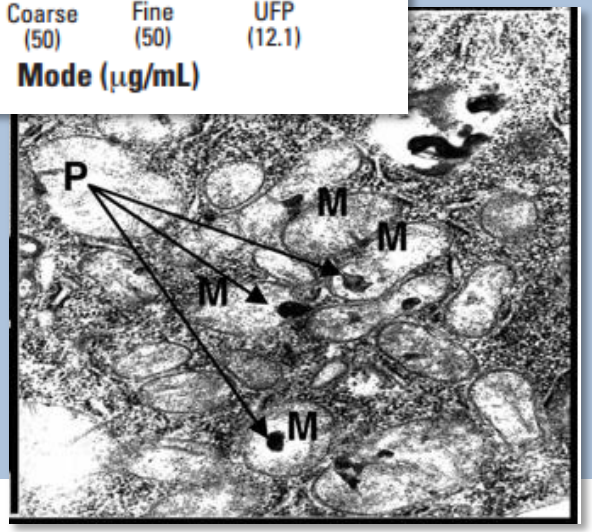


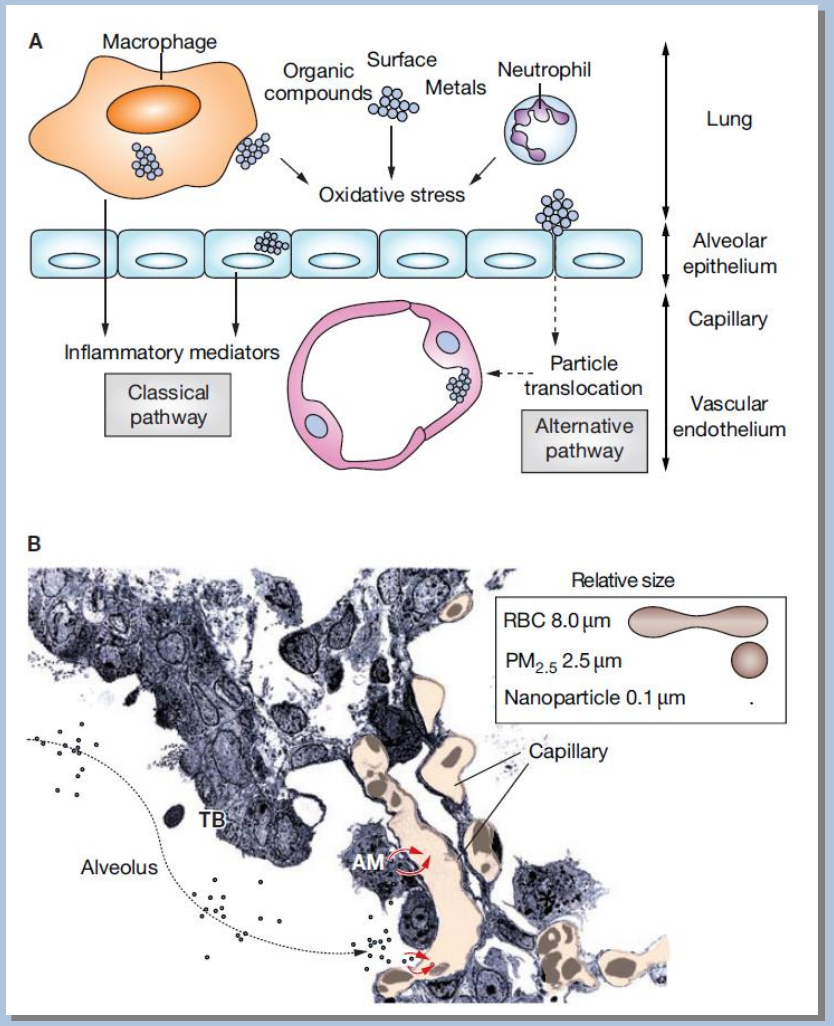
Peters Circulation. 2001

Mechanistic insight

Alternative pathway: direct translocation

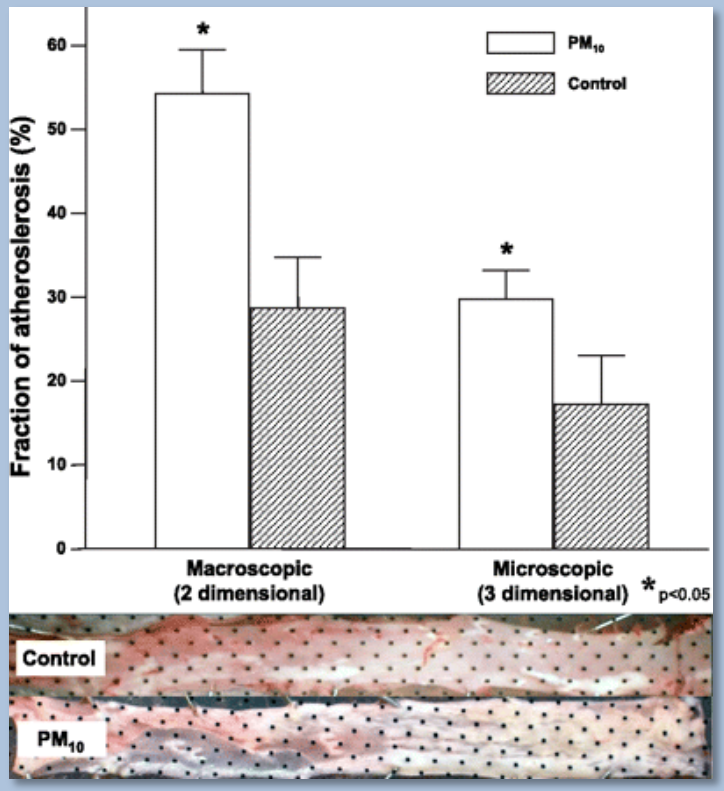


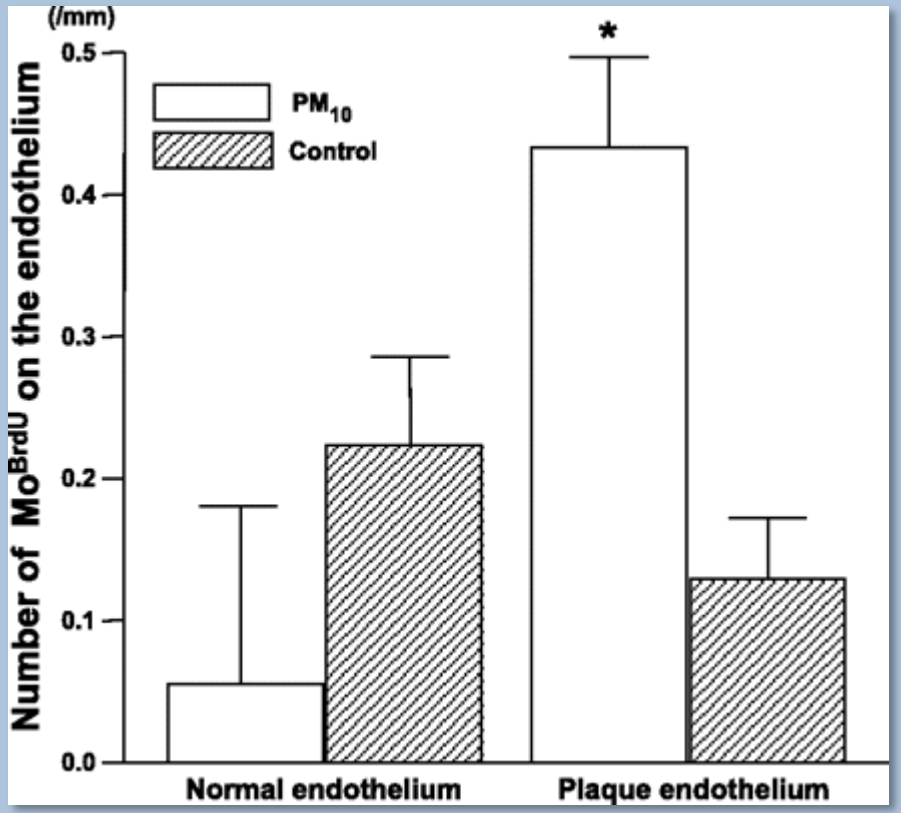




Mechanistic insight

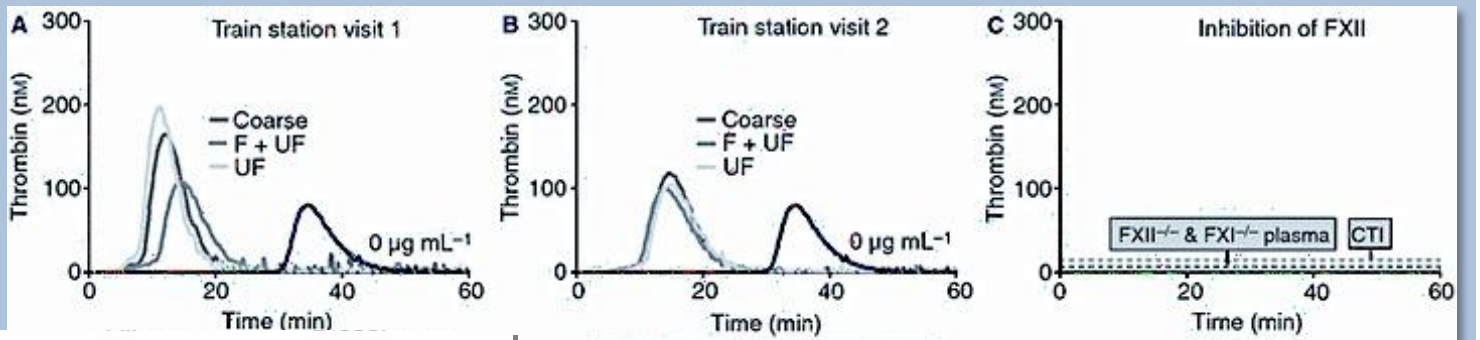
Alternative pathway





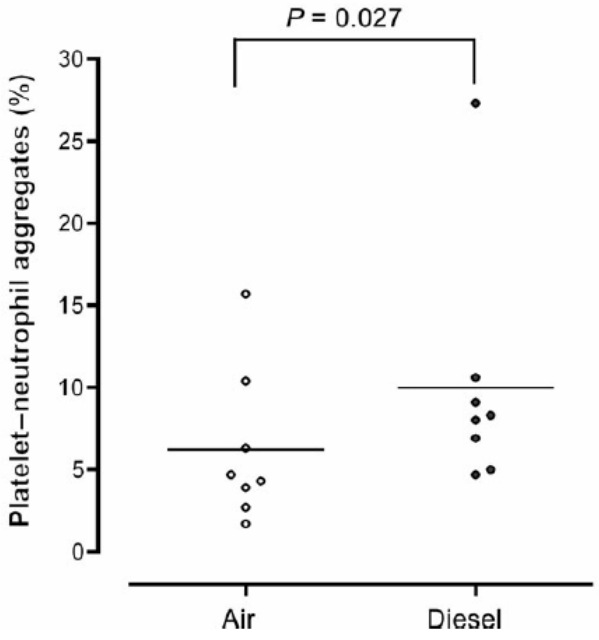
Yatera Am J Physiol 2008

Factor XII activation is essential to sustain the procoagulant effects of particulate matter



PM size	ETP (nM min⁻¹)
Coarse	884
Fine + UFPs	806
UFPs	837

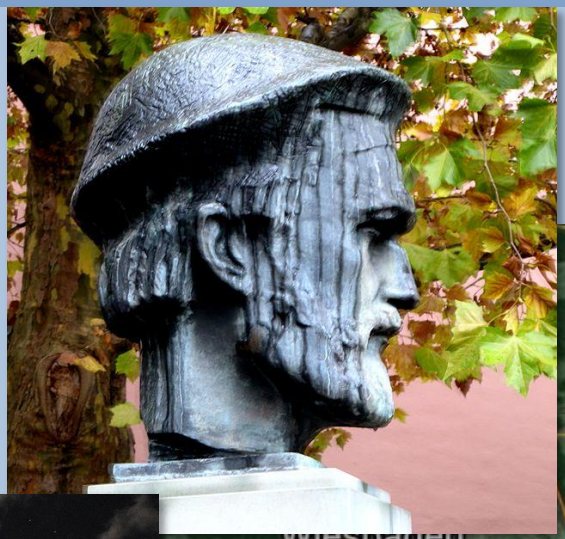
Kilinc et al, J Thromb Haemost 2011
Courtesy Prof H. Ten Cate

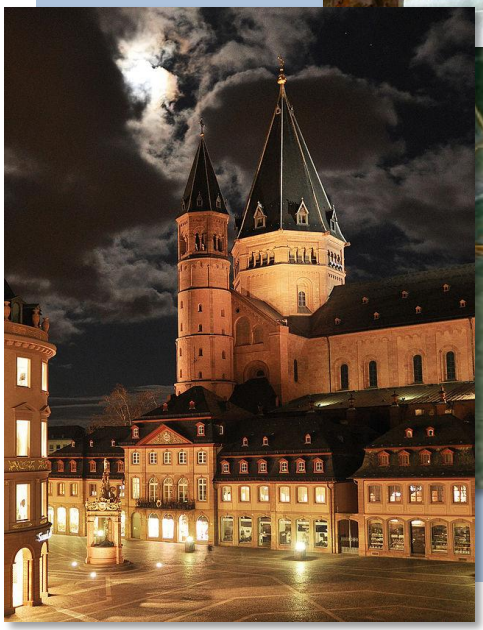


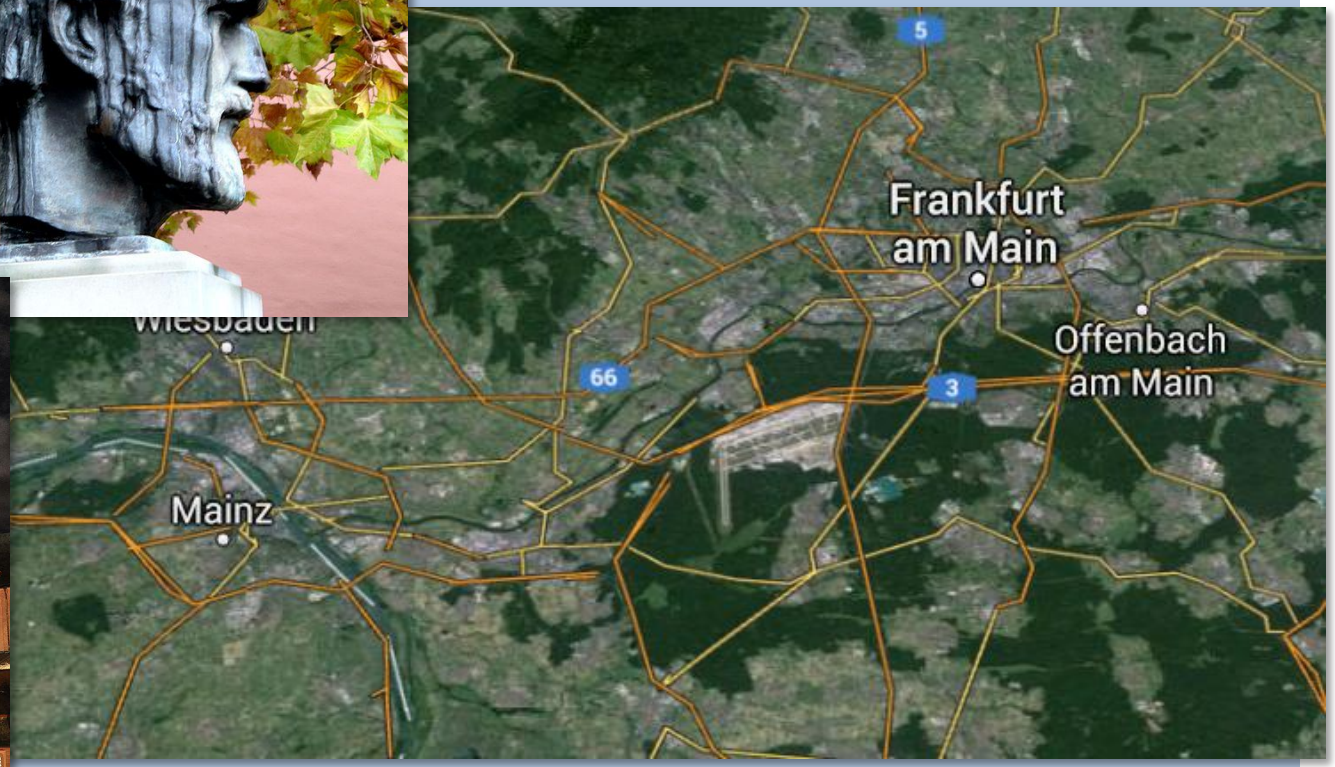
Diesel exhaust inhalation increases thrombus formation in man†

Andrew J. Lucking[1]*, Magnus Lundback[2], Nicholas L. Mills[1], Dana Faratian[1], Stefan L. Barath[2], Jamshid Pourazar[2], Flemming R. Cassee[3], Kenneth Donaldson[1], Nicholas A. Boon[1], Juan J. Badimon[4], Thomas Sandstrom[2], Anders Blomberg[2], and David E. Newby[1]

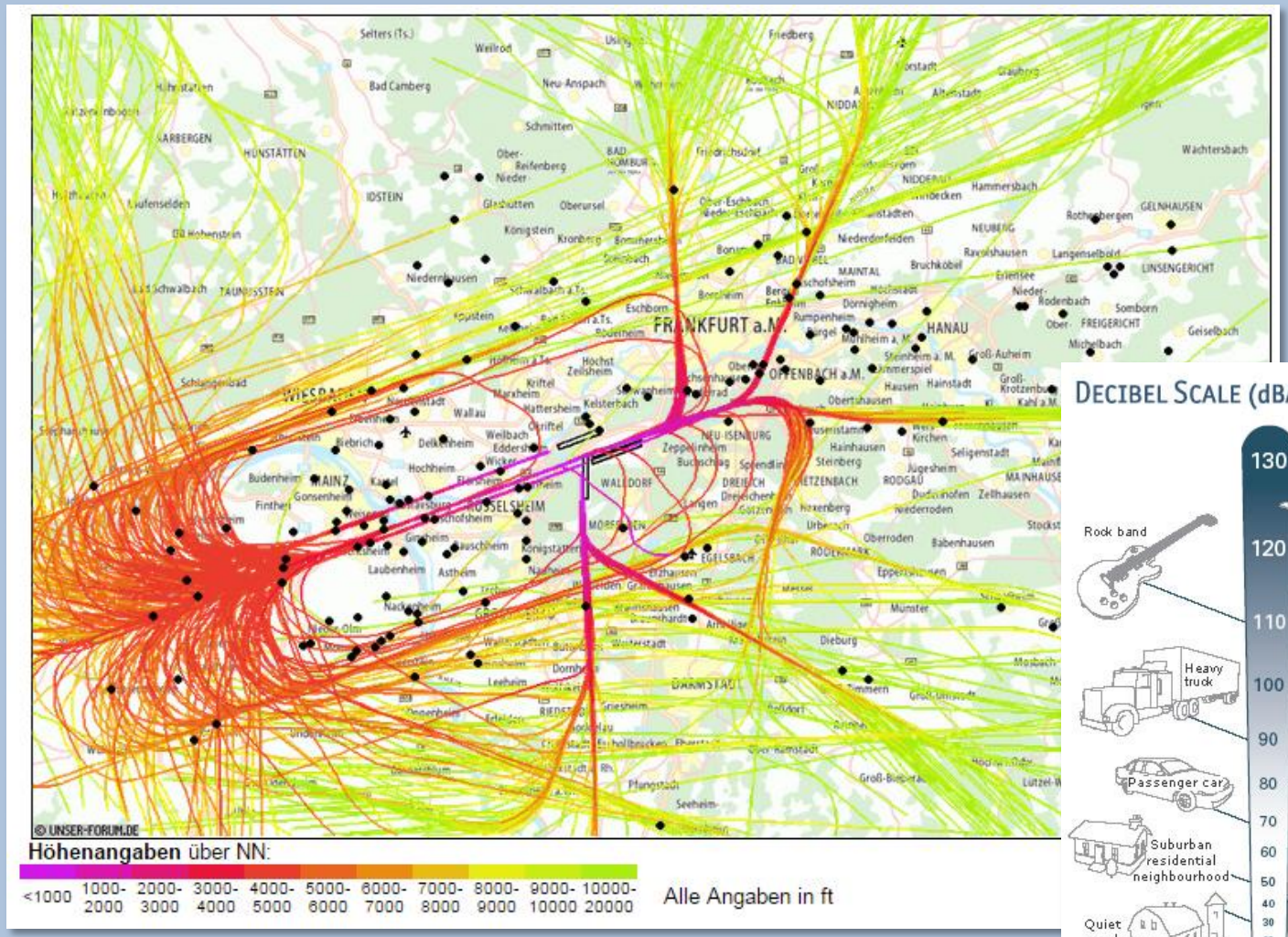
(Aircraft) noise







Noise


© UNSER-FORUM.DE
Höhenangaben über NN:
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8000-9000
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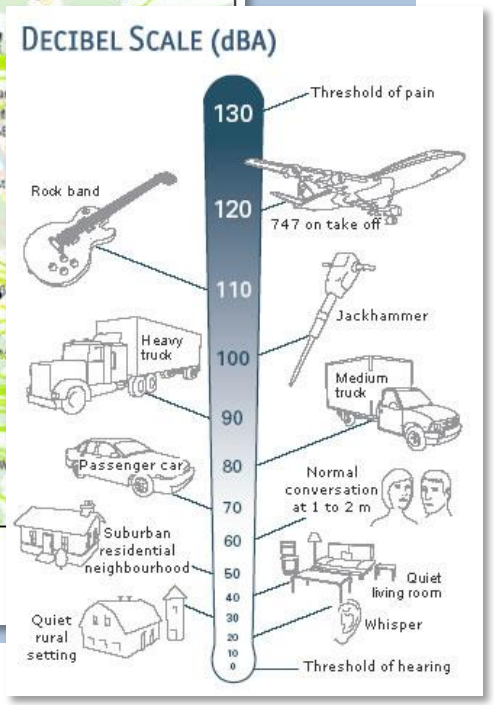
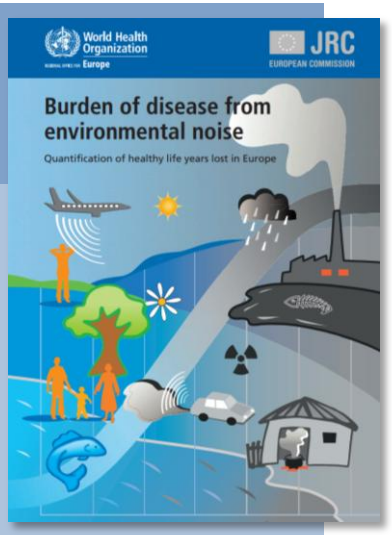
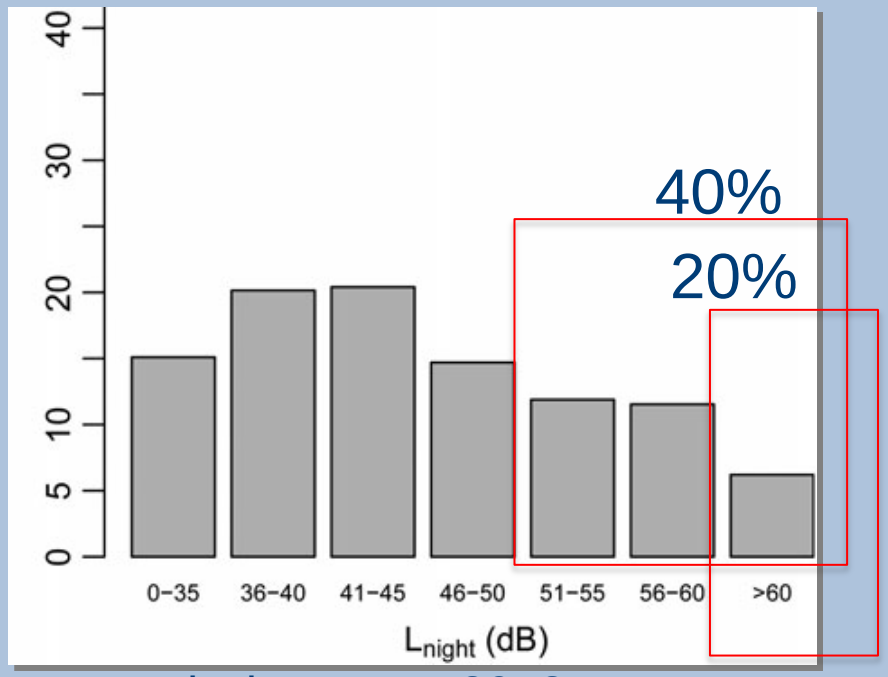

DECIBEL SCALE (dBA)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Threshold of pain
747 on take off
Rock band
Jackhammer
Heavy truck
Medium truck
Passenger car
Normal conversation at 1 to 2 m
Suburban residential neighbourhood
Quiet living room
Quiet rural setting
Whisper
Threshold of hearing

How loud is too loud?



- WHO recommends <40dB(A) during the night
  <55dB(A) during the day

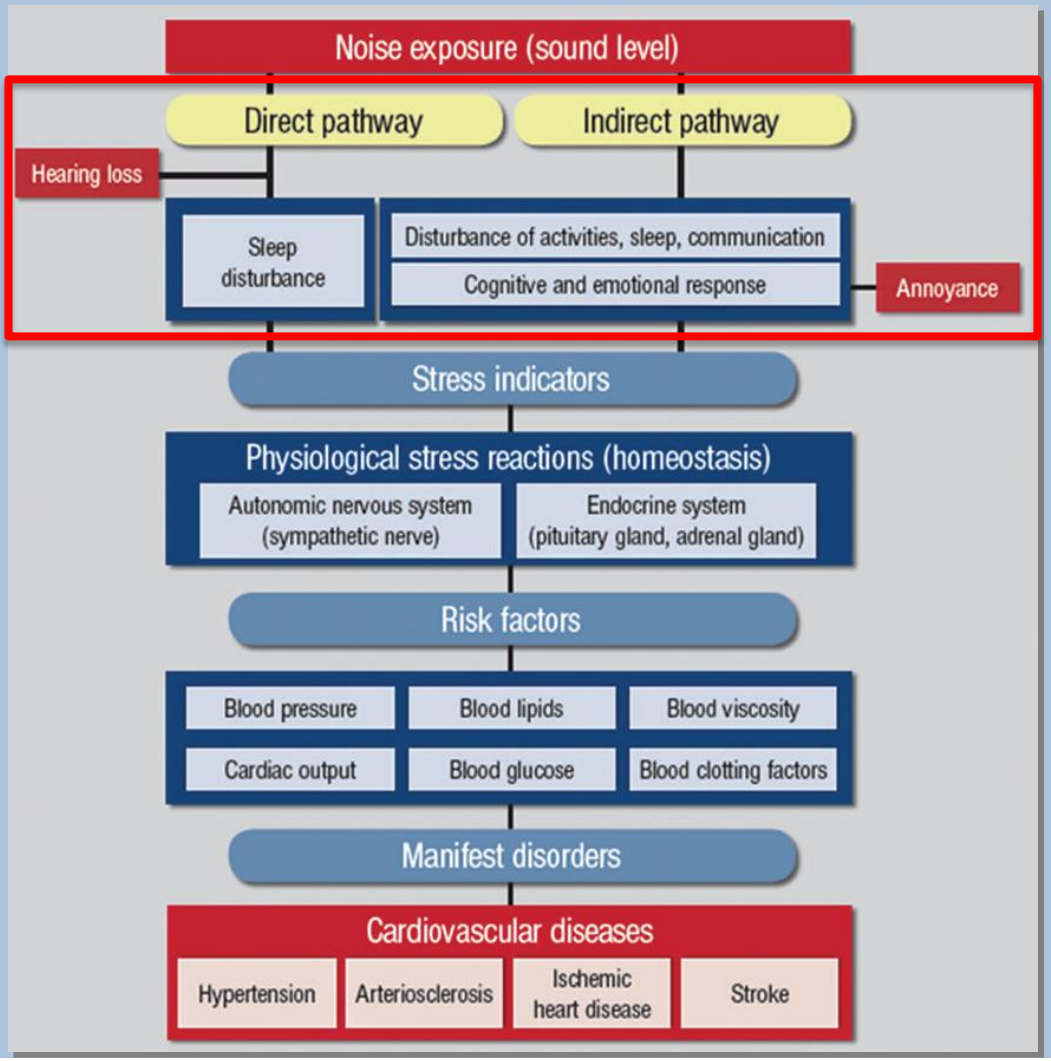


Kälsch Eur H J 2013

HR 1.07-1.18

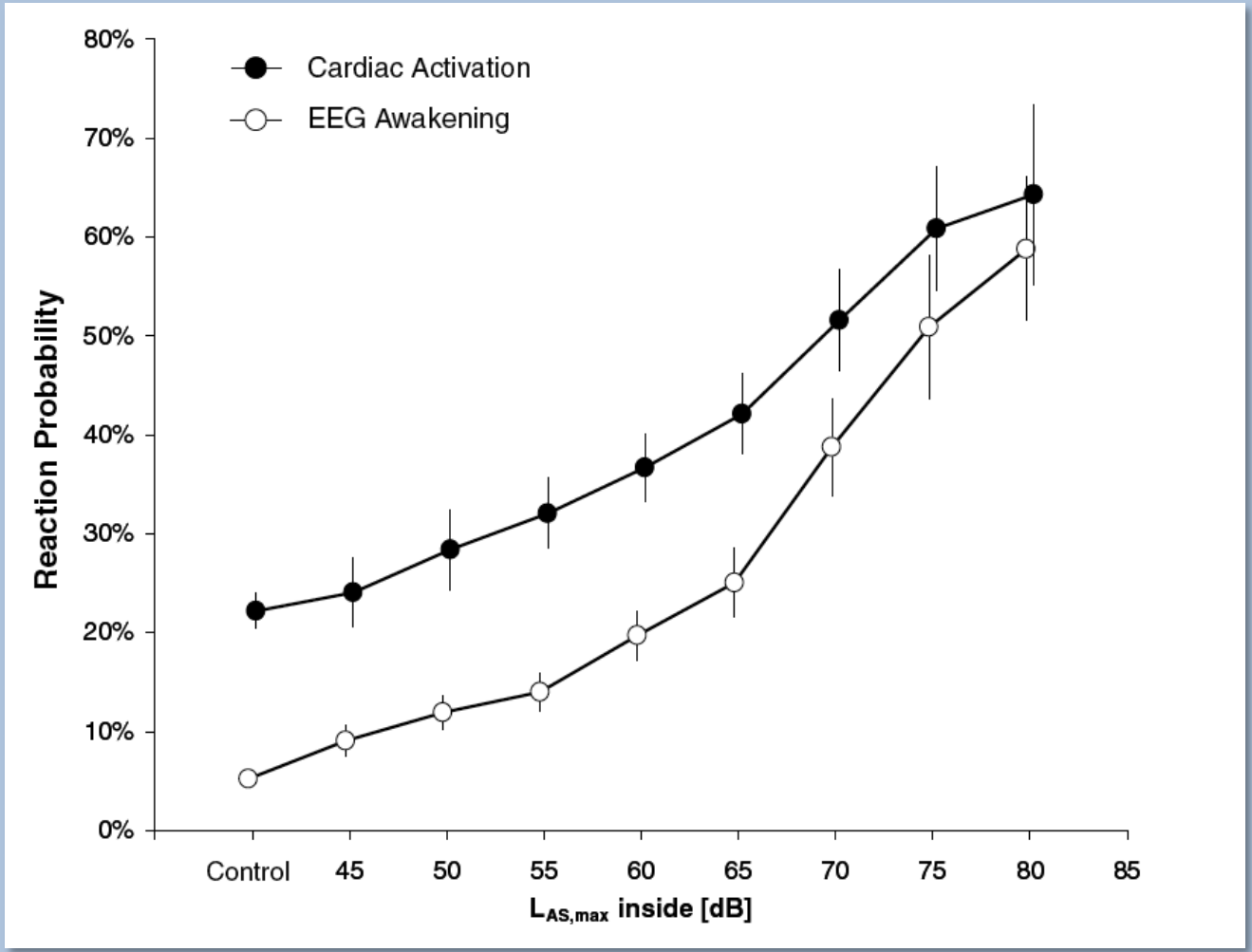
Groups at risk:
- Children
- Chronically ill, elderly
- Shift workers
- Less affluent

Pathophysiological reactions to stress



Henry and Stephens, 1977

Subcortical arousal – annoyance is not necessary

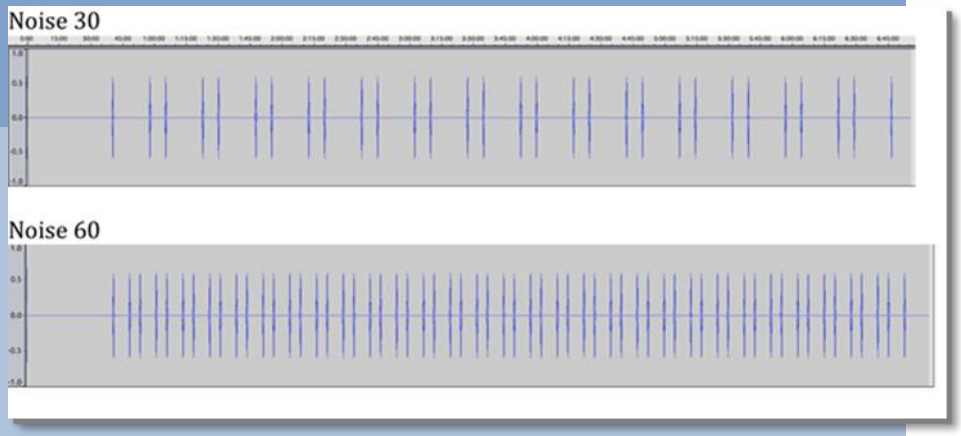


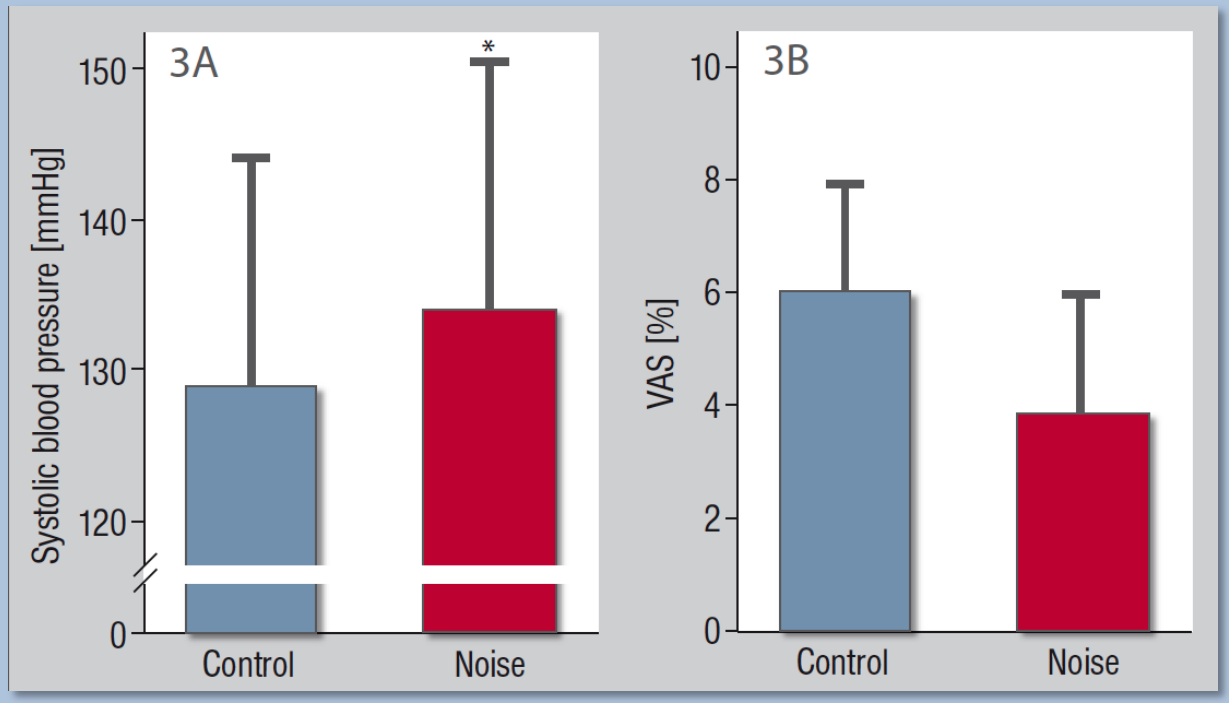
Basner M, et al. Physiol Meas. 2008;29:1089-1103.

European Heart Journal
doi:10.1093/eurheartj/eht269

FASTTRACK CLINICAL RESEARCH

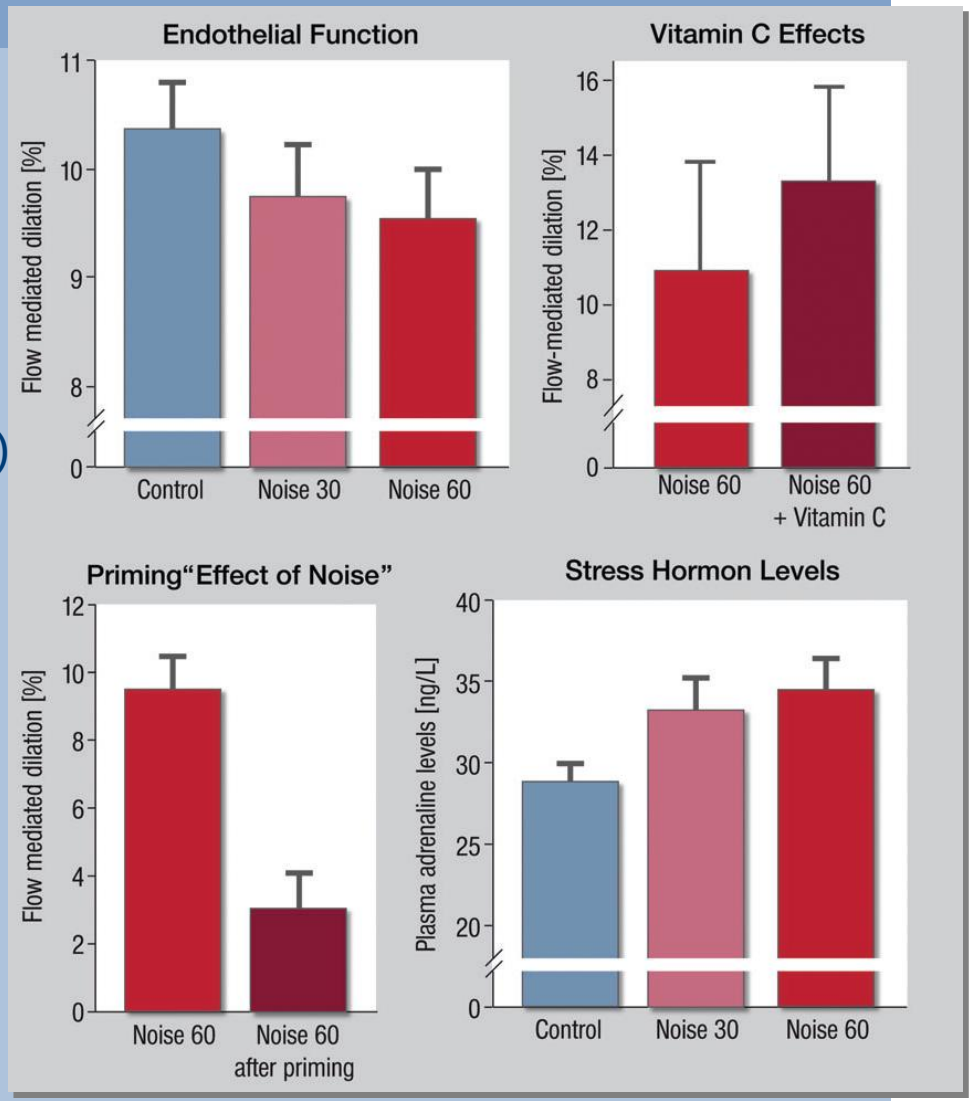
Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults





Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults

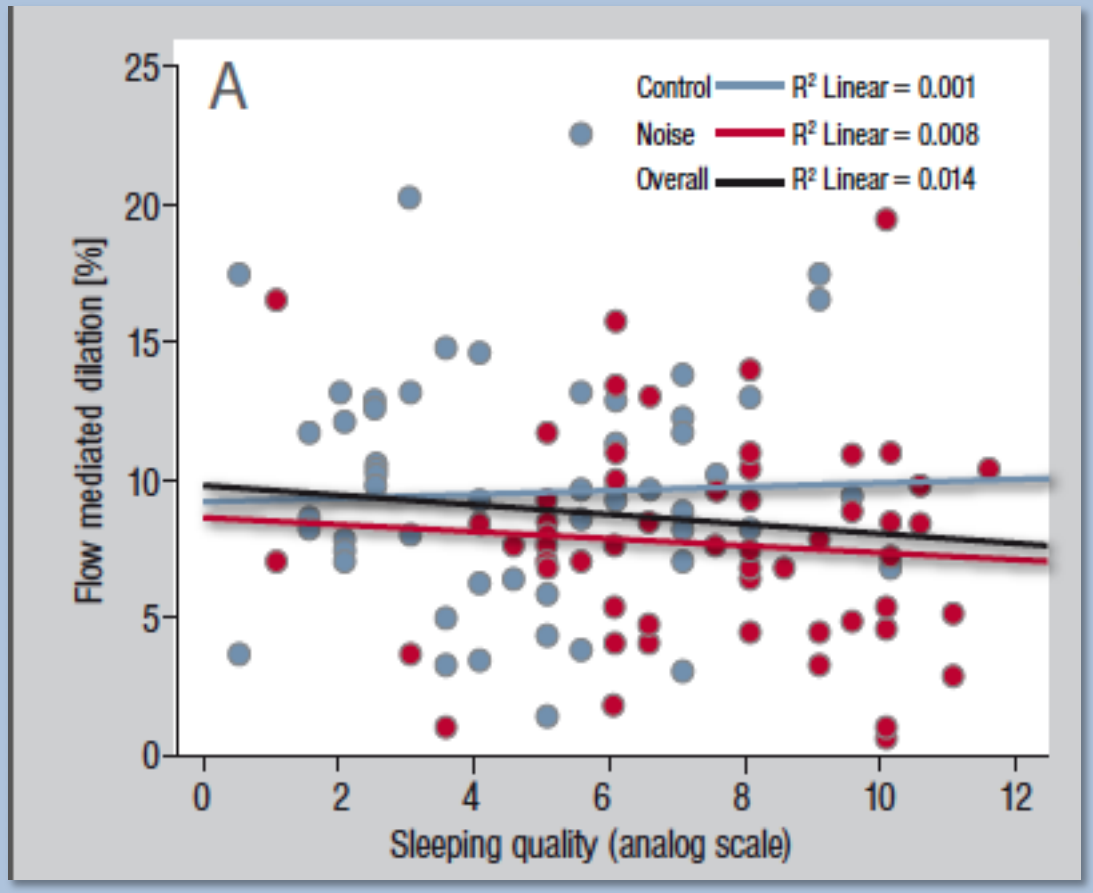
- Aircraft noise at night induces:
  - Endothelial dysfunction
  - Oxidative stress
  - Catecholamine release
  - Increased vessel stiffness(PTT)
  - Implaired sleep quality
  - No habituation, rather priming
  - Independent of annoyance



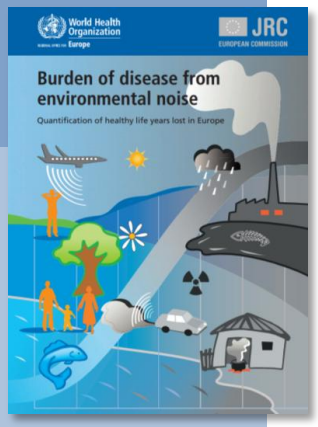
Schmidt FP et al. Eur Heart J. 2013

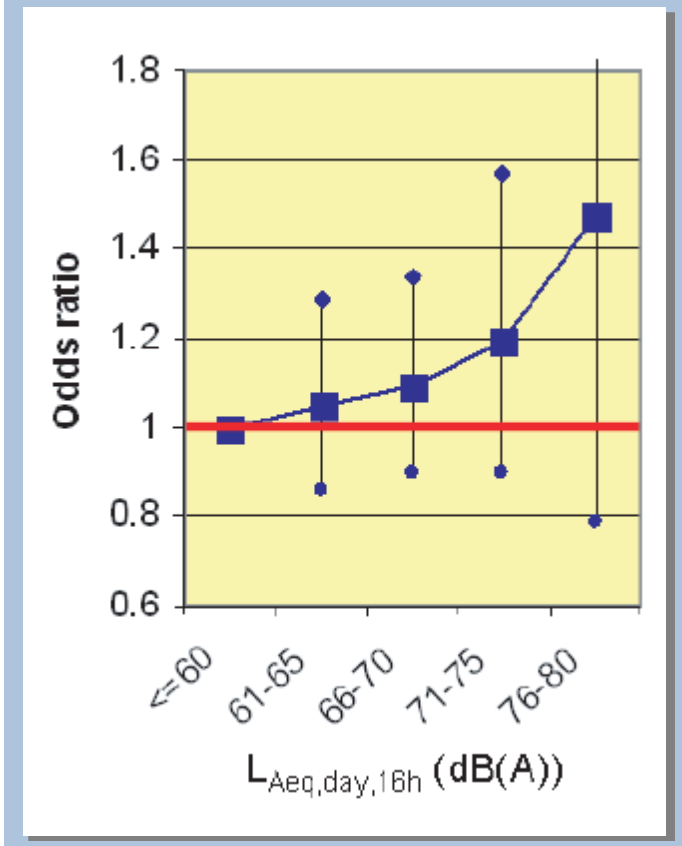
European Heart Journal
doi:10.1093/eurheartj/eht269

Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults

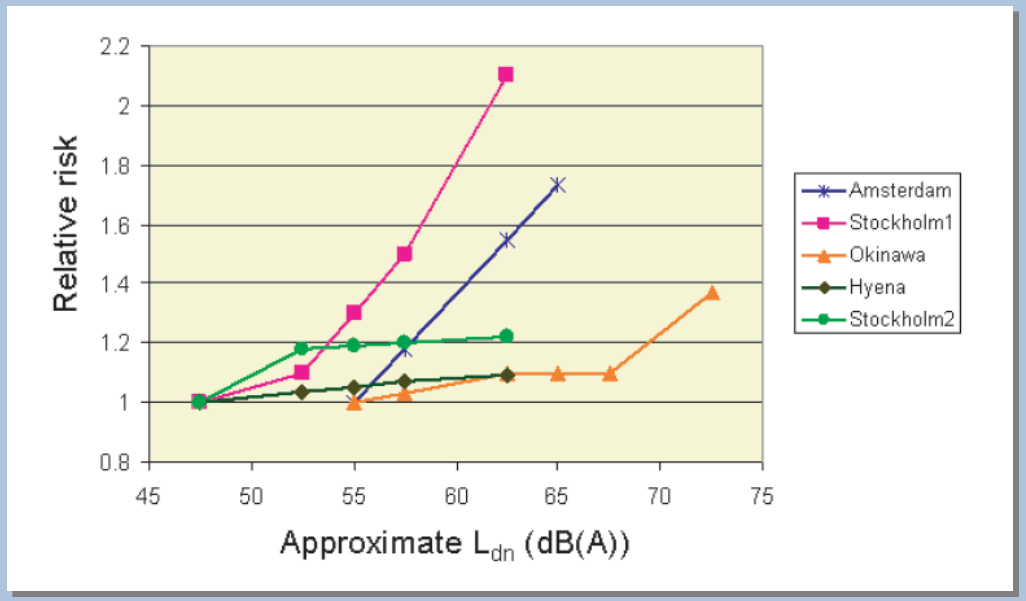


OR 1.07-1.17 in different studies





- Hypertension
- Ischaemic heart disease
- Stroke
- Dementia
- Diabetes mellitus



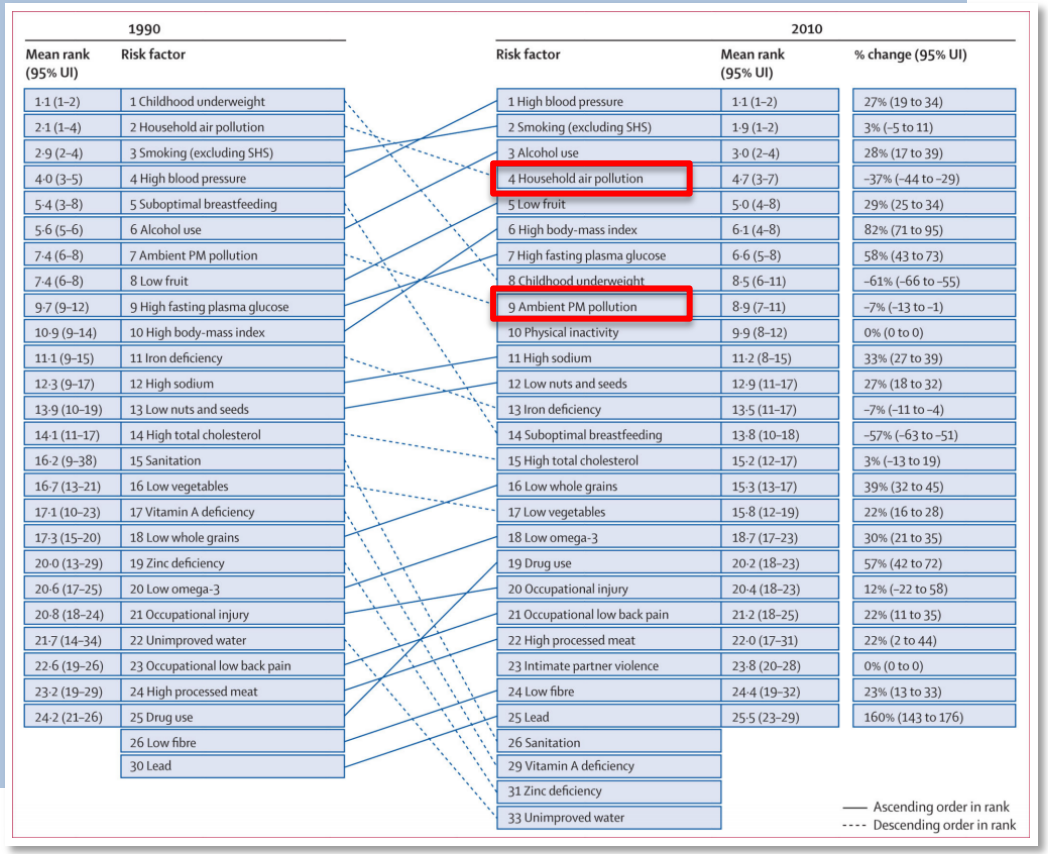
Are air pollution and traffic noise independently associated with atherosclerosis: the Heinz Nixdorf Recall Study

Hagen Kälsch[1], Frauke Hennig[2], Susanne Moebus[3], Stefan Möhlenkamp[1], Nico Dragano[4], Hermann Jakobs[5], Michael Memmesheimer[3], Raimund Erbel[1], Karl-Heinz Jöckel[3], and Barbara Hoffmann[2,6*], on behalf of the Heinz Nixdorf Recall Study Investigative Group

Summary

Conclusion Long-term exposure to fine PM and night-time traffic noise are both independently associated with subclinical atherosclerosis and may both contribute to the association of traffic proximity with atherosclerosis.

- Implications:
  - Ischemic heart disease
  - Arrhythmias
  - Heart failure
  - ICD discharge
  - Hypertensive crises
  - Ischemic stroke
- Habituation/priming, harvesting
- Annoyance
- Additive effect
- No randomized study possible
- Political implications



1990		2010		
Mean rank (95% UI)	Risk factor	Risk factor	Mean rank (95% UI)	% change (95% UI)
1·1 (1–2)	1 Childhood underweight	1 High blood pressure	1·1 (1–2)	27% (19 to 34)
2·1 (1–4)	2 Household air pollution	2 Smoking (excluding SHS)	1·9 (1–2)	3% (–5 to 11)
2·9 (2–4)	3 Smoking (excluding SHS)	3 Alcohol use	3·0 (2–4)	28% (17 to 39)
4·0 (3–5)	4 High blood pressure	4 Household air pollution	4·7 (3–7)	–37% (–44 to –29)
5·4 (3–8)	5 Suboptimal breastfeeding	5 Low fruit	5·0 (4–8)	29% (25 to 34)
5·6 (5–6)	6 Alcohol use	6 High body-mass index	6·1 (4–8)	82% (71 to 95)
7·4 (6–8)	7 Ambient PM pollution	7 High fasting plasma glucose	6·6 (5–8)	58% (43 to 73)
7·4 (6–8)	8 Low fruit	8 Childhood underweight	8·5 (6–11)	–61% (–66 to –55)
9·7 (9–12)	9 High fasting plasma glucose	9 Ambient PM pollution	8·9 (7–11)	–7% (–13 to –1)
10·9 (9–14)	10 High body-mass index	10 Physical inactivity	9·9 (8–12)	0% (0 to 0)
11·1 (9–15)	11 Iron deficiency	11 High sodium	11·2 (8–15)	33% (27 to 39)
12·3 (9–17)	12 High sodium	12 Low nuts and seeds	12·9 (11–17)	27% (18 to 32)
13·9 (10–19)	13 Low nuts and seeds	13 Iron deficiency	13·5 (11–17)	–7% (–11 to –4)
14·1 (11–17)	14 High total cholesterol	14 Suboptimal breastfeeding	13·8 (10–18)	–57% (–63 to –51)
16·2 (9–38)	15 Sanitation	15 High total cholesterol	15·2 (12–17)	3% (–13 to 19)
16·7 (13–21)	16 Low vegetables	16 Low whole grains	15·3 (13–17)	39% (32 to 45)
17·1 (10–23)	17 Vitamin A deficiency	17 Low vegetables	15·8 (12–19)	22% (16 to 28)
17·3 (15–20)	18 Low whole grains	18 Low omega-3	18·7 (17–23)	30% (21 to 35)
20·0 (13–29)	19 Zinc deficiency	19 Drug use	20·2 (18–23)	57% (42 to 72)
20·6 (17–25)	20 Low omega-3	20 Occupational injury	20·4 (18–23)	12% (–22 to 58)
20·8 (18–24)	21 Occupational injury	21 Occupational low back pain	21·2 (18–25)	22% (11 to 35)
21·7 (14–34)	22 Unimproved water	22 High processed meat	22·0 (17–31)	22% (2 to 44)
22·6 (19–26)	23 Occupational low back pain	23 Intimate partner violence	23·8 (20–28)	0% (0 to 0)
23·2 (19–29)	24 High processed meat	24 Low fibre	24·4 (19–32)	23% (13 to 33)
24·2 (21–26)	25 Drug use	25 Lead	25·5 (23–29)	160% (143 to 176)
	26 Low fibre	26 Sanitation		
	30 Lead	29 Vitamin A deficiency		
		31 Zinc deficiency		
		33 Unimproved water		

—— Ascending order in rank
---- Descending order in rank