Swiss TPH

Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
Institut Tropical et de Santé Publique Suisse

Department of Epidemiology & Public Health

Effects of Black Carbon Exposure on Human Health

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Presentation prepared for

15th ETH Conference on Combustion Generated Nanoparticles,

27.-29.6.2011, Zürich

Session 9: Global Warming 29.6.2011 – 11:30-12:50

Swiss TPH is an associated Institute of University of Basel

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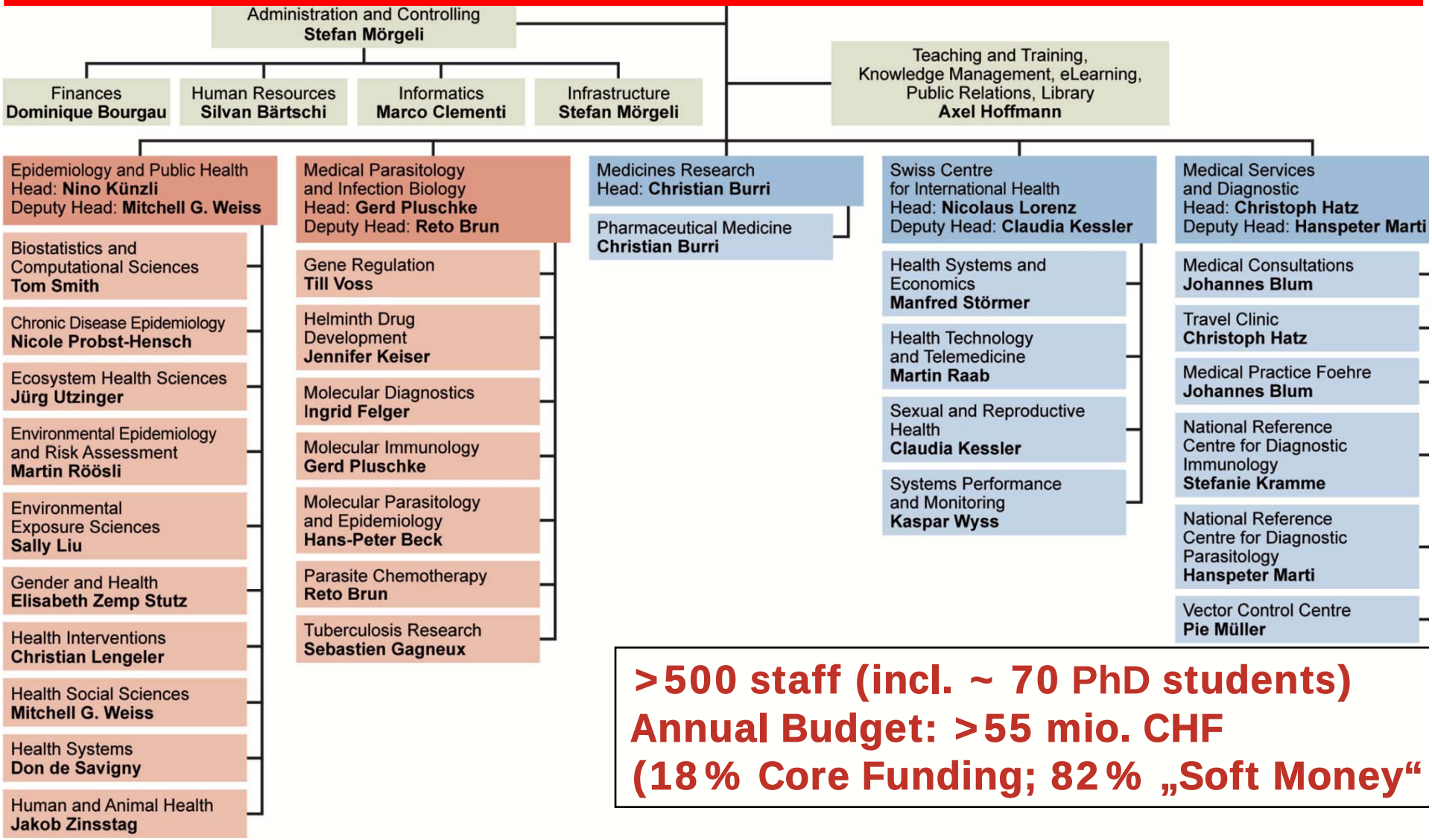

>500 staff (incl. ~ 70 PhD students)
Annual Budget: >55 mio. CHF
(18% Core Funding; 82% „Soft Money“

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Air pollution research collaboration across six units of the Department of Epi and Public Health

Christian Schindler et al

Nicole Probst-Hensch (Scientific Lead SAPALDIA)
Nino Künzli, Regula Rapp et al.

Martin Röösli, Charlotte Braun-Fahrländer et al

Harish Phuleria Deputy-Head / (Sally Liu († 6.6. 2011);
Regina Ducret, Martina Ragettli, Ming Tsai et al.

Elisabeth Zemp et al

Swiss TPH is

leading House of SAPALDIA coordination

Swiss TPH is an independent Institution - associated with University of Basel

QUESTIONS to be addressed

In light of strong evidence for a causal role of ambient air pollution on health:

- Are any health effects SPECIFIC TO BLACK CARBON?

→ if a policy would affect BC **SPECIFICALLY** (but not other pollutants), what would the related health effects be?

Questions of high interest for EU Policy makers

→ EC Task Force on Health has reviewed this question too (June 2011)

TFH Review of evidence on health effects of black carbon:

Metrics used to estimate the health effects of exposure to BC

Timo Lanki, Raimo Salonen

Evidence form toxicology including human clinical studies

Miriam E. Gerlofs-Nijland and Flemming R. Cassee, RIVM, Netherlands

Taimo Salonen, THL, Kuopio, Finland

Effects of BC exposure observed in epidemiologic studies

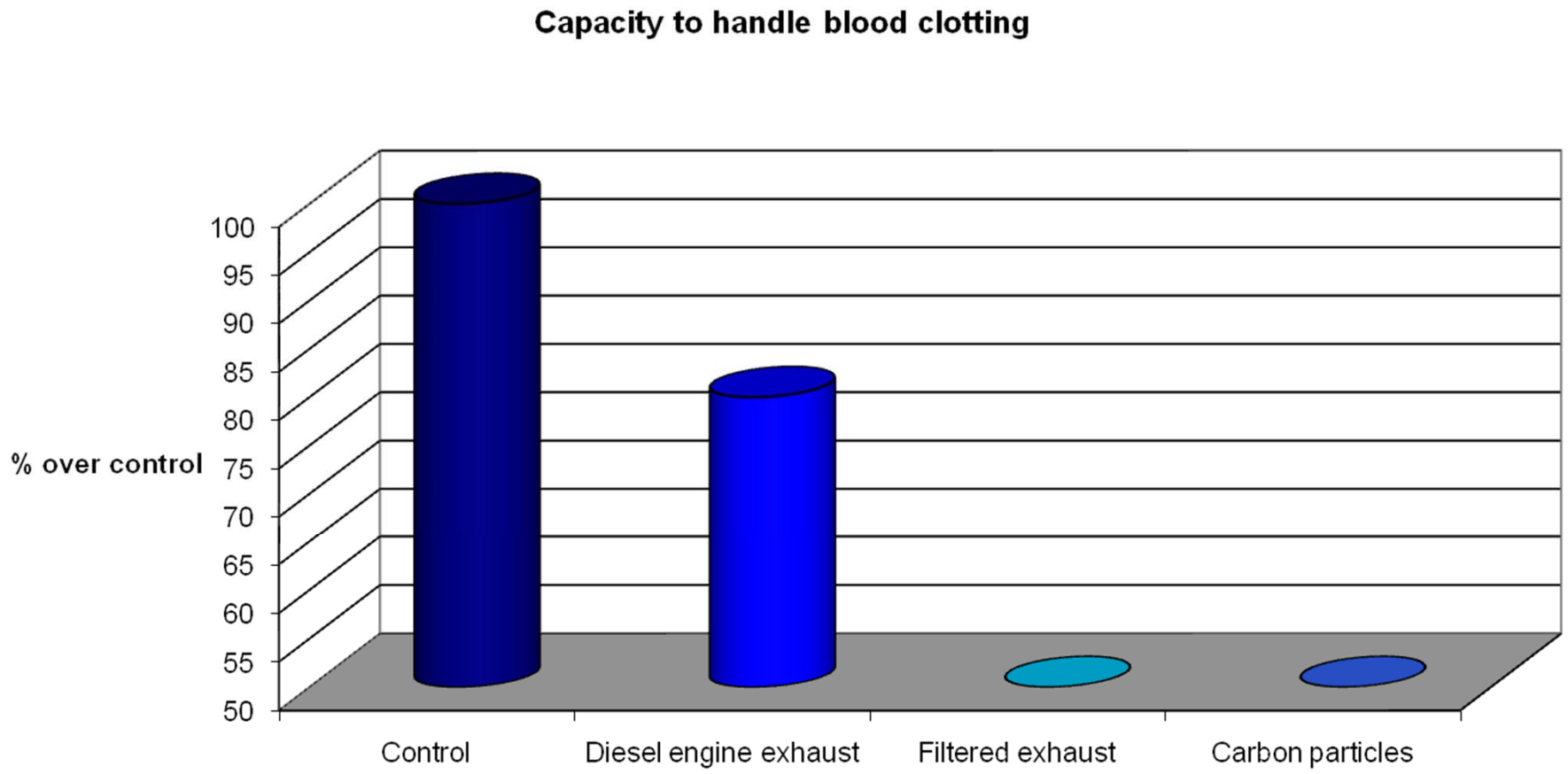
Nicole Janssen, Gerard Hoek, Paul Fischer, Bert Brunekreef, Flemming Cassee

National Institute for Public Health and the Environment (RIVM), Netherlands
Institute for Risk Assesment Sciences (IRAS), Utrecht Universtiy, Netherlands

Toxicological evidence

- Few studies available
- Often higher exposure than in real life (e.g. 100-350 ug/m3 BC)
- No comparative dose-response studies for BC versus PM, EC, OC etc.
- BC (EC) may not be a major directly toxic component of fine PM but a universal carrier of constituents of varying toxicity
- No evidence that some mechanisms to be SPECIFIC to BC

Miller et al Europ Heart J – in press



Slide from Dr. Flemming Cassee

Editorial in Press – Europ Heart J

NOT FOR PUBLIC RELEASE

European Heart Journal
doi:10.1093/eurheartj/ehr200

EDITORIAL

From bench to policies: ready for a nanoparticle air quality standard?

Nino Künzli[1,2*]

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Epidemiological Evidence of specific role of BC

Metrics used / Nomenclature

- Black carbon - BC
- Black smoke - BS
- Elemental Carbon – EC
- Soot
- Light Absorbance

As compared to

PM2.5 mass

(… and other metrics like

Redox activity, surface, number etc.

Association between daily concentrations of PM and **Mortality**

(7 time-series studies summarized by Jansson et al)
All estimates are highly statistically significant

	% change per 10 µg/m3 increase	
	PM10	Black Smoke
All cause mortality	0.48	0.68
Cardiovascular mort	0.60	0.90

CAVEAT: scaled to ambient conditions (e.g. min-to-max or interquartile range) BS are NOT larger than PM10 estimates

Association between daily concentrations of PM and

Hospital Admissions

(6 respiratory and 4 cardiac time-series studies summarized by Jansson et al)

BOLD estimates are statistically significant

	% change per 10 µg/m3 increase	
	PM10	**Black Smoke**
All respiratory, elderly	**0.70**	-0.06
Asthma+ COPD,elderly	**0.86**	0.22
Asthma, children	0.69	**1.64**
Cardiac, all age	**0.51**	**1.07**

CAVEAT: scaled to ambient conditions (e.g. min-to-max or interquartile range) BS are NOT larger than PM10 estimates !

Appropriate approach to disentangle PM and BC effects:
TWO-POLLUTANT MODELS !
Only 6 studies available (summary by Janssen et al)
(BOLD = statistically significant)

Example:

	PM		BC	
	alone	two	alone	two
Cardiac Death	**0.5**	-0.2	**1.1**	1.6

(APHEA – Le Tertre 2002)

BUT NOT ALL 6 STUDIES SEE THE SAME !

Some evidence for more stable effects

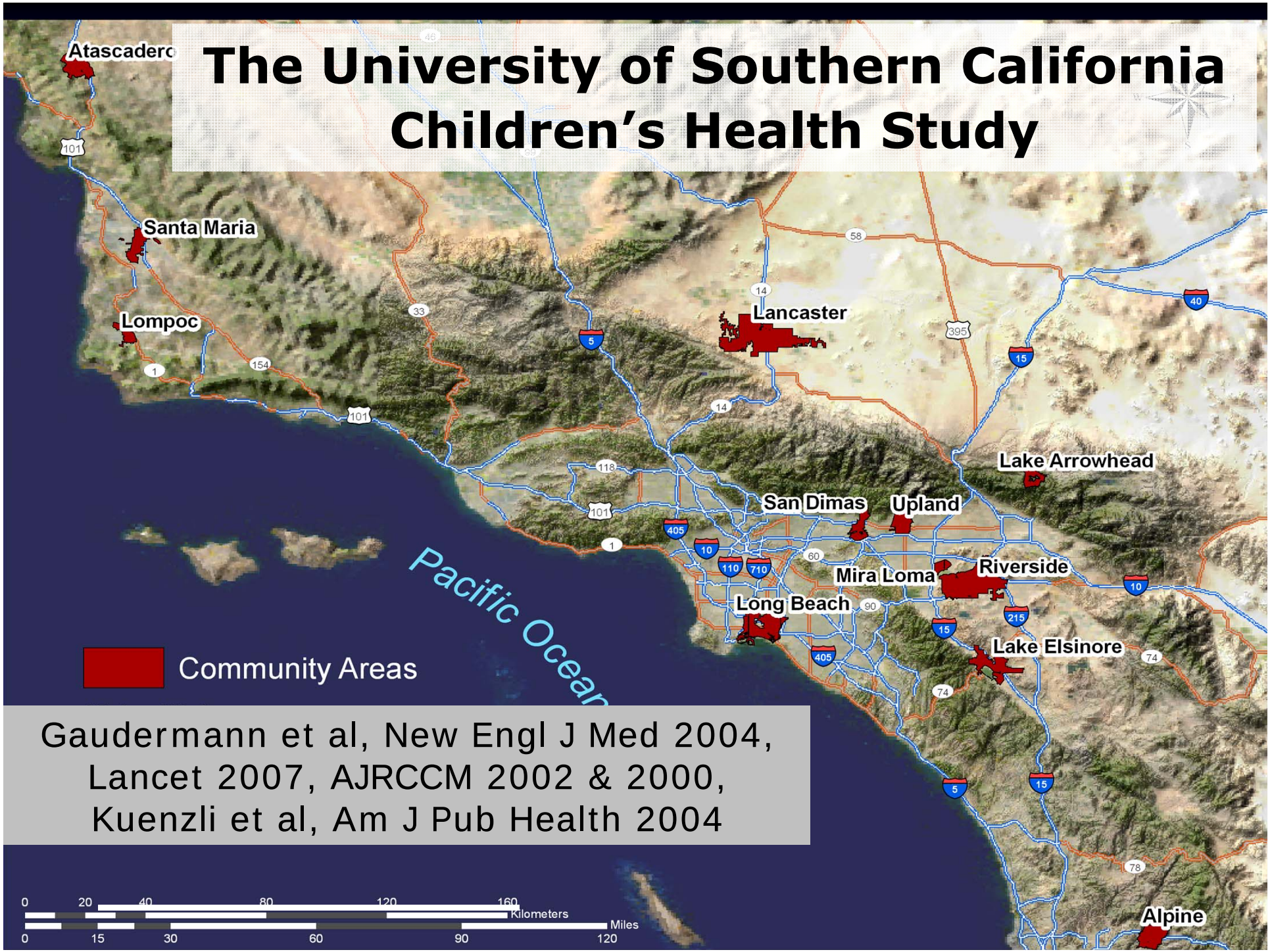
for BS – at least for cardio outcomes in adults

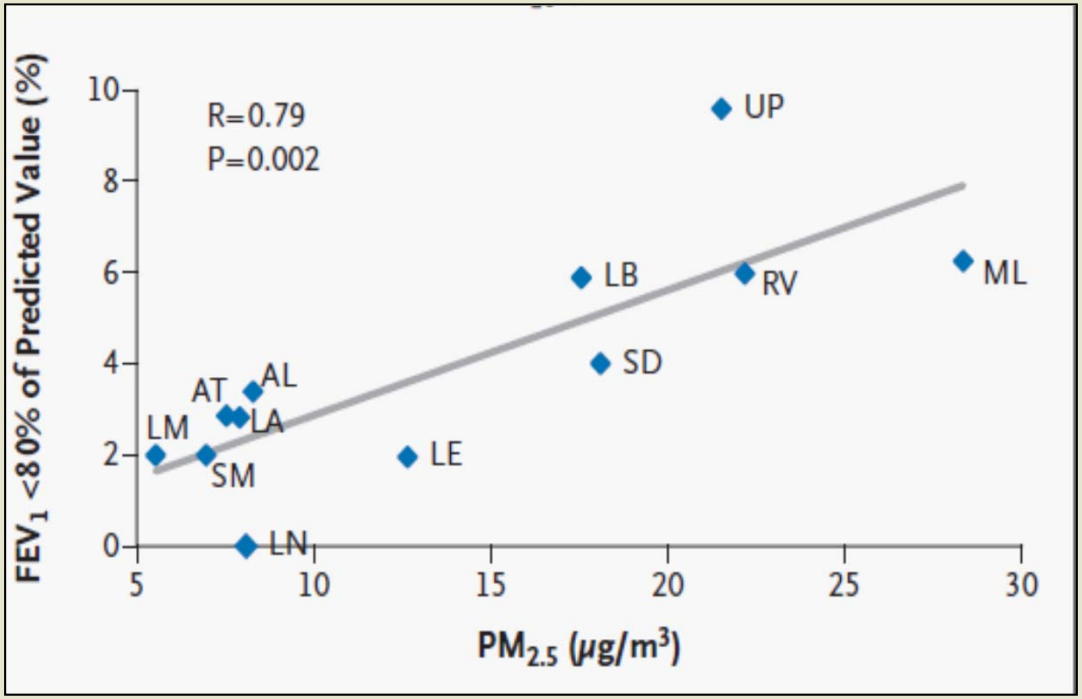
BUT – to remember

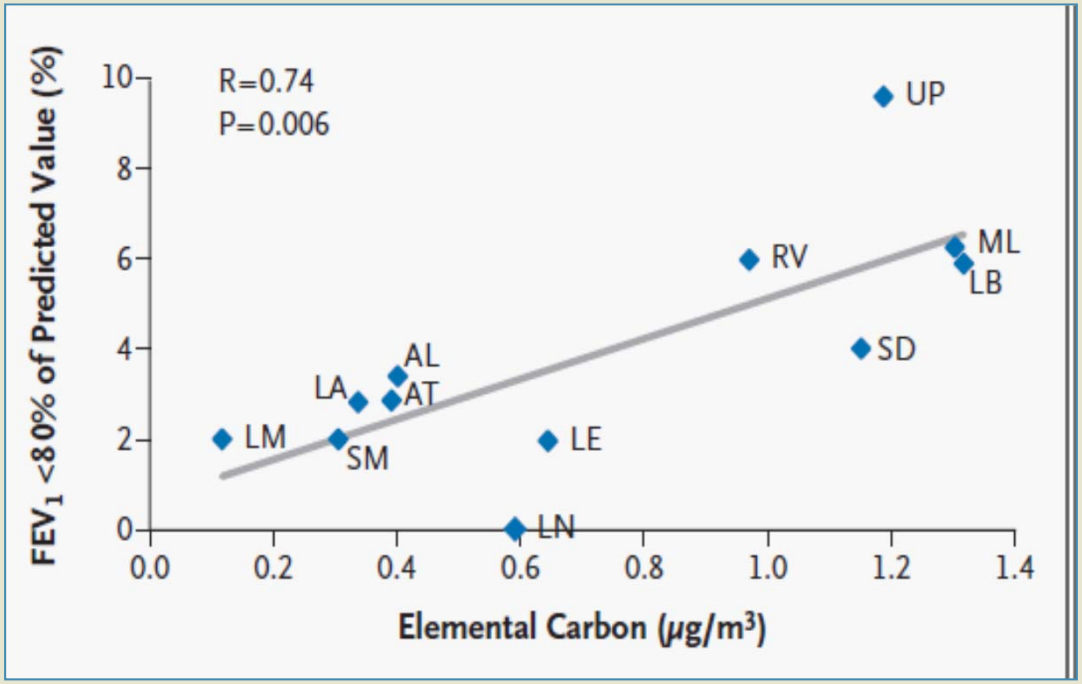
- Correlation between ambient concentration and personal exposure TEND TO BE HIGHER FOR BC-metrics than for PM2.5

- Indoor/outdoor correlation (infiltration) TEND TO BE HIGHER FOR BC-metrics than for PM2.5 (0.46- 0.84 versus 0.25-0.79)

- → error in „exposure term“ might be some what smaller for BC than PM2.5…!


The University of Southern California
Children's Health Study
Atascadero
Santa Maria
Lompoc
Lancaster
Lake Arrowhead
San Dimas
Upland
Mira Loma
Riverside
Long Beach
Lake Elsinore
Alpine
Pacific Ocean
Community Areas
Gaudermann et al, New Engl J Med 2004,
Lancet 2007, AJRCCM 2002 & 2000,
Kuenzli et al, Am J Pub Health 2004
0 20 40 80 120 160 Kilometers
0 15 30 60 90 120 Miles





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Long-term pollution effects on lung function growth led to significant deficits at age 18

Gauderman et al, NEJM 2004

USC Children's Health Study

PM2.5-EC – correlation: 0.91

… AND – to remember

- Many long-term mean concentrations of various pollutants are spatially correlated
- These correlations differ across regions and depend on spatial scale…

Cross-European correlations of annual mean concentrations of PM2.5 mass, PM Absorbance, redox potential, and various constituents on PM
Künzli et al, EHP 2006 (ECRHS Study)

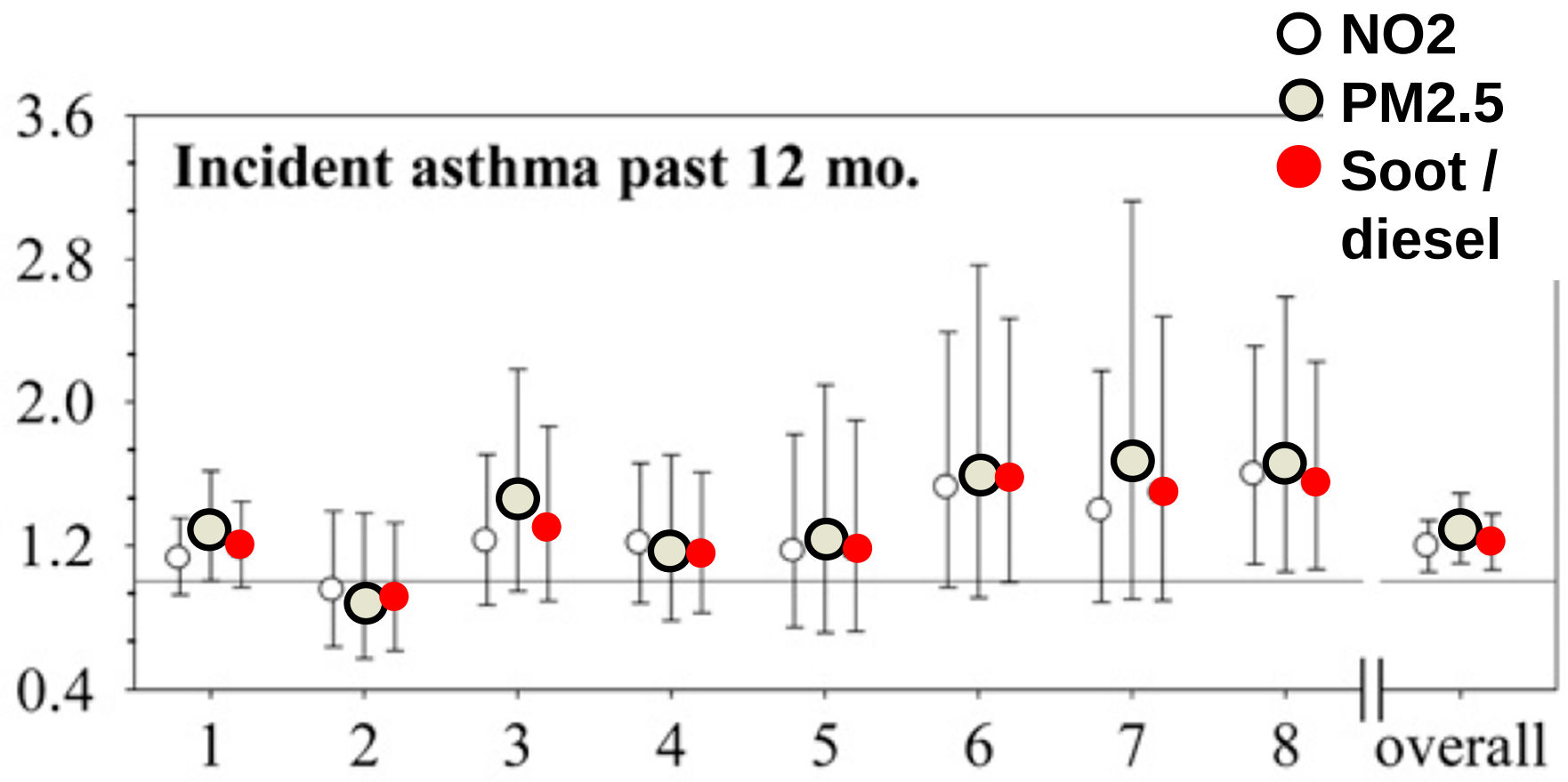
Table 3. Cross-community Pearson correlations between the annual mean of •OH formation, depletion rates of AA and GSH, $PM_{2.5}$ mass concentration, light absorbance (Abs), and mass concentration of chemical elements on $PM_{2.5}$.

	•OH	AA	GSH	$PM_{2.5}$	Abs	S	Si	Al	Fe	Zn	Pb
AA	0.65	1									
GSH	0.18	0.08	1								
$PM_{2.5}$	0.03	0.33	0.08	1							
Abs	0.16	0.49	0.28	0.93	1						
S	0.30	0.35	0.24	0.87	0.81	1					
Si	0.03	0.30	0.45	0.34	0.44	0.38	1				
Al	0.01	0.24	0.55	0.47	0.54	0.56	0.80	1			
Fe	0.45	0.59	0.41	0.85	0.90	0.78	0.45	0.58	1		
Zn	0.58	0.50	0.33	0.46	0.60	0.49	0.60	0.33	0.68	1	
Pb	0.30	0.45	0.36	0.88	0.89	0.85	0.43	0.60	0.94	0.63	1
Cu	0.39	0.60	0.49	0.63	0.69	0.72	0.74	0.74	0.76	0.67	0.80

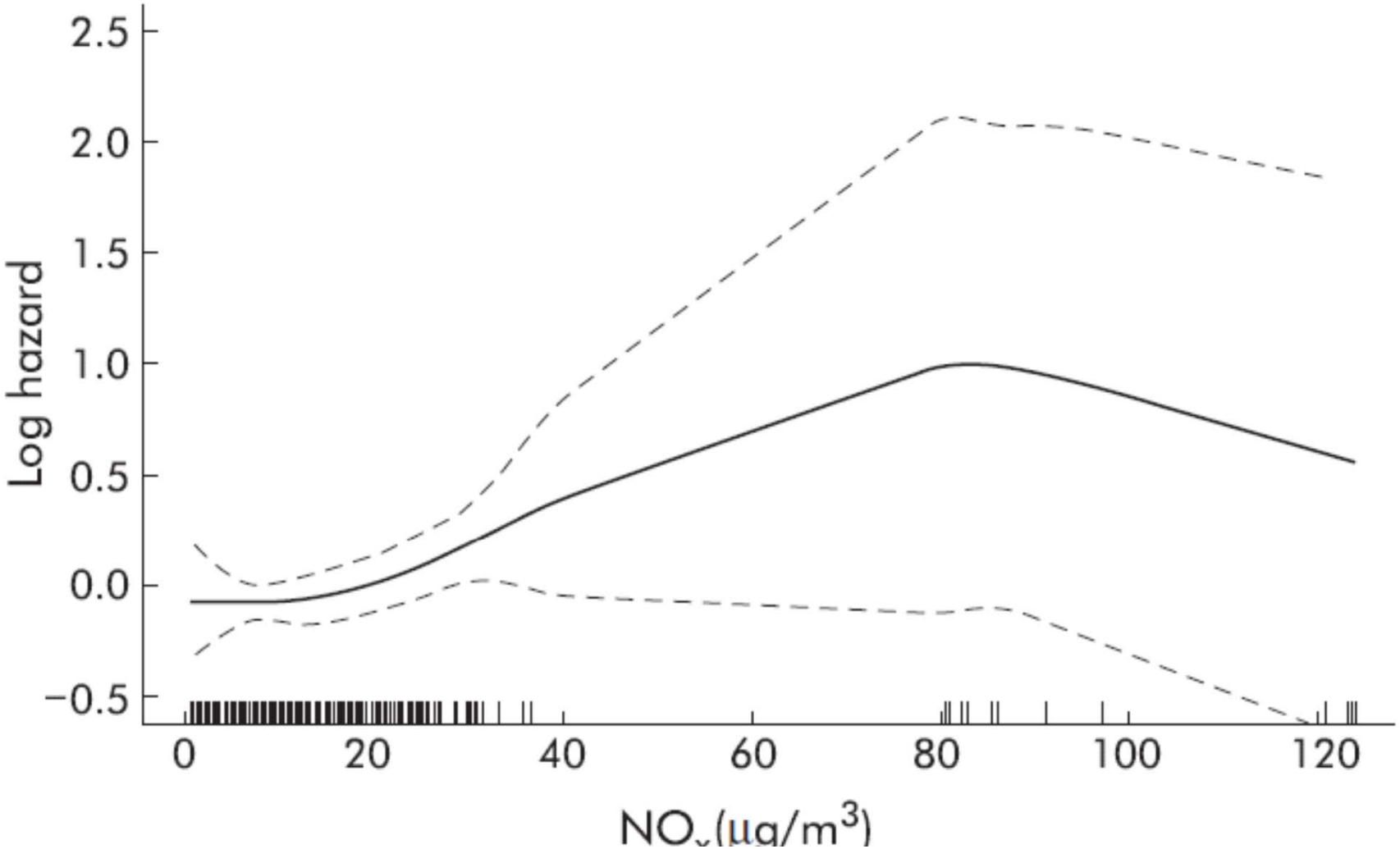
Annual means are derived from six pooled bimonthly suspensions (AA, GSH) and 31–36 filters (all other PM measures), respectively (see Table 1 and "Materials and Methods").

Home outdoor traffic-related pollution at birth is associated with the new onset of childhood asthma during the first 8 years of life (Dutch children)

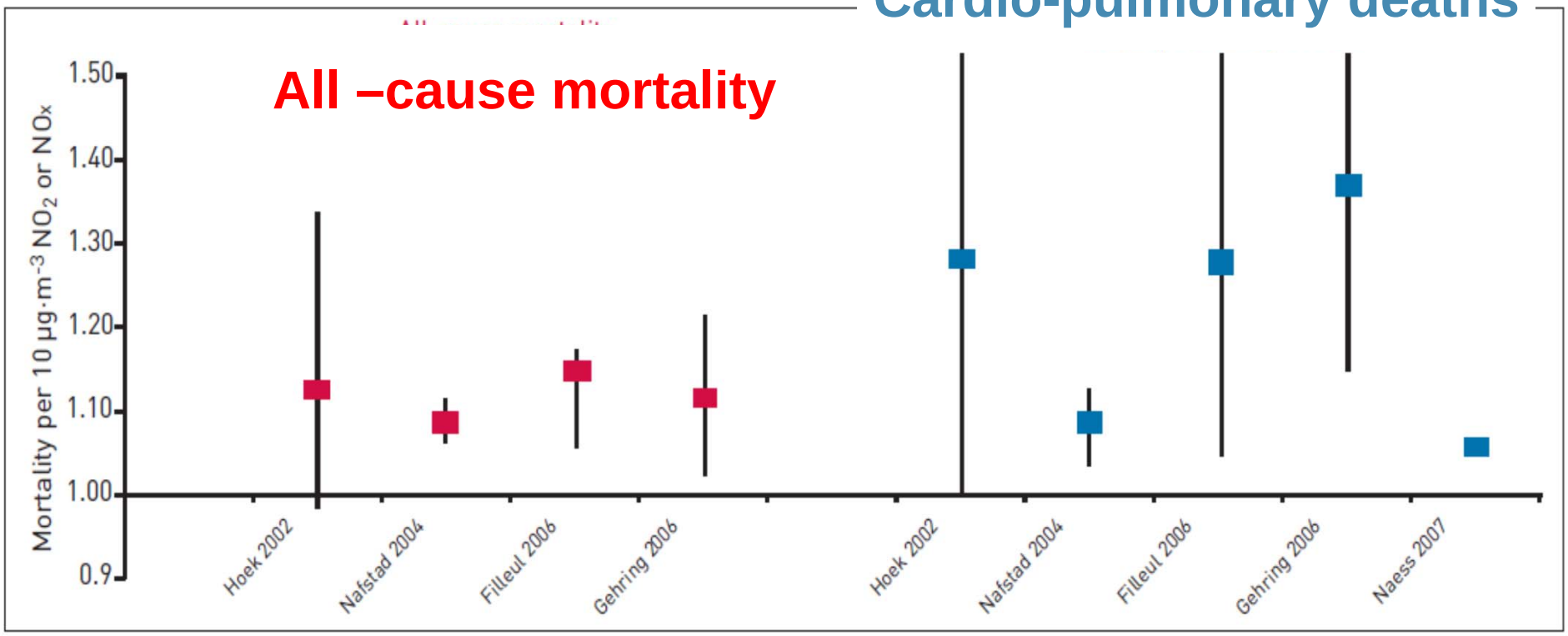
Gehring et al, AJRCCM 2010



Lung cancer is associated with the home outdoor levels of traffic-related NOx – a possible marker for fine and ultrafine particles (loaded with carcinogens - e.g. from Diesel particles) 27 year follow-up study of Norwegian men –
(Nafstad et al, Thorax, 2003)



European Cohort Studies: associations with mortality are similar for PM, NO2 and other markers of combustion related pollution…



From Künzli, Perez, Rapp – Air Quality and Health, 2010
Free pdf online in English, Italian and other languages
www.ersnet.org/index.php/publications/air-quality-and-health.html

CONCLUSIONS

CONCLUSION 1

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- Health impact of a policy or scenario that changes „Black Carbon“ alone without affecting PM10, PM2.5 nor „Particle Number“: very hard to estimate, if any
- A policy or scenario that affects the **MASS OF BC** more strongly than the **MASS of PM10 or PM2.5** would have stronger impact on health

BUT: are such policies or scenarios realistic, under any plausible technological, urban planning or climate change assumptions… ?

→ If correlations between PM and BC remain approximately the same as in the current „world of combustion“: evidence is rather limited to prioritize health relevance of BC versus other combustion-related PM‘s, constituents, and markers of pollution

CONCLUSION 2

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Black carbon, black smoke, elemental carbon, absorbance…

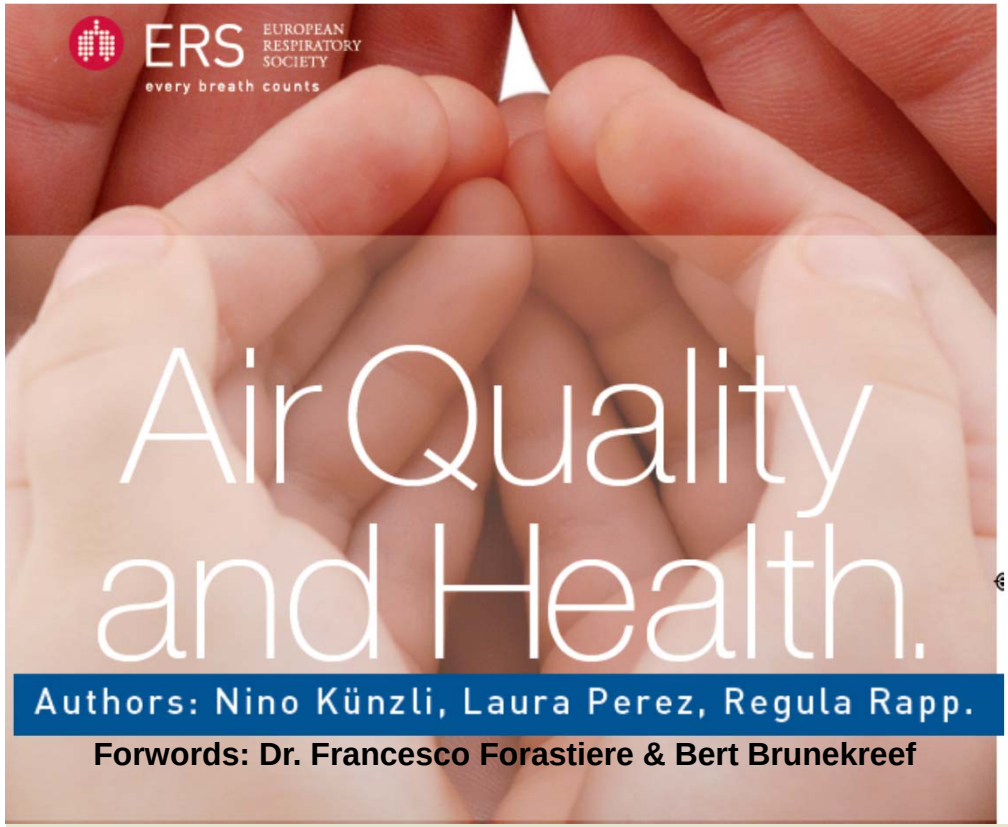
- Are very important markers of combustion related pollution that clearly affects health
- Are important markers of a carrier of toxicants brought to the respiratory track, the alveoli, the organs
- Relate to mechanisms and health effects that may not necessarily be the same than those due to PM10, PM2.5., or other particulate-related effects

→ **BC is a candidate – albeit not the only one - for clean air regulations IN ADDITION TO THE EXISTING PM-standards to protect public health**

… thank you Nino.Kuenzli@unibas.ch Swiss TPH

Order by email: Nora.Bauer@unibas.ch

12.00 CHF



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