Spatial variability and health effects of air pollutants in long-term studies

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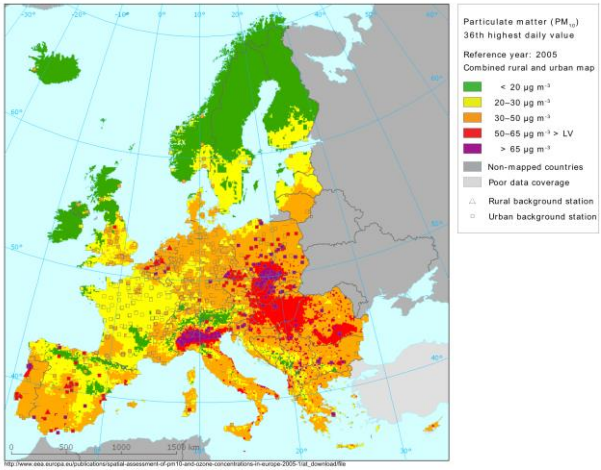
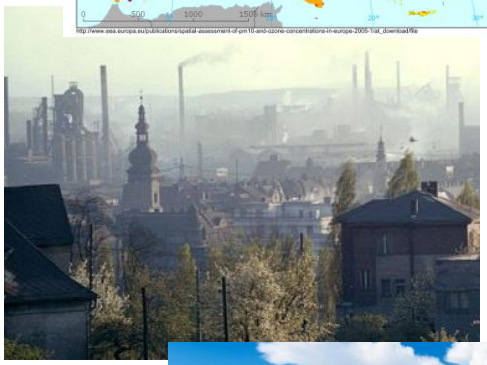
Long-term effect studies

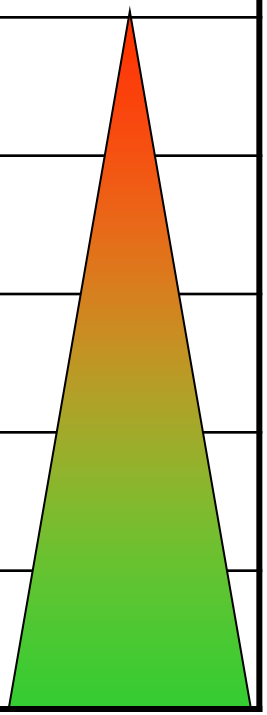
- Assessment of geographical variation (between study areas or participants) → assumes homogenous distribution over the whole area
- Exposure period: several years, at least one year
- Monitoring should be representative for study participants
- Identical equipment needed in each region





Approaches of exposure assessment

Method	General accordance with the „true“ exposure
Classification of population	Poor
Monitoring of ambient concentrations at fixed monitoring sites	Poor to fair
Air pollution modelling	Good
Personal monitoring	Good to very good
Biological monitoring	Very good



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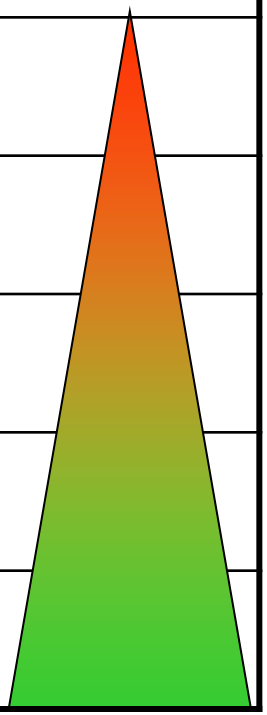

Classification of population

Classification of study population between low and high exposure:

- Rural vs. urban
- Job classification
- Presence of indoor sources
- Distance to major road

  (proximity of outdoor sources)
- Characterization of residence

  location

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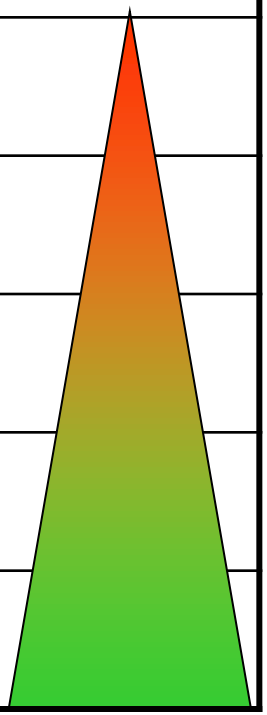
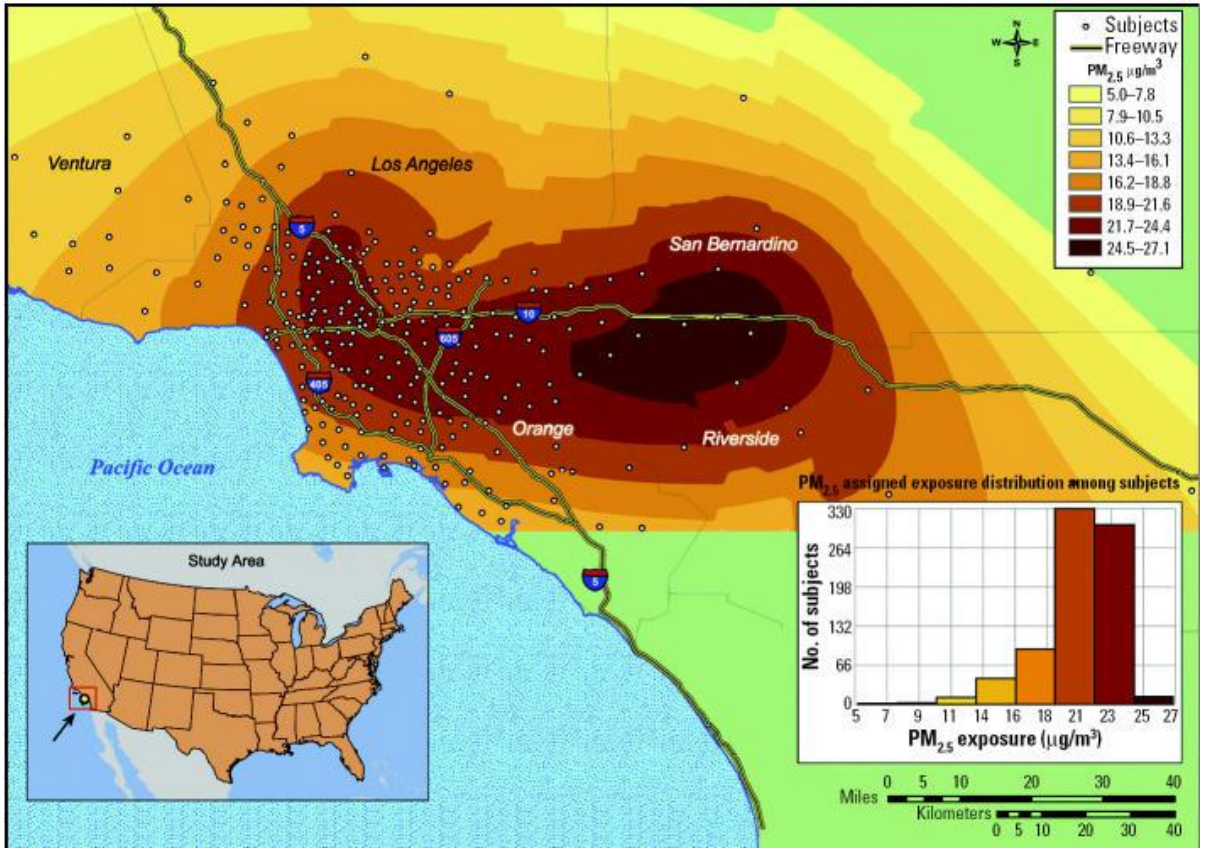


Air pollution modeling

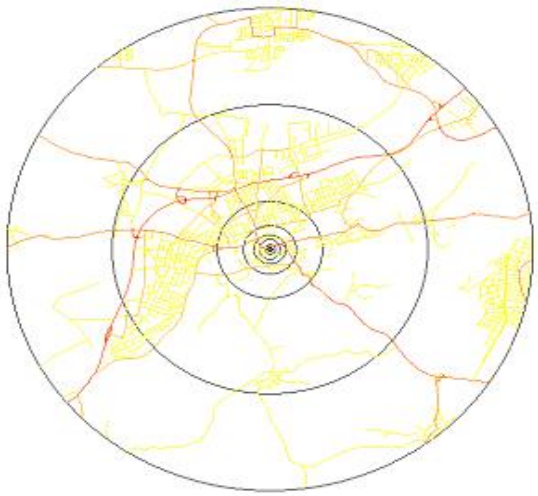
- Based on measurements (interpolation across the study area, land-use regression modeling)
- Based on emission, dispersion and meteorological data (dispersion modeling)



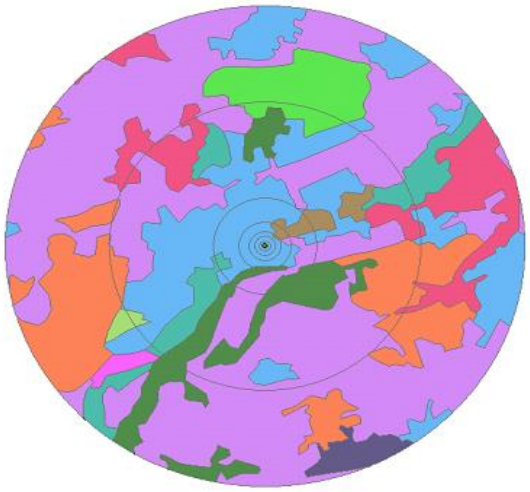
Interpolation based on 23 monitoring sites

Künzli et al., 2005

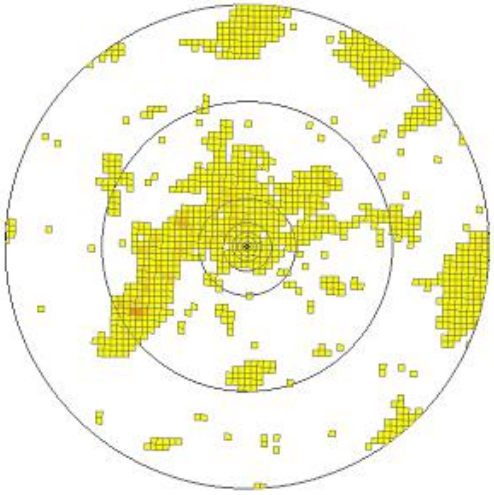
Most relevant GIS variables



Traffic variables



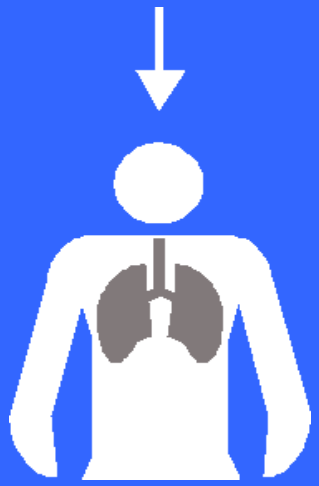
Land use



Population density

Health Effects of Air Pollutants

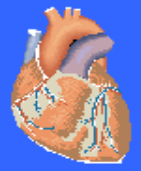
Inhalation of ambient particles



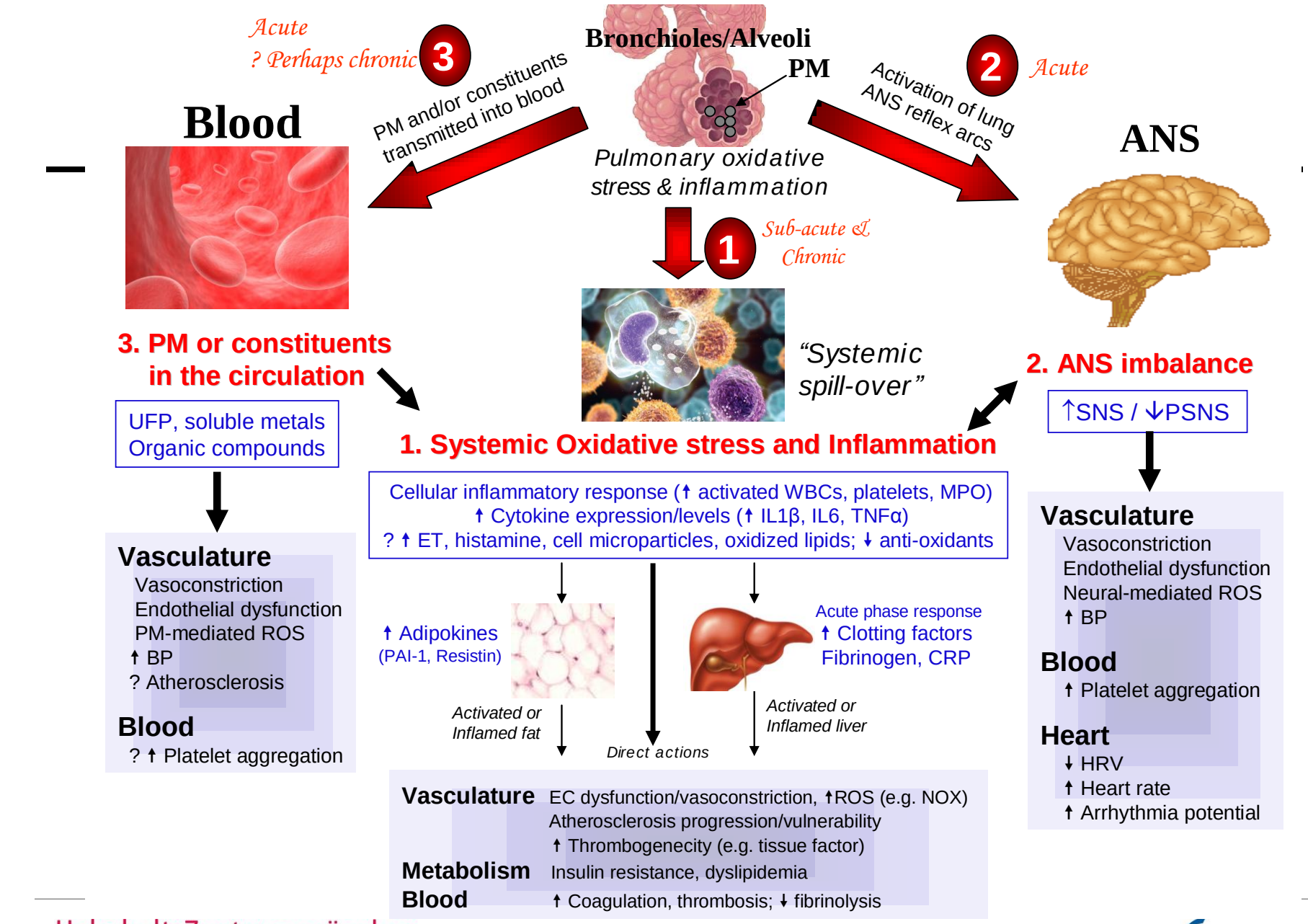
Local effects
Inflammation

Asthma
Bronchitis

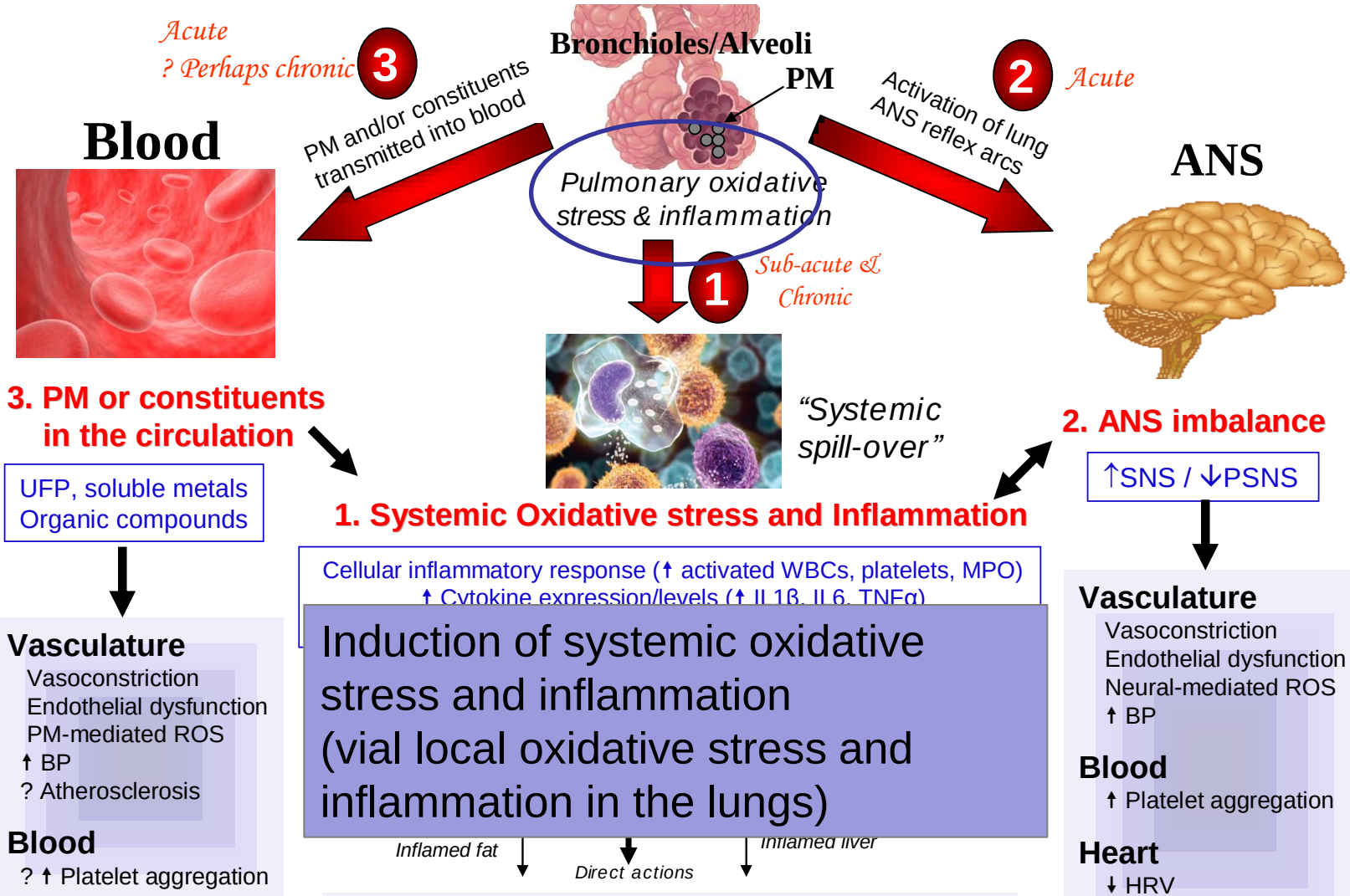
Systemic effects
Acute-Phase-Proteins
Cytokines



Ischemia
Arrhythmia



Brook et al. 2010



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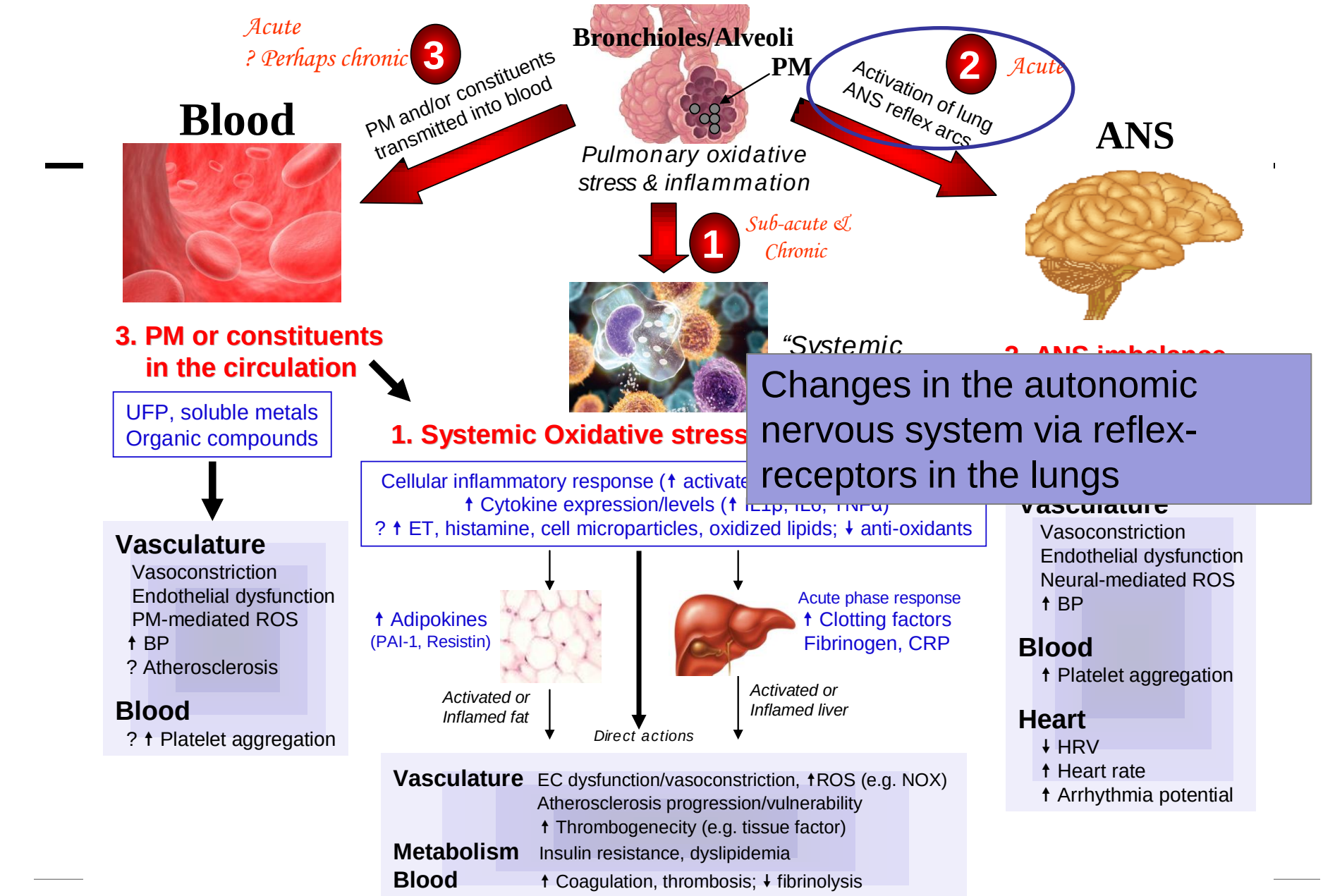

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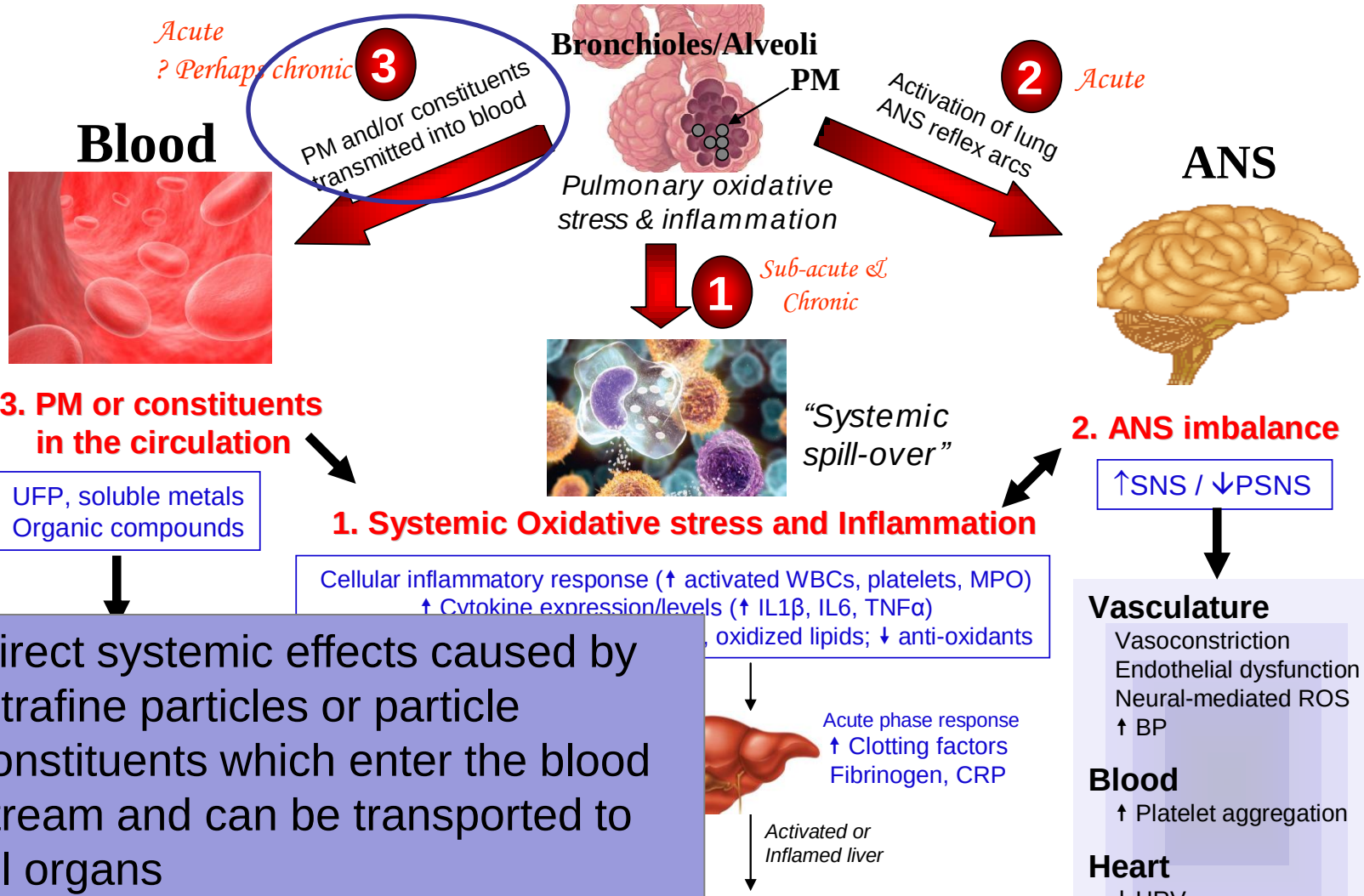

Direct systemic effects caused by ultrafine particles or particle constituents which enter the blood stream and can be transported to all organs

Brook et al. 2010

Studies on health effects of soot (BS/BC/EC/OC) are still comparatively rare…

Table 1. Air pollutants and health outcomes.

	Short-term studies						Long-term studies					
Variables	PM_{10}	$PM_{2.5}$	UFP	BS/BC	EC/OC	Other	PM_{10}	$PM_{2.5}$	UFP	BS/BC	EC/OC	Other
Mortality												
All cause	xxx	xxx	x	x	x		xx	xx	x	xx	x	x
Cardiovascular	xxx	xxx	x	x	x		xx	xx	x	xx	x	x
Pulmonary	xxx	xxx	x	x	x		xx	xx	x	xx	x	x
Pulmonary effects												
Lung function, e.g., PEF	xxx	xxx	xx		x		xxx	xxx				
Lung function growth							xxx	xxx				
Asthma and COPD exacerbation						x						
Acute respiratory symptoms		xx	x			x	xxx	xxx				
Medication use			x									
Lung cancer												
Hospital admission							xx	xx	x			x
Cardiovascular effects												
Hospital admission	xxx	xxx					x	x				x
ECG-related endpoints												
Autonomic nervous system	xxx	xxx	xx	x								
Myocardial substrate and vulnerability		xx	x	x		x						
Vascular function												
Blood pressure	xx	xxx	x	x	x	x						
Endothelial function	x	xx	x	x		x						
Variables	PM_{10}	$PM_{2.5}$	UFP	BS/BC	EC/OC	Other						
Blood markers												
Pro inflammatory mediators	xx	xx	xx	x	x	xx						
Coagulation blood markers	xx	xx	xx	x	x	x						
Endothelial function	x	x	xx	x	x	x						
Reproduction												
Premature birth	x	x				x						
Birth weight	xx	x				xx						
IUR/SGA	x	x				x						
Fetal growth						x						
Birth defects	x					x						
Infant mortality	xx	x				xx						
Sperm quality	x	x				x						
Neurotoxic effects												
Diseases of the central nervous system				x		xx						

x, few studies; xx, many studies; xxx, large number of studies.

Rückerl et al., 2011

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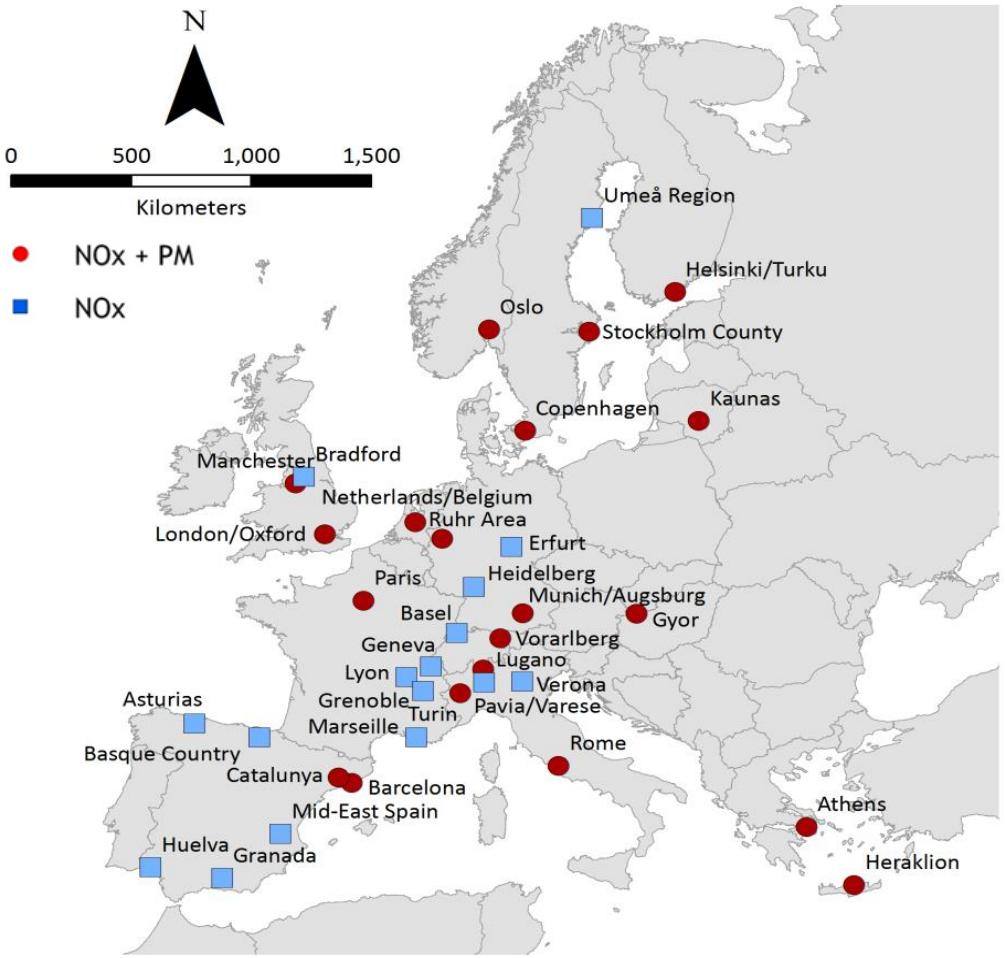
Only few additional studies since 2011, very few in China

Rückerl et al., 2011

European Study of Cohorts for Air Pollution Effects - ESCAPE



- Project period: 2008–12
- Exposure measurements: 2008-10 in 36 regions
- Health data from more than 30 cohorts (enrolled in 1992-2007)
- 24 universities and research institutes from Europe

Exposure Measurements

Particulate matter (PM_{10}, $PM_{2.5}$, $PM_{2.5}$ absorbance) and nitrogen oxides (NO_2, NO_x) were measured in each study area at 20 and 40 locations, respectively

Measurements were conducted during three 14-days periods spread over the year


PM pump


NOx passive sampler

Pooled hazard ratios for Coronary Events and stroke*

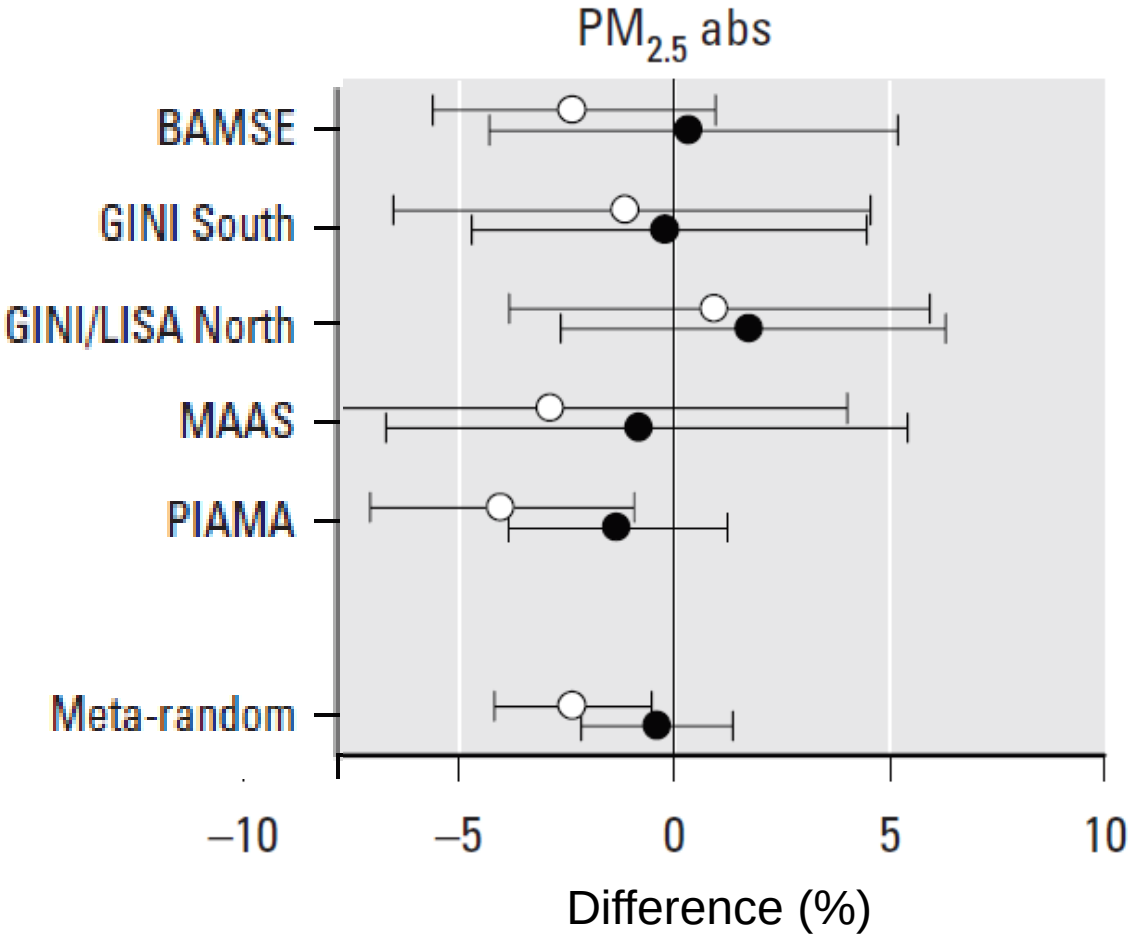
Exposure	Increment	Cohorts	Subjects	Coronary events	Stroke
PM10[1]	10	11	100,166	1.12 (1.01-1.25)	1.11 (0.90-1.36)
Coarse PM[1]	10	11	100,166	1.13 (0.96-1.33)	1.03 (0.80-1.33)
PM2.5[1]	5	11	100,166	1.13 (0.98-1.30)	1.19 (0.88-1.62)
PM Abs[2]	1	11	100,166	1.10 (0.98-1.24)	1.08 (0.83-1.41)
NO_2[1]	10	11	100,166	1.03 (0.97-1.08)	0.99 (0.89-1.11)
NO_x[1]	20	11	100,166	1.01 (0.98-1.05)	0.98 (0.89-1.07)
Traffic intensity nearest road[3]	5,000	10[5]	95,733	1.01 (0.98-1.04)	0.99 (0.97-1.02)
Traffic load major roads in 100m buffer[3,4]	500,000	11	100,166	1.0 0.99-1.01)	1.00 (0.99-1.01)

* Hazard ratios adjusted for age (time variable), year of enrolment, sex, marital status, education, occupation, smoking status, duration & intensity, and socioeconomic area indicator.

1 µg/m^3 2 PM2.5 absorbance in 1 10-5 m-1 3 adjusted for background NO_2

4 in vehicles*metres/day 5 all cohorts except HNR

Decreased lung function in children (FEV_1) in association with $PM_{2.5}$ absorbance

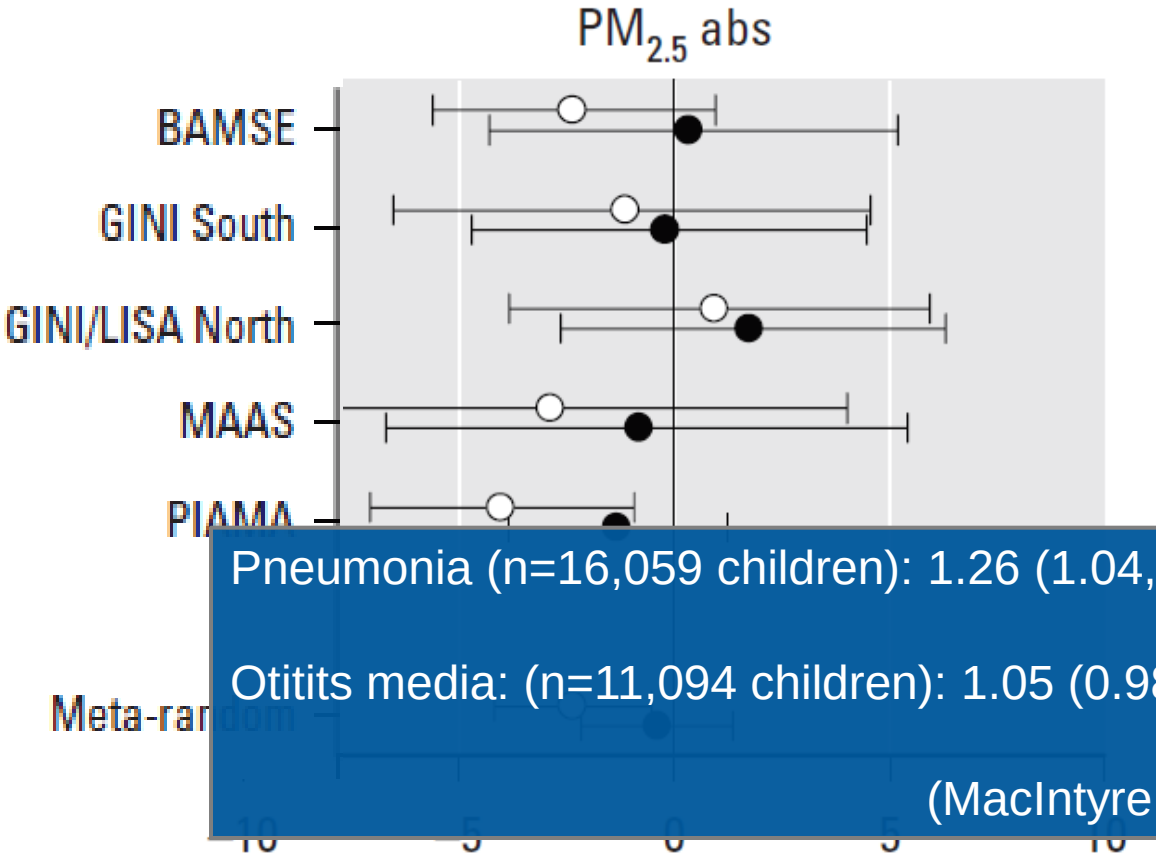


Decrease in forced expiratory volume in 1 second (FEV_1) per 1 unit $PM_{2.5}$ absorbance

○ Current address
● Birth address

Gehring et al., 2013

Increase in pneumonia and otitis media in children in association with $PM_{2.5}$ absorbance



Pneumonia (n=16,059 children): 1.26 (1.04, 1.52)

Otitits media: (n=11,094 children): 1.05 (0.98, 1.12)

(MacIntyre, 2014)

Decrease in forced expiratory volume in 1 second (FEV_1) per 1 unit $PM_{2.5}$ absorbance

Gehring et al., 2013

Research Gaps?

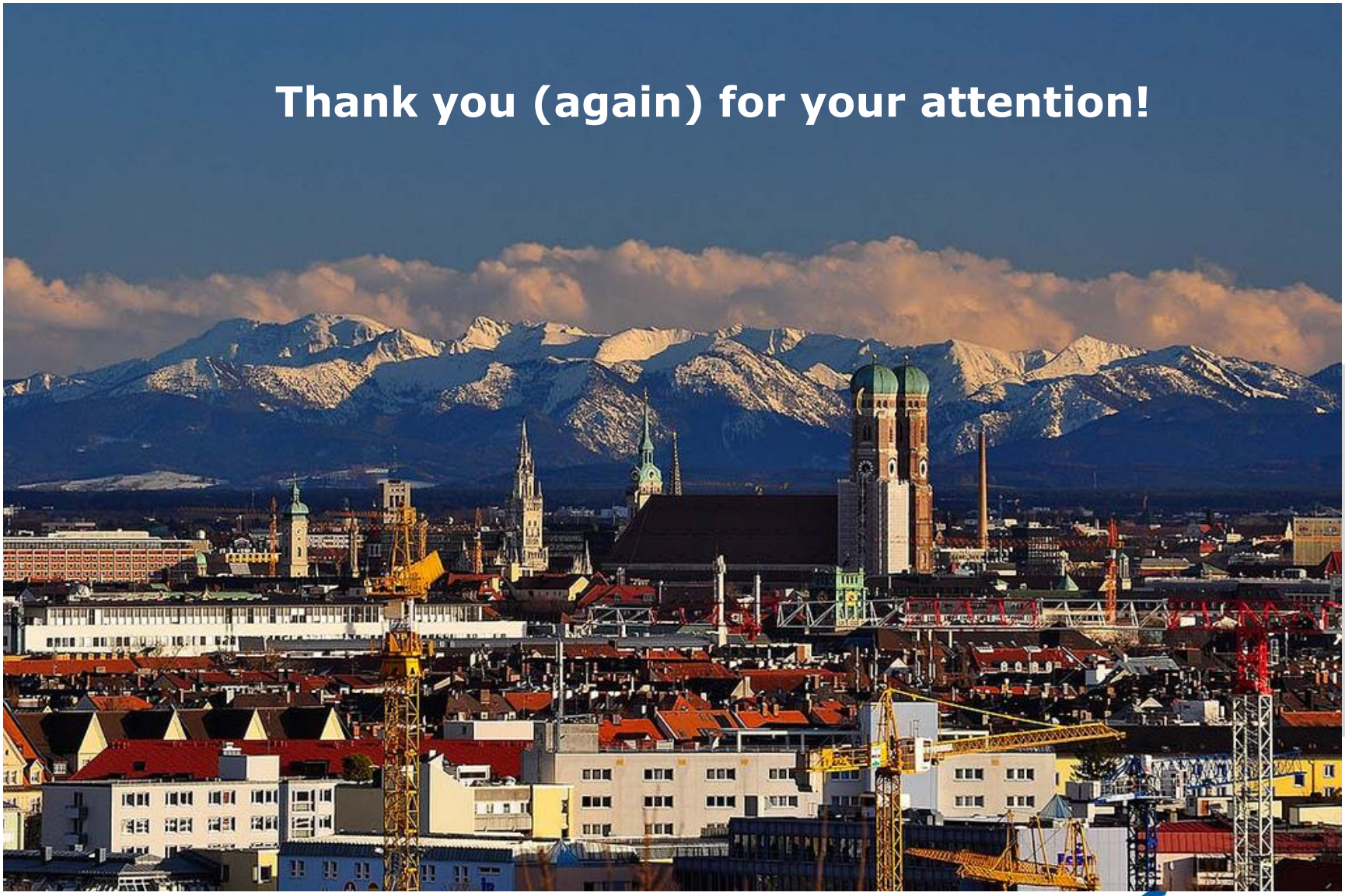
There is a lack of

- multicenter studies in China (long- and short-term)
- research on interactive/synergistic effects between air pollution and meteorology (e.g. data on urban heat islands)
- research on multipollutant exposures
- personal measurements studies

What do we need?

- Novel health outcomes, e.g. parameters healthy ageing (multi-morbidity, frailty, immune regulation,…) and mental health or metabolomics, lipidomics etc.
- Interactive effects of socio-economic status, stress, medication, urban green and urban blue
- "Intervention studies", e.g. supplements (omega 3 fatty acids, vitamin D) "against" adverse effects of air pollution
- Accountability studies: evaluation of air pollution reduction measures (see e.g. Olympic Games)

Thank you (again) for your attention!



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