HEALTH EFFECTS OF FINE AND ULTRAFINE PARTICLES IN EPIDEMIOLOGICAL STUDIES.

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Abstract:

Associations have been observed between ambient concentrations of particulate matter and morbidity and mortality consistently and coherently in epidemiological studies. These effects seemed to be attributable to fine particles (diameter below 2.5µm) when measurement techniques were employed. The effects were attributable to respiratory disease exacerbation as well as cardiovascular disease exacerbation. Recent studies investigating the biological mechanisms which might be responsible for linking deposition of particles in the lung to cardiovascular disease outcomes have suggested several pathways for particle action. These include an acute phase response leading to increases in systemic marker of inflammation in the blood, modification of the autonomic control of the heart and induction of endothelial dysfunction. These changes might predispose individuals to acute ischemia or to sudden cardiac death as indicated by the time-series analyses. Unclear is so far, which role the different components of the complex particle mixture play. A new approach is to address the role of ultrafine particles (diameter below 0.1µm) and to compare their health effects to those of fine particles. Data collected in Erfurt, Germany suggested that fine particles cannot be used as indicator for ultrafine particles. The limited body of studies including ultrafine measurements suggest that there might be health effects of ultrafine and fine particles independently of each other. Further research is needed to identify the particle properties responsible for the observed associations with fine particles.

Health effects of ultrafine and fine particles in epidemiological studies

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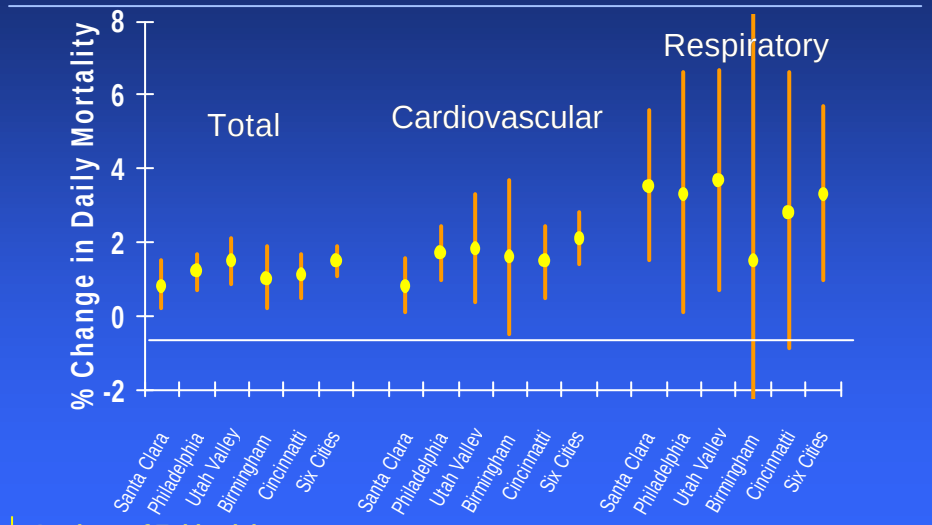
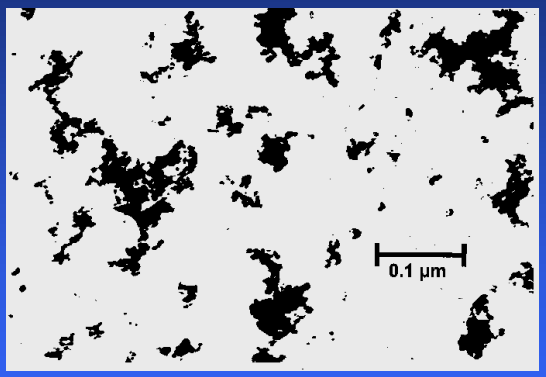
7th ETH Conference on Combustion generated Nanoparticles

Estimated Effect of Each 10 µg/m^3 Increase in PM_{10}



Characterization of ambient particles

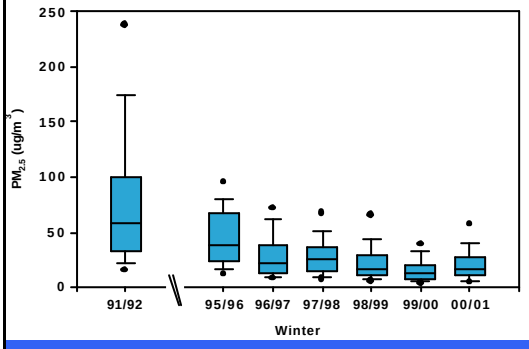


- by mass
- by number
- by chemical composition

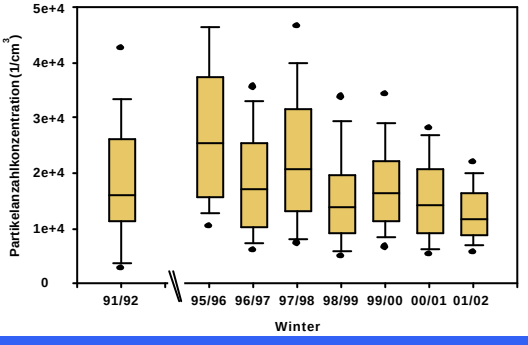
Kreyling et al. , GSF-IHB

Mass and Number (0.01-2.5 µm) in Erfurt, winter 91/92 - winter 00/01

Mass Concentration

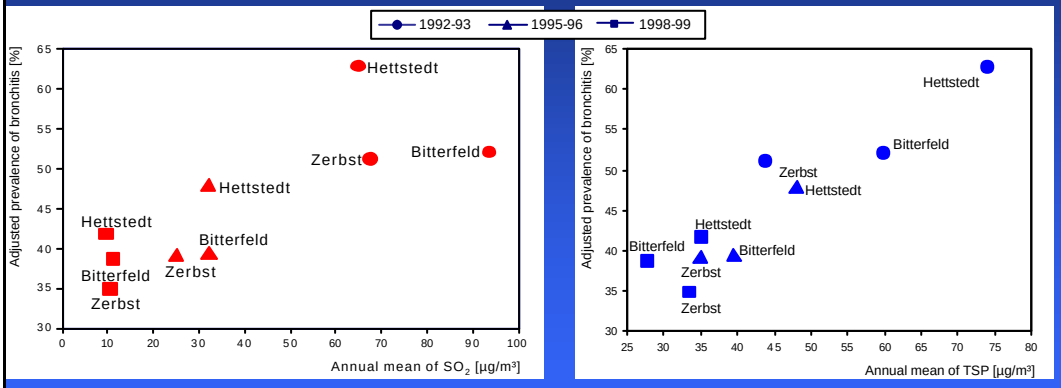


Number Concentration



Cyrys et al. (2002)

Adjusted prevalence of bronchitis and annual means of SO_2 and TSP in the Bitterfeld area



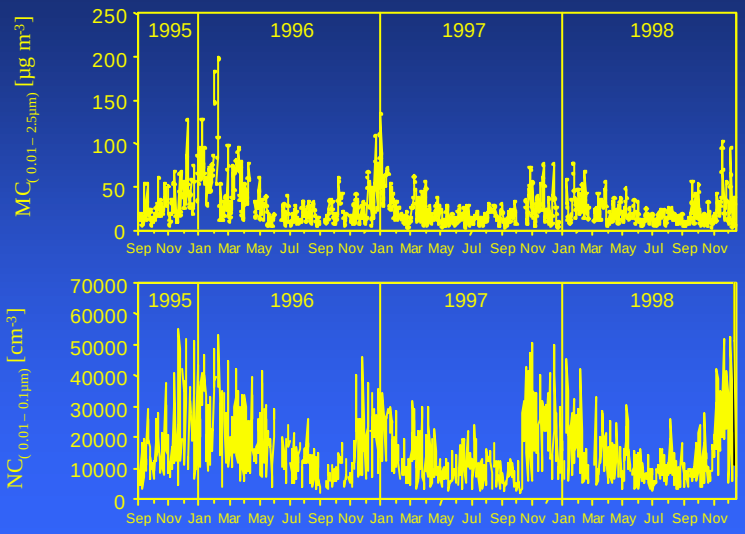
Heinrich et al. (2002)

Mortality Study on ultrafine particles

- Daily mortality counts were collected in Erfurt between summer 1995 and the end of 1998.
- Particle size distributions were measured with an aerosol spectrometer between 10 nm and 2.5 µm.
- Ultrafine particles were only moderately correlated with $PM_{2.5}$.

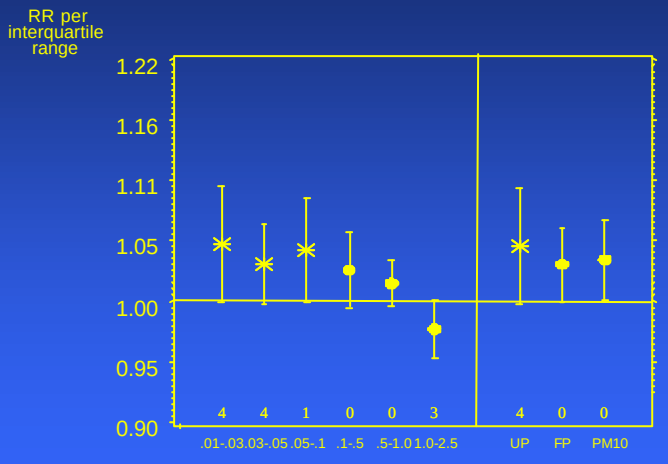
Wichmann et al. *HEI Report* 2000

Time series plots of "PM2.5" and UP



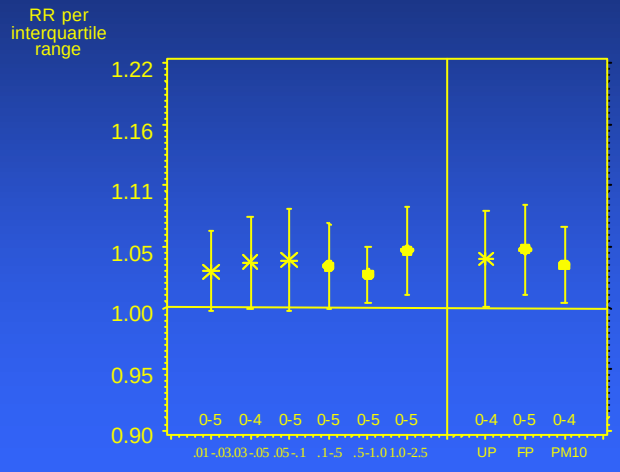
- Institute of Epidemiology

Total mortality in Erfurt



- Institute of Epidemiology

Total mortality in Erfurt



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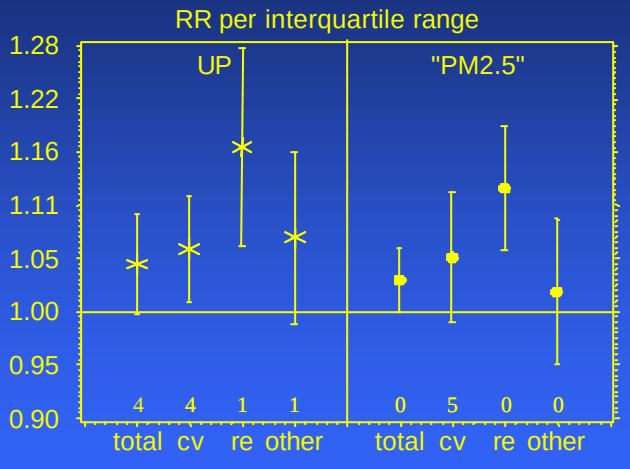
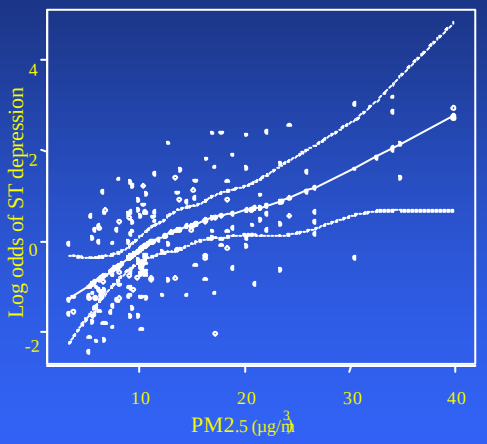
Regression results by disease group



- Institute of Epidemiology

Particulate air pollution and ST depressions: ULTRA

- Panel study of 131 CAD patients
- Amsterdam, Erfurt, Helsinki
- Age > 50 years, non-smoking, 12 examinations, winter 1998/99



Pekkanen et al. (2002) Circulation

Particulate air pollution and ST depressions during exercise: Helsinki

	UFP	ACP	PM2.5	$PM_{2.5-10}$
Lag 0	1.12	1.04	1.12	1.48
Lag 1	1.21	1.10	1.11	0.78
Lag 2	3.14*	3.29*	2.84*	1.99
Lag 3	1.45	1.19	1.40	0.46

Estimates for the interquartile range of the pollutant, *p < 0.01

Ultrafine particles and $PM_{2.5}$ induce ST-segment depression

	UFP	ACP	$PM_{2.5}$
Single	*3.14****	*3.29****	*2.84****
ACP	*1.34* 2.70**		
$PM_{2.5}$	*2.55*** 2.34**	*3.91*** 0.84	

$r_{ACP\ with\ UFP} = 0.53$

$r_{ACP\ with\ PM2.5} = 0.80$

$r_{UFP\ with\ PM\ 2.5} = 0.18$

Summary

- Although particle mass decreased, health effects can be demonstrated at current concentrations.
- Only a limited number of epidemiological studies have been conducted to study the health effects of ultrafine particles.
- Studies conducted thus far indicate that there might be an effect of ultrafine particles in addition to fine particle mass.

Outlook

- More evidence is needed to evaluate the role of sources of particles in association with adverse health outcomes.
- Studies assessing accountability will be important to inform regulatory decisions.