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In order to draw conclusions about the toxicity of an aerosol from epidemiological studies it is vital to know not only the personal exposure, but also the amount of particles deposited in the body. There are a variety of factors apart from the inhaled mass concentration that determines the respiratory tract deposition. These may for example be particle size and shape, particle chemistry, temperature, breathing pattern and lung morphology.

This work summarizes the most important findings on factors influencing respiratory tract deposition made in five recent human exposure studies with a set-up (RESPI) specifically developed to investigate the lung deposition of ambient "real-world" aerosols (Löndahl et al. 2006; Löndahl et al. 2007; Löndahl et al. 2008; Löndahl et al. 2008; Löndahl et al. 2009). The studied aerosols have been hydrophobic oil particles, hygroscopic salt, biomass combustion, traffic exhaust particles near a busy street, diesel particles and candle smoke. The studied size range was 10-600 nm. In total 76 (32 f / 44 m) volunteers participated.

Particle size and hygroscopicity: The importance of particle size on the respiratory tract deposition was evident from all five studies (Figure 1). Particle hygroscopicity alters the particle size in the lungs and is hence also a crucial characteristic. It influenced the deposition significantly of all studied aerosols apart from the oil and diesel particles.

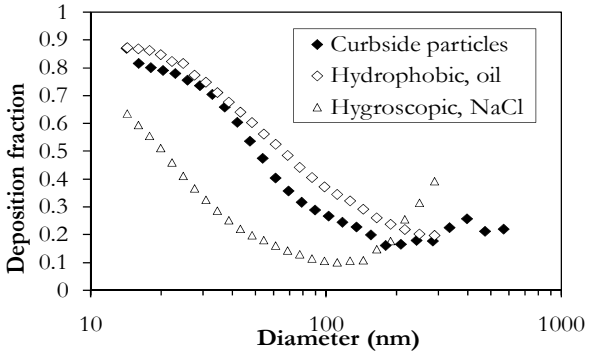

Figure 1 Mean deposition for 9 subjects of particles from salt, oil and the curbside of a busy street.

Particle shape: Particle shape had little influence on deposition (< 0.5 µm). The deposition of stable agglomerated diesel particles did not differ significantly from spherical oil particles of the same mobility size.

Particle density: The density had limited effect on deposition (< 0.3 µm) but knowledge of the effective density is crucial when the total mass of deposited particles, i.e. the mass dose, is calculated.

Breathing characteristics: Breathing pattern altered deposition significantly. On average the probability of the particles to deposit in the lungs was similar during rest and exercise. However, the dose by number, surface area and mass was higher during exercise because of the larger inhaled volume of per unit time.

Gender: Gender had little or no influence on the deposition probability (< 0.3 µm). The male subjects inhaled, on average, a larger volume of air and thus a higher dose.

Lung morphology: A group of 10 patients with COPD participated in one of the studies. These had a significantly altered deposition – especially for particles smaller than 100 nm.

Taken together the five studies have shown how the listed factors may interact to produce substantial variations in deposition. For instance the deposited number of traffic exhaust particles was around 16 times higher than for biomass combustion particles for similar mass exposures because of a combination of particle size, density and hygroscopicity. A person exercising close to the traffic may thus receive a dose, by number of particles, that is more than 60 times (16 x 4) higher than a relaxed person in a biomass smoke environment. Thus, dose estimates are crucial in epidemiological and toxicological studies.

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