Uptake of $PM_{2.5}$ mass by respiratory tract region and particle size: Hypothetical estimates for the FINRISK Cohort, Helsinki, Finland

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Particle size distribution is known to affect the lung deposition. However, particle size distribution modification by infiltration has not been evaluated.

The aim of this work is to use realistic spatial and hypothetical particle size distributions in Helsinki to estimate the contribution of local tailpipe, resuspension, and long-range transported particles to the human uptakes by respiratory tract regions.

Methods. Outdoor $PM_{2.5}$ concentrations were estimated for 5700 residential locations of FINRISK cohort members in 2010 using CAR-FMI dispersion model accounting for traffic sources and background concentrations observed at Luukki station. Particle source information (tailpipe, resuspension, background) was used to estimate hypothetical lognormal source-specific particle size distributions. Unimodal lognormal size distributions were created using literature (Kleeman *et al*., 2000, Hussein *et al*., 2005, 2008) for the traffic sources. Observed monthly average size distributions at the SMEAR II Hyytiälä rural background station (DMPS+APS) were used for the regional component (Figure 1). Previously developed and evaluated particle size specific mass-balance model was used to estimate the changes in the particle size distributions by infiltration (Hänninen *et al*., 2004, 2012). ICRP 1994 model was then used to calculate the hypothetical respiratory tract uptakes assuming that the subjects spent the whole year indoors at home.

Results. Particle mass uptake was dominated by accumulation mode particles in the alveolar region, followed by same particle size range in the bronchiole and then resuspension (Dp 1-2.5 µm) particles in the alveolar region (Figure 2). When looking at particle mass, ultrafines do not dominate uptakes even in the alveolar region. Accumulation mode particles have an order of magnitude higher contribution to alveolar uptakes when ignoring times spent in traffic. Accumulation mode particles may act as carriers of ultrafines and enhance their uptake in the alveolar region. Similar findings were recently presented by Zhang *et al*., (2012) for PAHs.

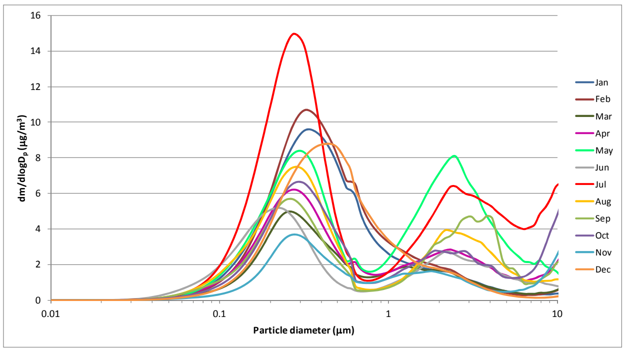

Figure 1. Monthly particle mass distributions from SMEAR II station located in Hyytiälä, Finland, 2010.

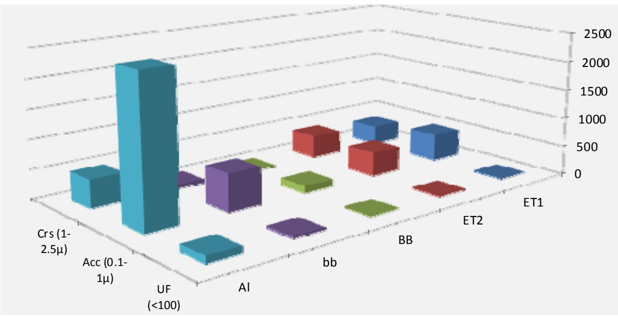

Figure 2. Annual PM mass uptake (µg) by respiratory tract region (x-axis) and particle size category (z-axis).

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