Estimation of the personal dose in school children due to PM$_{10}$ exposure

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Keywords: personal dose, PM, school, children
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Introduction

Children spend a large part of their time indoors, mainly at home and school. Air pollutants such as particulate matter can be found at high levels in these environments therefore children exposure may become significant. Investigation of the personal dose received by the children is important due to their vulnerability.

Methods

An intensive campaign was conducted in five schools and several houses in Lisbon (Portugal) whereby indoor/outdoor size-aggregated PM$_{10}$ was measured. This study focuses on the impact from children exposure in each school, thus for all measurements in houses an average value was adopted. Accordingly, a dosimetry model (ExDoM2; Chalvatzaki & Lazaridis, 2015) was implemented in order to estimate the personal dose received by children (10 years old) for one week exposure scenario (Monday-Sunday). The deposited dose rate (μg/h) is calculated as the product of inhalation rate, exposure concentration and deposition fraction. The equations of ICRP (1994; 2015) were used for the calculation of the deposition fractions where in the present case each size-aggregated fraction of PM$_{10}$ was considered as monodisperse.

Figure 1 shows that the weekly (cumulative) deposited dose of PM$_{10}$ ranged from 1,156 μg (SE) to 2,004 μg (SD). This finding is associated with the higher PM$_{10}$ concentration that was measured in school SD. The contribution of the school environment (indoor) at the weekly deposited dose for the above schools was estimated to be 59.6 % and 31 % for SD and SE respectively.
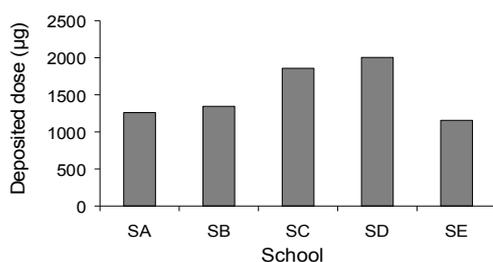
In addition, the higher deposited dose was obtained for the extrathoracic (ET) region compared to the lungs (BB+bb+AI). Specifically, a student in school SD received 1,486 μg in the ET (ET1+ET2) region and 518 μg in lungs during one week. The corresponding values for a student in school SE was 826 μg and 330 μg respectively.

After clearance, the higher dose of PM$_{10}$ for all schools was obtained to the oesophagus (764 μg, 817 μg, 1164 μg, 1260 μg and 692 μg for students in schools SA, SB, SC, SD and SE respectively). This finding is associated with higher deposited dose in the ET region.

It should be noted that particles are transferred to the oesophagus due to mucociliary clearance (ICRP, 2015). Specifically, the deposited particles into the ET region are transferred more quickly to the oesophagus in comparison with the other regions of the respiratory tract which require more time to reach the ET2 region (ICRP, 2015).

Conclusions

The differences in the deposited dose for each child are indicative of the concentrations measured in each school. These results highlight the importance of examining the impact of different schools to the personal dose.

Chalvatzaki E. and Lazaridis M. (2015). Development and application of a dosimetry model (ExDoM2) for calculating internal dose of specific particle-bound metals in the human body. Inhal. Toxicol. 27 (6), 308-320.

ICRP (1994). Human respiratory tract model for radiological protection. ICRP Publication 66. Ann. ICRP 24 (1-3). Pergamon Press, Oxford.

ICRP (2015). Occupational intakes of radionuclides: Part 1. ICRP Publication 130. Ann. ICRP, 44 (2).

Figure 1. Cumulative deposited dose of PM$_{10}$ in the respiratory tract at the end of one week.