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PAH indoor-to-outdoor relationship and exposure levels in Rome (EXPAH project)

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Background.

Polycyclic aromatic hydrocarbons (PAHs) are known to be harmful to human health. Spatial variability of the emissions, atmospheric dispersion, infiltration of the particles from outdoor to indoors, and population time-activity defines the exposures. Since the time spent inside is typically 80-90% (followed by time spent in traffic and outdoors), indoor exposures and thus particle infiltration from outdoors is a key issue.

Aim.

The aim of the work is to study the indoor-outdoor (I/O) relationship of PAH concentrations between non-heating and heating periods in different microenvironments (homes, schools, offices and traffic), and to estimate the population exposure levels in different seasons. This work is a part of the on-going Life+ EXPAH project.

Methods.

The current work uses $PM_{2.5}$-bound PAH concentration measurements carried out in Rome, Italy, as an input data. The I/O relationships of PAHs are evaluated and exposure levels are estimated by using population time-activity data and PAH concentrations in microenvironments. Moreover, ICRP lung deposition modelling approach was used to study the PAH deposition in respiratory tract.

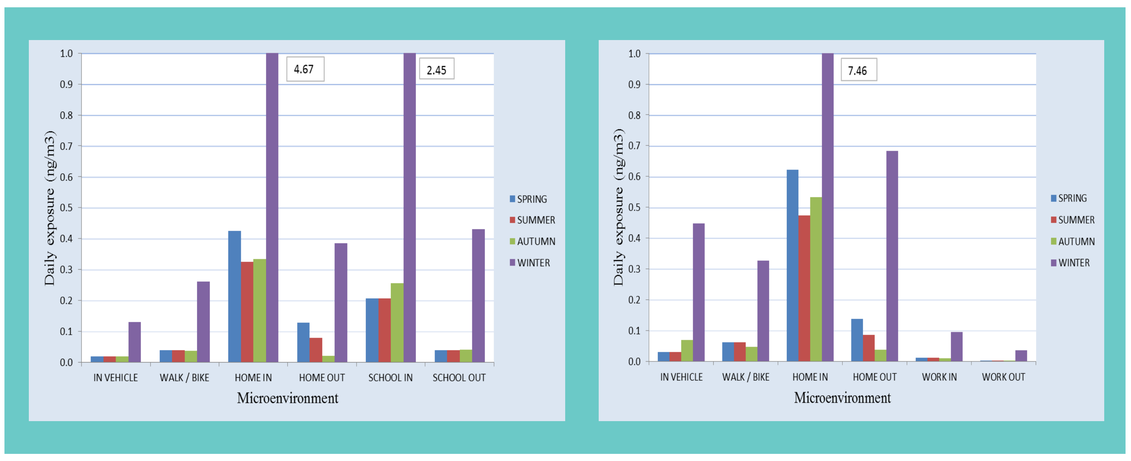

Figure 1: Average PAH exposure of children (left) and elderly (right) in different seasons. Graphs are scaled up to 1.0 ng/m3 truncating the highest peaks (highest values are marked next to bars).

Results.

High, up to 30-40 fold differences in outdoor PAH concentrations were observed between non-heating and heating seasons, and residential heating emissions contribute about 80% of the PAH exposure yearly in Rome. In case of children annual PAH exposure, the contribution of winter is 78.5% and in case of elderly 80.4% (see more detailed analysis in Figure 1).

Some evidence on seasonal variation of infiltration factors (analysed with mass-balance model) was noticed, presumably due to the differences in ventilation habits during various seasons, but in the medium-sized dataset collected in EXPAH study, the observed seasonal differences remained statistically not significant at 95% confidence level. Values presented in Table 2 are suggested for infiltration factors in Rome metropolitan area.

Study revealed that during a typical weekday more PAH is deposited in the lungs of elderly than children. This difference occurs mainly due to the larger amount of air breathed by elderly. Main interest in this modelling study is in the alveolar (Al) and bronchiolar (bb) deposition, since it is assumed that particles are required to deposit in those two regions to cause health effects (Figure 2).

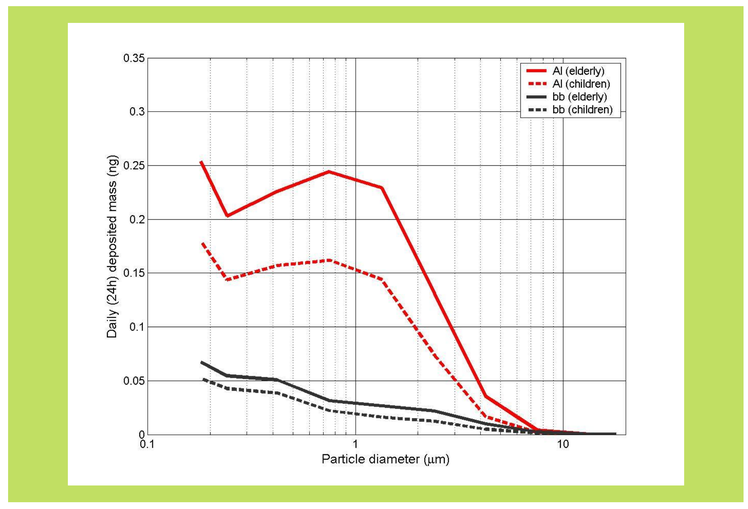

Figure 2: Comparison of daily (24h) PAH deposited mass (ng) between children and elderly in a typical spring/summer weekday.

Table 2: PAH infiltration factors for heating and non-heating seasons

Microenvironment	Non-heating	Heating
Homes	0.62	0.62
Schools	0.68	0.82
Offices	0.37	0.51
Cars and buses	0.75	0.83
Walk and bike	1.00	1.00

Conclusions.

Residential heating emissions contribute about 80% of the PAH exposure yearly in Rome metropolitan area followed by traffic and waste incineration.

ICRP lung deposition modelling approach was utilized for demonstrating differences between children and elderly respiratory tract PAH deposition.

Further research is needed especially regarding the seasonal variation of particle size distribution. Also, air exchange rates and deposition surfaces of buildings needs further study.

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And other EXPAH partners
(http://www.ispesl.it/expah/index.asp)