Indoor-to-outdoor particle concentration assessment for human exposure analysis

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SUMMARY
The objective of this study is to asses the indoor-to-outdoor particle concentration to calculate the daily children exposure levels in Lisbon. This information is useful in exposure studies with large population, because sampling indoor pollutants in all participants' house is impractical. In the scope of the European Project LIFE Index-Air PM2.5-10 and PM10 samples were collected in parallel in the indoor and outdoor of 40 homes. The chemical composition of PM was assessed to calculate the exposure of children to PM components. Three different parameters were used to assess the relationship between indoor and outdoor particles and their chemical constituents: indoor/outdoor (I/O) ratio, infiltration factor and penetration factor.

KEYWORDS
Particulate matter; exposure analysis; indoor-to-outdoor ratio; infiltration; penetration factor

1 INTRODUCTION

The level of the indoor air pollutants is the principal parameter for the assessment of the exposure and the health effects of these pollutants, because people spend the majority of their time indoors. The time activity patterns survey developed within the LIFE Index-Air project for children showed that during the week they spend 89% of their time indoors - 55% in home, 27% in classrooms, 3.5% in vehicles and 2.7% practicing indoor physical activities. During the weekends the time spent indoors slightly reduce to 87% - 76% in home, 5.4% in leisure indoor activities, 3.4% in transports, and 1.4% practicing indoor physical activities. However, due to the limited access to indoor environments in large population studies, outdoor air pollutant concentrations have often been used for the assessment of exposure, based on the assumption that the outdoor concentrations are the same as those indoors. However, this logic has been changed by a number of recent developments in both air pollution and scientific knowledge. Poor correlations have been found between ambient air concentrations and personal exposure and therefore this approach fails to account for all components of exposure.
LIFE Index-Air project (www.lifeindexair.net) is developing an innovative, versatile and modular policy tool that establishes a relation between children exposure to PM compounds, health effects and emission sources. This tool combines a pack of models to select cost-effective improvement measures to protect human health. The exposure module of the tool calculates exposure from outdoor PM levels, indoor-to-outdoor concentrations and time activity patterns.

2 METHODS

Indoor and outdoor particles were sampled in 40 homes located in Lisbon, Portugal with a Leckel sampler equipped with a PM10 size selective inlet and a single stage impactor plate to separate particles in two size fractions: 2.5μm<AD<10 μm and AD<2.5 μm. The filter loads

were measured by gravimetry in a controlled clean room. The elemental analysis of PM samples was performed with a high-resolution energy dispersive X-Ray fluorescence spectrometer; the elemental carbon and organic carbon fractions of PM was analyzed by a thermal–optical method, and Polyaromatic Hydrocarbons were analysed by gas chromatography–mass spectrometry.

3 RESULTS

Figure 1 presents the PM concentrations measured indoor and outdoor of the studied homes. Concentrations obtained during the campaign were mostly below the EU limit values but higher than the WHO guidelines. The highest concentrations of PM2.5 were obtained for the homes located in the central area of Lisbon in zones with higher road traffic.

The results showed that the average ratio indoor/outdoor is 1.1 for fine particles and decreases with the increasing particle size. The concentration of coarse particles was higher outdoor than indoor.

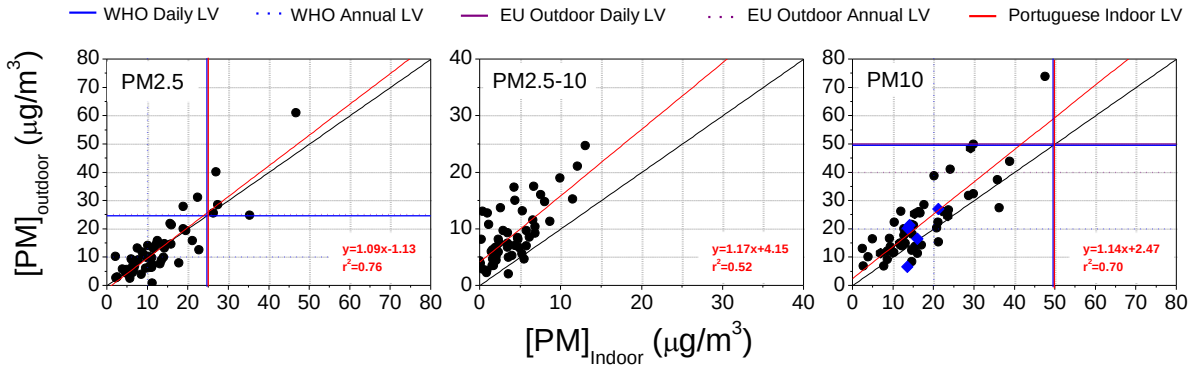

Figure 1: PM concentrations measured indoor and outdoor of the studied homes and representation of the limit values (LV).

4 DISCUSSION

This work used three different parameters to assess the relationship between indoor and outdoor particles: I/O ratio, infiltration factor and penetration factor.

Results showed that I/O ratio can provide a general overview on the relationship between indoor and outdoor PM concentration, nevertheless, it varied in an enormous range. Infiltration factor avoids the influence of indoor sources and consequently it was useful for qualifying the amount of indoor PM that contributed by outdoor environment. Penetration factor was the most relevant parameter to assess the penetration mechanism.

5 CONCLUSIONS

This study used PM indoor and outdoor concentrations to assess the penetration mechanism of PM. This information was essential to calculate children exposure to PM components in Lisbon.

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