Modelling the modifying effect of homes on population exposure to outdoor pollution

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Introduction

As most populations spend the majority of their time indoors, their exposure to outdoor air pollution will be influenced by building ventilation. We investigated the importance of ventilation in determining spatial variations in exposure to outdoor air pollution in London, a city with high levels of pollution, and a diverse, well-characterised domestic building stock.

Methods

Building simulations were run for a building stock consisting of 15 different building archetypes representative of the London domestic building stock, estimating the infiltration of $PM_{2.5}$, PM_{10}, NO_2, and SO_2 into the indoor environment. Indoor/outdoor (I/O) ratios were calculated for each archetype, and the results mapped using Geographic Information System (GIS) software for the 1.5 million London dwellings corresponding to the modelled archetypes. These data were combined with estimated spatial variation in the London background levels of the same pollutants to estimate the absolute indoor pollution concentration for each building, and consequently the population exposure inside dwellings. The health impacts associated with the indoor exposure to outdoor pollutants were estimated.

Results

There was appreciable variation across dwellings in the estimated ingress of pollution, with $PM_{2.5}$, for example, showing a nearly two-fold range (0.35 to 0.61) in I/O ratio. Mapped results showed a spatial variation in absolute exposure ranging from 5.2 to 11.4ug/m^3 for $PM_{2.5}$ with an apparent inversion of the risk of exposure compared to outdoor levels due to the concentration of flats with low I/O ratios in the polluted centre of the city versus more detached properties with higher ratios in the outskirts.

Conclusions

These results indicate that the spatial distribution of population exposure to pollution of outdoor origin may be appreciably different from that indicated by outdoor pollutant concentrations alone. Building type may be a potentially important modifier in epidemiological analyses.