Exposure of children and adults to particulate matter in urban areas – model calculations

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Calculations of individual aggregated respiratory dose of particulate matter related to outdoor sources have been made for a family of four living in Oslo. Their daily routine and activity level decide the quantitative contribution to the dose in the various micro environments.

The method

In the Urban Exposure project (EVK4-CT-2002-00090), a routinely used air quality management tool, AirQUIS, has been extended to provide exposure estimates based on most common micro environments, and an estimate of aggregated respiratory dose of particles based on activity level and physiological parameters. The outdoor concentrations are calculated using an Eulerian dispersion model. The indoor concentrations are calculated on the basis of outdoor concentrations taking into account house age and ambient wind speed. Based on defined daily routes, the hourly concentration of particulate matter is calculated for different micro environments. The respiratory deposition for various particle sizes is calculated on the basis of the micro environmental concentrations, activity level, gender and age. The aggregated daily dose is calculated from the hourly values.

Table 1: Daily routine and activity level for the four family members.

Child 5 year	Child 10 year	Father	Mother
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
GOING TO KINDERGARTEN	SCHOOL INDOOR	DELIVERING CHILDREN	DRIVING TO WORK
KINDERGARTEN INDOOR	SCHOOL INDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN INDOOR	SCHOOL INDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN INDOOR	SCHOOL OUTDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN OUTDOOR	SCHOOL INDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN OUTDOOR	SCHOOL INDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN OUTDOOR	SCHOOL OUTDOOR	WORKING AT HOME	WORK INDOOR
KINDERGARTEN OUTDOOR	SCHOOL OUTDOOR	WORKING AT HOME	WORK INDOOR
GOING HOME	SCHOOL OUTDOOR	GETTING CHILDREN	DRIVING HOME
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR
HOME INDOOR	HOME INDOOR	HOME INDOOR	HOME INDOOR

Colour key: Sleeping, Sitting, Walking, Playing

Description of calculations

Calculations have been performed for Oslo, which is the largest city in Norway (~500 000 inhabitants). The main emission sources for particulate matter are traffic, domestic wood burning and resuspension of particulate matter.

22 March 2003 represents a typical winter situation in Oslo. Calculations have been made for a family of four, living in a residential area established in the 1950s in the eastern part of Oslo.

The youngest child, aged 5, attends a kindergarten situated in the middle of the residential area which is exposed to both traffic and domestic wood burning.

The oldest child, aged 10, goes to school five minutes walk from home. The school is situated next to the woods with a moderately trafficated road passing by.

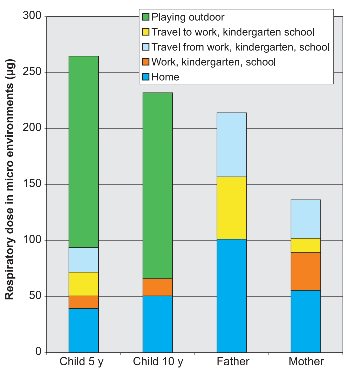

Figure 2: Aggregated respiratory dose (24 hour) of PM_{10} for the four individuals in the various micro environments.

The father works at home. In the morning and the afternoon he walks with his youngest child to and from the kindergarten, taking a circular route that also passes by the school of the oldest child.

The mother works in an office in the centre of town, and commutes by car. Her route takes her along the main roads from the residential area into town.

The placement of the various micro environments and travel routes are shown in Figure 1 and the time activity pattern is shown in Table 1.

Results and conclusions

The two children receive the highest respiratory doses (see Figure 2). The main contribution to the total aggregated dose comes from the time they spend outside playing. The youngest child receives the highest total respiratory dose due to his time spent outside the kindergarten playing.

The two children and their mother spend the same amount of time at home and the differences in respiratory dose are mostly due to lung capacity.

The calculated outdoor concentrations are comparable to the measured values (see Figure 3). The PM_{10} concentration for the indoor home environment is between 35 and 55% of the outdoor concentration when outdoor air is the only indoor source.

The results reflect the differences in concentrations in the various micro environments, the time spent there, the activity level and the variations in respiratory capacity due to age and gender.

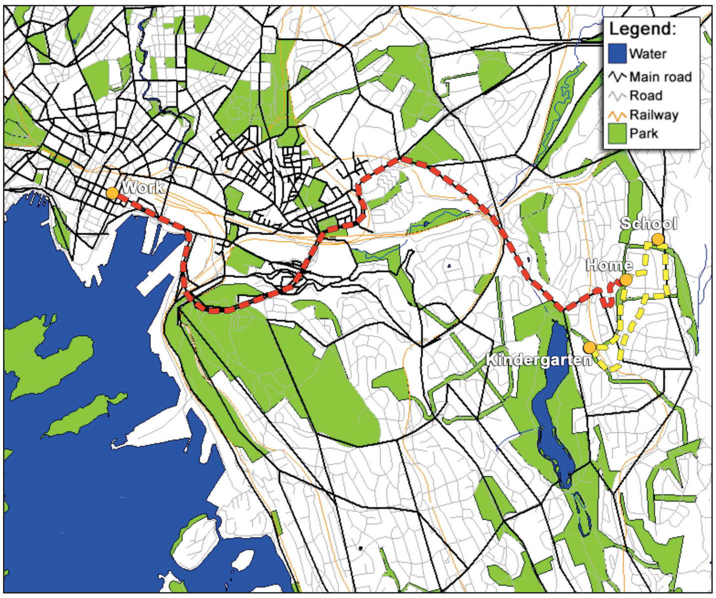

Figure 1: Map of Oslo showing home, school, kindergarten, work place and travel routes.

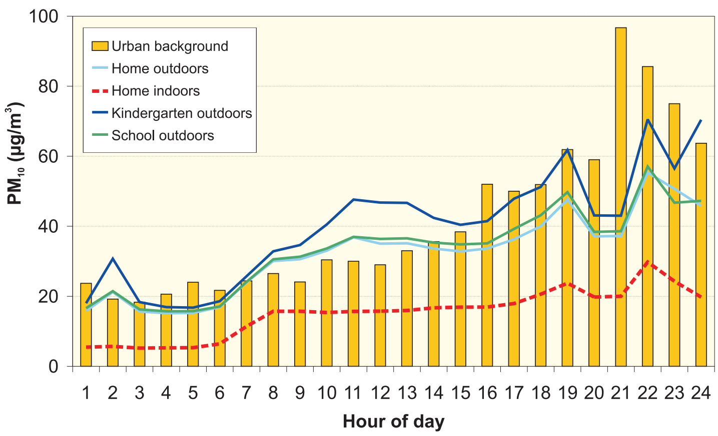

Figure 3: 24-hour concentrations of PM_{10} on 22 March 2003. Calculated concentrations at home (outdoors and indoors), outside the kindergarten and the school and the measured concentrations at an urban background station (Skøyen).