

## ABSTRACT

Research into indoor environment has shown that schools are buildings with high-levels of particulate matter concentrations. This is especially the case of schools situated in high-density traffic or in industrial areas. Several studies have also proven the impact of PM on the teenage generation's health. So far no detailed study has been performed to cover the environment of school gyms where the PM dynamics are different from other indoor microenvironments. This different dynamics relates to the gym environment heterogeneity and to the human activities taking place in it. Due to higher pulmonary ventilation, the exposure of the exercising pupils can reach levels possibly noxious to their health.

Size resolved mass concentrations of aerosol were measured in three elementary Schools in Prague. One school was situated in the city centre with high traffic density. The second school was situated on a plateau on the periphery with a medium level traffic. The third school can be found in Prague south-western suburbia, in an open landscape, with low traffic density. PM concentrations were measured simultaneously in naturally ventilated gyms and outdoors adjacent to the particular school building. Two pairs of monitors were used throughout the study: A DustTrak Aerosol Monitor and a Personal Cascade Impactor Sampler. In total, twenty monitoring campaigns, each 7-11 days long, were carried out at the three schools from 2005 to 2009. The total duration of the measurements amounts to 177 days. In two schools (central and suburban) the coarse particulate matter (PM<sub>10-2.5</sub>) deposited on the impaction plates of the photometers was also analyzed via Scanning electron microscopy and Energy Dispersive X-ray Spectrometry. During one campaign carried out simultaneously in the central and peripheral schools, the pupils' heart rates were measured during physical education classes. Prior to this measurements a panel of 32 pupils grades 5-8 (aged 10-15) took part in a laboratory stress examination to obtain detailed information about their relationship between the pulmonary ventilation and heart rate characteristics.

The PM indoor concentrations in the gym exceeded limits recommended by World Health Organization. The average 24hour PM<sub>2.5</sub> indoor concentration did not differ significantly from the data outdoor values with the correlation coefficient reaching 0.91. When comparing indoor and outdoor aerosol level, the correlation coefficient increased with decreasing aerodynamic diameter of the aerosol monitored ( $r = 0.32$  to  $0.87$ ). This indicates a higher infiltration of fine and quasi-ultrafine particles in the indoor environment. Coarse fraction (PM<sub>2.5</sub> - PM<sub>10</sub>) was related to the number of exercising pupils ( $r = 0.77$ ). The results show that human activity is its main source. In comparison to outside values, the indoor concentration of coarse aerosol increased several times during physical education days. Scanning electron microscopy showed that apart from numerous inorganic particles, the aerosol is composed mainly from organic residues such as various types of fibres and fungi, mite debris and most of all skin scales, which are the major part of organic aerosol in gyms. Based on the laboratory stress tests results the estimated ratio between the pulmonary ventilation of exercising and resting pupils was 3.8 (max. = 5.4; min. = 2.7; standard deviation 0.72) showing that physical exercise may cause a 4-fold increase in exposure to inhaled aerosol.

We can conclude that school gyms are indoor microenvironments with high concentration of (mostly coarse) aerosol particles and that exercise may result in exposure exceeding several times the recommended hygienic limits. Cleanliness, type and volume of the physical activity during physical education classes, health conditions of pupils as well as the sources of pollution outside schools are important factors which should be taken into account in education planning.

**Key words** : primary schools, gyms, air quality, aerosol exposure of children