Exposure to indoor air pollutants during physical activity in gymnasiums

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Physical activity has become a social need among people, and is clearly proved that exercise is a way to prevent all-cause and cardiovascular-related death, diabetes mellitus and obesity. However, athletes and the common individual can be at risk when they are practicing exercise in polluted environments due the fact that 1) the ventilation rates increase and the quantity of pollutants inhaled increase proportionally; 2) most of the air is inhaled through mouth, bypassing the normal nasal mechanisms for filtration of large particles and 3) the increased airflow velocity carries pollutants deeper in to the respiratory tract[1]. Due to these facts, research in the field of indoor and outdoor air quality while practice exercise is important to improve the scientific knowledge and the implementation of best practices/recommendations for people who workout.

Firstly, measurements of the indoor pollutants PM_{10}, CO_2, CO, H_2CO, VOCs and O_3 was made in 15 gymnasiums in Lisbon in order to get a general perception of IAQ in this setting. After this, three gyms were selected to perform a deep analysis during one week in each one. Measurements were performed during the occupation time, in the studios and in the bodybuilding room, in order to recognize daily patterns and identify pollutant sources.

PM was measured in the indoor of the gyms 1) with a direct reading equipment (Lighthouse 3016) with five different granulometries (PM_{10-5}, $PM_{5-2.5}$, $PM_{2.5-1}$, $PM_{1-0.5}$, $PM_{0.5-0.3}$) and 2) with a medium volume sampler (MVS6 Leckel) using teflon filters. Simultaneously, in outdoor was used a Partisol 2000 with teflon filters. Particle mass concentration was determined by gravimetry with a Mettler Toledo microbalance (UMT5). Filters were weighed before and after sampling in a humidity and temperature controlled room. Elemental analysis of PM_{10} sampled in the filters was performed by using Neutron Activation Analysis in Portuguese Research Reactor.

Figure 1shows that PM_{10} concentrations were different between gyms and spaces. The outdoor concentrations presented a great contribution in the PM_{10} indoor concentrations of gym 2. PM continuous measurements indicated that the concentrations increase when the spaces are occupied during classes, mostly in the coarse fraction (PM_{10-5} µm and PM_{5-10} µm).

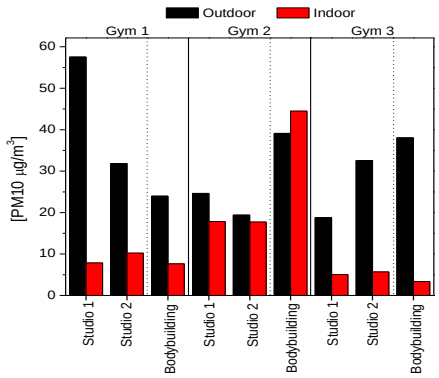

Figure 1. Concentrations indoor and outdoor measured in the spaces of the gyms

CO_2 concentrations presented very high values during physical activity. Table 1 show the maximum and the average values measured in the studios while physical activities classes were performed.

Table 1. Maximum and average CO_2 concentrations measured indoor during classes

		Maximum (mg/m^3)	Average (mg/m^3)
Gym 1	Studio 1	2738	1844
	Studio 2	2917	2118
Gym 2	Studio 1	3001	1997
	Studio 2	2200	1381
Gym 3	Studio 1	2219	963
	Studio 2	1652	1125

In addition to the pollutants assessment, a physiological analysis (respiratory frequency, heart rate, minute ventilation) was performed to the gym users during the physical activity, in order to establish the personal exposure to the measured air pollutants.

Results presented a strong support to the importance of the implementation of actions that will improve the air quality in sport facilities. It is crucial to improve the HVAC system maintenance, ventilation rates and occupants behaviour in order to potentiate the sport benefits.

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