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Indoor and Outdoor Air Pollution in Doha – cases of schools and residences

Balint Alfoldy*

Qatar University
* balint@qu.edu.qa

The World Health Organization (WHO) attributes air pollution to 1 in 8 deaths worldwide, where exposure to indoor air pollutants is a significant contributor to incidences of heart disease, respiratory problems, and cancer (WHO, 2014). Since people spend the major part of the day indoors - especially in Qatar -, indoor air quality (IAQ) is a significant factor affecting their overall pollutant exposure via the respiratory-inhalation pathway. IAQ is mainly determined by the geographical location of a building, its proximity to outdoor pollutant sources such as industry, construction activities, traffic or natural pollutant sources (e.g. desert sand particulates), as well as the building characteristics itself (building envelope, air tightness, ventilation/air conditioning system). Indoor sources like decoration and furniture, as well as indoor activities like cleaning and cooking also affect IAQ. Recently, the WHO ranked Qatar second position worldwide of countries with the highest ambient PM2.5 exposure (WHO, 2014). The issue can therefore be regarded as of great significance to public health for the citizens of Qatar, and therefore warrants scientific study and potential mitigation of excessive PM2.5 exposure. In particular, the young citizens of Qatar are especially susceptible to the impacts of PM2.5 inhalation due to their early stage of physiological development. A building can function as a protective shelter for poor outdoor air quality, but without a dedicated IAQ enhancement strategy, buildings may not automatically lead to a reduced indoor exposure to air pollutants, including PM2.5, as well as other potentially harmful pollutants including: oxides of nitrogen and sulphur (NO2, SO2); ozone (O3), natural radiation (radon, Rn); microorganisms (bacteria and fungal spores); a range of volatile organic compounds, and hydrocarbons. This study aimed

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to characterise IAQ of Qatar's indoor environments, with a particular focus on schools and residences with consideration of outdoor air quality (OAQ) conditions. Simultaneous IAQ/OAQ measurements have been conducted using established reference methods and sampling techniques specifically developed for IAQ studies. PM10, PM2.5 and ultrafine particle concentrations, aerosol size distribution and particle elemental composition have been measured. Volatile organic compounds, aldehydes, NO2, SO2 and O3 were monitored. CO2, temperature and relative humidity were also monitored, and the air exchange rate between indoor and outdoor environments has been assessed. Semi-volatile organic compounds, such as polycyclic aromatic hydrocarbons, phthalates and flame retardants have been quantified in order to identify specific sources of contamination as derived from combustion and/or building material emission sources. Three school classrooms and associated school-pupil homes were selected for conducting IAQ assessments in order to determine pupil exposure levels to air pollutants over a 24-hour period. Volunteers were equipped with personal exposure monitors for determining their location and activity-dependent air pollutant exposure levels. The first measurement campaign of the research project was conducted in May, 2017. Three classrooms were monitored and five residences, as well as the outdoor location in the school's garden. The results indicate that the indoor concentrations of VOCs, aldehydes and PAHs exceeded the outdoor levels, and that pollutants concentration in residences were consistently higher than in the school classrooms. In terms of particulate matter (PM2.5) the opposite trend was observed. The indoor PM2.5 levels were far lower than the reference outdoor concentration. Regarding the comparison of school class rooms and homes, the same trend as in the case of VOCs was observed. Namely, the PM2.5 levels in homes were consistently higher than in the school classrooms. Overall, the results show that indoor environments represent a protective shelter against the outdoor particulate air pollution ion Qatar. The indoor air quality is determined mainly by pollution sources indoors – particularly in residences due to the presence of more intensive and versatile emission sources – including furniture, decorations, use of air refreshers; as well as activity generated emissions by the inhabitants like cooking, cleaning, or smoking. The second measurement campaign will be conducted in December 2017, when new data will be collected under different seasonal conditions i.e. mild temperatures, where buildings typically have more ventilation with the outdoor environment, and where higher ingress of outdoor air pollution may be expected. The authors would like to thank Qatar National Research Fund (QNRF) for funding and supporting this project under the National Priorities Research Program (NPRP) award number NPRP 8-202-3-043.