Poster Presentation

INDOOR AIR QUALITY ASSESSMENT IN ELDERLY CARE CENTERS IN PORTO, PORTUGAL

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INTRODUCTION

According to the United Nations estimates, the total number of people aged 65 years and older was 506 million in 2008 and is anticipated to double to 1.3 billion by 2040, accounting for the 14 percent of total global population. This trend explains the increasing demand of long-term care services [1] such as elderly care centers (ECCs). Furthermore, considering that persons who are 65 years or older, often spend a considerable percentage of their lives indoors, it is clear that the possibility that adverse indoor climate can influence their health status cannot be ignored. This paper presents results which have been produced within the GERIA ongoing project 'Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers', by measuring and characterizing indoor air quality (IAQ) and thermal comfort (TC) in 22 ECCs in Porto, Portugal. The aim of the study was to evaluate 1) the IAQ and TC in a representative sample of ECCs in Porto as compared with international standards, 2) to study the variability among different spaces within single ECCs, and 3) how buildings characteristics may affect the extent of indoor air pollution or thermal regulation.

METHODOLOGIES

Of a total of 58 ECCs, located in Porto urban area, 38% (n =22) accepted to participate in this study. Indoor environmental parameters were measured twice, during winter and summer, starting from November 2011 till August 2013, in 141 ECCs rooms within dining rooms, drawing rooms, medical offices and bedrooms. These areas were assessed for IAQ chemical (CO_2, CO, Formaldehyde, TVOC, PM_{10}, $PM_{2.5}$) and biological contaminants (total bacteria and fungi). TC parameters were measured following ISO 7730:2005 (PMV and PPD indexes). The monitoring phase included daytime air sampling (starting at 10 am and continuing for at least 4 h to 8h during normal activities) conducted discretely to minimize nuisance to normal resident's activities. A walk-through building questionnaire was performed prior the monitoring and outdoor samples were also collected for comparison. Classical statistical methods were used to estimate means, medians and frequencies (percentages) in order to obtain insight into the ECCs characteristics and environmental monitoring results within and between buildings. The variables were tested for normality with Shapiro-Wilk test. Mann-Whitney (U) test and Kruskal-Wallis (H) for independent samples were conducted for seasonal effects assessment, indoor/outdoor and within buildings location differences. It was also performed a student t-test for the variable 'air temperature'. A 0.05 level of significance was used for all analyses. All data were analyzed using IBM SPSS 21.0.

RESULTS AND DISCUSSION

The 22 ECCs were located in the urban area of Porto city, most of them (n=17) in heavy traffic areas. A total of 716 elderly lived in these centers with a range of 7 to 136 occupants per building. As regards construction characteristic, 66% were an adaptation to ECC of an existing residential building, and 40% were also developing activities of day care centers for

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elderly. Most of them were built in stone masonry construction (49%) with single pane windows (87%). Only 30% had roof and walls insulation, while 61% of the sampled presented condensations and infiltrations along walls and roofs inside the buildings. All ECCs were smoke-free. Regarding the ventilation type, 87% had mixed ventilation (natural ventilation in the rooms along with exhaustion systems in the kitchen and bathrooms) while 13% had only natural ventilation in all the indoor areas. The overall $PM_{2.5}$ mean concentration of the 22 ECC was above international reference levels (35 µg/m^3) in both seasons. These findings showed as this parameters is critical for air quality, both for its sensitivity and for its possible influence on human health. Other studies [2, 3] have found, high levels of $PM_{2.5}$ in similar indoor environments, and the link with lung function [4] and respiratory diseases such as COPD [5, 6] has been quite demonstrated. Although all the other indoor air pollutants were within the reference levels peak values of PM_{10}, TVOC, CO_2, bacteria and fungi exceeded the reference levels, compromising indoor air comfort and worsening the already existent respiratory chronic diseases. TVOC, Bacteria, CO and CO_2 showed significantly higher indoor levels compared to outdoor, in both seasons. Indoor PM_{10}, TVOC, Bacteria and CO_2 present significant differences between seasons ($p < 0.01$). TVOC, bacteria and CO_2 show significant variation between ECC rooms ($p < 0.01$) and 4% of fungi samples were positive for pathogenic *Aspergillus species*. The winter PMV index is below references and between the 'slightly cool' and 'cool' (-2) points in the thermal sensation scale, which may potentiate respiratory tract infections. PPD and PMV indexes show significant differences by room and by season ($p < 0.01$). The building characteristics 'Insulation', 'Heating Ventilation' and 'Windows frames' appear to be the most influential parameters on IAQ and TC. The environmental parameters most commonly affected by building characteristics are the 'Bacteria', 'Fungi', 'Temperature', Relative Humidity', and 'PPD index'.

CONCLUSIONS

Our study suggested that attention is needed to $PM_{2.5}$ particle fraction, as well as, peak concentrations and fungi species that might compromised IAQ comfort. To prevent low indoor temperatures and discomfort, especially on winter season, simple measures could provide health benefits to ECC residents and workers, such as insulating ceilings, walls, and windows, maintaining natural and passive ventilation, solutions that are common in Portugal due to the advantage of the country's generally mild weather.

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