

# Health and Indoor Environment in Elderly Care Centers

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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. Furthermore, it is estimated that people spend 80 to 90% of their day indoors in developed countries, and elderly are likely to spend even more time indoors. Thus, indoor air pollutants may have special significance for this age group, even at low concentrations due to long exposure periods. Also, aging is associated with a decline in immune defenses and respiratory function, and predisposition to respiratory infections (Bentayeb et al., 2013).

## OBJECTIVES:

The aim of this paper was to evaluate 1) the indoor air quality (IAQ) and thermal comfort (TC) in a representative sample of elderly care centers (ECC) in Porto, Portugal, and compared with national and international standards, 2) to study the variability among different spaces within single ECC, 3) how buildings characteristics may affect the extent of indoor air pollution or thermal regulation, and 4) explore the impact of IAQ variables on respiratory health of ECC residents.

## MATERIALS AND METHODS:

Out of a total of 58 ECC located in Porto urban area, 38% (n=22) accepted to participate in this study. Indoor environmental parameters were measured twice, during winter and summer, in 141 ECC rooms within dining rooms, drawing rooms, medical offices and bedrooms. These areas were assessed for IAQ chemical (CO<sub>2</sub>, CO, Formaldehyde, TVOC, PM<sub>10</sub>, PM<sub>2.5</sub>) and biological contaminants (total bacteria and fungi). TC parameters were measured following ISO 7730:2005 (PMV and PPD indexes). A walk-through building questionnaire was performed prior the monitoring and outdoor samples were also collected for comparison. From September 2012 to April 2013, the standardized and validated Portuguese version of BOLD (Burden of Obstructive Lung Disease) questionnaire was applied by an interviewer to the elderly who gave their informed consent and were able to participate (n=143). All the participants should have had ≥ 65 years old and live in the ECC for more than two weeks. A descriptive analysis of the responses was performed. Classical statistical methods were used to estimate means, medians and frequencies (percentages) in order to obtain insight into the ECC 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 ECC 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 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 ECC were smoke-

free. Regarding the ventilation type, 87% had mixed ventilation (natural ventilation in the rooms along with exhaust systems in the kitchen and bathrooms) while 13% had only natural ventilation in all the indoor areas. The overall PM<sub>2.5</sub> mean concentration of the 22 ECC was above national (25 g/m<sup>3</sup>) and international reference levels (35 g/m<sup>3</sup>) in both seasons. These findings showed as these parameters are critical for air quality and could influence on human health. Other recent study (Bentayeb et al., 2013) also found, high levels of PM<sub>2.5</sub> in similar indoor environments, and the link with lung function and respiratory diseases such as COPD (Osman et al., 2007) has been quite demonstrated. Although all the other indoor air pollutants were within the reference levels peak values of PM<sub>10</sub>, TVOC, CO<sub>2</sub>, bacteria and fungi exceeded the reference levels, compromising indoor air comfort and worsening the already existent respiratory chronic diseases. TVOC, Bacteria, CO and CO<sub>2</sub> showed significantly higher indoor levels compared to outdoor, in both seasons. Indoor PM<sub>10</sub>, TVOC, Bacteria and CO<sub>2</sub> present significant differences between seasons ( $p < 0.01$ ). TVOC, bacteria and CO<sub>2</sub> 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 between the 'slightly cool' (-1) 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 variables 'Insulation', 'Heating Ventilation' and 'Windows frames' were significantly associated to chemical, biological and TC parameters. 'Bacteria', 'Fungi', 'Temperature', Relative Humidity', and 'PPD index' are the mostly affected by building characteristics (Table 1). In elderly respondents, breathlessness (27.5%) and cough (23.1%) were the major respiratory symptoms, and allergic rhinitis (21.7%) the main self-reported illness. Heart troubles were reported by 36.6% residents. Symptoms of wheezing (10.5%) in the last 12 months and asthma diagnosis (8.4%) were more common in females, as opposed to symptoms breathlessness (4.9%) and sputum (3.5%), more frequent in males. Smoking habits, both past and present, were more frequent in men (11.9%).

**Table 1** - Building characteristics in the indoor environmental evaluation

(significant differences by building variable and environmental evaluation:  $p < 0.001$ ;  $p < 0.01$ ;  $p < 0.05$ )

Significant differences by building variable and environmental evaluation: <span>p &lt; 0.001</span> , <span>p &lt; 0.01</span> , <span>p &lt; 0.05</span>												
Buildings Variables	Parameters											
	PM <sub>10</sub>	PM <sub>2.5</sub>	TVOC	HCHO	Bacteria	Fungi	CO	CO <sub>2</sub>	Temp.	RH	PPD	PMV
Adapted to ECC												
Building occupation												
Sources of pollution												
Walls												
Insulation												
Roof lining												
Ventilation type												
Heating ventilation												
Building pathologies												
Windows type												
Sealants												
Type sealants												
Windows frames												
Glass type												
Flooring												

## CONCLUSION:

Our study suggested that the IAQ in the ECC of Porto area is acceptable and no immediate intervention is required. Attention is needed to 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. Investigations are still needed to better understand the links between IAQ and respiratory health impairment in elderly. In this sense, logistic regression analysis is ongoing, thus focusing on the impact of IAQ and respiratory health symptoms on ECC residents.

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