Indoor Environment and Respiratory Health of Older People Living in Care Centres in Porto

Ana Mendes[1]; Ana Luísa Papoila[2]; Pedro Carreiro-Martins[3]; Iolanda Caires[3]; Teresa Palmeiro[3]; Lívia Aguiar[4]; Cristiana Pereira[1]

[1] National Health Institute, Portugal
[2] CEAUL, NOVA Medical School, Portugal
[3] CEDOC – Respiratory Diseases Research Group
[4] Instituto Nacional de Saúde Dr. Ricardo Jorge

ABSTRACT

Background: Considering that persons who are 65 years or older often spend an important part of their lives indoors, the possibility that adverse indoor climate might influence their health status must be considered. This cross-sectional study aims to evaluate the influence of indoor environmental parameters on older people respiratory health.

Methods: From September 2012 to April 2013, 21 care centres residences (CCR) in the city of Porto, Portugal participated in this study. The Portuguese version of BOLD (Burden of Obstructive Lung Disease) questionnaire was administered by an interviewer to older residents with≥ 65 years old who lived in the CCR for more than 2 weeks, gave their informed consent and were able to participate (n=143). Indoor environmental parameters (chemical and biological) were measured twice, during winter and summer in 135 areas within dining rooms, drawing rooms, medical offices and bedrooms. Mixed effects logistic regression models were used to study the association between the health questionnaire results and the monitored environmental parameters, adjusted for age, smoking habits, gender and number of years living in the CCR.

Results: our sample was characterized mainly by women (85%) with most people in the age group above 85 years old (48%). Forty percent of the participants perceived their health status as being currently sick and were mostly (61%) physically impaired. Cough (23%) and sputum (12%) were the major respiratory symptoms, and allergic rhinitis (18%) the main self-reported illness. Heart troubles were reported by 37% of the residents. Overall $PM_{2.5}$ median concentration was above the reference levels both in winter and summer seasons. Also, 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. In fact, older people exposed to PM_{10} above the reference levels presented higher odds of allergic rhinitis (OR = 2.9, 95% CI: 1.1 – 7.2).

Conclusion: In the CCR that participated in this study, allergic rhinitis was the main self-reported illness. High levels of PM_{10} were associated with 3-fold odds of allergic rhinitis. No association was found between indoor air chemical and biological parameters and respiratory symptoms.

Keywords: Allergic rhinitis, care centres residences, indoor air quality, older people, respiratory health

1. INTRODUCTION

Aged population is growing in most affluent socicties of the western world, increasing in absolute and relative terms. This has a major impact on the delivery of health care, including acute and emergency services. The older people require significantly more emergency care resources compared to younger adults due to a decline in immune defences and respiratory function, resulting in a higher predisposition to respiratory infections. Such conditions are highly prevalent, multifactorial, and associated with multiple comorbidities and poor outcomes, such as increased disability and decreased quality of life. Moreover, there is scientific evidence that due to existing cardiopulmonary co-morbidities (cardiovascular diseases, chronic bronchitis, emphysema, and asthma), older people suffer from reduced ability to breathe, and thereafter are greatly affected by the increased impairment that can result from exposure to air pollutants. Due to their reduced physical activities, outings and commuting, older people result also to be more exposed to air pollutants in the place where they live (Annesi-Maesano et al., 2013). After identifying the relationship between health and the residential environment for older people, a growing emphasis was placed on this subject leading to an increase in the number of housing support increased. Indoor residential places for older people like care centres residences (CCR) should be privileged because of the multiple advantages for studying the effects of indoor air quality on the respiratory health of older people (Bentayeb et al., 2013). Portugal has the 8th oldest population in the world and the 6th in Europe, with 23% of the population with more than 60 years old (Almeida-Silva, Wolterbeek, & Almeida, 2014). Furthermore, between 1998 and 2010, the number of CCR increased 49% in our country (GEP/MSESS, 2010). In this sense, the GERIA project 'Geriatric study in Portugal on Health Effects of Air Quality in Care Centre Residences' aims to provide insights about the association between respiratory health and indoor air quality at elderly settings, with the purpose of contributing to a health improvement of the older population. This paper presents results of a substudy within the GERIA project, in Porto city CCR.

2. MATERIALS AND METHODS

All CCR located within the Porto urban area and included in the 'Portuguese Social Charter' were invited to participate in our study. Out of a total of 58 CCR, 36% (n = 21, with 685 residents) accepted to participate. All the participants should had ≥ 65 years old, live in the CCR for more than 2 weeks and possess cognitive and interpretative skills in order

to complete a questionnaire. Environmental data was collected for each CCR in two seasons (summer and winter) starting from November 2011 till August 2013. Moreover, in each CCR the Portuguese version (Martins et al., 2009) of the respiratory health questionnaire BOLD (Buist et al., 2005; Global Initiative for Chronic Obstructive Lung Disease, 2001) was administered by a trained interviewer to the older people who gave their informed consent and were able to participate (n= 143); it was conducted from September 2012 to April 2013, along the winter season environmental sampling campaign. This study was approved by the Ethics Committee and the Portuguese Data Protection Authority. An exploratory analysis was carried out for all variables. Mann–Whitney and Kruskal–Wallis tests were used to compare seasonal effects assessment because of the existence of outliers, high variability and skewed distributions. Main health outcomes were wheezing, cough, sputum, asthma and allergic rhinitis. Mixed effects logistic regression models were used to study the association between these health outcomes and environmental parameters [categorized above and below the reference values ("Ordinance 353-A/2013 of 4th December. Diário da República, 1.ª série, No. 235. Ministry of Environment, Territory Planning, Health and Solidarity, Employment and Social Security. Lisbon. Portugal.," 2013)], adjusted for age, smoking habits, gender and the number of years living in the CCR. The 95% confidence intervals (CI) were also calculated whenever appropriate. A 0.05 level of significance was used for all analyses. Data were analysed using IBM SPSS 21.0 (SPSS, Inc., Chicago, IL, USA) and STATA 12.0. (StataCorp LP, Stata Statistical Software; TX, USA).

3. RESULTS AND DISCUSSION

The overall $PM_{2.5}$ median concentration of the 21 CCR was above national references (25 $\mu g/m^3$) ("Ordinance 353-A/2013 of 4th December. Diário da República, 1.ª série, No. 235. Ministry of Environment, Territory Planning, Health and Solidarity, Employment and Social Security. Lisbon. Portugal.," 2013) in both seasons. These findings showed how this parameter is critical for air quality for its possible influence on human health particularly to susceptible groups with pre-existing lung or heart disease as older people and children (World Health Organization, 2013). Although all the other indoor air pollutants median concentrations were within the reference levels, peak values of PM_{10} (1730 $\mu g/m^3$) in summer, as well as, TVOC (973 $\mu g/m^3$; 931 $\mu g/m^3$), CO_2 (2313 mg/m^3; 2697 mg/m^3) and bacteria (2282 CFU/m^3; 996 CFU/m^3) in both seasons, exceeded the reference levels, compromising indoor air comfort and possibly worsening the already existent respiratory chronic diseases. Fungi median concentrations are slightly above references in the winter season (185 CFU/m^3 indoor > 166 CFU/m^3 outdoor) and the indoor peak values in both season also raise concern (2224 CFU/m^3; 1218 CFU/m^3). Moreover 4% of fungi samples were positive for *Aspergillus* species known potential pathogenic/toxigenic species which constitute a threat predominantly to subjects with immunity disorders (Aguiar et al., 2014) such as older persons. TVOC, bacteria, CO and CO_2 showed significantly higher indoor levels compared to outdoor, in both seasons showing predominance of indoor sources. Indoor TVOC and CO_2 presented significant differences between seasons ($p < 0.001$). There were also significant differences between CCR evaluated spaces for TVOC ($p < 0.001$), CO_2 ($p < 0.001$) and bacteria ($p < 0.01$) parameters.

From the 668 older people living in the studied CCR, 21% (n = 143) were within the inclusion criteria and agreed to answer the health questionnaire. The sample is characterized mainly by women (85%) with most people in the age group above 85 years old (47%). Most of them are widowers (60%) living in the CCR for about 2 to 10 years (58%). Regarding occupation, the majority of residents were working class person who performed manual labour (57%) with elementary and middle school education (65%). Forty percent of the residents considered themselves sick and most of them (61%) had a degree of physical impairment, mobility or were bedridden. Concerning the non-respondents (79%) they were also mostly women (62%), 53% lived in the CCR in between 2 to 10 years and 46% had more than 85 years old. The known causes of this high rate of non-response were disability and disease compromising the cognitive and interpretative skills to answer the questionnaire (60%). In older people respondents, cough (23%) and sputum (12%) were the major respiratory symptoms, and allergic rhinitis (22%) the main self-reported illness. Heart troubles were reported by 37% of the residents.

Table 1 represents the analysis of the mixed effects logistic regression models between the main health outcomes (wheezing, cough, sputum, asthma and allergic rhinitis) and the monitored environmental parameters, adjusted for age, smoking habits, gender and the number of years living in the CCR. Older people exposed to PM_{10} above the reference levels presented higher odds of allergic rhinitis (OR = 2.9, 95% CI: 1.1 – 7.2). For each degree increase in temperature a 20% decrease in the odds of having allergic rhinitis (OR = 0.8, 95%:0.6 – 1.0) was found. No significant associations between wheezing, cough, sputum from the chest and asthma, and environment were found.

4. CONCLUSIONS

Our final remarks regarding this work are the following: (i) Cough and sputum were the major respiratory symptoms, and allergic rhinitis the main self-reported illness in older people living in CCR; (ii) Overall $PM_{2.5}$ median concentration was above reference levels both in winter and summer season; (iii) Peak values of PM_{10}, TVOC, CO_2, bacteria and fungi exceeded the reference levels, compromising indoor air comfort and exacerbating older residents' respiratory chronic diseases; (iv) Older people exposed to PM_{10} above the reference levels have higher risk of allergic rhinitis. With a view to improve the CCR indoor environments, adequate measures such as local exhaust ventilation systems near cooking and gas burning devices, as well as daily slightly moist cleaning of the rooms surfaces would reduce particle accumulation and re-suspension. Low indoor temperatures and discomfort, especially on winter season, could be prevented by simple measures such as insulating ceilings, walls and windows, maintaining natural and passive ventilation.

Table 1. Associations between health outcomes and environmental parameters adjusted odds ratio (95% CI)

	Crude Odds-ratio (95% CI)	Adjusted Odds-ratio (95% CI)
Wheezing in the past 12 months		
Fungi	3.21 (0.69 – 14.90), $p = 0.136$	3.74 (0.78-17.78), $p = 0.097$
Age		1.04 (0.96-1.13), $p = 0.315$
Relative Humidity	3.75 (0.88 – 16.04), $p = 0.075$	4.09 (0.93-18.02), $p = 0.062$
Age		1.03 (0.95-1.12), $p = 0.402$
Cough		
Fungi	2.29 (0.87 – 2.06), $p = 0.095$	2.38 (0.88-6.44), $p = 0.088$
Age		1.00 (0.95-1.07), $p = 0.820$
Allergic rhinitis		
PM_{10}	2.44 (1.03 – 5.78), $p = 0.044$	2.87 (1.14-7.24), $p = 0.025$
Age		1.02 (0.94-1.09), $p = 0.567$
Gender		0.07 (0.009-0.54), $p = 0.010$
Smoked cigarettes		8.74 (1.97-38.72), $p = 0.004$
CO	1.74 (1.11 – 2.74), $p = 0.017$	1.62 (0.95-2.77), $p = 0.078$
Age		1.02 (0.95-1.10), $p = 0.514$
Gender		0.09 (0.01-0.72), $p = 0.023$
Smoked cigarettes		6.66 (1.47-30.15), $p = 0.014$
CO_2	1.00 (0.99-1.00), $p = 0.052$	1.00 (0.99-1.00), $p = 0.091$
Age		1.02 (0.95-1.09), $p = 0.641$
Gender		0.08 (0.01-0.65), $p = 0.018$
Smoked cigarettes		7.43 (1.65-33.49), $p = 0.009$
Temperature	0.79 (0.64 – 0.97), $p = 0.024$	0.79 (0.64-0.98), $p = 0.031$
Age		1.01 (0.94-1.09), $p = 0.775$
Gender		0.09 (0.01-0.69), $p = 0.020$
Smoked cigarettes		7.27 (1.69-31.10), $p = 0.007$

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