ESCOLA SUPERIOR DE TECNOLOGIA DA SAÚDE DE LISBOA
INSTITUTO POLITÉCNICO DE LISBOA

HTRC
Health and Technology Research Center

The impact of indoor air quality on respiratory health of older people: spirometry and exhaled breath condensate assessment

J.Belo, Carreiro-Martins, A.L. Papoila, T. Palmeiro, I. Caires, M. Alves, S. Nogueira, F. Aguiar, A, Mendes, M. Cano, M.A. Botelho, N. Neuparth

Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers
GERIA PROJECT

Projeto: PTDC/SAU-SAP/116563/2010

PhD Grant: SFRH/BD/72399/2010

FCT
Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Promotor:

ISPUP
INSTITUTO DE SAÚDE PÚBLICA
DA UNIVERSIDADE DO PORTO

Ministério da Saúde | Instituto Nacional de Saúde Doutor Ricardo Jorge

Rational

- Population aging[1]
- In general, seven million of deads are due the indoor and outdoor environmental exposure[2]
- The elderly are identified as the one of the principal risk groups [3]
  - Progressive decline of biological functions
  - Cummulative environmental exposure
  - 90% of the time is in indoor spaces

1. United Nations. Department of Economic and Social Affairs. World economic and social survey, 2007: development in an ageing world.
2. World Health Organization. “Burden of disease from the joint effects of household and ambient air pollution for 2012”.2014
3. Sandstrom T et al. “The need for a focus on air pollution research in the elderly”. 2003

Main Goal

The main goal of this study was to describe the impact of environmental exposure from the point of view of IAQ in the respiratory health in a sample of elderly people living in nursing homes. The elderly were evaluated through spirometry and exhaled breath condensate (EBC).

Study design

817 elderly from 18 nursing homes cited in Lisbon filled the following inclusion criteria:

≥ 65 years old

≥ 6 months of residence

269 elderly with **spirometry**

- Whitout contraindications for the spirometry
- With aparent cognitive capacity to understand the specific manouvers
- Spirometry that accomplish quality criteria

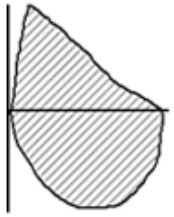
→ Test used to assess how well your lungs work by measuring how much air you inhale, how much you exhale, quickly and fast

150 elderly were randomly selected from those who had a spirometry to performe a **exhaled breath condensate**.

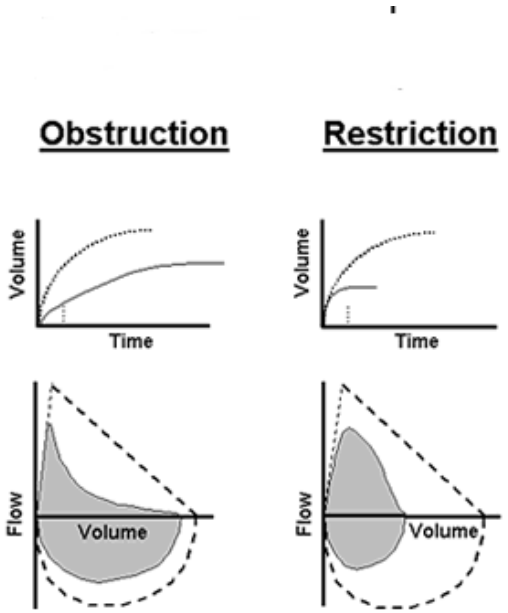
→ Collection of a sample of exhaled air into a refrigerate tube during a normal breathing

Variables

- **Spirometry**
  - Forced Vital Capacity (FVC)
  - Forced volume in one second of a FVC (FEV1)
  - FEV1/FVC



Normal



Variables

- **EBC**
  - Airway pH – acidity of the respiratory epitelium fluid

- **IAQ parameters (bedrooms and living rooms):**
  - Physical and chemical agents: CO_2, formaldehyde, TVOC, PM_{10} e $PM_{2,5}$
  - Microbiological agents: total bacteria and fungi

Results

- Age:
  - 81.9 ± 7.5 years
- Sex:
  - 70.6% of female
- Residence time
  - 5.6 ± 5.1 years
- Reported respiratory disease
  - 29,4%
- Spirometry
  - Mean values did not present statistically significant differences in relation to the fixed value defined as normal
- pH:
  - Mean value was compatible with airway acidity

Results

	n	Median [P_{25} –P_{75}]	Min-Max	p value[b]	> National References (%)	National References [a]
PM_{10} (µg/m³)						
Living room	84	43.0 [32.7-143.6]	13.1-3598.4	0.143	36.9	50 µg/m³
Bedroom	54	44.3 [14.2-91.6]	11.5-2148.5		77.8	
$PM_{2.5}$ (µg/m³)						
Living room	78	14.1 [13.1-75.9]	11.8-293.0	0.380	39.7	25 µg/m³
Bedroom	53	14.6 [13.7-45.0]	13.0-535.6		43.4	
TVOC (µg/m³)						
Living room	85	84.8 [70.0-217.5]	60.8-331.6	0.162	0	600 µg/m³
Bedroom	55	113.1 [76.7-336.1]	48.0-661.4		1.9	
Formaldehyde (µg/m³)						
Living room	85	14.0 [10.0-20.0]	8.0-54.0	0.512	0	100 µg/m³
Bedroom	55	17.5 [10.0-24.0]	8.5-40.0		1.8	
CO (ppm)						
Living room	85	0 [0-0.2]	0-7.0	0.018	0	10 ppm
Bedroom	55	0.1 [0-0.6]	0.0-1.8		0	
CO_2 (ppm)						
Living room	85	947.0 [842.0-1146.0]	700.0-2626.0	0.088	36.6	1250 ppm
Bedroom	55	1178.0 [975.0-1326.0]	642.0-1813.0		36.4	
Bacteria (CFU /m³)						
Living room	85	414 [304.0-568.0]	106.0-1464.0	0.207	60.0	Indoor < outdoor + 350CFU/m³
Bedroom	54	348 [250.0-672.0]	64.0-10512.0		38.9	
Fungi (CFU /m³)						
Living room	85	314 [212.0-472.0]	58.0-10512.0	0.518	28.2	Indoor < outdoor
Bedroom	52	316 [228.0-430.0]	52.0-2212.0		38.5	

[a] Law 353-A/2013, of December 4th

[b] Mann-Whitney test

CO: carbon monoxide; CO_2: carbon dioxide; CFU: colony-forming unit; $PM_{2.5}$: fine particles with an aerodynamic diameter smaller than 2.5 µm; PM_{10}: particles with an aerodynamic diameter smaller than 10 µm; TVOC: total volatile compounds.

Results

	Crude odds ratio (95% CI)	$\hat{\beta}$ (95% CI)
%FVC		
Total bacteria	-0.51 (-0.86 to 0.16|); p=0.004	-0.53 (-0.87 to -0.20); p=0.002[a]
Respiratory disease		
%FEV_1/FVC		
Bactérias	0.23 (0.07 to -0.39); p=0.004	0.22 (0.08 to 0.37); p=0.003[b]
pH		
$PM_{2.5}$	-0.04 (-0.01 to -0.001); p=0.003	-0.04 (-0.06 to -0.01); p=0.002[c]

%FVC: percentage of the predicted value for forced vital capacity; %FEV_1/FVC: ratio between FEV_1 and FVC; $PM_{2.5}$: fine particles with an aerodynamic diameter smaller than 2.5 μm;

The regression coefficient estimate considers an increase of 10 $\mu g/m^3$ for $PM_{2.5}$ and of 100 CFU/m^3 for bacteria;

[a] Adjusted for respiratory disease
[b] Adjusted for age, respiratory disease, exposure to dust in the workplace and smoke history
c Adjusted for age

- Exposure to bacteria was associated with a spirometry impairment, that suggest a restrictive ventilatory pattern

- Exposure to increased levels of $PM_{2,5}$ was related to higher airway acidity.

Results

- Exposure to bacteria was associated with a spirometry impairment, that suggest a restrictive ventilatory pattern

- Exposure to increased levels of $PM_{2,5}$ was related to higher airway acidity.

- Bacteria exposure is linked to inflammatory response and oxidative stress [25,26]
- Higher levels of inflammatory biomarkers are associated to the physiopathology of Pulmonary fibrosis [27]
- Exposure to $PM_{2,5}$ - inflammatory response [28]
- Airway pH is a biomarker of inflammation[29]

25. Karottki DG et al. “Indoor and outdoor exposure to ultrafine”. 2015
26. Faridi S et al. “Bioaerosol exposure and circulating biomarkers in a panel of elderly subjects and healthy young adults”. 2017
27. Johannson KA et al. “Air pollution exposure: a novel environmental risk factor for interstitial lung disease?”. 2015
28. Vossoughi M et al. “Air pollution and subclinical airway inflammation in the SALIA cohort study”. 2014
29. Hárvath H et al. “Exhaled breath condensate: methodological recommendations and unresolved questions”. 2005

Conclusion

- In terms of environmental pollutants' impact on respiratory markers, the results of this work point to a relation between the bacteria and $PM_{2.5}$ exposure and a higher respiratory vulnerability in older people

Limitations

- Unable to establish a causal relationship between environmental exposure and results observed in respiratory biomarkers
- The results are not representative of the elderly population

Futures research

- A longitudinal study concerning bacteria and $PM_{2.5}$ exposure:
  - Explore the exhaled breath condensate as a useful tool to identify more exposure biomarkers
  - Explore the restrictive pattern measuring the total lung capacity

THANK YOU FOR YOUR ATTENTION