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

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

Joana Belo
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
  - Cumulative environmental exposure
  - 90% of the time is in indoor spaces

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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**
- Without contraindications for the spirometry
- With apparent cognitive capacity to understand the specific manoeuvres
- 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 perform 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
Variables

• EBC
  • Airway pH – acidity of the respiratory epithelium fluid

• IAQ parameters (bedrooms and living rooms):
  - Physical and chemical agents: CO\textsubscript{2}, formaldehyde, TVOC, PM\textsubscript{10} e PM\textsubscript{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

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Median [P_{25} – P_{75}]</th>
<th>Min-Max</th>
<th>p value[^b]</th>
<th>&gt; National References (%)</th>
<th>National References[^a]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM_{10} (µg/m^3)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living room</td>
<td>84</td>
<td>43.0 [32.7-143.6]</td>
<td>13.1-3598.4</td>
<td>0.143</td>
<td>36.9</td>
<td>77.8</td>
</tr>
<tr>
<td>Bedroom</td>
<td>54</td>
<td>44.3 [14.2-91.6]</td>
<td>11.5-2148.5</td>
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<tr>
<td><strong>PM_{2.5} (µg/m^3)</strong></td>
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</tr>
<tr>
<td>Living room</td>
<td>78</td>
<td>14.1 [13.1-75.9]</td>
<td>11.8-293.0</td>
<td>0.380</td>
<td>39.7</td>
<td>43.4</td>
</tr>
<tr>
<td>Bedroom</td>
<td>53</td>
<td>14.6 [13.7-45.0]</td>
<td>13.0-535.6</td>
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<tr>
<td><strong>TVOC (µg/m^3)</strong></td>
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</tr>
<tr>
<td>Living room</td>
<td>85</td>
<td>84.8 [70.0-217.5]</td>
<td>60.8-331.6</td>
<td>0.162</td>
<td>0</td>
<td>1.9</td>
</tr>
<tr>
<td>Bedroom</td>
<td>55</td>
<td>113.1 [76.7-336.1]</td>
<td>48.0-661.4</td>
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<tr>
<td><strong>Formaldehyde (µg/m^3)</strong></td>
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<tr>
<td>Living room</td>
<td>85</td>
<td>14.0 [10.0-20.0]</td>
<td>8.0-54.0</td>
<td>0.512</td>
<td>0</td>
<td>1.8</td>
</tr>
<tr>
<td>Bedroom</td>
<td>55</td>
<td>17.5 [10.0-24.0]</td>
<td>8.5-40.0</td>
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<td><strong>CO (ppm)</strong></td>
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</tr>
<tr>
<td>Living room</td>
<td>85</td>
<td>0 [0-0.2]</td>
<td>0-7.0</td>
<td>0.018</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bedroom</td>
<td>55</td>
<td>0.1 [0-0.6]</td>
<td>0.0-1.8</td>
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<tr>
<td><strong>CO_2 (ppm)</strong></td>
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<td></td>
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</tr>
<tr>
<td>Living room</td>
<td>85</td>
<td>947.0 [842.0-1146.0]</td>
<td>700.0-2626.0</td>
<td>0.088</td>
<td>36.6</td>
<td>36.4</td>
</tr>
<tr>
<td>Bedroom</td>
<td>55</td>
<td>1178.0 [975.0-1326.0]</td>
<td>642.0-1813.0</td>
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<tr>
<td><strong>Bacteria (CFU/m^3)</strong></td>
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<td></td>
</tr>
<tr>
<td>Living room</td>
<td>85</td>
<td>414 [304.0-568.0]</td>
<td>106.0-1464.0</td>
<td>0.207</td>
<td>60.0</td>
<td>38.9</td>
</tr>
<tr>
<td>Bedroom</td>
<td>54</td>
<td>348 [250.0-672.0]</td>
<td>64.0-10512.0</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Fungi (CFU/m^3)</strong></td>
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<td></td>
</tr>
<tr>
<td>Living room</td>
<td>85</td>
<td>314 [212.0-472.0]</td>
<td>58.0-10512.0</td>
<td>0.518</td>
<td>28.2</td>
<td>38.5</td>
</tr>
<tr>
<td>Bedroom</td>
<td>52</td>
<td>316 [228.0-430.0]</td>
<td>52.0-2212.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[^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

<table>
<thead>
<tr>
<th>%FVC</th>
<th>Crude odds ratio (95% CI)</th>
<th>( \hat{\beta} ) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bacteria</td>
<td>-0.51 (-0.86 to 0.16); p=0.004</td>
<td>-0.53 (-0.87 to -0.20); p=0.002(^a)</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>%FEV(_1)/FVC</td>
<td>0.23 (0.07 to -0.39); p=0.004</td>
<td>0.22 (0.08 to 0.37); p=0.003(^b)</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM(_{2.5})</td>
<td>-0.04 (-0.01 to -0.001); p=0.003</td>
<td>-0.04 (-0.06 to -0.01); p=0.002(^c)</td>
</tr>
</tbody>
</table>

%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 µg/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$^{29}$

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