Occupational Exposure to Particles During Hotel´S Rooms Cleaning

Inês Costinha[1], Sofia Simões[1], Filipa Figueiredo[1], Susana Viegas[2]
[1]ESTeSL-IPL, Portugal; [2]Environment and Health RG - Lisbon School of Health Technology, Portugal

ABSTRACT
Background: The majority of studies investigated ambient particles, although in most industrialized countries people spend most of their time indoors and significant emissions of fine and ultrafine particles leading to human exposure are caused by various indoor tasks, including cleaning tasks. **Objective:** To characterize the occupational exposure to particles during cleaning of hotel´s rooms. **Methodology:** Measurements of mass concentration and particle number concentration were performed before and during cleaning tasks in two rooms with different floor types (wood and carpet) with the equipment Lighthouse, model 3016 IAQ. **Results**: Considering mass concentration, particles with higher mass were responsible for higher levels of contamination, particularly PM5.0 and PM10.0. However, considering the particle number concentration, the smaller particle size (0.3 mμ) obtained the higher values. **Conclusion:** It was observed higher number of particles of the smaller size in all tasks, which is associated with worse health effects. It was observed that the room with wood in the floor has lower values when compared to the room with carpet. The tasks with greater exposure were the "vacuuming" and "clean up powder".

KEYWORDS: Particles, Occupational Exposure, Cleaning Tasks, Hotel Room

1. INTRODUCTION
People live and work most of the time indoors, where air circulation can be insufficient and produce an accumulation of pollutants, often harmful to health (Sodré et al., 2008).
Exposure to particles is linked to increased morbidity and mortality with over a million premature deaths worldwide. There is a clear link between particles and cardiovascular diseases as well as allergic and inflammatory conditions of the lung (Kim et al., 2006; Brook et al., 2010).Significant emissions of fine and ultrafine particles leading to human exposure are caused by various indoor tasks, including cleaning tasks (Afshari et al., 2005). Recently, there are some studies supporting that size distribution and particle number concentration may have advantages over particle mass concentration for assessing the health effects of particles (Viegas et al., 2014).
This study aimed to characterize the occupational exposure to particles during the cleaning of hotel rooms and to compare exposure between two rooms with different floor types (wood and carpet).

2. MATERIAL AND METHODS
The study was conducted in a hotel located in Lisbon, Portugal. For the study were chosen two bedrooms. They were constituted by a WC, wood furniture (bed, two bedside tables, a support desk and a desk) and a window. The rooms had different floor types: carpet in room 1 and wood in room 2. The rooms in which were made measurements were vacated on the same day (check-out).
Particles measurements
On March 07, 2015 were carried out measurements in the morning period in room 1 and in the afternoon in room 2.
Measurements were done with the window closed and before there were any cleaning operations. Measurements continued, but this time with the window open and during the following tasks: "remove waste", "remove bed linen"; "clean up WC", "make bed"; "clean up powder" and "vacuuming".
Measurements of PM were performed using a portable direct-reading equipment - Lighthouse, model 3016 IAQ – that gives information regarding mass concentration in 5 different sizes ($PM_{0.5}$, $PM_{1.0}$, $PM_{2.5}$, $PM_{5.0}$, $PM_{10.0}$) and the particle number concentration by each diameter size (0.3μm, 0.5μm, 1.0μm, 2.5μm, 5.0μm, 10.0μm). All the measurements were conducted continuously with the duration of 5 minutes near the worker nose and during each task performance. The cleaning process in each room took on average 50 minutes. An outdoor reference sample was also performed. Data were analyzed using Microsoft Office Excel spreadsheets, by task and by room.

3. RESULTS AND DISCUSSION
Values of the mass concentration in the room 1 were higher in all the particles sizes than room 2 (Figure 1). Outdoor values were lower than those obtained in Room 1 when the window was closed and without cleaning tasks (A). In relation to Room 2, the values were lower than those of the Outdoor as regards $PM_{10.0}$ and $PM_{5.0}$; and values were higher than of the Outdoor as regards $PM_{0.5}$; $_{1.0}$ and $_{2.5}$; when measuring with the window closed and without task (A'). As expected the highest values belong to $PM_{10.0}$ in both Rooms. In Room 1, the higher values were related to the tasks: "vacuuming" ($3.10x10^{-1}mg/m^3$), "clean up powder" ($2.38x10^{-1}mg/m^3$) and "remove waste" ($2.37x10^{-1}mg/m^3$). In Room 2 the highest values were on the tasks: "clean up powder" ($1.89x10^{-1}mg/m^3$), "remove bed linen" ($1.88x10^{-1}mg/m^3$) and "make bed" ($1.34x10^{-1}mg/m^3$).

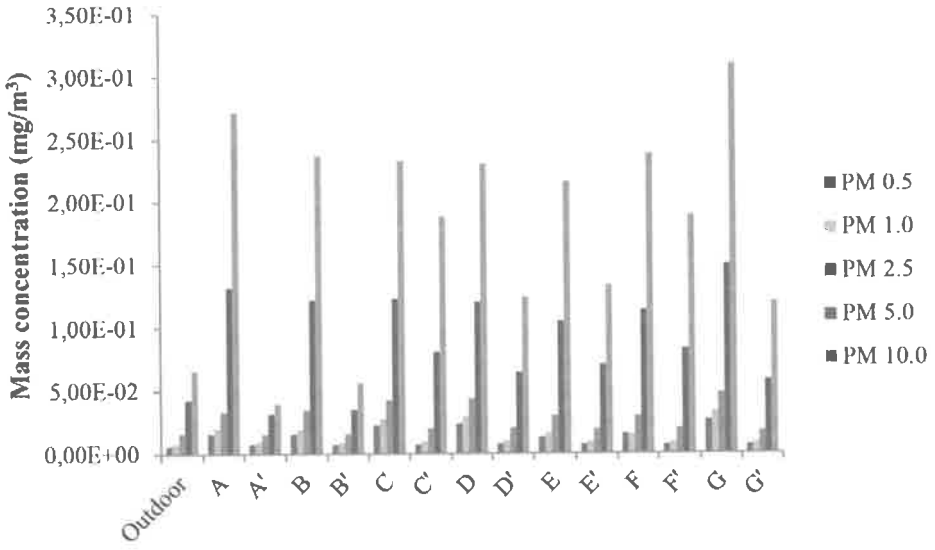

Figure 1 - Particles distribution in Outdoor, Room 1 and Room 2 in the different cleaning tasks.
Cleaning tasks: A and A '- "Without cleaning tasks and closed window"; B, B' – "remove waste"; C, C' – "remove bed linen"; D, D' – "clean up WC"; E, E' – "make bed"; F, F' – "clean up powder" and G, G' – "vacuuming".
Room 1 – A, B, C, D, E, F, G. Room 2 – A', B', C', D', E', F', G'

Regarding particle number concentration, 0.3µm size had the higher values in the rooms and in outdoor. In this particle size the tasks with higher counts were: "vacuuming" with $7.53x10^4$; "clean up WC" with $6.67x10^4$ and "remove linen" with $6.27x10^4$ in room 1. In room 2 were: "clean up WC" with $2.11x10^4$; "remove waste" with $1.98x10^4$ and "remove bed linen" with $1.97x10^4$.

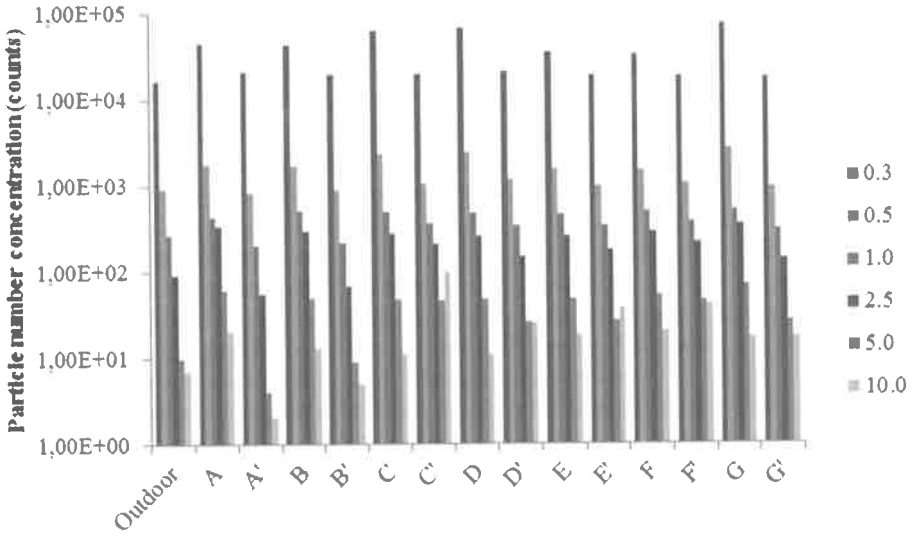

Figure 2 - Particle number concentration (counts) in Outdoor, Room 1 and Room 2 in the different cleaning tasks.
Cleaning tasks: A and A '- "Without cleaning tasks and closed window"; B, B' – "remove waste"; C, C' – "remove bed linen"; D, D' – "clean up WC"; E, E' – "make bed"; F, F' – "clean up powder" and G, G' – "vacuuming".
Room 1 – A, B, C, D, E, F, G Room 2 – A', B', C', D', E', F', G'

In general, in the room 1 was found greater values of mass concentration and number of particles, probably due to room's typologies, since room 1 has carpet and this can the reason of this difference. Additionally, in the room 1 the task with higher values was the "vacuuming", while in the room 2 was the "clean up powder", following by "clean up WC". These tasks probably lead to the resuspension of particles coming essentially from the floor (carpet), but also from furniture and cleaning products being used (Corsi et al., 2008).
Particles toxicity depends on its size, its constitution (U.S. EPA, 2005; Fromme, 2012), duration and frequency of exposure and individual susceptibility (Kim et al., 2006). Smaller the size greater the level of penetration in the organism (Brook et al., 2010) so, the fine and ultrafine particles may enter directly into blood circulation (Brook et al., 2010). Thus, the protective measures to be implemented should focus on the tasks that have greater exposure to the smaller particles.

Similar to others studies, in this study was also observed higher particle contamination indoors than in the outdoor probably due to the tasks being developed indoors and also due to the higher dispersion that occurs outdoor (Chao et al., 1998; Jones et al., 2000).

4. CONCLUSION

Considering the obtained results additional studies should be done in this setting, with a bigger sample of rooms, with different room occupancy, in different seasons in order to determine if there is influence of temperature and humidity. It is also important to mention that particles should be characterized regarding their chemical and biological composition to perform more detail and accurate risk assessment.

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