Intervention reducing particle exposure in Homes of 50+ year olds

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SUMMARY
An intervention reducing particle exposure was conducted in 27 apartments of 50+ year olds in Denmark. Two recirculating particle filtration units were installed in each apartment. They operated for two weeks in active filtration mode and for two weeks in sham mode in a randomized cross-over design. The intervention resulted in 54% reduction of PM₂.₅ (median value) and 47% reduction of modified average concentration of UFP. Improved microvascular function was associated with actual PM₂.₅ reduction, suggesting a positive effect of filtration at substantial exposure contrasts.

PRACTICAL IMPLICATIONS
Exposure to particles in indoor air is a serious global problem with strong impact on health. Filtering recirculated air may reduce exposure to both particles originating from outdoor and indoor sources.

KEYWORDS
Recirculation, PM₂.₅, ultrafine particles, cardiovascular diseases

1 INTRODUCTION
Exposure to particles in air is a serious global problem with strong impact on health (Ruckerl et al. 2011). In developed regions like Denmark people spend 80-90% of their lives indoors but there is still uncertainty concerning the importance of particle exposure inside the home. Indoor exposure may be reduced by filtering the particles originating outdoors from the supply of outdoor air. This already happens in most ventilation systems with mechanical air supply and the supply filter efficiency is a key parameter. Filtering recirculated air may reduce exposure to both outdoor and indoor sources.

The purpose of this paper is to present ways to reduce indoor exposure, investigate the important parameters for effectiveness of recirculation and document the impact of filtering the particles from indoor air in Danish homes.

2 MATERIALS/METHODS
The study was conducted in 27 dwellings located in Greater Copenhagen area, Denmark, close to heavily trafficked roads. It included 48 non-smoking subjects in the age group 51-81 years, who were spending much time in their home. Because of their age it was assumed that their cardiovascular function was particularly sensitive to particle exposure. The study was a four-week intervention with randomised and double-blinded cross-over design. Sham and active filtering periods was implemented without informing subjects and research partners responsible for quantification of vascular function. Each period lasted two weeks.
During the active filtering period, the air was recirculated through particle filtration units (PFU) with HEPA filter. In sham filtration periods, the filter was substituted with a sham filter made from a perforated plate. The details are given in Spilak et al. (2014a,b). Two PFU were installed in each apartment, one on living room and one in bedroom. The measurements included mass concentration of PM$_{2.5}$ and number concentration of ultrafine particles (UFP), relative humidity, air temperature and concentration of CO$_2$, NOx, ozone, air change rate and re-circulating air change rate. Information about dwelling characteristics and occupant behaviour was collected by inspector-answered and occupant-answered questionnaires as well as occupant-answered diaries. Microvascular and lung function as well as number of biomarkers in blood were measured to assess the impact of the intervention on health (Karottki et al. 2013).

3 RESULTS
Median PM$_{2.5}$ concentrations were 7.3 µg/m$^3$ in living room and 8.1 µg/m$^3$ in bedroom during sham filtration. A significant reduction to 4.2 µg/m$^3$ was achieved in both rooms during active filtration. Larger area per person was associated with lower PM$_{2.5}$ concentrations for both scenarios and both rooms. The best particle-removal efficacy was obtained for a high ratio of recirculation rate to air change rate (Spilak et al. 2014a).

Somewhat less impressive but still significant reduction of median UFP concentrations were achieved from 7669 /cm$^3$ during sham filtration to 5358 /cm$^3$ during active filtration. The calculated average removal rate of UFP concentrations during active filtration was 1.7h$^{-1}$ and 0.47 h$^{-1}$ for sham filtration. Higher outdoor air change rate was shown to help to reduce UFP peaks caused by human activities, while it increased the indoor UFP concentrations significantly in the absence of strong indoor sources (Spilak et al. 2014b).

There was no significant effect of the intervention status on microvascular and lung function. Microvascular function was however significantly associated with significant PM$_{2.5}$ decrease, particularly among subjects not taking any drugs (Karottki et al. 2013), suggesting that positive effects of filtration require substantial exposure contrasts.

4 CONCLUSIONS
Particle exposure in homes may be reduced by functional devices and installations. This may give health benefits to occupants.

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5 REFERENCES