Effect of room air cleaner on exposure and human responses - a case study

Nordic Ventilation Forum Online

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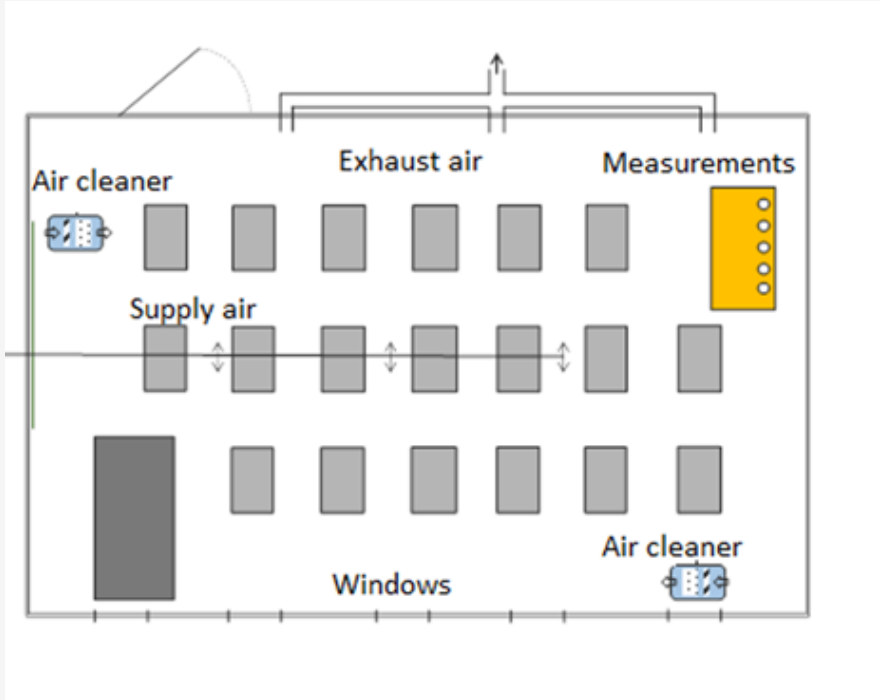
Motivation for the study

Aims of the study

- PUHHO study aimed to :
  - assess the effect of air cleaners on particulate matter, volatile chemicals and indoor microbiota in occupied Finnish classrooms
  - explore associations of air cleaner operation with pupils' symptoms.
  - ➢ Provide 'real-world' research data on the efficiency of air cleaners on different indoor air impurities and perceived health.

Implementation of the study 1/2

- The study was conducted during one school year in 18 classrooms of six elementary schools.
- Two units of the same type of air cleaner in each classroom with moderate airflow (200 - 400 m^3/h)

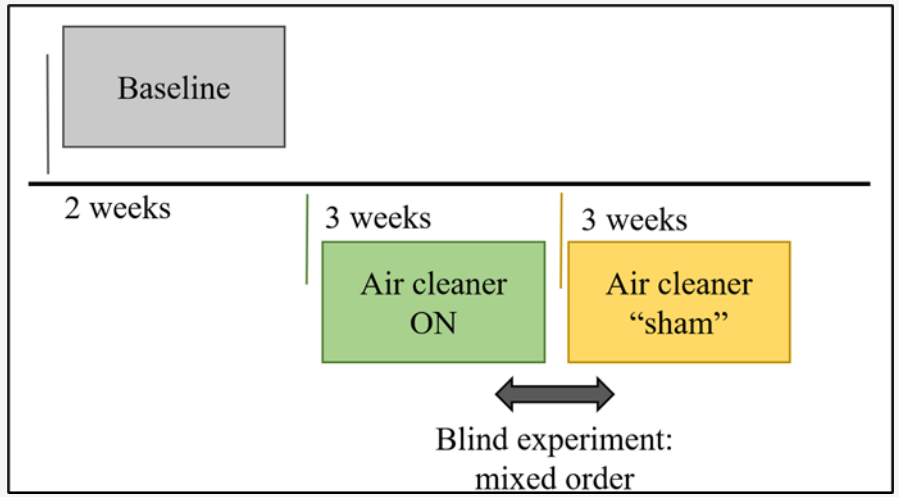


A layout of the placing of sampling devices and air cleaners in the classroom

Implementation of the study 2/2

- Study design:

two weeks without air cleaner, three weeks with air cleaner in regular operation and three weeks in sham operation (air cleaner circulating air without filtration).



Type of air cleaners

- Three different air cleaner model was used in the study.
- Technologies: HEPA, activated carbon and electrostatical precipitator.

Air cleaner	Filters used	Airflow	Sham operation
P1	Pre-filter, activated carbon (4 kg), HEPA (E11)	200 m^3/h	Removal of activated carbon and HEPA filters.
P2	High voltage accumulator, collector electrode, activated carbon (800 g)	230 m^3/h	Removal of collector voltage and activated carbon.
P3	Pre-filter, HEPA (H14), activated carbon (400g)	420 m^3/h	Removal of activated carbon and HEPA filters.

Filters used in different air cleaner models, airflow and how sham operation was performed

Methods 1/2

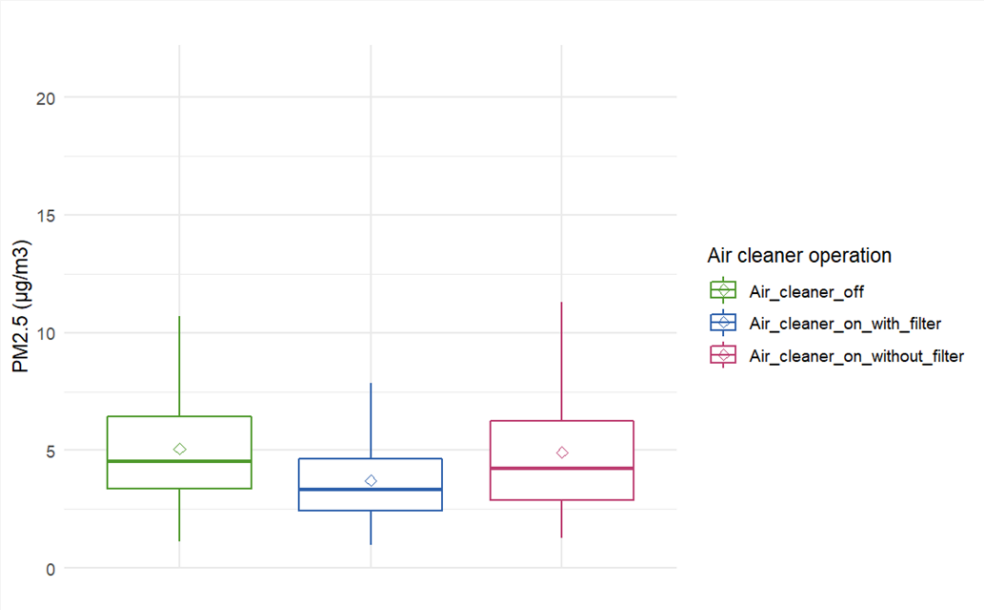
- Analysis of particulate matter
  - To evaluate the variation of PM_{10} and $PM_{2.5}$ levels during interventions, their mass fractions were measured continuously with optic small device (DustTrak DRX 8533).
- Volatile organic compounds were measured once a week during 90 min of school day on Tenax TA/Carbograph 5 TD absorption tubes with the airflow of 100 ml/min from each classroom and from outdoor air on the school yard.

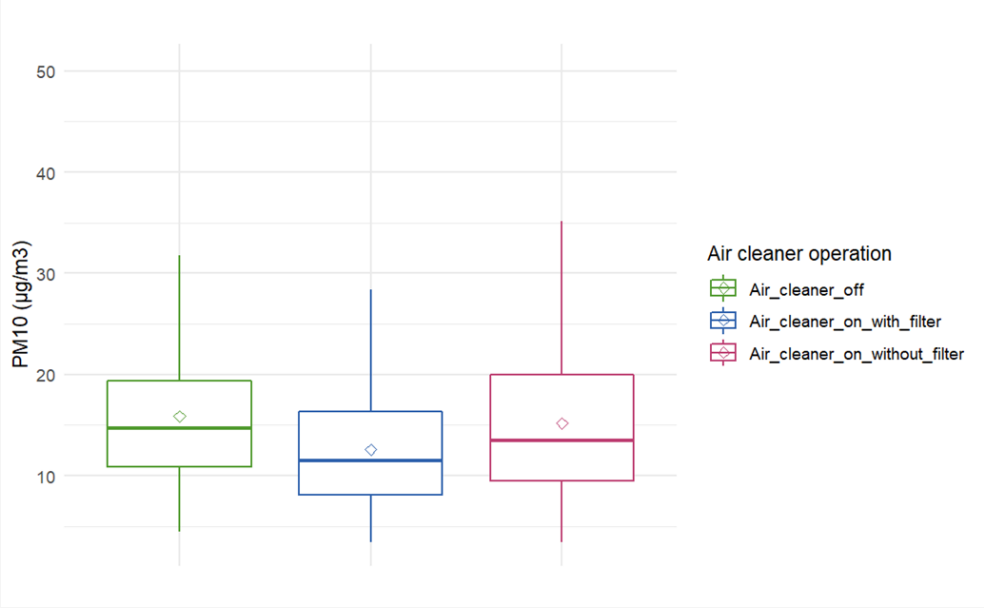
Methods 2/2

- Microbial measurements
  - settled dust samples.
  - active air sampling during school hours.
    - qPCR analyses
  - Symptom reporting:
    - pupils filled daily diary during school days throughout three study periods.
    - Lower/upper respiratory and general symptoms.

Results on particulate matter

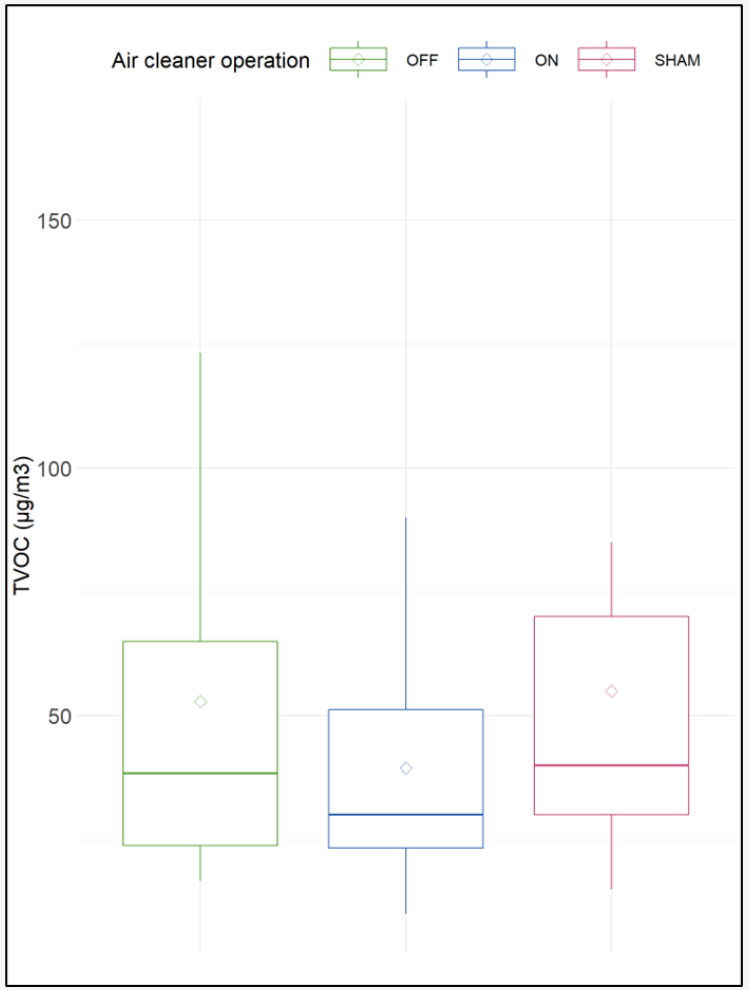
- For operating with filter, the mean difference between measured and expected $PM_{2.5}$ levels was 28% and for sham operation 6% compared to baseline.
- For PM_{10} levels, when operating with filter, the difference was 29% and for sham operation 0.2% compared to baseline.
- The changes were not statistically significant.





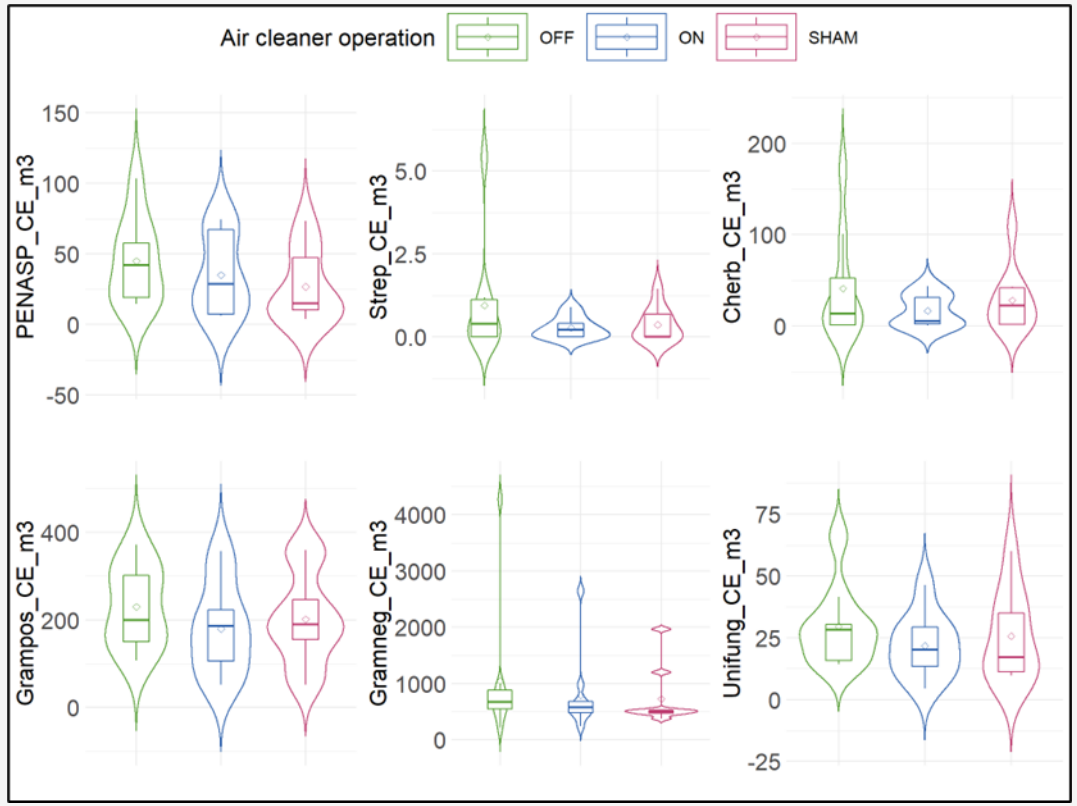
Results on VOCs

- A statistically non-significant decrease (25%) of TVOC levels was observed when comparing the regular air cleaner operation to the baseline.
- With sham operation, a tiny (4%) increasement was determined when compared to the baseline.



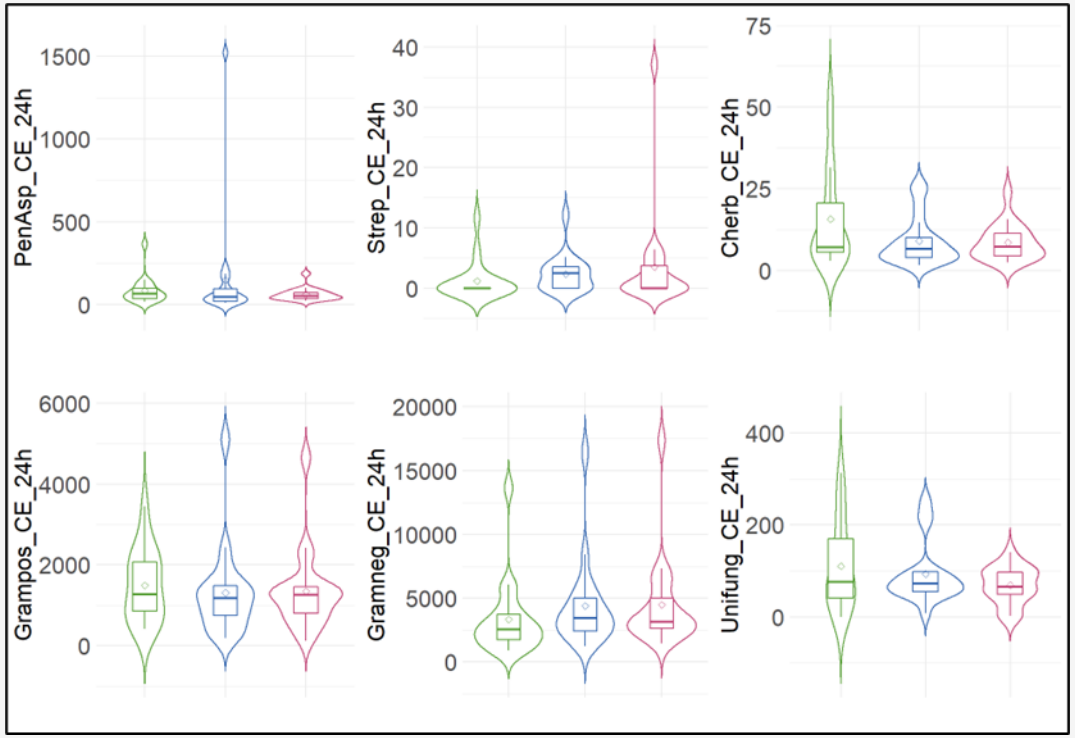
Results on microbes in air samples

- We found non-significant decreases (22–71%) in levels of microbial groups in air samples, when normal filtering was used.
- Also sham operation was associated with decreased microbial levels similarly or even more, compared to baseline, in most cases.



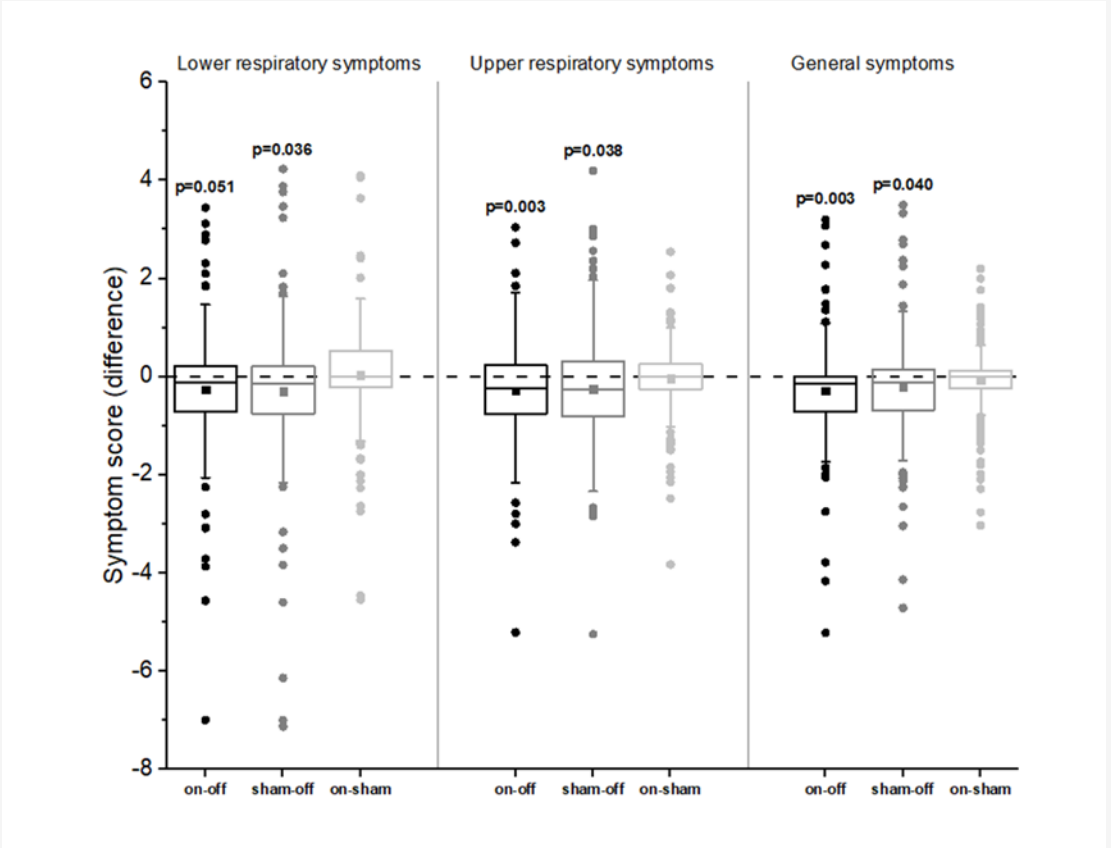
Results on microbes in settled dust

- For settled dust samples, differences between air cleaner operation status were inconsistent and statistically non-significant between microbial groups.



Results on symptom reporting

- Filtration by air cleaners reduced upper respiratory tract symptoms (5%; p=0.051). Lower respiratory tract (4%) and other more general symptoms (5%) were reduced statistically significantly.
- No differences between regular air cleaner operation with filter and sham-operation.



Conclusions

- The study does not show significant impact of air cleaner operation with the used CADR on indoor volatile chemical, particle or microbial levels, though moderate reduction during both sham and actual filtration operation was observed compared to baseline measurements.
- The finding that both sham and filtration operation of air cleaners were associated with reduced symptom reports of the pupils should motivate follow-up investigation.

Thank you for your attention!

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