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Studying performance of mobile air cleaning devices in classrooms: a pilot study comparing two passive bio-aerosol sampling methods

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Introduction:
Application of mobile air cleaning devices (MACs) in schools has been put forward as a potential control measure to limit and/or prevent respiratory virus outbreaks through reduction of viral concentrations in air. However, evidence on the effectiveness of air cleaning technologies on viral levels in general, and in schools specifically is lacking. Exploring airborne viral exposure levels is a challenging task which is further complicated by the realities of sampling in active and dynamic classrooms. .Therefore, we compared applicability of two passive bio-aerosol sampling methods in a pilot study on performance of air cleaning devices.
Methods:
Five Dutch primary schools were enrolled in a randomized cross-over study during October till end December 2023. The study included 45 classrooms equipped with three different types of MACs and included 15 control classrooms with no MACs installed. MACS were operational for three weeks and switched off for three weeks during the study period. In each classroom bio-aerosol air samples were passively collected during each of these three week periods. A regular sized electrostatic dustfall collector (EDC) and a smaller electrostatic cloth in a petridish (miniEDC) were applied. Both sample types were placed side by side into a box hung 30cm below the ceiling of the classroom. Human viruses (respiratory syncytial virus A (RSV A), influenza A and B) and bacterial markers representing various origin niches were determined by qPCR. The latter included total bacteria (16S rRNA), S. salivarius (oral), S. aureus (skin and upper respiratory tract), M. catarrhalis (upper respiratory tract) and S. epidermidis (skin). Differences in microbial levels between EDC and miniEDC, and associations between microbial levels and operational status of MACs (for classrooms equipped with MACs) or sampling order (for control classrooms) were explored.
Results:
Levels of viral and bacterial markers were generally low, often below the limit of quantification of the respective qPCRs, except for total bacteria which was measurable and quantifiable in all in EDC and miniEDC samples. Total bacterial (16SrRNA) yield was higher for EDCs than miniEDCs. Of the viral markers influenza A and B were not detected in any of the samples, whereas RSV A was detected in 60% and 65% of EDC and miniEDC samples, respectively. Detection levels of S. salivarius, S. epidermidis, S. aureus and M. catarrhalis ranged between 60-90% for EDC and between 40-80% for mini EDC samples, showing generally higher probability of detection in EDC samples. A trend of lower bacterial and viral detection was observed with MACs on compared to with MACs off. While these findings suggest a potential reduction in microbial load, the statistical significance of the observed differences remains uncertain due to the limited sample size. Also, detection of bacterial and viral markers in control classrooms varied between sampling periods.
Conclusion:
MiniEDCs take up less space and are more easy to handle in the laboratory, but showed to be less sensitive than regular EDCs. Passive bio-aerosol sampling with EDCs can be a useful tool to study the impact of MACs on microbial levels in future large-scale studies, as they are cost effective and easily implemented. Natural variation of bacterial and viral levels over time should be taken into consideration when designing such a study, favoring a randomized controlled trial with classroom as the randomization unit.

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