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Evaluation of the effectiveness of in-room portable high-efficiency particulate air (HEPA) air purifiers in improving indoor air quality (IAQ) in School setting.

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Abstract

The Illinois School Indoor Air Quality Impact Study is a collaborative initiative funded by SHIELD Illinois, the University of Illinois System's initiative that brought innovative saliva-based COVID-19 testing to K-12 schools and later transitioned to assisting schools with other preventative measures. The collaboration involves the Illinois Department of Public Health (IDPH), the University of Illinois Chicago (UIC), and Illinois Institute of Technology (IIT). The project aims to evaluate the effectiveness of in-room portable high-efficiency particulate air (HEPA) air purifiers in improving indoor air quality (IAQ) in pre-K through 6th-grade classrooms in Illinois, which were provided to public schools by the IDPH in 2023.

The team has recruited 3 schools in each of urban, suburban, and rural areas that received air purifiers through this program and have agreed to long-term indoor monitoring in their classrooms. In each school, at least two classrooms of the same grade, size, and student population were selected for monitoring, including at least one with an air purifier and at least one without an air purifier. In each of these classrooms (with and without an air purifier), a low-cost IAQ monitor (Atmocube, Atmo, USA; capable of measuring PM1, PM2.5, PM4, PM10, CO2, VOCs, noise, temperature and relative humidity) and a plug load data logger (HOBO UX120, Onset Corp, USA) were deployed to monitor IAQ conditions and air cleaner power operation patterns throughout the school year (target: 12 months). In a more limited number of schools, two Protector 2 Pro (Naneos, Switzerland) monitors, measuring particle number concentrations (PNC) and size distribution in the range of 10-300 nm, one in a classroom with air purifier and one in a classroom without air purifier, were also deployed for a shorter duration (target: 3 months). For this conference, we will present the PNC and PM mass concentration data from two schools, namely schools A and B, located in an urban area.

Preliminary data from School A and School B provide insightful comparisons regarding the impact of air purifiers on air quality. In School A, on weekdays, classrooms with air purifiers ("With AP") had a significantly lower mean PM2.5 concentration of 1.95 μg/m³ compared to classrooms without air purifiers ("No AP"), which had a mean PM2.5 concentration of 3.78 μg/m³. Outdoor PM2.5 levels averaged 5.09 μg/m³ on weekdays, with a maximum observed value of 44.7 μg/m³. The maximum PM2.5 levels in classrooms with air purifiers reached 8.2 μg/m³, while those without air purifiers were significantly higher, peaking at 13.0 μg/m³. On weekends, when air purifiers are assumed to be turned off (plug load data logging is still ongoing and not all data have been retrieved yet), the mean indoor PM2.5 level in classrooms without air purifiers dropped to 2.79 μg/m³, and outdoor levels increased to 7.59 μg/m³, with a maximum of 52.0 μg/m³.

Similarly, School B showed trends supporting the effectiveness of air purifiers. On weekdays, classrooms with air purifiers maintained a mean PM2.5 level of 0.98 μg/m³, while this concentration remained almost

unchanged in classrooms without air purifiers (a mean of 1.01 μg/m³). Outdoor levels averaged 11.51 μg/m³, with a dramatic maximum of 415.4 μg/m³. The maximum observed PM2.5 levels in classrooms with air purifiers was 5.7 μg/m³, while those without air purifiers reached 14.7 μg/m³. On weekends, the levels in classrooms without air purifiers dropped to 0.47 μg/m³, while outdoor PM2.5 levels were 3.35 μg/m³, with a maximum of 35.4 μg/m³. On weekends, a noticeable decrease in indoor PM2.5 levels is observed.

These data underscore the significant role that air purifiers can play in maintaining cleaner indoor air during school hours, especially in environments with higher outdoor pollutant levels. Nevertheless, a proper comparison of the PM and UFP concentrations in classrooms with and without air purifiers will be conducted when data from plug load loggers are available indicating the period when the air purifiers were in operation and their setting level.

In addition to analyzing real-world classroom conditions, a laboratory study is underway to replicate typical classroom activities (e.g., painting, gluing, use of printers, and microwaves), which are known to be the source of ultrafine particles (UFPs) in schools. This lab study aims to explore how the air purifiers currently being utilized in schools in IL might influence the UFP concentrations and their size distributions. We will continue data collection and data analysis until the conference and will present our final conclusion on the effectiveness of the air purifiers in schools A and B.

Findings from this study will guide public health strategies and policies to enhance air quality in schools, ensuring a healthier learning environment for all.

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