Utilization of ventilation systems to maintain selected environmental comfort parameters at the required level

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SUMMARY

In recent times, society has become increasingly aware of potential health problems associated with indoor environments. This is particularly important when considering young children, whose immune systems are not fully developed. Additionally, indoor air quality is influenced by outdoor air quality, which is often poor in many areas, especially in urbanized areas. This article presents the results of research on selected environmental comfort parameters conducted in preschool classrooms located near busy roads. Each preschool classroom has an independent ventilation system managed by childcare providers. The article focuses on microbiological indicators of air quality (the general count of mesophilic bacteria, the general count of psychrophilic bacteria, the count of Staphylococcus (*Staphylococcus*) mannitol positive (type α) and mannitol negative (type β), the count of *Pseudomonas fluorescens* bacteria, actinomycetes (*Actinobacteria*), physical parameters (temperature, relative humidity, suspended particles), and chemical parameters (carbon dioxide and radon concentrations). Our analysis indicates that when the ventilation system in the building is consciously operated, it ensures the maintenance of the analysed parameters at an acceptable level. The main sources of microbial air pollutants in indoor environments are the buildings themselves, including the people inside them. The use of the ventilation system has led to an improvement in the physical property of the air, but did not significantly improve its microbiological quality.

KEYWORDS

preschool, air quality, microbiological contamination, ventilation installation

1 INTRODUCTION

According to studies on environmental air quality (IEQ), both microbiological contaminations and physical and chemical conditions (temperature, humidity, dust and gases) can have a significant negative impact on human health, comfort and productivity (Bragoszewska et al., 2018; Al Horr et al., 2016; Asadi et al., 2017; Niu et al., 2022). The quality of environment air depends on, in addition to the building technical state, the quality of the air outside the building, indoor contaminant sources, and a way to control the air flow in the room. Well-designed ventilation systems can improve the quality of the indoor environment, but if they are used without adequate knowledge, we may experience a periodic deterioration of IAQ.

2 METHODOLOGY

Air samples were collected in the selected rooms of the preschool and outdoor in the vicinity of the buildings. We present results of measurements of microbiological and chemical parameters that were conducted in one day in March 2024. The measurements were carried out in a room with a volume of 168 m^3, where on the day of the measurements there were 11 children and two caretakers.

The measurement devices for the physical and chemical parameters were placed at a height of approximately 150 cm above the floor. The microbiological parameters of the measurement devices were placed 1.5 m above floor level in the middle of each room and 1.5 m above the ground level for outdoor air samples. We analysed the air samples for the following microorganisms: mesophilic bacteria on nutrient agar, psychrophilic bacteria on nutrient agar, mannitol-positive (M+) and mannitol-negative (M–) *Staphylococcus* on Chapman medium, *Actinobacteria* on Pochon medium, *Pseudomonas fluorescens* on King B medium and identification of colonies in UV rays, as well as the total number of microscopic fungi on Czapek-Dox and Waksman medium (Basińska et al., 2019).

3 RESULTS

The purpose of the study was to check whether the design air stream supplied to a preschool room from a centralised supply and exhaust system could improve air quality.
Along with the measurement of CO_2, a microbiological assessment was carried out, the concentrations of which were related to the parameters of the outdoor air.
Figure 1 shows the change in CO_2 concentration over time on Friday 8 March 2024, which shows that after the supply and exhaust system is turned off and the children leave the room, the CO_2 concentration decreases to the value close to the outdoor air - stable condition.

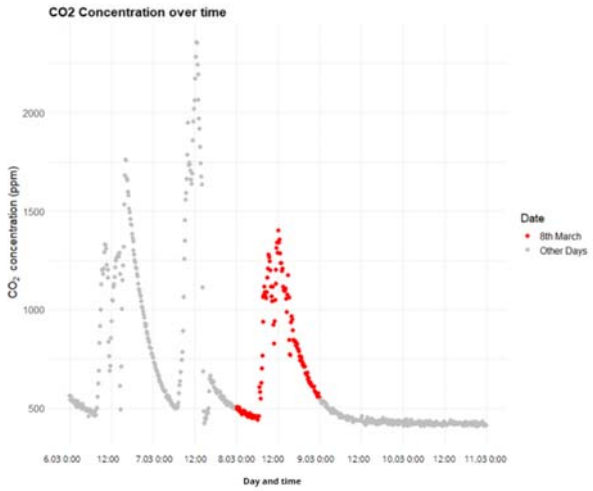

Figure 1: Change in CO_2 concentration over time

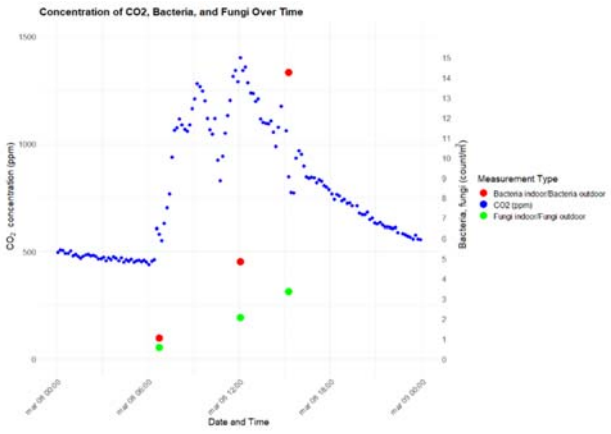

Figure 2: Change in CO_2 concentration and bacteria and fungi on march 8

Figure 2 shows the sum of bacteria and the average value of fungi from colonies grown on two media in relation to a given number of colonies in the outdoor air.
During the entire day of operation of the ventilation system, the CO_2 concentration is maintained at a satisfactory level. Microbiological measurements performed at 6:00 a.m., 12:00 p.m. and 5:00 p.m. indicate a significant increase in the concentration of microorganisms in the preschool room. The recorded maximum value for fungi is 1540 CFU/m^3 or for bacteria is 8560 CFU/m^3, both recorded for 3 pm. These values are significant compared to the measurements of other researchers in public buildings (Hayleeyesus et al., 2014) and close to the value of lecture rooms at the University of Poznań, however, these researchers did not record such large increases as we do (more than 10 times) in the number of bacteria in relation to the morning hour (Stryjakowska-Sekulska et al., 2007).

4 CONCLUSION

The use of the ventilation system has led to an improvement in the physical property of the air, but did not significantly improve its microbiological quality.
The high number of people per unit area of the room contributes to poor air quality in terms of microbiology, but reducing the number of children per unit area is not possible. It is possible that supplementing children's activity and play schedules with longer periods of time outdoors even in lower temperatures could have a positive impact on air quality. In our opinion, the most popular indicator of carbon dioxide concentration should be supplemented by the microbiological indicators i.e. the number of bacteria and fungi.

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