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Indoor air quality assessment through relationships between fungal and bacterial loads and physical parameters in primary school classrooms in Montevideo, Uruguay

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Exposure to bacteria and fungi in enclosed spaces for long periods of time has been associated with adverse health effects. Airborne fungi can cause lung disease and irritation of the mucous membrane and airborne bacteria are possible catalysts for conditions such as asthma, rhinitis and bronchitis. The issue of healthy educational buildings is a global concern because children are particularly at risk not only of lung damage and infection but also present a decreased cognitive performance and reduced productivity caused by poor indoor air quality (IAQ). In this study, the relationships between bacterial and fungal loads and physical parameters are sought in order to have a better understanding and offer alternatives that improve the IAQ in classrooms.

Four bacterial and fungal culture campaigns were conducted in 11 classrooms distributed in four schools in a humid subtropical climate zone like Montevideo, Uruguay during 2023-2024. Environmental parameters (outdoor temperature, relative humidity, season), ventilation and comfort parameters (indoor CO2, temperature and humidity, fungal and bacterial cultures) and other parameters (occupancy, open windows and doors, air-conditioning operation, buildings, among others) were taken during biological data collection periods. Microbiological sampling was carried out biannually (winter and spring), using air filtration by CAPTUS system (AravanLabs). The CFU (colony-forming unit) count for both fungi and bacteria was performed on samples taken from five classrooms across two different school shifts.

The Spearman correlation matrix, along with the Mann-Whitney and Kruskal-Wallis tests, were used to assess the correlation between bacterial and fungal loads and physical parameters.

There were significant correlations between bacterial loads and mean CO2 ($r = 0.30$, $p < 0.03$), and mean outside temperature ($r = -0.27$, $p < 0.05$) values. A significant difference was found between the bacterial count and a CO2 value of 800 ppm ($U = 196.0$, $p = 0.016$), reported by Morawska et al. 2024 as a threshold to maintain a low infection risk under standard classroom conditions. There is an increase in the average bacterial count of 56% in the winter season while only an increase of 9% is observed in the average fungal count compared to the values reported in spring. No significant differences were found between the biological counts and parameters such as building, season, and schedule (morning/afternoon) based on the Kruskal-Wallis test ($p>0.05$). Results highlight the importance of continuous monitoring of CO2, temperature, and relative humidity in schools as a simple yet effective mechanism that can be used to make various decisions that promote better IAQ in classrooms.

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