

Ventilation concepts in classrooms: Results of a long-term study in three elementary schools

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ABSTRACT

Indoor environmental quality, including temperature and indoor air quality, is essential for the comfort and health of occupants. Good indoor air quality is particularly important in frequently used spaces, such as classrooms, to reduce the spread of airborne infections. In this context an observational study was conducted to investigate the influence of ventilation concepts in real school operations on indoor environmental quality, health and energy efficiency. Three different ventilation concepts were compared: natural ventilation in combination with carbon dioxide (CO₂) traffic lights, mechanical ventilation with decentralized air handling units and a central ventilation system.

The randomized controlled trial lasted from October 2023 to April 2024 during the winter infection season. It involved the investigation of eight classrooms in three elementary schools in Germany with children in grades 2-4. One focus is on the impact of the ventilation concepts on comfort and health of the pupils. Therefore, questionnaires were used and saliva samples from pupils were collected to examine them for infection parameters. The second focus is on how the ventilation concepts affect indoor air parameters. For this purpose, a long-term monitoring over the entire study period was conducted. Various measurement data inside the eight classrooms and weather data for each school were recorded continuously.

This contribution focuses on evaluating the long-term monitoring inside the classrooms to assess indoor air quality and thermal comfort, also considering natural ventilation caused by open windows. The arithmetic mean values over 45-minute school hours during occupancy are compared across the entire study period. The CO₂ concentration can be used as an indicator for the indoor air quality. The lowest CO₂ levels are observed in classrooms with decentralized ventilation units, while the highest concentrations are measured in those with a central ventilation system. Classrooms with natural ventilation maintain acceptable values below 1000 ppm most of the time. However, regarding temperature, the lowest room temperatures occur for natural ventilation. The children's perception of temperature, recorded using a comfort questionnaire, shows similar results. This study comes to mixed findings for the mechanically ventilated classrooms, underlining the importance of proper operation of ventilation systems.

KEYWORDS

indoor air quality; schools; long-term monitoring; mechanical ventilation; natural ventilation