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School, Air and Health: Influence of ventilation concepts on health, well-being and comfort of schoolchildren

Submission date
27/10/2025

Recruitment status
No longer recruiting

Registration date
26/11/2025

Overall study status
Completed

Last Edited
26/11/2025

Condition category
Other

[_] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol

Background and study aims
Good indoor air quality is essential for children's health, comfort and ability to concentrate in school. Many classrooms are still ventilated by manually opening windows, which may not always provide enough fresh air and can be uncomfortable, especially in winter. Mechanical ventilation systems could improve air quality and reduce the spread of infections. The study aims to investigate under real-life school conditions how different classroom ventilation concepts influence indoor air quality, the occurrence of upper respiratory tract infections (URTIs), and pupils' comfort and well-being during teaching hours.

Who can participate?
Pupils aged 6 to 12 years, enrolled in the participating classes in the selected primary schools, take part voluntarily with parental consent.

What does the study involve?
The study takes place in three primary schools in Bavaria, Germany, and runs from October 2023 to April 2024 during the winter infection season. It is a controlled observational study with three groups. Three ventilation concepts are investigated: manual window airing, decentralised mechanical ventilation, and centralised mechanical ventilation. Window opening is possible in all three concepts.
Throughout the study, a continuous upper respiratory symptom survey is completed at home. At three timepoints (beginning, middle and end of the study) data are collected at school. Participating pupils complete short questionnaires about their comfort and well-being, and saliva samples are collected to analyse infection-related biomarkers. In addition, environmental parameters are measured at the three timepoints.
During the entire study period, long-term monitoring is performed to continuously measure environmental conditions such as CO2 concentration, temperature, humidity, particulate matter, and window opening states in classrooms, as well as ambient parameters at each school site.
The study does not change or manipulate the classroom ventilation systems; it only observes existing conditions under normal teaching operation.

What are the possible benefits and risks of participating?
The study helps to understand how classroom ventilation affects children's health, comfort and well-being and may contribute to healthier learning environments in schools.
Participation does not involve any medical treatment or intervention. The collection of saliva samples is non-invasive and harmless. The main potential disadvantage is the small amount of time needed for filling out questionnaires and providing samples during the school day. No financial or material incentives are provided for participation.

Where is the study run from?
Institute for Energy and Building, Technische Hochschule Nürnberg Georg Simon Ohm (Germany), with the expertise of Institute of Ecomedicine, Paracelsus Medical University (Austria)

When is the study starting and how long is it expected to run for?
October 2023 to April 2024

Who is funding the study?
The Federal Institute for Research on Building, Urban Affairs and Spatial Development on behalf of the Federal Ministry for Housing, Urban Development and Building with funds from the Future Building Research Funding

Who is the main contact?
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Study information

Scientific Title
Controlled observational study on the influence of different classroom ventilation concepts on health, well-being and comfort of schoolchildren (short title: School, Air and Health, German: Schule, Luft und Gesundheit; acronym: SLG)

Acronym
SLG

Study objectives
The study aims to investigate under real-life school conditions how different classroom ventilation concepts influence indoor air quality, the occurrence of upper respiratory tract infections (URTIs), and pupils' comfort and well-being during teaching hours.

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 13/09/2023, Joint Ethics Committee of the Universities of Applied Sciences of Bavaria (GEHBa) (Wileystraße 1, Neu-Ulm, 89231, Germany; +49 (0)731 9762 1625; antrag@gehba.de), ref: GEHBa-202307-V-119-R

Study design
Single-centre longitudinal controlled observational cohort study

Primary study design
Observational

Study type(s)
Prevention

Health condition(s) or problem(s) studied
Respiratory health, thermal comfort and well-being of primary schoolchildren in relation to indoor air quality and classroom ventilation conditions

Interventions
The study compares different classroom ventilation concepts as natural exposures affecting indoor air quality.

Three main ventilation types are observed under normal operating conditions:
1. Window airing
2. Decentralised mechanical ventilation (window airing is also possible)
3. Centralised mechanical ventilation (window airing is also possible)

No experimental manipulation is performed; the study observes existing systems and their effects on indoor air quality parameters, using long-term environmental monitoring, as well as on pupils' health, comfort and well-being, using questionnaires and saliva sample collection.

Intervention Type
Other

Primary outcome(s)
Occurrence and severity of upper respiratory tract infections (URTIs), measured using the Wisconsin Upper Respiratory Symptom Survey for Kids (WURSS-K) each time disease symptoms occur and until they have completely resolved.

Key secondary outcome(s))
At three timepoints (beginning, middle and end of the study; November 2023, January 2024, and April 2024) the following secondary outcomes are measured:
1. Well-being: assessed using the World Health Organization-Five Well-Being Index (WHO-5).
2. Perceived comfort and indoor air quality: assessed using a self-developed comfort questionnaire addressing thermal, acoustic, and air quality perception.
3. Salivary biomarkers of infection and immunity, measured using Luminex-ELISA:
3.1. Salivary C-reactive protein (sCRP)
3.2. Salivary Immunoglobulin A (sIgA)
4. Environmental parameters:
4.1. Negative ion concentration, measured using an air ion counter
4.2. Indoor air temperature, relative humidity, carbon dioxide (CO2) concentration, air velocity, measured using a universal indoor air quality instrument
4.3. Particulate matter (PM1, PM2.5, PM4, PM10) and dCn (P/cm3), measured using a portable fine dust measurement device
4.4. PM0.3 and lung-deposited surface area (LDSA), measured using a portable nanoparticle detector
4.5. Airborne microbial contamination, measured using an air sampler and agar strips for the determination of colony forming units (CFU)

During the entire study period, continuous monitoring is performed for indoor parameters in each classroom and ambient parameters at each school site:
5. Indoor parameters: Indoor air temperature, relative humidity, CO2 concentration, particulate matter PM2.5 and volatile organic compounds (VOC), measured using a multi-sensor measurement device
6. Window opening states, measured using window contact switches
7. Electrical power of decentralised air handling units, measured using an electrical current transformer
8. Meteorological parameters: ambient air temperature, relative humidity, air pressure, global solar radiation, wind speed and wind direction, measured using a multi weather sensor
9. Ambient particulate matter concentration PM2.5 and PM10, measured using a particulate matter sensor

Completion date

30/04/2024

Eligibility

Key inclusion criteria
1. Enrolment in one of the participating classes in the selected primary schools
2. Pupils aged 6–12 years
3. Voluntary participation following written informed consent from parents or legal guardians

Participant type(s)
Learner/student

Healthy volunteers allowed
No

Age group
Child

Lower age limit
6 years

Upper age limit
12 years

Sex
All

Total final enrolment
109

Key exclusion criteria
1. Lack of parental or guardian consent
2. Pupils who personally do not wish to participate

Date of first enrolment
01/10/2023

Date of final enrolment
20/11/2023

Locations

Countries of recruitment
Germany

Study participating centre
Michael-Ende-Schule Nürnberg
Michael-Ende-Straße 20

Nürnberg
Germany
90439

Study participating centre
Adalbert-Stifter-Grundschule Fürth
Oberfürberger Str. 46
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Germany
90768

Study participating centre
Grundschule Großenseebach
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91091

Sponsor information

Organisation
Technische Hochschule Nürnberg Georg Simon Ohm

Organisation
Paracelsus Medical University

ROR
https://ror.org/03z3mg085

Funder(s)

Funder type
Government

Funder Name
Federal Institute for Research on Building, Urban Affairs and Spatial Development on behalf of the Federal Ministry for Housing, Urban Development and Building

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available