

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	<input type="checkbox"/> Prospectively registered <input type="checkbox"/> Protocol
Registration date 26/11/2025	Overall study status Completed	<input type="checkbox"/> Statistical analysis plan <input type="checkbox"/> Results
Last Edited 26/11/2025	Condition category Other	<input type="checkbox"/> Individual participant data <input checked="" type="checkbox"/> 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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Additional identifiers

Clinical Trials Information System (CTIS)

Nil known

ClinicalTrials.gov (NCT)

Nil known

Protocol serial number

Nil known

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, PM_{2.5}, PM₄, PM₁₀) and dCn (P/cm³), measured using a portable fine dust measurement device
 - 4.4. PM_{0.3} 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 PM_{2.5} 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

Fürth

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90768

Study participating centre

Grundschule Großenseebach

Neue Str. 40

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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