Indoor air quality, temperature and cognitive performance

Published: 28-03-2024
Last updated: 29-04-2024

This study aims to examine the interactive effect of indoor air quality and temperature on human cognitive performance. The main research objective of this study is to examine how poor indoor air quality in terms of 900 ppm CO2 compared to 3,000 ppm...

Ethical review	Approved WMO
Status	Pending
Health condition type	Other condition
Study type	Interventional

Summary

ID

NL-OMON56702

Source
ToetsingOnline

Brief title
Aeolus

Condition

- Other condition

Synonym
thermal conditions, ventilation

Health condition

De cognitieve prestaties van gezonde deelnemers

Research involving
Human

Sponsors and support

Primary sponsor: Wählen
Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: CO2, Cognition, Temperature, within-subject

Outcome measures

Primary outcome

The main study parameters are the achieved scores of the cognition test, mainly derived from the CANTAB Cognition Test and the Cognitive Ability Task.

Secondary outcome

As secondary research objectives, it is additionally examined if humans perceive the air quality as less pleasant under the higher temperature, even if the air quality itself does not change in terms of carbon dioxide concentration. Also, the physiological reaction towards poor air quality and elevated temperature will be examined in isolation and interaction. Specifically, it will be investigated how these two factors affect the following physiological parameters: Capillary blood CO2 and pH level, salivary cortisol and alpha-amylase, blood cytokins serum concentration, lung function, heart rate, respiration rate, skin temperature, core temperature, blood pressure, physical activity, and metabolic rate.

Study description

Background summary

The indoor environmental quality of buildings has a profound impact on

occupants* cognition and health. Humans living in developed economies spend nearly 90 percent of their time indoors, either working, sleeping or following recreational activities. The indoor environment became an important factor with a large body of evidence emphasizing the strong impact buildings have on workers* productivity. Western economies shift their production capital more and more towards services, thus knowledge workers, who create value with their brain power, become an increasingly important production factor for these economies. Studies have shown that the indoor environment in school buildings has a strong effect on the academic performance of university students and pupils at school. Suboptimal indoor air quality and thermal environment hence may impair academic achievements, which can decrease human capital accumulation, earning potential and job market success later in life. Thus, real estate developers, architects and health scientists examined the effect the indoor air quality and indoor thermal environment have on human cognitive performance. Past research reveals that a low supply of fresh outside air into buildings lead to the accumulation of carbon dioxide and other air pollutants emitted by the occupants and the building environment itself. Mechanical ventilation is often not provided in buildings in Europe, especially for older buildings. It has been shown that humans sitting in insufficiently ventilated rooms show poorer cognitive performance than their counterparts sitting in rooms with higher ventilation rates. Additionally, evidence from literature shows that higher temperatures can also negatively affect human cognitive performance. In the last decades, more frequent, longer lasting and extremer heat waves have been recorded in Europe. Because only a small share of the office and school building stock in Europe is equipped with air conditioning, most occupants have to withstand uncomfortable heat indoors in office and school buildings during such heat waves. The lack of air conditioning and mechanical ventilation can lead to profound trade-offs that building occupants have to make, when outdoor temperatures rise in summer and during heat waves. On the one hand, they could keep the windows open to ensure good air quality, but this allows hot air to enter the room and (further) heat it up. On the other hand, if the windows are kept closed, hot air stays outside, however, carbon dioxide and air pollutants accumulate inside. Depending on the insulation level and building materials used, the building will heat up slower or faster, when outside temperature and sun radiation levels stay elevated over several days. In combination, without appropriate access to mechanical cooling and (natural) ventilation, this leads to poor air quality and elevated temperature indoors. Even though this trade-off is a well-known issue in the indoor environment sector, only few studies have examined the interaction effect of bad air quality and high temperature on humans. Most of these studies included perceived air quality and comfort as the main outcome, showing that higher temperature modulates the perception of air quality negatively. However, little is known about this interactive effect with regards to cognitive performance.

Study objective

This study aims to examine the interactive effect of indoor air quality and temperature on human cognitive performance. The main research objective of this study is to examine how poor indoor air quality in terms of 900 ppm CO2 compared to 3,000 ppm and elevated temperature of 35°C compared to 23°C affect cognitive performance, respectively. Furthermore, it will be examined if a higher temperature of 35°C compared to 23°C amplifies the negative effect of poor air quality in terms of 3000 ppm CO2 concentration vs. 900 ppm CO2 concentration on cognitive performance?

Study design

A cross-over single-blinded treatment design will be used. Subjects will undergo four difference conditions ((1) 900 ppm CO2 and 23°C, (2) 900 ppm CO2 and 35°C, (3) 3,000 ppm CO2 and 23°C, and (4) 3,000 ppm CO2 and 35°C). Subject will be blinded to the air quality level; however, it is not possible to blind them to the temperature condition due to its easy detection.

Intervention

Each subject undergoes four conditions in randomized order. Two conditions consist of poor air quality defined as 3000 ppm carbon dioxide and 23°C or 35°C temperature, respectively. These two temperature conditions will be repeated, but then with good air quality defined as 900 ppm CO2.

Study burden and risks

Subjects have to come once for a screening session and then for the four testing conditions to the MRUM lab facilities. They will stay in the respiration room for eight hours on each test day. They have to conduct cognition tests two times a day and fill out questionnaires about their perception of the indoor environmental quality.

Contacts

Public
Wählen

Universiteitssingel 40
Maastricht 6229 ER
NL
Scientific
Wählen

Universiteitssingel 40

Maastricht 6229 ER
NL

Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)

Inclusion criteria

Adults between 18 to 40 years old
Western-European background
Generally healthy
No medication which may influence the outcome parameters. This will be determined
on a case-by-case basis. Contraceptive uses for women are allowed and will be verified
through a questionnaire.
Non-smokers or persons who quit smoking more than five years ago

Exclusion criteria

• Participants, who do not want to be informed about unexpected medical findings, or do
not wish that their treating physician will be informed, cannot participate in this study
• Individuals with a diagnosed physical or mental disability or ADHD or depression
• Any medication or medical condition that might interfere with the physiological outcome
parameters or in some regards impair cognition
• Unstable body weight (weight gain or loss >3kg in the past three months)
• Participation in another biomedical study within 1 month prior to screening visit
• Shift workers

• Colour blindness
• Pregnancy
• People with a low haemoglobin or haematocrit concentration
• Not having visited or resided in a warm country in the last 3 months
• Participants with asthma or restricted lung function due to allergies

Study design

Design

Study type:	Interventional
Intervention model:	Crossover
Masking:	Single blinded (masking used)
Control:	Uncontrolled
Primary purpose:	Basic science

Recruitment

NL

Recruitment status:	Pending
Start date (anticipated):	01-03-2024
Enrollment:	18
Type:	Anticipated

Medical products/devices used

Registration:	No

Ethics review

Approved WMO

Date:	28-03-2024
Application type:	First submission
Review commission:	METC academisch ziekenhuis Maastricht/Universiteit Maastricht, METC azM/UM (Maastricht)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL85595.068.23