Romanian Journal of Civil Engineering, Volume 17 (2026), Number 2

Effects of elevated CO_2 concetrations in student dormitories: An experimental study

Efectele concentrațiilor ridicate de CO_2 în căminele studențești: un studiu experimental.

Andreea-Miruna Tokar [1]

[1] University of Oradea, Faculty of Medicine and Farmacy
December 1st no.10, Oradea, Romania
E-mail: tokar.andreeamiruna@student.uoradea.ro

DOI: 10.37789/rjce.2026.17.2.11

Abstract: *The impact of sleep quality on overall health is significant thus it is necessary to maintain the standards for air quality in civilian buildings. Student accommodations often lack these standards especially in thermal comfort, lighting and air quality. This study shows improper CO2 concertation in newly built student dormitories that have an effect on both mental and physical health The study shows that CO2 concentrations are above average (≈1278 CO2 ppm) especially during nighttime correlated with thermal discomfort caused by lack of proper ventilation in the sleeping and studding area.The collaboration between the medical and engineering field is important in order to maintain proper standards for air quality that will in turn also decrease several afflictions and risk of diseases.*

Key Words: air quality; CO_2 concertation; health effects.

1. Introduction

Sleep quality plays an important role in long time mental and phisical health and academic performance as shown in the speciality literature [1,2,3]. Sleep quality is defined as continuous sleep that from which one wakes up refreshed with few nighttime awakenings and fast initiation[4]. Students, especially, need to benefit from optimal sleep due their necesity to perform increased and continous intelectual activities.

Most students live in student housing for tree to six years and can suffers aflictions such as: diminised logical thinking, higher rate of awakening during the night [5], throat discomfort, dyspnea, dry and itchy skin, dificulty falling asleep and waking up, congested nose, bad air smell [6]. According to the standard I5-2022 [7], good air quality in civilian building has a CO2 concetration of less that 400 ppm. Bad air quality according to the same standard in cosidered to have a concetration of CO2 of more that 1000 ppm. It is worth mentioning that these symtoms can be acentuated by intrinsic

The article was received on 02.06.2026, accepted on 10.06.2026 and published on 12.06.2026

factors such as: stress, lack of proper nutrition, smoking, alcohool consumption, inadequent sleep hygene. Several other external factors are also be at play such as: suboptimal lighting as shown by other studies regarding the same student accomodation [8], thermal discomfort, noise pollution.

2. Considerations regarding the level of CO2 concentration during sleep on health

The scope of the paper is to determine if CO_2 concentrations in student living accommodations are up to standard while also correlating the findings with the health effects that subpar CO_2 concentrations have on occupants.

The study took 10 days (from the 18th of March to the 28th of March) and it focused on the CP1 student accommodations from the University of Oradea that opened in October 2024. The room that was used in the research as shown in Fig.1. is 58.85 m^3 and has no mecanical venitaltion sistems in the sleeping area. A small mecanical ventilator is used for the bathroom. The sleeping area has a window for natural ventilation that features a ventilation slot. The dormitory room studied is inhabited by two people.

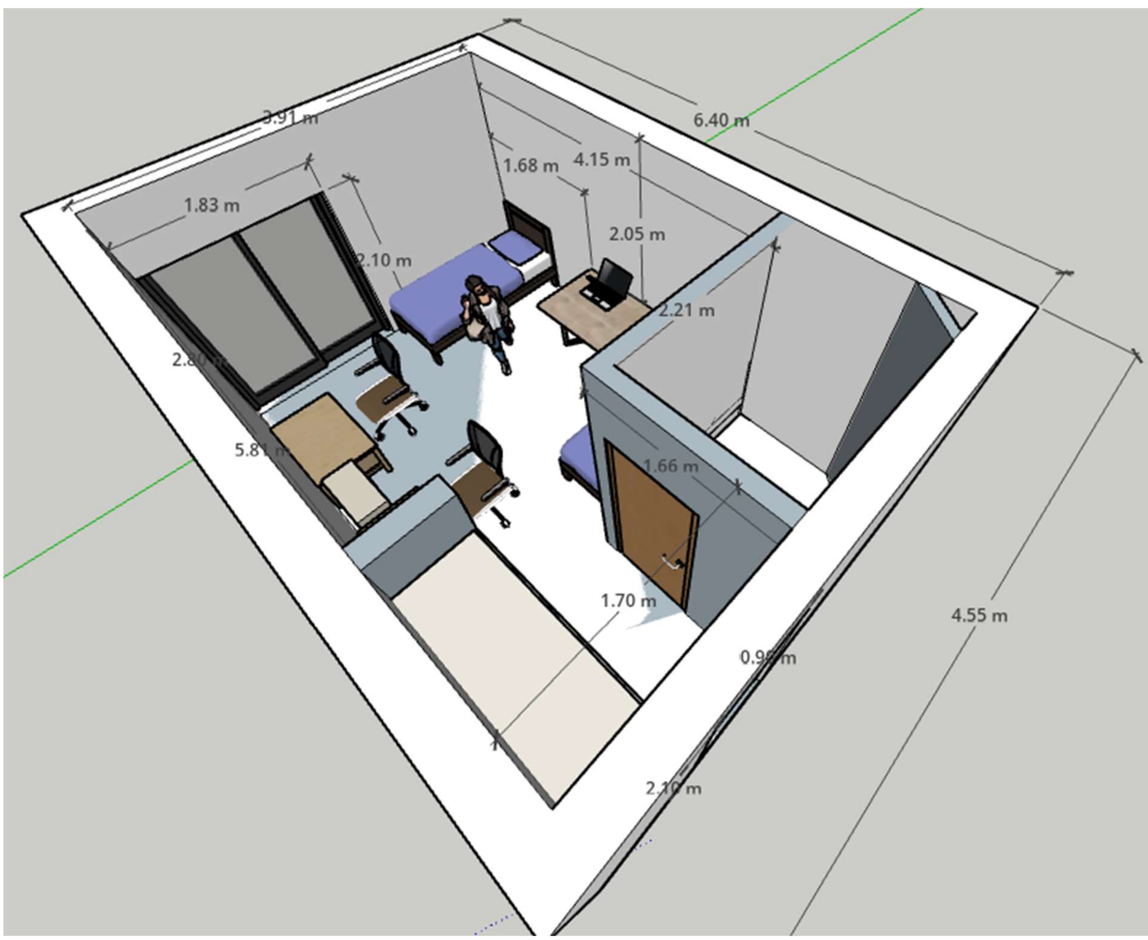

Fig.1. Floor plan

For the measurements a TESTO 480, SN 2309679, aparatus was used, that provides information about air pressure, humidity, temperature and CO_2 concetration. The paper was focused only on the latter two ones. The probe was set between the two beds at a distance from the window opening in order to prevent abrupt variontions from air currents caused by the window's opening (Fig. 2.).

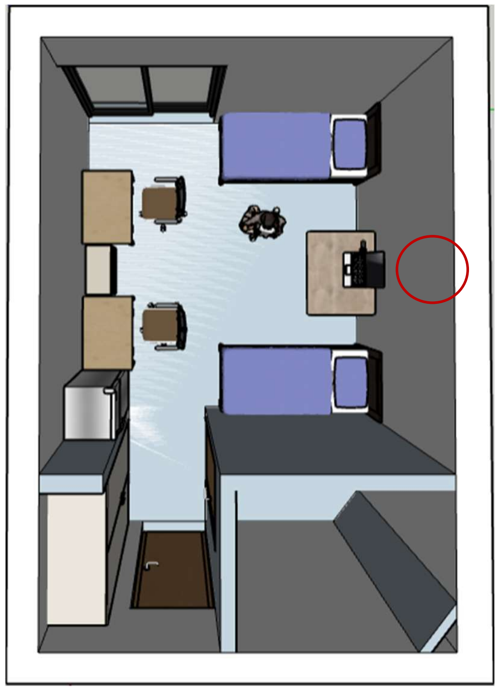

Fig.2. Probe placement

3. Results and Discutions

The data was analized for three diffrent perspectives in coreletion with temperature:

3.1. Overall assesment

Over the ten day period in which the study as conducted bowth CO_2 concetration and temprature were measured as shown in Fig.3.

Both inferior (less than 400 ppm) and superior (more than 1000 ppm) thresholds are showcased in the graph. As considered by the I5 normative a CO_2 concertation of over 1000 ppm is correlated with bad air quality.

As it can be seen in fig.3 the CO_2 concertation rarely goes below 400 ppm thus the registered air quality is between medium and low with an average of 1287 ppm which surpasses the superior threshold indicating lo air quality in the sleeping area during day time and especially during night time.

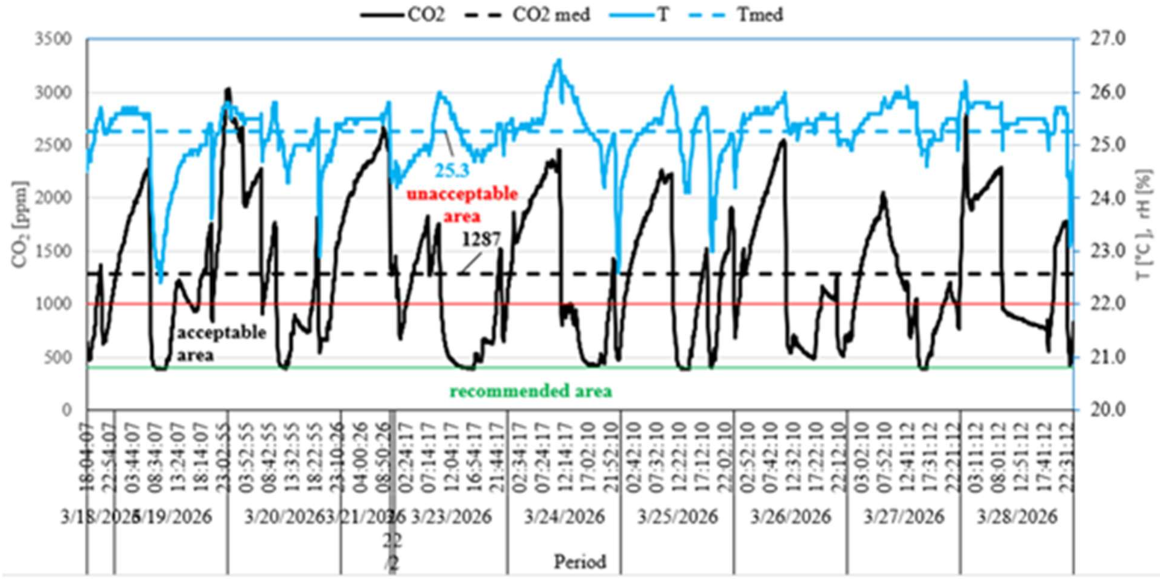

Fig.3. Measurements over a ten days period

Thermal comfort as also taken into consideration. It can be seen that CO_2 concertation is almost directly proportional with temperature that also reaches values correlated with thermal discomfort (≈25.3ºC median temp). Due to lack of mechanical ventilation thermal discomfort ill only worsen in the warmer season when temperatures can reach up to 28ºC during the day.

3.2. 24 h assesment

During a 24 hour period it can be seen that drastic CO_2 concetration increases happen both during the night and during the time students are not in the dormitories. This is caused by the lack of mechanical ventilation in the student accomodation. In addtion higher CO_2 concetrations may be registered in the cold season due to the fact that using natural ventilation, in this case, causes thermal discomfort. As shown in Fig. 4 there are drastic drops in CO_2 concentrations and temperature whenever the window is fully open for even less than 5 minutes (Segments AB and EF). While the ventilation sloth is used the CO_2 concetration curb decreases at a lower rate hile temperature still rises(Segment CD).

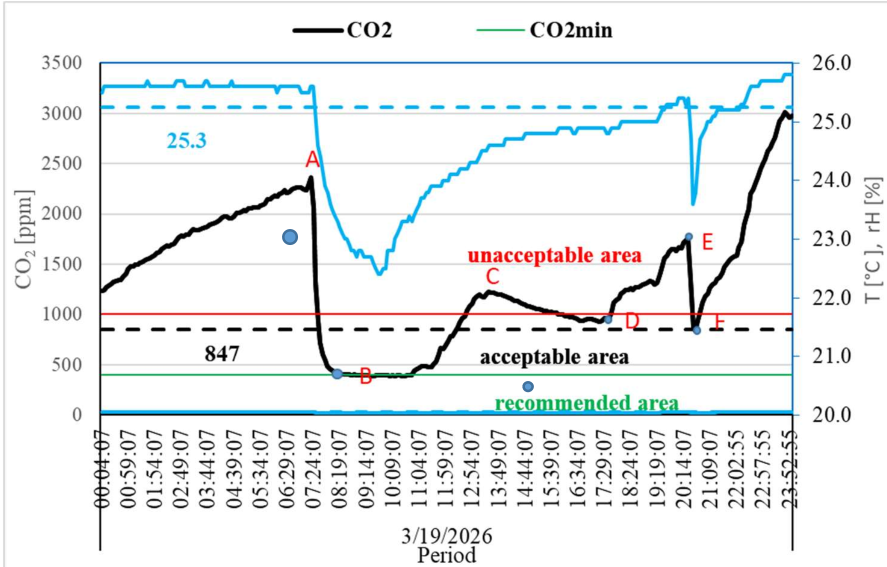

Fig.4. The 24 hours measurements

3.3. Nightime assesment (8 p.m.-8 a.m.)

Nighttime is the most affected perion during the day by the lack of mechanical ventilation as shown in Fig. 5.

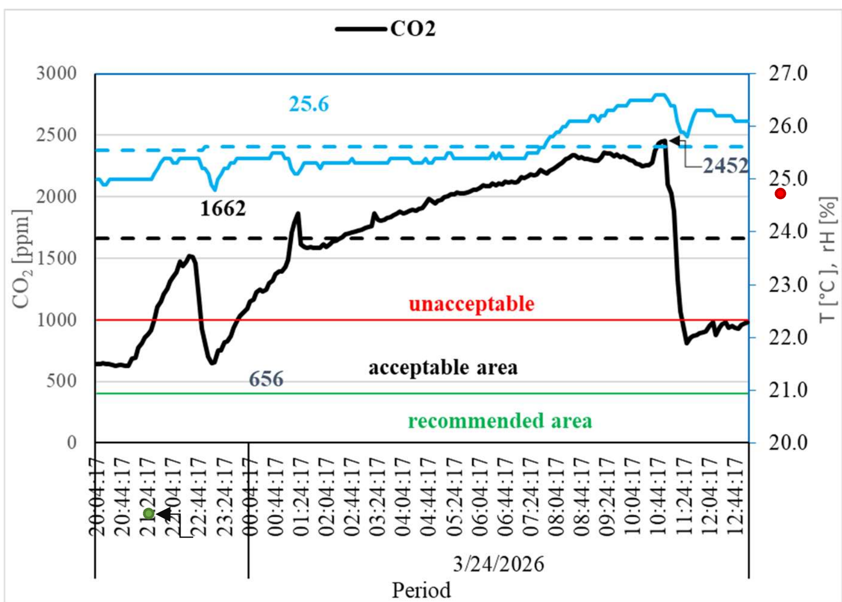

Fig.5. Night-time measurements

Both CO_2 concentration and temperature increase by morning, reaching above average values.

The theoretical CO_2 concentration is calculated using formula 1 [9]. Thus the CO_2 concertation accumulated from two people after a 12 hour sleep period in a room without mechanical or natural ventilation is 13.166 ppm.

$$C(t) = C_0 + (\frac{N \cdot \nu_b \cdot V_b \cdot C_b}{V}) \cdot t \qquad (1)$$

Where:

V=58.85 m^3	room volume
N=2	number of people
ν_b=12 breaths/min [10]	breath frequency
t= 720 min	time
C_b=45000 ppm [11]	CO_2 concentration in exhaled breath
V_b=0.0005 m^3 [12]	volume per breath
$C(t)=C_{teor}$	theoretical room CO_2 concentration in accumulated in t minutes ppm
C_0=656 ppm	initial CO_2 concentration (at 11 p.m. as shown in Fig.5.)
C_{exp}= 2452 ppm	CO_2 concentration, determined experimentallyat 11 a.m. as shown in Fig.5.

Exchange rate ηe in %, is calculated with rel. 2.

$$\eta_e = \frac{C_{teor} - C_{exp}}{C_{teor}} \cdot 100 \qquad (2)$$

Comparing the theoretical CO2 accumulation with the experimentaly measured CO2 concertation registered at 11 am after a 12 hours period without mechanical or natural ventilation the exchange rate is 0,81%.

4. Conclusions

In conclusion the authors propose stricter standards for student dormitories designs that take into consideration air quality and proper ventilation. This paper also shows the necessity of interdisciplinary collaboration between building services engineers and the medical field in order to account for the health impacts that deficient air quality has on buildings' occupants.

5. Refrences

[1] L. A. Musshafen, R. S. Tyrone, A. Abdelaziz, C. E. Sims-Gomillia, L. S. Pongetti, F. Teng, L. M. Fletcher, J. C. Reneker, „Associations between sleep and academic performance in US adolescents: a systematic review and meta-analysis”, *Sleep Medicine*, vol. 83, 2021, pp. 71-82.

[2] S. Qu, M. Wang, Y. Peng, „Associations between residential environmental health and sleep quality: Potential mechanisms”, *Sleep Medicine*, vol. 103, 2023, pp. 16-23.

[3] A. Agostini, S. Centofanti, „Normal Sleep in Children and Adolescence”, *Child and Adolescent Psychiatric Clinics of North America*, vol. 30, no. 1, 2021, pp. 1-14.

[4] C. Kline, „Sleep Quality”, în M. D. Gellman, J. R. Turner (eds.), *Encyclopedia of Behavioral Medicine*, Springer, New York, 2013.

[5] X. Zhang, T. Zhang, G. Luo, J. Sun, C. Zhao, J. Xie, J. Liu, N. Zhang, „Effects of exposure to carbon dioxide and human bioeffluents on sleep quality and physiological responses”, *Building and Environment*, vol. 238, 2023.

[6] R. Wang, W. Li, J. Gao, C. Zhao, J. Zhang, Q. Bie, M. Zhang, X. Chen, „The Influence of Bedroom CO_2 Concentration on Sleep Quality”, *Buildings*, vol. 13, 2023.

[7] MDLPA, I 5 – 2022, Normativ Normativ pentru proiectarea, executarea şi exploatarea instalaţiilor de ventilare şi climatizare, 2022.

[8] I.-D. Holecică, A.-M. Tokar, D. Tokar, „Considerations regarding the impact of artificial lighting on health”, *Revista Română de Inginerie Civilă*, 2026.

[9] Institute of Medicine (US), „Clearing the Air: Asthma and Indoor Air Exposures”, National Academies Press, Washington DC, 2000.

[10] S. Fritz, L. Chaitow, G. M. Hymel, „Review of Pertinent Anatomy and Physiology”, în *Clinical Massage in the Healthcare Setting*, Mosby, 2008, pp. 140-195.

[11] M. Li, G. Bekö, N. Zannoni, G. Pugliese, M. Carrito, N. Cera, C. Moura, P. Wargocki, P. Vasconcelos, P. Nobre, N. Wang, L. Ernle, J. Williams, „Human metabolic emissions of carbon dioxide and methane and their implications for carbon emissions”, *Science of The Total Environment*, vol. 833, 2022.

[12] J. L. Sparling, M. F. Vidal Melo, „Pulmonary Pathophysiology and Lung Mechanics in Anesthesiology”, în E. Cohen (ed.), *Cohen's Comprehensive Thoracic Anesthesia*, Elsevier, 2022, pp. 66-87.