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Publication date
2023

Document Version
Final published version

Citation (APA)
Hamida, A. B., Eijkelenboom, A. M., & Bluyssen, P. M. (2023). *University students' perception of the sound environment at their home study places*. 1-2. Abstract from 18th Healthy Buildings Europe Conference 2023, Aachen, Germany.

Important note
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University students' perception of the sound environment at their home study places

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Background. People are staying indoors for most of their time (on average 90%), where they are exposed to different environmental stimuli (e.g., noise, temperature) that are related to the indoor environmental quality (IEQ) factors (Bluyssen, 2020). Students in higher education spend substantial time at their study places (at home or educational buildings) for their study-related activities (Beckers *et al.,* 2016a). Noise is one of these environmental stimuli that could affect the students' health and comfort. It was found that noise affected students' health (Tristan-Hernandez *et al.,* 2017), perception (Dzhambov *et al.,* 2021), and performance (Shu & Ma, 2019). However, previous studies mainly focused on the students' sound environment perception in classroom settings, while few (e.g., (Ramu *et al.*, 2021) and (Beckers *et al.,* 2016b)) investigated their perception in their study places.

Aims. This study aims to identify the sound sources that students are exposed to at their home study places. Furthermore, this study shows to which extent students are satisfied with the sound environment of their study places.

Methods. An online questionnaire survey (built in Qualtrics XM) was completed by 451 first-year bachelor students at the faculty of Architecture and the Built Environment at TU Delft in 2021 and 2022 (Hamida *et al.,* 2023). This questionnaire includes different sections, in which this extended abstract focuses only on the questions related to the study place (home or educational building), sound sources in home (10 outside sources, and 7 inside sources), and sound environment perception (on scale 1 to 7, in which 1 indicate dissatisfied, and 7 satisfied). The cumulative percentage of students who scored from 1 to 3 were calculated as the dissatisfaction level. The data were exported to IBM SPSS 26 for the analysis. As the question related to the sound sources was limited to students' homes, this study focused only on the home study places. The majority of the mostly used study places of students (74%) were in their homes, while one quarter (26%) was at educational buildings. After cleaning the dataset, this study includes 333 students, who study most of their time at home.

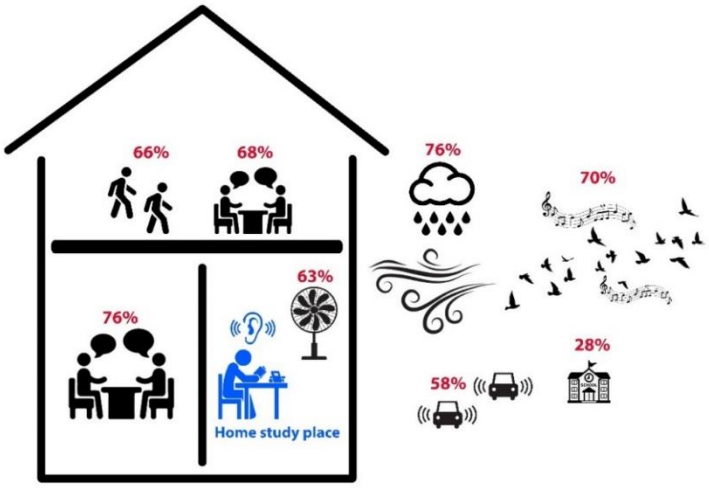
Results. With regards to the sound sources, **Figure 1** illustrates the sound sources from both outdoors and indoors that were perceived most in students' study places. Outside weather sounds (76%), birdsongs (70%), and busy road (58%) were the most reported sounds from the outside. Almost one third of the students (28%) noticed sounds generated by public buildings, such as schools, nearby their home study places. Pertaining the sounds from the inside, students were mainly exposed to sounds by people speaking inside their home (76%), neighbours speaking in adjacent spaces of the building (68%), and the movements of neighbours (e.g., footsteps) in adjacent spaces (66%). Also, more than half of the students (64%) were exposed to mechanical sounds (e.g., refrigerator, installations) in their home study places. Regarding the students' sound perception, almost one third of the students (28%) was dissatisfied with the sounds from the outside. Fewer students were dissatisfied with the sounds indoors produced by people (21%) and produced by building installations (16%).

Conclusions. In conclusion, this study found that almost one-third of the students are dissatisfied with the sounds from outdoors. In particular, weather sounds (winds and rains), birdsongs, and busy road were the most dominant sounds. Fewer students were dissatisfied with sounds from the inside generated by people. The most reported indoor sounds that were found in students' study places were the people speech (inside home and neighbours), and

people movements in the adjacent areas of the study place. A previous study (Puglisi *et al.,* 2021) concluded that 25% of people who worked from home during COVID-19 were annoyed by the sounds induced by people speech and movements. Furthermore, this present study found that more than half of students are exposed to mechanical sounds. According to Dzhambov *et al.* (2021), mechanical sounds were associated with students' health. Outcomes from this study shed the light on the importance of the sound quality on students comfort at their home study places. However, one of the limitations of this study is that objective measurements of the sound environment were not carried out. Hence, it is important to further investigate how the students experience these sound sources at their study places by understanding in-depth the sound environment (e.g., sound pressure level) and the building characteristics (e.g., windows) of these places.

Keywords. Indoor environmental quality (IEQ), sound environment, study places, sound perception, sound sources, students.

Figure 1



Sound sources (from the outside and from the inside) at students' home study places.
* Note: the icon size refers to the amount of existence of the sound sources at home study places.

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