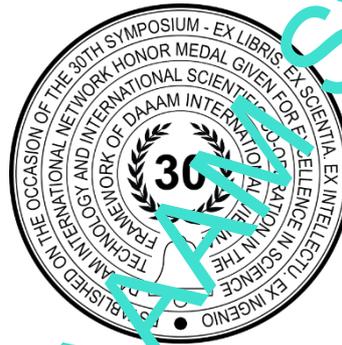


# PERCEPTION OF INDOOR AND OUTDOOR NOISE AT URBAN SETTLEMENTS

Mirela Alispahic, Halima Hadziahmetovic, Sanda Midzic Kurtagic, Rehana Blazevic, Azrudin Husika & Kerim Druskic



**This Publication has to be referred as:** Alispahic, M[irela]; Hadziahmetovic, H[alima]; Kurtagic, M. S[anda]; Husika, A[zrudin] & Druskic, K[erim]; (2022). Perception of indoor and outdoor noise at urban settlements, Proceedings of the 33rd DAAAM International Symposium, pp.xxxx-xxxx, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-xx-x, ISSN 1726-9679, Vienna, Austria  
DOI: 10.2507/33rd.daaam.proceedings.xxx

## Abstract

This paper aims to assess the perception of residents about the level of noise caused by indoor and outdoor activities. The survey was also conducted to assess the level and type of negative emotions caused by noise. The survey included different groups of residents, as well as different types of buildings in which they live. 201 respondents were included in the survey, and the survey focused on outdoor sources of noise such as traffic, children's playgrounds, sports fields and cafes and restaurants, and indoor types of noise such as loud music, renovation of apartments, family quarrels and children's games. 72 respondents stated that they were most irritated by noise from construction work in neighbouring apartments, 51 of them cited arguments and noise from neighbouring apartments and 29 respondents mentioned loud music. However, the respondents express empathy towards children, because the noise caused by children's play does not bother them.

Keywords: indoor noise; outdoor noise; noise perception; acoustic comfort

## 1. Introduction

Noise pollution has been generally described as noise coming from road or railway traffic, industrial activities and public construction work as the most common sources of pollution, [1, 2]. However, larger cities are increasingly faced with the problem of noise arising from recreational activities located in city centres. More and more frequent and massive forms of socializing outdoors, in cafes, restaurants or parks, on walks, at music or sports events, especially in summer and at night. In addition to this problem, residents of buildings are also exposed to sources of noise resulting from various activities of their neighbours, especially in multi-story buildings. The level of indoor noise is recognized as a significant factor that affects the acoustic comfort, health and psychological state of building occupants, but the problem has not been sufficiently investigated.

Several recent studies dealt with this issue and the methodology of recreational noise research. Ljunggren *et al.* [3] investigated a possible correlation between sound insulation and subjective noise perception of residents. The research

methodology was based on i) field measurements (noise caused by typing on a typewriter, noise manifested by the use of a rubber ball, according to ISO 16283-2), ii) characterization of buildings (in terms of materials and construction period) and a iii) questionnaire aimed at identifying the subjective perception of noise from neighbour's activities (noise caused by daily activities in the apartment: footsteps, moving furniture, etc.). Ottoz et al. [4] designed a questionnaire to study a socio-economic and health (self-reported health consequences of sleep) perspective of the subjective perception of outdoor noise by residents caused by recreational activities in Milan and Turin accompanied with a field measurement of a noise level. More recent works also treated the possible impact of forced stay in residential units during the COVID-19 quarantine on the subjective perception of noise and the connection with the acoustic comfort of the residents, [5], [6]. In Bosnia and Herzegovina, as well as in the Sarajevo Canton, the level of noise in buildings is regulated and refers to outdoor stationary and non-stationary noise sources. However, the issue of noise caused by sources inside residential buildings has not been the subject of research so far. Therefore, this paper aims to assess the perception of residents about the level of noise caused by outdoor sources of noise as traffic, children's playgrounds, sports fields and cafes and restaurants, and indoor types of noise as loud music, renovation of apartments, family quarrels, footsteps and children's games.

## 2. Questionnaire survey

The questionnaire was made of an introductory section including the information sheet and two more sections focusing on: basic demographic information (age, sex, educational level, basic employment information), respondents' home characteristics (individual family houses, old apartment buildings, renewed or newly built ones, number of apartments on the floor), sound sources information relevant for indoor soundscapes (traffic noise and other noise from outside) and personal description of different noise perception.

Information about the housing context that was collected were: the ownership status, the house typology (single-family house, apartment block with two or more apartments on a floor), other people at home (children, spouse, parents, roommates), the number of people living at home. Also, the respondents were asked to identify the nearness of some recreational facilities in the area, such as children's playgrounds, stadiums and similar facilities, cafes and restaurants. They were requested to indicate whether they have to close the windows because of the noise from the street in the summer, as well as to state what they feel about it (irritation, annoyance, indifference or empathy).

In the following, the participants were asked to describe which of their neighbours' activities disturb them the most (home renovation, loud music, arguments or loud speech, footsteps from neighbours, children's noises or moving furniture).

### 2.1. Quantitative analysis of collected data

201 respondents participated in the online survey, 128 women and 73 men. The predominance was the working-age population: between 30 and 45 years (105 or 52.2 %), between 45 and 60 years (43 or 21.4 %) and only eight respondents were over 60 years old. The level of education of the respondents is above the statistical average in Bosnia and Herzegovina as follows: master's degree or doctorate for 37 respondents (18.4 %), university degree for 75 respondents (37.3 %), secondary school for 82 respondents (42.3 %) and the rest with a lower level of education (7 respondents in total). As for the respondents' age and educational distribution, this can be explained by implementing an online questionnaire because this methodology is closer to a younger and more educated population. Also, it can be confirmed based on the respondents' employment status: out of a total of 201 respondents, 145 were employed (71.6 %).

The majority of respondents own an apartment where they live (87.1 %), of which 43 % or 86 of respondents live in individual family houses, and the rest live in residential buildings. Also, almost 59 % of the respondents stated they lived in the same home for more than ten years, and 57 % of those said they lived there with more than two members, including children. 36.3 % of respondents have been living with someone else without children, and 6.7 % of those have been living alone.

The environment of respondents who lived in individual family houses has been generally described as quiet: 57 respondents from this group stated that their home is located further from the airport, main road, tram or railway, but also from children's playgrounds, restaurants and recreation centres, while only 26 of them pointed out that is located near the road. Similarly, 60 respondents replied that they were not exposed to any source of noise from human activities in neighbouring apartments or courtyards. It was noticed that there were no respondents in this group who reflected on their feelings about the noise that irritated them the most.

For the respondents in apartment buildings, the reflection were quite opposing. Only 26 respondents from this group stated that their homes are located further from the airport, main road, tram or railway, and 22 said they are far from children's playgrounds, restaurants or sports centres. Also, 72 respondents stated they were exposed to renovation sounds from neighbouring apartments, followed by arguments (51 respondents) and loud music (29 respondents). As for the home typology, 75 % of the respondents stated they lived in multi-storey buildings with more than two apartments on the same floor, and almost 70 % said they lived in old apartment buildings.

So, the following discussion will be focused on this group of respondents.

2.2. Qualitative data analysis of observed group

The sound environment while being at home was reported to be dominated by sound generated by the renovation of neighbouring apartments, followed by outdoor sounds, by pets from neighbouring apartments and by sound generated by other human beings present at home (loud music and TV played, footsteps or moving furniture). Also, many respondents reflected on their perceptions of different sources of noise: "It irritates me I can't sleep and rest"; "I can't sleep, I have to turn up the television"; "The ceiling tolls from the footsteps in the bedroom"; "First I get nervous, and after all that drilling, a headache comes without warning"; etc. It was noticed that the words "sleep", "rest", and "bedroom" were frequently repeated in the comments left by the respondents. The previous answers could indicate the nature and consequences of the noise perceived at home, generated by other people's activities. The majority of the respondents who mentioned complaints caused by noise from activities in other apartments lived in buildings with more than two apartments on the same floor, almost 96%. There was no significant difference between old buildings and newly.

Further, 60 or 52 % respondents replied that they have to close the windows in the summer, and 90 % were irritated with this, as detailed in Figure 1.

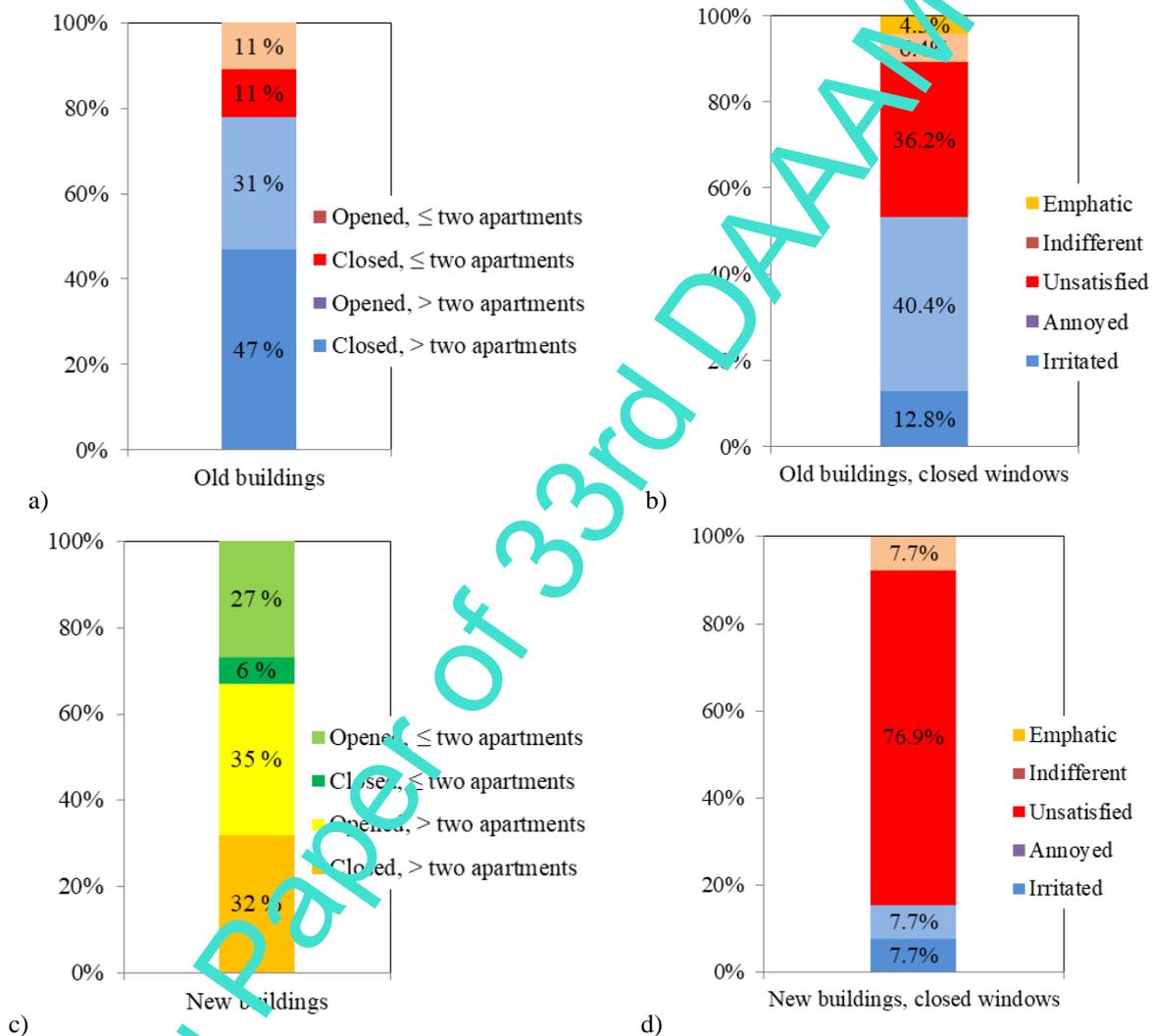


Fig. 1. Percentage values of responses to: a) closed windows in summer for the old buildings concerning the number of apartment units on the same floor; b) annoyance levels due to closed windows-old buildings; c) closed windows in summer for the new buildings concerning the number of apartment units on the same floor; d) annoyance levels due to closed windows-new buildings.

Furthermore, reported annoyance levels were compared across the socio-demographic variables (gender, age, educational level) and the building's characteristics. Reported indoor and outdoor noise annoyance levels differ significantly by

respondents who lived in the building with more than two apartment units on the same floor, period of construction, educational level, and age group (test Anova, p-value > 0.05).

The results showed that the reported annoyance level is related to the level of education of the respondents, and it did not differ significantly according to gender, although females reported higher annoyance and anger ratings. Also, younger respondents showed higher empathy, especially those in the 18 to 30 age group. Respondents with a higher level of education showed more empathy towards loud music from the neighbours and noise from nearby cafes. At the same time, they showed the lower empathy towards the noise generated by the apartment renovation, followed by the noise made by pets. However, they reported the level of annoyance as moderate (those irritancy ratings were associated with more than two apartments on the building's floor). Contrary to this, respondents with a lower level of education reported higher irritancy ratings.

The respondents showed empathy towards noise associated with children, both from outdoor and indoor sources; there was no significant difference across the socio-demographic variables, although younger respondents showed slightly higher empathy.

Similarly, a survey in the UK showed that the most annoying neighbouring noise sources were voices, pets, and radio/television, whereas neighbours' footsteps and banging on walls or floors were the least annoying [7], [8]. In contrast, a study in Korea [9] found that the most noise irritation was associated with other people's footsteps, children running, moving furniture, and dropping small items, almost 78 %. At the same time, 3.7 % of respondents said that were irritated by renovation works in the neighbouring apartment (plumbing, hammering).

The outdoor and indoor noise exposure levels ranging from one to five in the preceding Figure 2 have been presented as exposure level 1: neutral/no exposure; level 2: slight; level 3: moderate; level 4: considerable; level 5: extreme based on respondents' reflection.

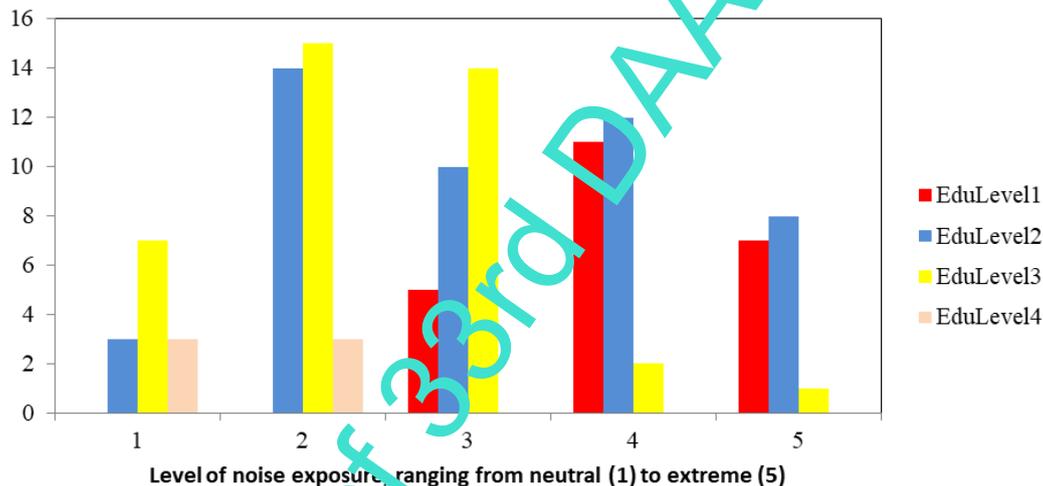


Fig. 2. The reported outdoor and indoor noise exposure levels ranging from one to five: EduLevel1- master's degree or doctorate, EduLevel2- university degree, EduLevel3-secondary school, EduLevel4-lovest level

### 3. Conclusion

As already mentioned, the problem of exposure to indoor and outdoor noise sources is quite complex (it depends on a large number of parameters, both objective and subjective), so it is difficult to investigate it. As for recreational noise sources, it is related to specific urban areas, and exposure to it can be variable, depending on the period of the year when people's outdoor activities are more pronounced. Therefore, it is necessary to analyse the problem using a different methodology like online surveys and field research of the selected location and residential building. Current research is divided into two parts: the first part of the research concerning residents' perception is discussed in this paper, and the second part concerning field research is planned in the following.

The first part of the research was related to the online survey of residents living in apartment buildings and family houses. The purpose of the questionnaire was to determine whether there is a certain level of annoyance with the quality of life in apartment buildings, and it refers to outdoor (both usual and recreational) and indoor noise sources (possible sources of frustration arising from continuous exposure to noise generated by neighbours' everyday activities). The results of the survey showed that the residents are most disturbed by the noise generated by the renovation of the neighbouring apartments, the by sound generated by pets, and the least by loud music and noise made by children. However, many respondents indicated that noise disturbs their rest and sleep, which affects their health and quality of life. As for outdoor

noise sources, the problem was the proximity of the road and public places such as the markets. Children's playgrounds, cafes and restaurants were not indicated as sources of frustration.

The limitation of this type of research is reflected in the online questionnaire, which included younger groups of respondents with a higher level of education. The survey should be conducted in the field to include respondents of different socio-economical statuses, educational levels and ages. In the same way, the survey should include those respondents from locations in the city of Sarajevo, who are more exposed to sources of outdoor noise, originating from the activities of people.

In the following, it is planned to select a specific residential building and conduct a field analysis of the building's micro-location (it is necessary to specify where the building is located to identify possible sources of noise inside the building or outside the building: proximity to roads, railways, recreation facilities (stadiums, cafes, restaurants, children's playgrounds, markets and similar), analysis building characteristics (old building with or without renovation, newly built one, condition of the building envelope, number of floors in the building, number of apartments on the floor, and if possible acoustic characteristics of the space). Field measurements of indoor noise levels are also planned. Based on the information concerning both subjective and objective noise obtained in the analysis, it would be possible to estimate the actual situation and make appropriate recommendations accordingly.

#### 4. References

- [1] Badida, M.; Herczner, P.; Konkoly, J. & Lumnitzer, E. (2011). Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, Vol. 22, 1, B. Katalinic (Ed.), Published by DAAAM International, Vienna, Austria, DOI: 10.2507/daaam.scibook.2020.03
- [2] Navrud S. The State of the Art on Economic Valuation of Noise,” Report prepared for the European Commission, DG Environment, 1-38, available at Navrud S. 2010. “Economic Valuation of Transportation Noise in Europe,” 34 Rivista Italiana Di Acustica 3; 2002. p. 15–25.
- [3] Ljunggren, F.; Simmons, C. & Öqvist, R.. (2017). Correlation between sound insulation and occupants' perception – Proposal of alternative single number rating of impact sound, part II. *Applied Acoustics*, Vol. 123, pp. 143-151, <https://doi.org/10.1016/j.apacoust.2017.03.014>
- [4] Ottoz, E.; Rizzi, L. & Nastasi, F. (2018). Recreational noise: Impact and costs for annoyed residents in Milan and Turin. *Applied Acoustics*, Vol. 133, pp. 173–181, doi.org/10.1016/j.apacoust.2017.12.021
- [5] Torresin, S.; Albatici, R.; Aletta, F.; Babich, F.; Oberman, T.; Stawinoga, A.E. & Kang, J. (2021). Indoor soundscapes at home during the COVID-19 lockdown in London – Part I: Associations between the perception of the acoustic environment, occupants activity and well-being. *Applied Acoustics*, Vol. 183, 108305, doi.org/10.1016/j.apacoust.2021.108305
- [6] Torresin, S., Albatici, R., Aletta, F., Babich, F., Oberman, T., Stawinoga, A.E., Kang, J., 2022. Indoor soundscapes at home during the COVID-19 lockdown in London – Part II: A structural equation model for comfort, content, and well-being. *Applied Acoustics*, Vol. 185, 108379, doi.org/10.1016/j.apacoust.2021.108379
- [7] Defra. Survey of noise attitudes (SoNA) 2015, Report Ref: 47067932.NN1501.R1/02. AECOM Infrastructure & Environment UK Limited; 2015
- [8] Park, S. H., Lee, P. J., 2019. Reaction to floor impact noise in multi-storey residential buildings: The effects of acoustic and non-acoustic factors. *Applied Acoustics*, Vol. 150, p. 268–278, doi.org/10.1016/j.apacoust. 2019. 02. 021
- [9] Park, S. H., Lee, P. J., Lee, B. K., 2017. Levels and sources of neighbor noise in heavyweight residential buildings in Korea. *Applied Acoustics*, Vol. 120, p. 148–157, doi.org/10.1016/j.apacoust.2017.01.012