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Exposure to headphone-generated noise and associated hearing risks in students

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ABSTRACT

Introduction: Noise is the leading cause of hearing loss worldwide. In recent years, reduced hearing ability among young people has been observed, along with an increased frequency of headphone use for sound transmission. The purpose of this study is to determine the frequency and patterns of headphone use for sound reproduction among students and to analyze their impact on the occurrence of symptoms associated with hearing loss.

Methods: The cross-sectional study included students from two public universities from three public faculties in Bosnia and Herzegovina. Both qualitative and quantitative analyses were used to process the results. To test the statistical significance of the findings, the Chi-square goodness-of-fit test was applied, with the level of statistical significance set at 0.01.

Results: The study sample included 246 participants and it was found that 77.6% of surveyed students use headphones for sound transmission. The longest duration of use was reported by 44.6% of participants, who had been using headphones for more than 5 years. The most common maximum daily use was up to 2 h (28.7%), while 67.5% of respondents reported using headphones every day, most often in the evening (46.4%). The Chi-square test showed statistically significant differences in the frequency of symptom occurrence following headphone use ($\chi^2(6) = 55.466$, $p < 0.001$). The most frequently reported symptoms were tinnitus (28.3%), a sensation of fullness and ear pressure (17.8%), and ear pain (16.2%).

Conclusion: The results indicate a high prevalence of headphone use among students, with many reporting daily use over several years. The analysis showed a statistically significant association between headphone use and the occurrence of hearing-related symptoms, suggesting a potential threat to the auditory health of young people. These findings highlight the need to educate youth on the safe use of headphones.

Keywords: Headphones; students; noise; hearing loss

INTRODUCTION

Hearing loss is the most common sensory impairment (1). It is estimated that noise accounts for one-third of all hearing loss cases worldwide. Noise has a cumulative effect on the human body, so an individual may be exposed to a noisy environment for a long time before the first symptoms appear. Hearing loss caused by long-term exposure to noisy environments is entirely preventable. If hearing loss occurs for this reason, it stabilizes and does not worsen once noise exposure stops. Until now, prevention efforts have mainly focused on preventing hearing loss in the workplace. However, an increase in hearing impairment among young people has been observed (2-4). Most young people use headphones that deliver sound directly into the ear canal, exposing them to very high-intensity sounds (5). Sound intensity and duration of exposure are directly related to their potential effects on hearing (6). Noise-induced hearing loss can cause permanent damage, making the use of a hearing aid necessary (7). Headphone use can lead to hearing damage for several reasons, including excessive volume, prolonged use, poor sound quality, improper fit, and increasing volume in noisy environments. With the rise of smartphones and digital platforms, headphone use has become widespread among young people. Headphones are also commonly used during interactive entertainment, exposing users to loud sounds such as explosions and other in-game effects (8). While headphone use provides convenience and privacy, excessive or improper use can seriously impact hearing. Results of previous studies Wang's et al. (9,10) highlight the importance of preventive activities aimed at reducing risks and promoting proper headphone use among the younger population.

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The aim of this research is to determine the frequency and patterns of headphone use for sound reproduction among students and to analyze their impact on the occurrence of symptoms associated with hearing loss.

METHODS

A cross-sectional study was conducted to assess the prevalence and patterns of headphone use. Both qualitative and quantitative analyses were used to process the results. For this study, a measurement instrument was developed based on a review of the literature on headphone usage patterns and associated health effects, and it was adapted to the objectives of this research. The development of the instrument was preceded by preparatory activities, including a review of previous studies, examination of relevant literature, and field analysis. Before the main study, a pilot survey was administered to 30 young individuals to assess the reliability of the instrument. The reliability of the questionnaire was evaluated using Cronbach's alpha, which yielded an overall coefficient of 0.84. The instrument was designed to provide respondents with predefined answer options, while also allowing them to add responses that reflected their personal headphone usage habits and symptoms experienced after use.

In the introductory section of the questionnaire, data on participants' gender and age distribution were collected. The second part gathered information related to headphone usage habits, including type, frequency, and duration of use. Data collected in this section included whether the respondent uses headphones (yes/no), the type of headphones used (in-ear, over-ear, or other devices with increased volume), maximum daily use (in hours), total years of use (up to 5 years, 5–10 years, over 10 years), frequency of use (daily, on weekends, weekly, or several times per month), the device used with the headphones (phone, tablet, or computer), and the time of day headphones were used (morning, evening, or other, as indicated by the respondent). The third part of the questionnaire assessed possible hearing decline and other health-related symptoms, including tinnitus, ear pain, a sensation of fullness or ear pressure, difficulties understanding speech, and impaired perception of surrounding sounds.

Participants were selected from two public universities, from three different faculties: two in the social sciences, which educate students who will later work with youth, and one in the health sciences, to raise awareness about the importance of proper headphone use. They were invited to participate voluntarily, and informed consent was obtained from all participants.

The project was approved by the Ethical committee of Ministry of Education and Science of Tuzla Canton. On application, the measurement instrument and research procedures were submitted for review and received approval. Participants were students from the first, second, and third cycles across all years of study. Two faculties were in the social sciences and one in the health sciences. Respondents were thoroughly informed about the study's objectives. Participation was voluntary, and the questionnaire was completed anonymously, with all participants providing informed consent. All respondents were surveyed directly in the presence of an audiology expert. The study also followed the ethical guidelines established in the Declaration of Helsinki.

Assessment of normality using the Kolmogorov–Smirnov and Shapiro-Wilk tests showed that the data were not normally distributed. Therefore, a non-parametric Chi-square goodness-of-fit test was used in the statistical analysis, as the assessment of the frequency and significance of symptom occurrence was conducted only on the subsample of respondents who use headphones.

RESULTS

The study sample included 246 participants who provided informed consent and completed the entire questionnaire. Table 1 shows the gender distribution: 20 male respondents (8.1%) and 226 female respondents (91.9%) (arithmetic mean = 1.92; standard deviation [SD] = 0.27). The youngest participants were born in 2005 and the oldest in 1999. The largest proportion of respondents were born in 2004 (31.7%), followed by 2003 (24.0%) and 2005 (18.7%). The least represented cohorts were 1999 (1.2%) and 2000 (2.4%). The average age of the students was 21 years (SD = 1.30), ranging from 20 to 26 years.

Table 2 shows that of the 246 students surveyed, 171 (77.6%) reported using headphones. Among these users, 59.3% used in-ear headphones, while 18.3% used over-ear headphones. Students who did not use headphones (22.4%) often increased the volume on other devices such as radios, TVs, or mobile phones. Regarding the duration of headphone use, 44.5% had been using headphones for 5–10 years, 36.6% for up to 5 years, and 18.8% for more than 15 years. The maximum daily exposure to headphones was 2 h for 28.7% of respondents, 1 h for 20.4%, 3 h for 20.0%, 4 h for 14.2%, and more than 5 h for 16.7%. Most participants used headphones every day (67.5%), suggesting that listening to music or other content through headphones is an integral part of students' daily activities. Smaller proportions used headphones only on weekends (11%) or several times per month (18.8%). These data highlight that headphone use is predominantly a daily practice among students, which may have important implications for the development of hearing-related symptoms, especially among those exposed to high sound intensity

TABLE 1. Sample structure of respondents by gender and age

Variables	Distribution of respondents		AM*	SD**
	f	%		
Gender				
Male	20	8.1	1.9187	0.27385
Female	226	91.9		
Birth year				
1999	3	1.2	4.4593	1.30164
2000	6	2.4		
2001	16	6.5		
2002	38	15.4		
2003	59	24.0		
2004	78	31.7		
2005	46	18.7		

AM*: Arithmetic mean, SD**: Standard deviation

TABLE 2. Patterns and frequency of headphones usage

Variables	Distribution of respondents	
	f	%
Headphones		
Uses	191	77.6
Does not use	55	22.4
Headphones type		
In-ear headphones	146	59.3
Over-ear headphones	45	18.3
Does not use headphones but often increases volume on another device	55	22.4
Usage period in years		
5	70	36.6
5–10	85	44.5
>15	36	18.8
Maximum daily duration of headphone use		
1.00	39	20.4
2.00	55	28.7
3.00	38	20.0
4.00	27	14.2
> 5.00	32	16.7
Uses headphones		
Every day	129	67.5
On the weekends	21	11
Several times a month	36	18.8
Once a month	5	2.6
The device headphones connect to		
Phone	167	87.4
Laptop	11	5.8
Phone and laptop	11	5.8
Computer	2	1.0
Time of day		
Morning	42	22.1
Evening	88	46.4
All the time	60	31.6

over extended periods. Headphones were most often used with mobile phones (87.4%), while smaller percentages used them with computers (5.8%) or both computers and laptops. The most frequent time of use was in the evening (46.4%), with a significant proportion (31.6%) reporting continuous use throughout the day.

Table 3 shows that a significant proportion of respondents (66%) reported increasing the volume on their headphones in noisy environments. Most participants used moderate (49.7%) or loud (37.7%) volume levels, while fewer used low (7.3%) or very loud (5.2%) settings. The results indicate statistically significant differences in the distribution of volume levels and volume adjustment ($\chi^2(3) = 112.770$, $p < 0.001$). The expected values for all volume categories were 47.8, implying that, under a uniform distribution, each category would have approximately the same number of respondents. Residual analysis showed significant deviations from the expected values: Moderate and loud volume levels were substantially above the expected values (47.3 and 24.3, respectively), whereas low and very loud volumes were well below the expected values (−33.8 and −37.8, respectively). For additional volume increases in noisy environments, the number of respondents who increased the volume was significantly higher than expected, with a positive residual value of +30.5.

TABLE 3. Headphone volume and additional amplification

Variables	Distribution of respondents		Expected values	Obtained values
	f	%		
Sound volume				
Low	14	7.3	47.8	−33.8
Moderate	95	49.7	47.8	47.3
Loud	72	37.7	47.8	24.3
Very loud	10	5.2	47.8	−37.8
Additional increase in volume in noisy environments				
Yes	126	66	95.5	30.5
No	65	34	95.5	−30.5

$\chi^2(3)=112.770$, $P<0.001$

Data analysis presented in Table 4 showed that respondents reported various symptoms after using headphones, and the Chi-square test indicated statistically significant differences in the frequency of individual symptoms ($\chi^2(6) = 55.466$, $p < 0.001$). The most frequently reported symptom was tinnitus (f = 54; 28.3%), occurring significantly more often than expected. Notable frequencies of ear fullness and pressure (f = 34; 17.8%) and ear pain (f = 31; 16.2%) were also observed. Less common symptoms included hearing loss (f = 21; 11%), while difficulties in perceiving sounds (f = 9; 4.7%) and understanding speech (f = 9; 4.7%) were the least reported, occurring significantly less than expected. Thirty-three respondents (17.3%) did not report any symptoms following headphone use. These results indicate that tinnitus, ear fullness and pressure, and ear pain are the most common negative effects of headphone use, whereas more severe issues such as speech comprehension difficulties and sound sensitivity were not statistically significant. Overall, the findings suggest that symptom occurrence among respondents is not random but is significantly associated with headphone use.

DISCUSSION

The study aimed to assess the frequency and patterns of headphone use among students and to evaluate their potential impact on the occurrence of hearing loss-related symptoms. A high proportion of students (77.6%) reported using headphones. Among those who did not use headphones (22.4%), many indicated that they often increase the volume on other music playback devices. This finding aligns with previous research Biassoni et al. (11), which showed that young people are prone to exposure to elevated noise levels from various sound sources, increasing the risk of developing symptoms associated with hearing impairment. These results support recent evidence (12) from a student sample, which found that 93.5% of participants use headphones. Research WHO (13) among young individuals in moderately and highly developed countries also indicated that a substantial proportion use headphones at elevated sound levels.

The study found that 59.3% of respondents use in-ear headphones, which reduces the distance between the sound-emitting device and the delicate structures of the ear, while 18.3% use over-ear headphones. Similar usage patterns

TABLE 4. Symptoms after headphone use

Symptoms	f	%	Expected values	Obtained values
Tinnitus	54	28.3	27.3	26.7
A sensation of fullness and ear pressure	34	17.8	27.3	6.7
I have not experienced any symptoms	33	17.3	27.3	5.7
Ear pain	31	16.2	27.3	3.7
I had reduced hearing	21	11	27.3	−6.3
I had sensitivity to sounds or sound intolerance	9	4.7	27.3	−18.3
Difficulties understanding speech	9	4.7	27.3	−18.3

χ^2 (6)=55.466, *P*<0.001

were reported in previous research Mohammadpoorasl et al. (12), where 51.3% of students used in-ear headphones and 42.2% used over-ear headphones.

The findings show that the largest proportion of respondents have used headphones for 5–10 years (44.5%), representing nearly half of the total sample and suggesting a long-standing habit of headphone use. The second most common group consists of those who have used headphones for up to 5 years (36.6%), while a notable proportion reported using headphones for more than 15 years (18.8%). Regarding maximum daily duration, the most common category was 2 h/day (28.7%), with approximately equal proportions reporting 1 h (20.4%) and 3 h/day (20.0%). A smaller proportion reported 4 h/day (14.2%), while a notable number (16.7%) indicated usage exceeding 5 h daily. This suggests that a significant portion of respondents exceeds the threshold often cited in the literature as risky for potential health consequences, particularly regarding hearing and overall psychophysiological strain. A study with youth reported an average daily listening time of 90 min, with individual usage ranging from 10 min to 4 h (14). A review of research (15-17) on youth samples revealed a consistent pattern in headphone usage duration, indicating that a substantial proportion of young people engage in daily listening for extended periods.

Regarding sound volume, most respondents reported setting their headphones to a moderate level (49.7%). However, a significant proportion also opted for loud playback (37.7%), indicating a high-risk group. Smaller percentages used low (7.3%) or very loud (5.2%) volume levels. In addition, 66% of students reported increasing the volume in noisy environments, while 34% did not. This finding is important as it suggests that environmental noise influences listening habits and increases the risk of noise-related symptoms. Research Osmanoğlu et al. (18) on music listening with headphones shows that 36.4% of respondents listen at a medium volume, 50% at a loud volume, and 13.6% at a very loud volume. Studies Harrison (19) indicate that listening through headphones on buses or in subways, where ambient noise exceeds 80 decibels, is a significant risk factor for hearing damage or noise-related symptoms. Research Byeon (20) indicates that headphone use in environments with elevated noise levels is a significant predictor of hearing impairment. Furthermore, studies Hong et al. (21) on youth samples have demonstrated that listening through headphones can lead to high-frequency hearing loss.

The study results identified various symptoms associated with headphone use and noise exposure. The most frequently reported symptom was tinnitus, experienced by 28.3% of respondents. This is significant, as tinnitus often represents the first sign of potential hearing damage or the onset of chronic tinnitus. The second most common symptom, a sensation of fullness and ear pressure, was reported by 17.8% of respondents, while 17.3% reported no symptoms. Ear pain was reported by 16.2% of respondents, hearing loss by 11%, and difficulties in perceiving external sounds and understanding speech by 4.7%. Improper headphone use, which can lead to hearing damage and tinnitus in young people, often occurs because they are not adequately informed about the potential consequences (22). Studies Chagok et al. (23) among students have shown that more than 62% of respondents were exposed to excessive noise levels that can cause hearing loss. Another study Widén et al. (24) among adolescents identified subjective auditory complaints, including hearing loss, increased sensitivity to sound, and tinnitus.

CONCLUSION

Headphone use is a prevalent habit among students, with most respondents using headphones daily and for extended periods. A significant number of students prefer in-ear headphones, which increases the risk of exposing the delicate inner ear structures to high noise levels. It is particularly concerning that some respondents exceed the recommended duration and intensity of listening each day, and many raise the volume in noisy environments, further increasing the likelihood of noise-related symptoms. The most commonly reported symptoms – tinnitus, a sensation of fullness in the ears, ear pain, and difficulty understanding speech – indicate that the consequences of these habits are already affecting a substantial proportion of young people. These findings align with previous research, confirming that improper headphone use and exposure to excessive noise are risk factors for hearing damage, including temporary or permanent hearing loss and chronic tinnitus. Implementing preventive measures, such as limiting listening duration and volume, avoiding headphone use in noisy environments, and having regular audiological checkups, could significantly help preserve the hearing health of young people.

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DECLARATION OF INTEREST

Authors declare no conflict of interests.

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