RESEARCH ARTICLE

Association Between Headphone Usage and Noise-Induced Hearing Loss Among Medical Students

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Abstract

Aim: Medical students are reported to use headphones for their educational and entertainment purposes. On the other hands, these devices have also been associated with a rising number of cases involving reduced hearing capabilities. This study aimed to evaluate the association between headphone usage and frequency of noise-induced hearing loss (NIHL) among medical students. Methods: A cross-sectional correlational study from Jan 2026 to May 2026. The study involved 104 medical students from various medical colleges across Pakistan. Data was collected, which included a self-assessment hearing test. Pilot testing on 4 participants of different age groups were done online and then audiometry was performed in the Otorhinolaryngology department of Abwa medical College, Faisalabad. After validating, the tool was circulated via google forms to various medical students. Self-reported auditory data were collected. Participants' self-reported auditory data were analyzed, and a hearing frequency test categorized them into normal (≥16001 Hz) and abnormal (≤16000 Hz) hearing groups according to the reference age related frequency table. Data was transferred to Excel and analyzed statistically. Student hearing frequencies were correlated with reported headphone volume and usage duration. A p-value less than 0.05 considered significant. One-way ANOVA test, chi-square test and independent t-test used to determine associations between headphone usage and hearing loss. Results: Out of 104 invited students, who returned the form with hearing test. Only 53.85% exhibited normal hearing thresholds. A significant association was found between NIHL and listening duration ($\chi^2 = 6.75$, $p = 0.0093$). Also between NIHL and volume ($\chi^2 = 8.32$, $p = 0.004$). One-way ANOVA has shown significant differences in hearing frequencies between safe and unsafe listening groups; ($F = 15.62$, $p = 0.000196$). Furthermore T-tests confirmed that prolonged exposure to high sound levels reduced hearing frequency significantly ($t = -12.59$, $p < 2.34 \times 10^{-18}$). Conclusion: This study highlights a significant association between prolonged, high-volume headphone usage. And early-onset hearing deterioration among medical students. The findings reinforce the urgent need for awareness campaigns on safe listening practices. This urges regular hearing assessments to mitigate risk of NIHL in young adults.

Keywords: Noise-induced hearing loss • medical students • personal listening devices • headphones • earphones • sensorineural hearing loss

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Introduction

Hearing impairment is a significant health concern. Thus affecting millions of individuals globally with varying demographics and geographics.[1] Noise-induced hearing loss (NIHL) arises from excessive and prolonged exposure to loud sounds. The auditory system comprises intricate mechanisms; the sensitive hair cells within the cochlea of the inner ear, make it highly vulnerable to damage.[2] Prolonged exposure to excessive noise levels can lead to irreversible damage to these hair cells, resulting in sensorineural hearing loss.[3]

If left unaddressed, NIHL progresses to deafness. Thus severely impacting an impacting individual's quality of life.[4] The consequences of hearing loss extend beyond the individuals affected. Hence placing an additional burden on families and communities.[5] The use of personal listening devices (headphones, earbuds) is identified as one of the key factors leading to NIHL.[6] These hair cells convert sound vibrations into electrical signals for the brain. Once lost, these hair cells cannot regenerate which leads to permanent hearing loss.[7] This concern is especially relevant among medical students who frequently use headphones in high-stress academic settings. Such patterns may accelerate hair cell damage and contribute to early-onset hearing loss.[8]

This study aims to determine the association between headphone usage and noise-induced hearing loss among medical students.[9] Raising awareness of the issue among the general public and medical students is crucial. By addressing it early, we can prevent the long-term

consequences of hearing loss.[10] This research will contribute to evidence-based policymaking and search for alternative solutions and promote development of safer audio technologies. This study seeks to encourage healthier listening practices and foster a culture of responsible audio device usage. Thus highlighting the potential risk of hearing loss with personal listening devices among students.[11]

Methodology

This analytical, cross-sectional correlational study was conducted online, and students from different medical colleges in Pakistan were invited.

Inclusion criteria comprised MBBS students from all five years of undergraduate medical education.

Exclusion criteria included non-medical students and postgraduate students, students already having sudatory disorders, those with pre-existing hearing disability, and students not using headphones.

The study was conducted from Jan 2026 to May 2026 and involved 104 undergraduate MBBS students. Convenience sampling was used due to feasibility and accessibility constraints. Participants were invited through social media platforms and academic WhatsApp groups using Google Forms performa. Out of 150 invited participants, 104 responded, and completed the hearing frequency test.

Ethical approval was obtained from the College's Ethical Review Committee of ABWA Medical College, Pakistan (Approval letter No. ABWA/MC/DME/956/2024).

Data was collected using a structured Google form.

The study questionnaire was developed following a literature review and included sections on demographic information, usage patterns of headphones, and a self-assessment of hearing ability. At the end of the form, participants completed a frequency-based audio recording test (https://www.arealme.com/hearing-test/en/?utm) and were instructed to identify and record the highest audible frequency they could detect, in the form.

Validation: Pilot testing on 4 participants of different age groups were done online and then audiometry was performed in the Otorhinolaryngology department of Abwa medical College, Faisalabad. After validating, the tool was circulated via google forms to various medical students

Humans acan generally sense sounds from 20Hz to 22000Hz. As the person ages or due to NIHL this frequency shrinks. Based on the arealme.com hearing test, the following table was used as a reference for normal age-related hearing thresholds:

Table 1. A Reference Age/Frequency Chart

Age	Highest hearable audible frequency (Hz)
9-24	17200-20200
25-44	13200-17200
45-64	9200-13200
65+	<9000

These ranges are based on the scientifically derived formula:

$$\text{age} \approx 110 - (\text{frequency} / 200) \text{ or } \text{frequency} \approx 200 \times (110 - \text{age})$$

The Classification of listening behaviours; 'safe' and 'dangerous' was based on guidelines of the National Health Service (NHS), UK. Guidelines recommend limiting exposure to sounds above 85dB to less than 8 hours per day, with duration decreasing as volume increases. NHS recommend listening to headphones or earbuds at no more than 60% of maximum volume for no longer than 60 minutes at a time to prevent hearing loss.[12]

Data anonymity and participant confidentiality were strictly maintained. Data were analyzed in Microsoft Excel, and statistical significance was determined using:

One-way ANOVA to compare the hearing frequencies between safe and unsafe listening groups.

Independent t-test to assess differences in hearing thresholds with respect to sound levels, and Chi-square tests to determine association between NIHL, listening volume, and duration.

A p=value <0.05 was considered statistically significant.

Results

Out of 150 invited participants, 104 completed the survey, and recorded their hearing frequencies using the online frequency test.

Demographic Data

The mean age of participants was 21.94 + 1.1 years. Majority students were from the age group 23-24 years (n=43, 41.3%). In terms of gender distribution, 42 were males (40.4%), and 62 were females (59.6%). Most students were enrolled in private medical colleges (n=88, 84.6%), and the highest representation was from the 4th and final year MBBS students (each n=30,28.8%) (See Table 2 below).

Table 2. Demographic distribution of our participants (n=104)

Variable	No. of Participants	Percentage %
Age Group		
19-20	24	23.1
21-22	35	33.7
23-24	43	41.3
25-26	02	1.9
Gender		
Male	42	40.4
Female	62	59.6
Institutional Affiliation		
Public	16	15.38
Private	88	84.61
Class Wise Distribution		
1st year MBBS	17	16.3
2nd year MBBS	17	16.3
3rd year MBBS	10	9.6
4th-year MBBS	30	28.8
5th year MBBS (Final year)	30	28.8

Patterns of usage of personal learning devices

Among participants, 53(51%) used earbuds, 15 (14.4%) used headphones, and 36 (34.6%) used both. Usage duration varied: 37 (35.6%) reported using devices for less than 1 hour/day, while 67(64.4%) exceeded 1 hour /day. Listening volume was also reported: 16 (15.4%) use safe levels (1-4), 50 (48.1%) used moderately unsafe levels5-7), 34 * 32.7%) used high unsafe levels (8-10), and 4 (3.8%) reported extreme usage (>10) (See Table 3).

Table 3. Patterns of Listening Device Usage (n=104)

Category of listening device used	No. of Participants	Percentage %
Earbuds	53	51
Headphones	15	14.4
Both	36	34.6
Duration/ Hours per day Usage Time		
Less than 1 hour	37	35.6
1-2 hours	32	30.8
3-4 hours	24	23.1
5-6 hours	8	7.7
>6 hours	3	2.9
Listening Volume Level		
1-4 (safe)	16	15.4%
5-7 (moderately unsafe)	50	48.1%
8-10 (highly unsafe)	34	32.7
10 above (extremely unsafe)	4	3.8

The following Table 4 categorizes the participants' usage patterns between safe and dangerous usage based on the NHS guidelines.

Table 4. Safe vs. Dangerous Usage Classification (based on NHS guidelines)

Listening Duration (Hours/Day)	Number (n)	**Percentage (%)**
≤ 1 hour		35.6
> 1 hour		64.4
Listening Level (Scale/Rate)		
1-4 (Low)	16	15.4
> 4 (Moderate to High)	88	84.6

Reported Hearing Loss Symptoms

Of 104 participants, 18 (17.3%) reported experiencing ringing/buzzing noise, while 15 (14.4%) reported muffled hearing (See Tabel 5)

Table 5. Self-Reported Hearing loss symptoms

	Number (n)	Percentage %
Ringing, Buzzing, Noise		
Yes	18	17.3
No	86	82.7
Temporary Hearing loss, Muffled hearing		
Yes	15	14.4
No	89	85.6

Self-Assessment of hearing loss

Of 104 respondents, who completed the frequency test. Only 56 participants (53.85%) reported normal hearing frequencies (>16001 Hz), consistent with age norms, while 48 participants (46.15% reported frequencies <16001 Hz, suggesting abnormal hearing levels (See Table 6).

Table 6. Self-reported frequencies by participants (n=104)

Reported Frequ	Count (n)	Percenta	Age- based Hearing Level

ncy Range (Hz)		ge (%)	
0-4000	9	8.65	Extremely Abnormal (65+ yrs)
4001-8000	4	3.85	Extremely Abnormal (65+ yrs)
8001-12000	19	18.27	Abnormal (45–64 yrs)
12001-16000	16	15.38	Abnormal (25–44 yrs)
16001-20000	55	52.88	Normal (≤24 yrs)
>20000	1	0.96	Normal (≤24 yrs)

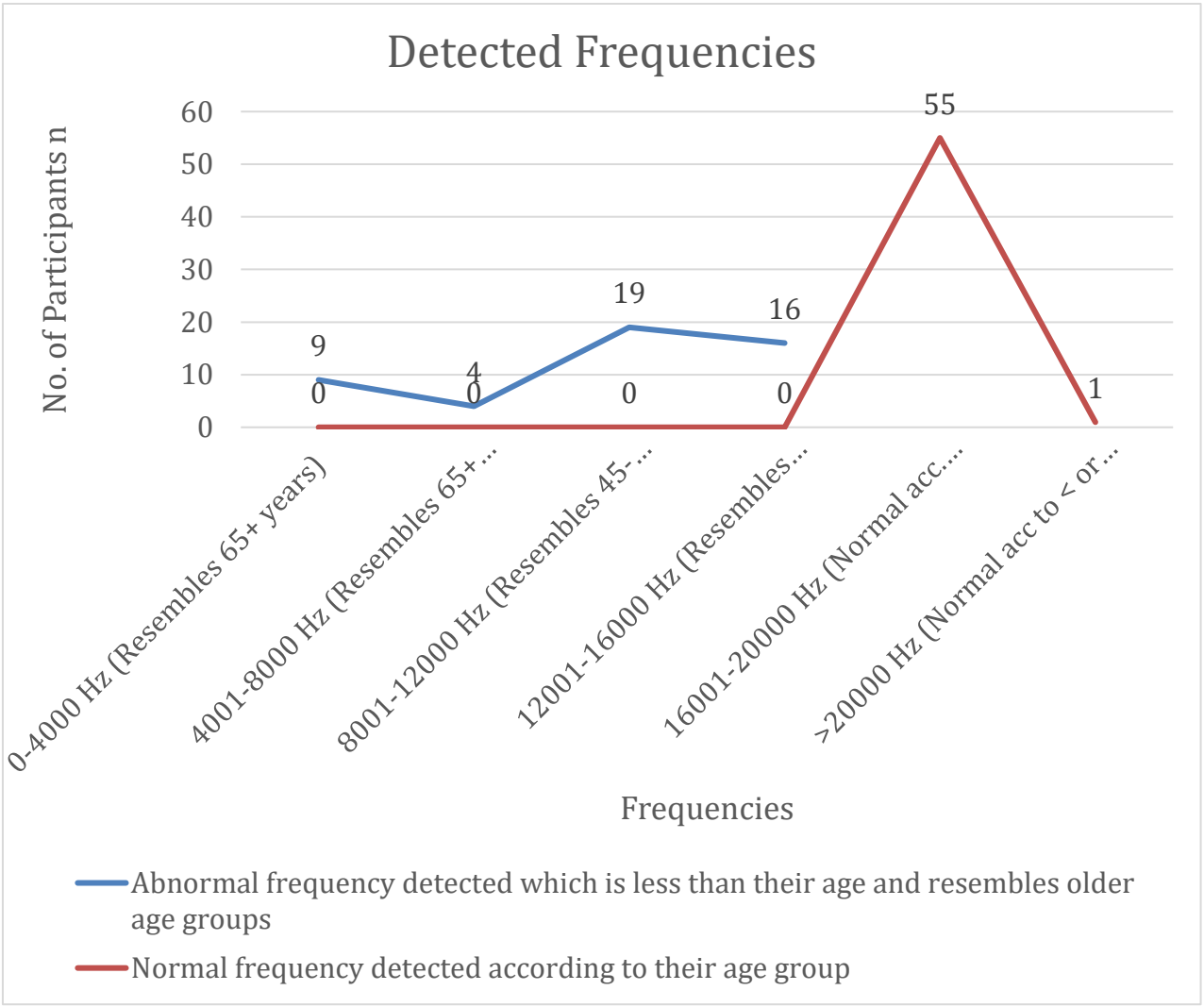


Figure 1. Detected Frequencies

The following table 7 presents the distribution of hearing frequencies across various listening durations and device volume levels among 104 participants completing the frequency test.

Table 7. Listening Duration and Volume Level vs. Reported frequency Hz (n=104)

	0-4000 Hz, n=9	4001-8000 Hz, n=4	8001-12000 Hz, n=19	12001-16000 Hz, n=16	16001-20000 Hz, n=55	>20000 Hz, n=1
Listening Duration						

<1 hour, n=37	4	2	5	5	20	1
1-2 hours, n=20	2	1	5	4	8	0
3-4 hours, n=20	1	1	5	4	9	0
5-6 hours, n=13	1	0	2	2	8	0
>6 hours, n=14	1	0	2	1	10	0
						Total=104

Hearing Scale/level/volume of device used						
	n=9	n=4	n=19	n=16	n=55	n=1
1-4, n=16	2	1	4	3	6	0
5-7, n=44	4	1	10	6	23	0
8-10, n=25	2	1	4	4	14	0
10 above, n=19	1	1	1	3	12	1
						Total=104

A One-Way ANOVA test revealed a statistically significant association between listening duration and hearing frequency.

$F = 116.40$, $p = 1.49 \times 10^{-13}$ ($p < 0.05$)

This indicates that prolonged exposure to listening devices significantly affects hearing thresholds.

NIHL and Listening Duration Association

To further assess the relationship between NIHL and listening duration participants were categorized into groups of having normal and abnormal hearing as shown in Table 8 below:

Table 8. Association between NIHL vs Duration (n=66)

NIHL Status	**Dangerous (>1 hour/day)**	**Safe (≤1 hour/day)**	**Total (n)**
Abnormal Hearing ≤16000 Hz	54 (50+4)	6 (5+1)	60

Normal Hearing ≥16001 Hz	8 (7+1)	6 (5+1)	14
Total	62	12	66

The Chi-square test showed a significant association:

$\chi^2 = 6.75$, $p = 0.0093$

This confirms that longer listening durations are significantly associated with NIHL among participants.

A similar analysis was conducted to demonstrate the relationship between NIHL and volume levels, as shown in Table 9 below.

Table 9. Association between NIHL vs Volume Level (n=66)

NIHL Status	**Dangerous Listening Level (5-10+)**	**Safe Listening Level (1-4)**	Total
Abnormal Hearing ≤16000 Hz	54	6	60
Normal Hearing ≥16001 Hz	6	0	6
Total	60	6	66

The Chi-square test showed a significant association:

$\chi^2 = 8.32$, $p = 0.004$

This confirms that higher listening volumes are significantly associated with NIHL among participants.

Discussion

This study assessed the association between headphone usage and noise-induced hearing loss (NIHL) among undergraduate medical students. By evaluating their usage patterns, the presence of transient auditory symptoms, and the highest perceivable audio frequencies. The findings closely align with the existing literature. Hence supporting the growing concern regarding personal audio device usage and its adverse impact on auditory health.

A study conducted in 2023 reported a significant association between prolonged headphone use and NIHL, particularly in academic settings such as online learning environments where improper headphone use was prevalent.[13] These results corroborate our findings, as our data show a marked decline in hearing frequencies among students with extended and high-volume usage., affirming auditory damage.

Similarly, research from 2022 highlighted that continuous exposure to high-volume headphone audio could significantly impair the auditory system, reinforcing the need for monitoring and preventive interventions.[14] In our study, 48.1% of participants reported using volume levels between 5-7, 32.7% between 8-10, and 3.8% exceeding levels of 10. These levels are above the recommended safe listening thresholds and suggest a considerable long-term risk of NIHL.

Additional evidence from a 2012 study identified specific demographic groups susceptible to NIHL. These include frequent loud music listeners, individuals exposed to occupational noise, and people lacking awareness of hearing protection measures.[15] Our study found 100% participants utilized personal listening devices for various activities; academic purposes, entertainment, and gaming. Another 2024 study revealed that although students were aware of NIHL, preventive measures were often disregarded. Hence emphasizing the gap between knowledge and practical implementation.[16] This underscores need for targeted awareness campaigns. Thus also intensifies the implementation of protective strategies in educational institutions and public health policy.

Consistent to previous literature, our findings identified tinnitus as a common symptom among frequent headphone users. A 2023 conducted study strengthens this observation,[17] as it identifies tinnitus as a prevalent symptom among frequent headphone users. A 2021 study established significant correlation between prolonged headphone use and auditory deterioration. Which ultimately leads to NIHL, especially in adolescents.[18] A metanalysis conducted in 2022 demonstrated that young adults are especially vulnerable to NIHL. This was due to prolonged exposure to high-volume sound through personal hearing devices[19]. As our study focused exclusively on young adults, these findings further substantiate the increased risk within this demographic.

Moreover, a 2022 study noted that students are moderately aware of NIHL. Only a small fraction actively engages in protective hearing practices, indicating a pressing need for further education and intervention strategies.[20] Our study reinforces this need by demonstrating the prevalence of high-risk listening behaviors even among informed medical students.

This study contributes to the growing body of evidence calling for the integration of NIHL prevention strategies into educational curricula, institutional policies, and broader public health campaigns. Longitudinal research is warranted to assess the progression of NIHL .Hence evaluating the long-term effectiveness of intervention measures among young adults. Its also important to reiterate recommendations by the National Health Service (NHS). NHS advises limiting headphones or earbud use to no more than 60% of maximum volume for a duration of not exceeding 60 minutes at a time to minimize the risk of hearing loss.[12]

Limitations and Future Directions

While convenience sampling enabled efficient data collection from a geographically diverse cohort, it may limit the generalizability of findings to the broader population of medical students. Future studies should consider probability based or stratified sampling techniques to enhance external validity as well as use larger sample sizes, and more complex variables that could benefit from advanced statistical software such as R or Python-based platforms to allow for multivariate or regression analysis and more robust data modelling. Another limitation of this study was using an online hearing frequency test, which may not offer the clinical precision of audiometric testing conducted in controlled environments. Future studies should use standardized audiometric equipment to validate and compare results. Nevertheless, the online tool provided a consistent baseline for relative frequency detection, particularly for preliminary screening purposes among young adults.

Conclusion

This study highlights a significant association between prolonged use of personal listening devices, particularly at high volumes, and early onset noise-induced hearing loss (NIHL) among undergraduate medical students. The vast majority of participants demonstrated a hearing frequency threshold below the expected age-related norms suggesting a concerning trend for early or retreating line in this population

Both listening duration and volume were found to be statistically associated with decreased hearing frequencies. These findings Given the growing reliance on headphones for academic and recreational purposes, early interventions, including public health messaging, routing, routine hearing screenings and promotion of safe listening behaviours, are essential for mitigating long-term auditory damage. This study underscores the role of. Medical education institutions foster responsible digital device use among students and contribute to preventing NIH in young adults.

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Conflict of interest

None to declare

Author's Contribution

Mubeen Safdar (Main Author): Idea Conception, design of work, Interpretation of data for work, Final approval of version to be published, Data analysis, Methodology, Tables, References, Interpretations.

Daniyal Abid (Co Author): Data collection and interpretation, Data analysis, Comparison with existing literature and review

Tayyab Sajjad: Questionnaire design and work

Ammar Asif: Initial Manuscript writing.

Noor-i-Kiran Naeem: Idea conception, Final Manuscript writing, Supervision

References

1. World Health Organization, *Deafness and hearing loss*. https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss.
2. Fettiplace, R. and C.M. Hackney, *The sensory and motor roles of auditory hair cells*. 2006. doi: 10.1038/nrn1828.
3. Liberman, M.C. and S.G. Kujawa, *Cochlear synaptopathy in acquired sensorineural hearing loss: Manifestations and mechanisms*. 2017. doi: 10.1016/j.heares.2017.01.003.
4. Monzani, D., et al., *Psychological profile and social behaviour of working adults with mild or moderate hearing loss*. Acta Otorhinolaryngologica Italica, 2008. 28(2).

5. Stevens, G., et al., *Global and regional hearing impairment prevalence: An analysis of 42 studies in 29 countries*. Eur J Public Health, 2013. 23(1). doi: 10.1093/eurpub/ckr176.

6. Le Prell, C.G., et al., *Extended high-frequency thresholds in college students: Effects of music player use and other recreational noise*. J Am Acad Audiol, 2013. 24(8). doi: 10.3766/jaaa.24.8.9.

7. Keppler, H., et al., *Short-term auditory effects of listening to an MP3 player*. Archives of Otolaryngology - Head and Neck Surgery, 2010. 136(6). doi: 10.1001/archoto.2010.84.

8. Masterson, E.A., et al., *Hearing Impairment Among Noise-Exposed Workers — United States, 2003–2012*. MMWR Morb Mortal Wkly Rep, 2016. 65(15). doi: 10.15585/mmwr.mm6515a2.

9. Hodoshima, N., *Correlation between a questionnaire about noise-induced hearing loss and spl of portable music players of high school and university students*. In: American Society of Mechanical Engineers, Noise Control and Acoustics Division (Publication) NCAD, 2012. doi: 10.1115/NCAD2012-1412.

10. Ding, T., A. Yan, and K. Liu, *What is noise-induced hearing loss?*. 2019. doi: 10.12968/hmed.2019.80.9.525.

11. Mohammadpoorasl, A., et al., *Prevalence and Pattern of Using Headphones and Its Relationship with Hearing Loss among Students*. Health Scope, 2018. 7(4). doi: 10.5812/jhealthscope.65901.

12. NHS UK, *Looking after your hearing*. https://www.royalfree.nhs.uk/patients-and-visitors/patient-information-leaflets/looking-after-your-hearing.

13. Gupta, A., S.S. Bakshi, and R. Kakkar, *Epidemiology and Risk Factors for Hearing Damage Among Adults Using Headphones via Mobile Applications*. Cureus, 2022. doi: 10.7759/cureus.25532.

14. Pavlova, G., S. Markelova, and V. Martiusheva, *Key hearing loss risk factors for children, adolescents and youth associated with use of mobile electronic devices with headphones*. Российский вестник гигиены, 2022. doi: 10.24075/rbh.2021.028.

15. Gilles, A., et al., *Prevalence of leisure noise-induced tinnitus and the attitude toward noise in university students*. Otology and Neurotology, 2012. 33(6). doi: 10.1097/MAO.0b013e31825d640a.

16. Alzahrani, R.A., et al., *Noise-Induced Hearing Loss Awareness and Prevention: A Cross-Sectional Study Among the Population of the Southern Region of Saudi Arabia*. Cureus, 2024. doi: 10.7759/cureus.66793.

17. Osmanoğlu, H., H.T. Dizdar, and A.A. Koçyiğit, *The effects of music listening time with headphones on hearing thresholds among the young population*. The Egyptian Journal of Otolaryngology, 2024. 40(1): p. 13.

18. Byeon, H., *Associations between adolescents' earphone usage in noisy environments, hearing loss, and self-reported hearing problems in a nationally representative sample of South Korean middle and high school students*. Medicine, 2021. 100(3): p. e24056.

19. Dillard, L.K., et al., *Prevalence and global estimates of unsafe listening practices in adolescents and young adults: a systematic review and meta-analysis*. BMJ Glob Health, 2022. 7(11): p. e010501.

20. AlQahtani, A.S., et al., *Awareness about the relation of noise induced hearing loss and use of headphones at Hail region*. Annals of Medicine & Surgery, 2022. 73. doi: 10.1016/j.amsu.2021.103113.