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### DECLARATIONS

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### ETHICAL APPROVAL

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# Association Between Headphones Usage Duration and Hearing Loss Symptoms Among Medical Students

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## ABSTRACT

**Background:** Prolonged use of personal listening devices has become increasingly prevalent among university students, raising concerns about early auditory damage due to unsafe listening practices. Medical students represent a high-risk group because of extended academic and recreational headphone use. **Objective:** To determine the association between the duration of headphone usage and self-reported hearing loss-related symptoms among medical students. **Methods:** A cross-sectional observational study was conducted from September to December 2024 among 264 medical students aged 18–26 years at two medical institutions in Lahore. Data were collected using a structured, self-administered questionnaire assessing headphone usage patterns, listening behaviors, and hearing-related symptoms on a five-point Likert scale. Associations between headphone usage duration and hearing-related symptoms were analyzed using the Chi-square test, with  $p < 0.05$  considered statistically significant. **Results:** The mean age of participants was  $21.73 \pm 2.01$  years, and 56.1% were female. Daily headphone use exceeded one hour in 68.6% of students, and 95.5% reported cumulative use for more than three years. A significant association was observed between daily headphone usage duration and frequency of asking others to repeat themselves ( $\chi^2 = 32.68, p < 0.001$ ), as well as between cumulative years of headphone use and difficulty hearing in noisy environments ( $\chi^2 = 25.10, p = 0.014$ ). **Conclusion:** Prolonged headphone usage is significantly associated with hearing-related symptoms among medical students. These findings highlight the need for targeted educational interventions to promote safe listening behaviors and reduce the risk of early auditory impairment.

### Keywords

Hearing loss; headphones; medical students; noise-induced hearing loss; listening habits

## INTRODUCTION

Hearing is a critical sensory function that underpins effective communication, learning, and social interaction, and even subtle impairments can adversely affect academic performance and quality of life. Sound perception depends on the integrity of the auditory system, particularly the cochlear hair cells, which transduce mechanical sound vibrations into neural signals. These sensory cells are highly vulnerable to damage from excessive noise exposure and, once injured, do not regenerate, resulting in permanent auditory deficits (1,2). Noise-induced hearing loss is therefore a major and largely preventable public health concern, with sustained exposure to sound levels exceeding 85 dB recognized as a principal risk factor for irreversible cochlear damage (3).

In recent years, personal listening devices especially headphones have emerged as a prominent source of prolonged and often unregulated noise exposure. The widespread use of smartphones and digital media has normalized extended headphone use for both academic and recreational purposes. The World Health Organization estimates that approximately 1.1 billion adolescents and young adults worldwide are at risk of hearing loss due to unsafe listening practices, including excessive volume levels and prolonged listening duration (4). Unlike occupational noise exposure, personal listening behaviors are largely self-directed, increasing vulnerability among young adults.

University students represent a particularly high-risk population due to frequent reliance on headphones for studying, online learning, and entertainment. Headphones deliver sound directly to the ear canal and can generate high sound pressure levels near the tympanic membrane, especially when used at elevated volumes or for extended periods (5). Prolonged exposure has been linked primarily to sensorineural hearing loss and early auditory symptoms such as tinnitus, hearing fatigue, and difficulty understanding speech in noisy environments (6). Even mild hearing impairment can lead to social isolation and reduced academic engagement (7).

Despite growing awareness, unsafe listening behaviors remain common among students. While international studies have explored headphone use and hearing outcomes, there is limited local evidence focusing on the association between usage duration and functional hearing symptoms among

medical students. Therefore, this study aimed to evaluate the association between the duration of headphone usage and hearing loss-related symptoms among medical students.

## MATERIALS AND METHODS

This descriptive observational study employed a cross-sectional design and was conducted from September 2024 to December 2024 at Fatima Memorial Hospital College of Medicine and Dentistry and the FMH Institute of Allied Health Sciences, Lahore. Undergraduate medical students aged 18–26 years enrolled at the participating institutions were recruited using convenience sampling, yielding a total sample size of 264 participants.

Data were collected using a self-designed, structured questionnaire. The instrument captured demographic information (age, gender, academic year, and living status) and headphone usage characteristics, including type of headphones (insert, supra-aural, circumaural), daily duration of use (<1 hour, 1–2 hours, 2–4 hours, 4–6 hours), and cumulative years of use (1–3 years, 3–5 years, 5–8 years, >8 years). Listening behaviors and hearing-related symptoms were assessed using a five-point Likert scale (never, rarely, sometimes, often, always). Symptom domains included hearing fatigue, tinnitus, ear pain, difficulty hearing conversations in noisy environments, perception of others mumbling, and frequency of asking others to repeat themselves.

Data were entered and analyzed using IBM SPSS Statistics version 27. Categorical variables were summarized using frequencies and percentages, and continuous variables were summarized using means and standard deviations. Associations between headphone usage duration and hearing-related symptoms were assessed using the Chi-square test. Statistical significance was set at  $p < 0.05$ .

## RESULTS

A total of 264 medical students aged 18–26 years participated in the study. The mean age of the participants was  $21.73 \pm 2.01$  years. Females constituted 56.1% ( $n=148$ ) of the sample, while males accounted for 43.9% ( $n=116$ ). Most participants were in their final academic year (34.5%), followed by first-year (19.7%), fourth-year (17.0%), third-year (16.3%), and second-year students (12.5%). Regarding living arrangements, 73.5% resided with family, 22.3% were hostel residents, and 4.2% reported other arrangements. Insert-type headphones were the most commonly used (71.6%), followed by supra-aural (23.1%) and circumaural headphones (5.3%). Daily headphone use was most frequently reported as 1–2 hours (32.6%) and less than 1 hour (31.4%), while 21.2% reported 2–4 hours and 14.8% reported 4–6 hours of use per day. More than half of the participants (54.2%) had been using headphones for 3–5 years, and 41.3% reported cumulative use of 5–8 years (Table 1).

**Table 1. Demographic and Headphone Usage Characteristics of Participants ( $n=264$ )**

Variable	Category	Frequency (%)
Age (years)	Mean $\pm$ SD	21.73 $\pm$ 2.01
Gender	Male	116 (43.9)
	Female	148 (56.1)
Academic year	First	52 (19.7)
	Second	33 (12.5)
	Third	43 (16.3)
	Fourth	45 (17.0)
	Final	91 (34.5)
Living status	With family	194 (73.5)
	Hostel	59 (22.3)
	Other	11 (4.2)
Headphone type	Insert	189 (71.6)
	Supra-aural	61 (23.1)
	Circumaural	14 (5.3)
Daily duration	<1 hour	83 (31.4)
	1–2 hours	86 (32.6)
	2–4 hours	56 (21.2)
	4–6 hours	39 (14.8)
Years of use	1–3 years	11 (4.2)
	3–5 years	143 (54.2)
	5–8 years	109 (41.3)
	>8 years	1 (0.4)

**Table 2. Distribution of Headphone-Related Behaviors and Hearing Symptoms ( $n=264$ )**

Variable	Never n (%)	Rarely n (%)	Sometimes n (%)	Often n (%)	Always n (%)
Use headphones at high volume	19 (7.2)	55 (20.8)	62 (23.5)	69 (26.1)	59 (22.3)
Take breaks during use	30 (11.4)	43 (16.3)	92 (34.8)	56 (21.2)	43 (16.3)
Notice hearing fatigue	49 (18.6)	56 (21.2)	87 (33.0)	48 (18.2)	24 (9.1)
Experience tinnitus	81 (30.7)	68 (25.8)	74 (28.0)	29 (11.0)	12 (4.5)
Difficulty hearing in noise	36 (13.6)	51 (19.3)	91 (34.5)	54 (20.5)	32 (12.1)
Ask people to repeat	28 (10.6)	59 (22.3)	119 (45.1)	41 (15.5)	17 (6.4)

Behavioral patterns and auditory symptoms associated with headphone use are summarized in Table 2. High-volume listening was reported as often or always by 48.4% of participants, while only 3.8% consistently monitored their headphone usage duration. Hearing-related symptoms were common: 33.0% reported sometimes experiencing hearing fatigue, 28.0% reported tinnitus sometimes, and 34.5% reported sometimes having difficulty hearing conversations in noisy environments. Asking others to repeat themselves was reported sometimes by 45.1% and often or always by 21.9% of participants.

**Table 3. Association Between Daily Headphone Usage and Asking People to Repeat Themselves**

Daily duration	Never	Rarely	Sometimes	Often	Always	$\chi^2$	p-value
<1 hour	18	19	35	9	2	32.68	<0.001
1–2 hours	4	27	35	11	9		
2–4 hours	2	10	28	12	4		
4–6 hours	4	3	21	9	2		

A statistically significant association was observed between daily duration of headphone use and frequency of asking people to repeat themselves ( $\chi^2 = 32.68$ ,  $p < 0.001$ ). Participants using headphones for longer durations demonstrated progressively higher frequencies of reporting this symptom (Table 3). The effect size, estimated using Cramer's V, indicated a moderate association ( $V = 0.25$ ).

**Table 4. Association Between Years of Headphone Usage and Difficulty Hearing in Noisy Environments**

Years of use	Never	Rarely	Sometimes	Often	Always	$\chi^2$	p-value
1–3 years	4	2	3	0	2	25.10	0.014
3–5 years	23	33	50	24	13		
5–8 years	8	16	38	30	17		
>8 years	1	0	0	0	0		

Similarly, cumulative years of headphone use were significantly associated with difficulty hearing conversations in noisy environments ( $\chi^2 = 25.10$ ,  $p = 0.014$ ), with a small-to-moderate effect size (Cramer's  $V = 0.22$ ). Increased cumulative exposure was associated with higher frequencies of reported difficulty (Table 4).

## DISCUSSION

The present study demonstrates statistically significant associations between prolonged headphone use and self-reported hearing-related symptoms among medical students, supporting growing evidence that unsafe listening is a major, preventable contributor to early auditory morbidity in young adults. Globally, unsafe listening practices remain widespread; a systematic review and meta-analysis estimated substantial exposure to potentially harmful sound levels among adolescents and young adults, placing a large proportion at risk for hearing loss (14). The symptom burden observed in the current cohort particularly speech perception difficulties has important clinical relevance, as such functional complaints may precede audiometrically detectable hearing loss.

A key finding was the significant association between daily headphone usage duration and asking others to repeat themselves, an indicator of reduced speech understanding. Similar findings have been reported in student populations, where prolonged headphone use was associated with higher hearing-related risk scores (8). Although causal inference cannot be established due to the cross-sectional design, the observed exposure response pattern strengthens biological plausibility.

The association between cumulative years of headphone use and difficulty hearing in noisy environments further supports the concept of cumulative auditory damage. Speech-in-noise difficulty is increasingly recognized as an early manifestation of noise-related cochlear neural injury, even in individuals with normal pure-tone thresholds (15). The findings of the present study align with this mechanistic framework.

Risk behaviors were prevalent in the cohort, including frequent high-volume listening and limited monitoring of listening duration. Similar patterns have been documented among adolescents and young adults in prior studies (13). Preventive strategies endorsed by the WHO–ITU global standard emphasize exposure monitoring, volume limitation, and user education to mitigate these risks (16). The predominance of insert-type headphones is clinically relevant, as earphone design influences preferred listening levels and sound exposure (10). According to noise-risk estimation frameworks, both intensity and duration of exposure contribute to the probability of noise-induced hearing loss (17).

Limitations include reliance on self-reported data, absence of audiometric confirmation, and convenience sampling, which may limit generalizability. Nevertheless, the consistent duration-dependent associations observed provide a strong rationale for preventive interventions and further research incorporating objective hearing assessments.

## CONCLUSION

Prolonged headphone usage is significantly associated with self-reported hearing-related symptoms among medical students. Increased daily listening duration and longer cumulative exposure were linked to functional auditory difficulties, particularly in speech understanding. These findings highlight the importance of promoting safe listening behaviors, including volume moderation, time limitation, and regular listening breaks, to reduce the risk of early auditory impairment in young adults.

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