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Personal Audio Device Use, Safe Listening Awareness And Hearing-Related Symptoms Among Medical Students: A Cross-Sectional Study

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Abstract
Background: *The widespread use of personal audio devices (PADs), particularly wireless earbuds and headphones, has raised concerns regarding recreational noise exposure and its potential impact on hearing health among young adults. Medical students constitute a population at risk because of frequent and prolonged use of these devices. This pilot study assessed PAD usage patterns, hearing-related symptoms, awareness of safe listening practices, and willingness to adopt healthier listening behaviours among undergraduate medical students.*
Methods: *A descriptive cross-sectional pilot study was conducted among 51 undergraduate medical students using a structured, self-administered online questionnaire. Information regarding demographic characteristics, type and duration of PAD use, preferred listening volume, hearing-related symptoms, awareness of safe listening practices, and willingness to modify listening behaviour after hearing-health education was collected. Data were analysed using descriptive statistics and presented as frequencies and percentages.*
Results: *All participants (100%) reported using personal audio devices. Wireless earbuds were the most commonly used devices (88.2%). Nearly half of the participants (45.1%) had been using PADs for 3–5 years, while 41.2% reported daily use of 1–2 hours. Most participants preferred listening at 40–60% of the maximum device volume (51.0%). The majority (74.5%) reported no hearing-related symptoms; however, tinnitus was reported by 13.7%, ear fullness by 7.8%, reduced hearing by 5.9%, difficulty understanding speech by 3.9%, and temporary hearing loss by 2.0% of participants. Following hearing-health education, 96.1% expressed willingness to adopt safer listening practices by reducing listening volume.*
Conclusion: *Personal audio device use was universal among the surveyed medical students. Although most participants reported moderate listening habits and no hearing-related symptoms, the occurrence of tinnitus and other auditory complaints highlights the importance of preventive strategies. The high willingness to adopt safer listening practices suggests that hearing-health education may be an effective intervention. Larger multicentre studies incorporating objective audiological assessments are recommended to validate these findings.*
Keywords: *Personal audio devices; Recreational noise; Safe listening; Hearing health; Noise-induced hearing loss; Medical students; Tinnitus; Cross-sectional study.*

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I. Introduction

The rapid advancement of digital technology has led to a remarkable increase in the use of personal audio devices (PADs), including smartphones, wireless earbuds, headphones, and portable music players. These devices have become an integral part of daily life, particularly among adolescents and young adults owing to their convenience, portability, and widespread availability. While PADs offer significant benefits for communication, education, and entertainment, prolonged use at high listening volumes has raised concerns regarding recreational noise exposure and its adverse effects on hearing health [1,4,10].

Noise-induced hearing loss (NIHL) is one of the most common preventable causes of sensorineural hearing loss worldwide. Although traditionally associated with occupational noise exposure, NIHL is increasingly recognized among young individuals because of unsafe recreational listening practices. Exposure to excessive sound through personal listening devices may produce temporary threshold shifts, tinnitus, cochlear injury, and eventually permanent hearing loss depending on both the intensity and duration of exposure [2,3,6,11,16].

Recent technological advances and the widespread availability of smartphones and wireless earbuds have substantially increased recreational noise exposure among adolescents and young adults. Several studies have demonstrated that many users listen at sound levels exceeding internationally recommended safety limits, thereby increasing the risk of auditory damage [9,15,18,23,32].

The World Health Organization (WHO) estimates that more than one billion adolescents and young adults worldwide are at risk of hearing loss due to unsafe listening practices. To address this growing public health concern, WHO launched the Make Listening Safe initiative and, in collaboration with the International Telecommunication Union (ITU), developed the Global Standard for Safe Listening Devices and Systems, promoting safer listening behaviours through volume limitation, exposure monitoring, and user education [37,38,40].

The likelihood of hearing damage depends on cumulative noise exposure. Experimental and clinical studies have demonstrated that prolonged exposure to excessive sound levels may result in irreversible cochlear hair-cell damage and cochlear synaptopathy ("hidden hearing loss"), even when conventional audiometric thresholds initially recover. Early manifestations include tinnitus, difficulty understanding speech in noisy environments, and temporary threshold shifts before permanent sensorineural hearing loss develops [16,20,23,33–35].

Medical students constitute an important population for studying personal audio device use because smartphones and digital learning platforms are extensively integrated into their academic and personal lives. Long study hours, online educational activities, and frequent use of wireless earbuds may increase cumulative recreational noise exposure. As future healthcare professionals, their awareness of safe listening practices is particularly important, both for protecting their own hearing and for educating patients regarding hearing conservation [13,14,24,30–32].

Although several international studies have investigated listening behaviours and hearing-related symptoms associated with personal audio device use, published data from Indian medical students remain relatively limited. Most available studies have focused on adolescents or the general college population, highlighting the need for institution-specific data regarding listening patterns, hearing-related symptoms, and awareness of safe listening practices among medical undergraduates [15,19,26–29].

Therefore, the present pilot cross-sectional study was undertaken to assess the patterns of personal audio device use, preferred listening practices, hearing-related symptoms, awareness regarding safe listening, and willingness to adopt safer listening behaviours following hearing-health education among undergraduate medical students. The findings may provide baseline evidence for future multicentre studies and support the development of educational interventions aimed at preventing recreational noise-induced hearing loss among young adults [36–40]

Effective postoperative analgesia is a cornerstone of surgical recovery [1]. Conventional systemic opioids and NSAIDs often present side effects such as respiratory depression or gastric irritation [2]. Transdermal drug delivery systems (TDDS) bypass first-pass metabolism and provide a controlled release of medication [3, 9]. This study evaluates if the transdermal diclofenac patch can match or exceed the efficacy of the traditional intramuscular route in lower abdominal surgical cases [10]

II. Material And Methods

This descriptive cross-sectional pilot study was carried out in the Department of Otorhinolaryngology, Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bengaluru, from June 2026 to July 2026. A total of 51 undergraduate medical students participated in the study [14,24].

Study Design

Descriptive cross-sectional study**.**

Study Location

This was a tertiary care teaching hospital-based study conducted in the Department of Otorhinolaryngology, Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bengaluru.

Study Duration

June 2026 to July 2026.

Sample Size

A total of 51 undergraduate medical students were included in the study.

Sample Size Justification

As this was a pilot study, a formal sample size calculation was not performed. A convenience sample of 51 undergraduate medical students was recruited to evaluate the feasibility of the study, assess patterns of personal audio device use, identify self-reported hearing-related symptoms, and generate preliminary data for future large-scale studies [24,30,32].

Study Population and Sampling Method

The study population comprised undergraduate medical students enrolled at Akash Institute of Medical Sciences and Research Centre during the study period. Participants were recruited using convenience sampling after obtaining voluntary electronic informed consent. Participation was anonymous, and each participant was allowed to submit only one response [14,24].

Inclusion Criteria

1. Undergraduate medical students aged 18 years and above.
2. Students currently enrolled at Akash Institute of Medical Sciences and Research Centre.
3. Students who reported using at least one personal audio device.
4. Students who provided electronic informed consent.
5. Students who completed the questionnaire in its entirety.

Exclusion Criteria

1. Students unwilling to participate in the study.
2. Incomplete or duplicate questionnaire responses.
3. Individuals with a previously diagnosed hearing impairment or chronic otological disease (self-reported).
4. Students with a history of ear surgery or congenital hearing disorders (self-reported).

Procedure Methodology

After obtaining approval from the Institutional Ethics Committee and electronic informed consent from all participants, data were collected using a structured, self-administered online questionnaire developed after reviewing the relevant literature on recreational noise exposure, hearing conservation, and safe listening practices [18,24,30,37,40].

The questionnaire consisted of four sections:

- Demographic characteristics (age and gender).
- Personal audio device usage patterns, including type of device, duration of use, average daily listening time, and preferred listening volume.
- Self-reported hearing-related symptoms such as tinnitus, ear fullness, reduced hearing, temporary hearing loss, and difficulty understanding speech.
- Awareness regarding safe listening practices and willingness to modify listening behaviour following hearing-health education.

The questionnaire was distributed electronically using Google Forms. Participation was voluntary, anonymous, and confidential. Responses were automatically recorded into a secure electronic database. Duplicate responses were excluded before analysis.

Outcome Measures

The primary outcome measures included:

- Pattern of personal audio device use.
- Type of personal audio device used.
- Duration of personal audio device use.
- Average daily listening duration.
- Preferred listening volume.
- Self-reported hearing-related symptoms.
- Awareness regarding safe listening practices.
- Willingness to adopt safer listening behaviours following hearing-health education.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using IBM SPSS Statistics Version 26.0 (IBM Corp., Armonk, NY, USA) [24]. Descriptive statistics were used for data analysis. Categorical variables were expressed as frequencies and percentages, whereas continuous variables, where applicable, were summarized as mean ± standard deviation (SD). As this was an exploratory pilot study with a relatively small sample size, no inferential statistical tests were performed, and the findings are presented descriptively [24,30]

III. Result

Demographic Characteristics

Table No. 1: Demographic Characteristics of Study Participants (N = 51)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	18	35.3
Female	33	64.7
Total	**51**	**100**

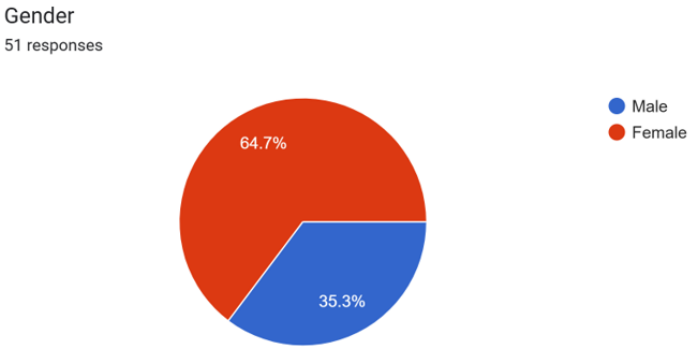

Figure 1. Gender distribution of study participants.

Table No. 2: Type of Personal Audio Device Used (N = 51)

Type of Device	Frequency (n)	Percentage (%)
Wireless earbuds	45	88.2
Wired earphones	6	11.8
Total	**51**	**100**

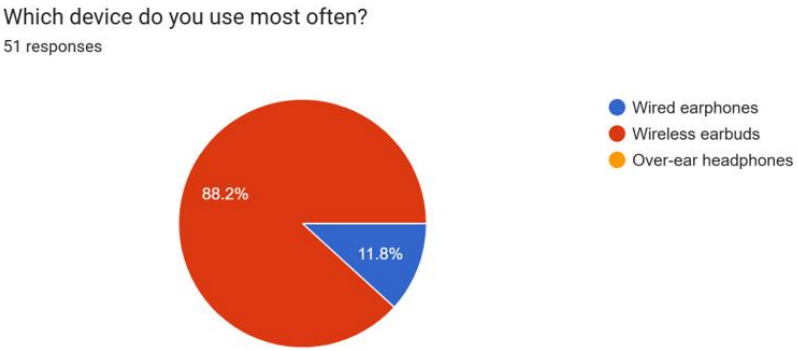

Figure 2. Distribution of personal audio devices used by participants.

Table No. 3: Duration of Personal Audio Device Use (N = 51)

Duration of Use	Frequency (n)	Percentage (%)
<1 year	4	7.8
1–2 years	16	31.4
3–5 years	23	45.1
>5 years	8	15.7
Total	**51**	**100**

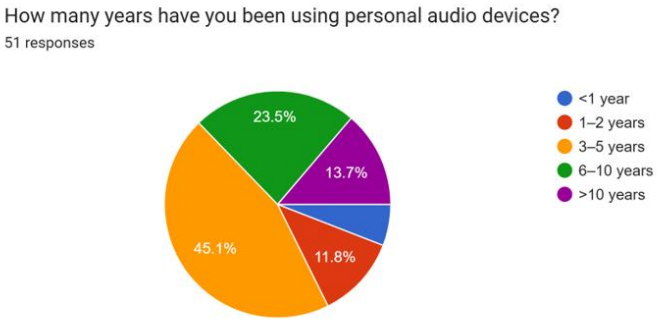

Figure 3. Duration of personal audio device use among participants.

Table No. 4: Daily Duration of Personal Audio Device Use (N = 51)

Daily Listening Duration	Frequency (n)	Percentage (%)
<1 hour	8	15.7
1–2 hours	21	41.2
2–4 hours	18	35.3
>4 hours	4	7.8
Total	**51**	**100**

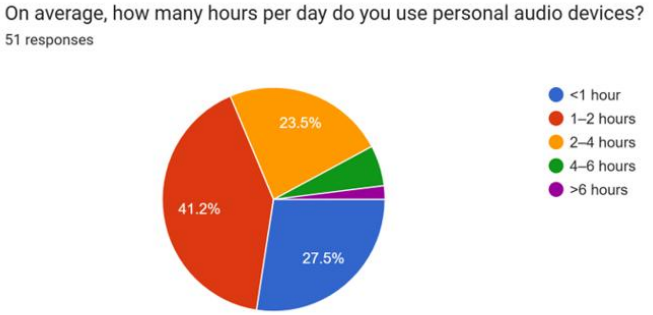

Figure 4. Average daily duration of personal audio device use.

Table No. 5: Preferred Listening Volume (N = 51)

Preferred Volume	Frequency (n)	Percentage (%)
<40%	12	23.5
40–60%	26	51.0
>60%	13	25.5
Total	**51**	**100**

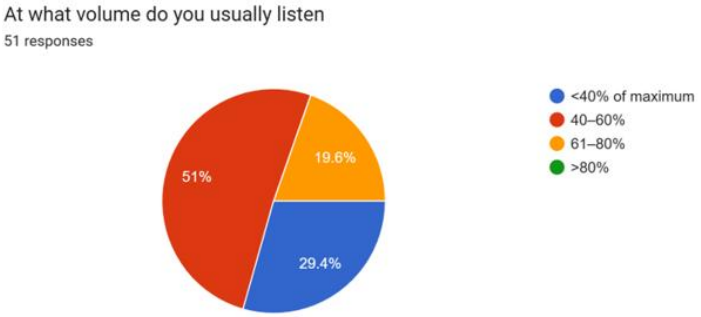

Figure 5. Preferred listening volume among participants.

Table No. 6: Self-reported Hearing-related Symptoms (N = 51)

Symptom	Frequency (n)	Percentage (%)
No symptoms	38	74.5
Tinnitus	7	13.7
Ear fullness	4	7.8
Reduced hearing	3	5.9
Difficulty understanding speech	2	3.9
Temporary hearing loss	1	2.0

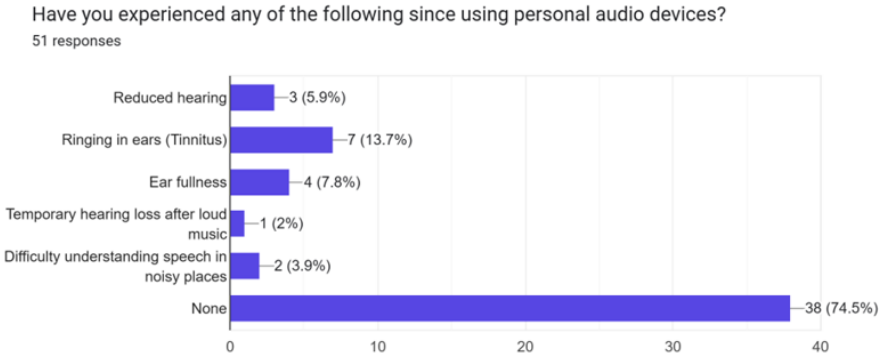

Figure 6. Distribution of self-reported hearing-related symptoms.

Table No. 7: Willingness to Adopt Safer Listening Practices Following Hearing-health Education (N = 51)

Response	Frequency (n)	Percentage (%)
Yes	49	96.1
No	2	3.9
Total	**51**	**100**

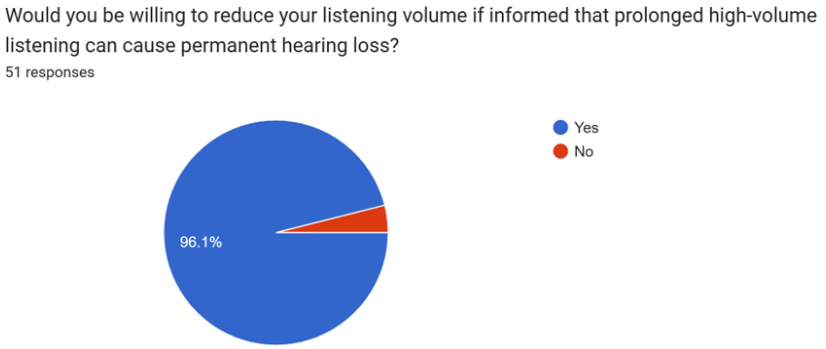

Figure 7. Willingness to adopt safer listening practices following hearing-health education.

IV. Discussion

The present descriptive cross-sectional pilot study was conducted to evaluate the pattern of personal audio device (PAD) use, hearing-related symptoms, awareness regarding safe listening practices, and willingness to adopt healthier listening behaviours among undergraduate medical students. With the increasing popularity of smartphones and wireless listening devices, recreational noise exposure has become an important public health concern among young adults. The findings of the present study provide preliminary data regarding listening habits and hearing-health awareness in this population.

The present study demonstrated that 100% of the participants reported using personal audio devices, indicating the universal adoption of these devices among undergraduate medical students. Wireless earbuds were the most commonly used listening devices, accounting for 88.2% of users. These findings are consistent with the observations of Vogel et al. and Sulaiman et al., who reported widespread use of portable listening devices among

adolescents and young adults owing to their convenience and portability [14,18,24]. The increasing preference for wireless earbuds reflects recent technological trends and may contribute to prolonged daily listening because of their ease of use [32,37].

The majority of participants (45.1%) had been using personal audio devices for 3–5 years, and 41.2% reported an average listening duration of 1–2 hours per day. These findings suggest sustained exposure to recreational noise over several years. Similar listening patterns have been reported by Serra et al., Portnuff, and Keppler et al., who emphasized that cumulative duration of exposure plays an important role in the development of noise-induced hearing damage [9,28,30–32]. Although most participants in the present study reported listening within a moderate daily duration, prolonged cumulative exposure over several years may still increase the risk of auditory injury.

More than half of the participants (51.0%) preferred listening at 40–60% of the maximum device volume, while approximately one-quarter reported using higher listening volumes. The World Health Organization recommends maintaining listening volumes below 60% of the maximum output and limiting exposure duration to reduce the risk of recreational noise-induced hearing loss [37,38,40]. Similar recommendations have been highlighted by Fligor and Cox and Breinbauer et al., who demonstrated that many commercially available personal listening devices are capable of producing sound levels exceeding safe exposure limits [6,22].

The majority of participants (74.5%) reported no hearing-related symptoms, suggesting that most students had not experienced clinically significant auditory complaints. However, tinnitus (13.7%) was the most frequently reported symptom, followed by ear fullness (7.8%), reduced hearing (5.9%), difficulty understanding speech (3.9%), and temporary hearing loss (2.0%). These findings are comparable with studies by Widén and Erlandsson, Figueiredo et al., and Vogel et al., who also identified tinnitus as one of the earliest and most common symptoms associated with recreational noise exposure among young adults [7,20,29]. Experimental studies have suggested that such symptoms may represent early cochlear injury even in individuals with apparently normal hearing thresholds [16,33–35].

An important finding of the present study was that 96.1% of participants expressed willingness to adopt safer listening practices after receiving hearing-health education. This observation indicates a high level of receptiveness toward preventive interventions among medical students. Similar findings have been reported by Keppler et al. and the World Health Organization, which emphasize that educational programmes and awareness campaigns can positively influence listening behaviours and reduce the future burden of recreational noise-induced hearing loss [25,30,37,40].

Medical students represent future healthcare professionals who are expected to play an important role in promoting hearing conservation and preventive health education. Improving their knowledge regarding safe listening practices may have a multiplier effect, as they can subsequently educate patients and the general public regarding the prevention of recreational noise-induced hearing loss. Therefore, incorporating hearing-health education into undergraduate medical curricula may contribute to improved awareness and healthier listening behaviours [30,37,38].

Although the present study was limited by its pilot design and relatively small sample size, it provides valuable baseline information regarding personal audio device use and hearing-health awareness among undergraduate medical students. The findings may assist in planning larger multicentre studies incorporating objective audiological assessments such as pure-tone audiometry and otoacoustic emissions to better evaluate the relationship between recreational noise exposure and hearing outcomes [23,33,38].

Overall, the present study demonstrates that personal audio device use is nearly universal among undergraduate medical students. While most participants reported moderate listening habits and no hearing-related symptoms, the occurrence of tinnitus and other auditory complaints highlights the importance of early preventive strategies. The high willingness to adopt safer listening practices following hearing-health education supports the implementation of awareness programmes aimed at promoting hearing conservation and reducing the future burden of recreational noise-induced hearing loss among young adults [37,38,40].

V. Conclusion

The present descriptive cross-sectional pilot study provides valuable baseline information regarding personal audio device (PAD) usage patterns, hearing-related symptoms, awareness of safe listening practices, and willingness to adopt healthier listening behaviours among undergraduate medical students. The study demonstrated that the use of personal audio devices was universal among the participants, with wireless earbuds being the predominant listening device. Most students reported listening for 1–2 hours per day at a preferred volume of 40–60% of the maximum device output, indicating generally moderate listening practices.

Although the majority of participants did not report hearing-related symptoms, a notable proportion experienced tinnitus, ear fullness, reduced hearing, difficulty understanding speech, and temporary hearing loss. These findings suggest that even in a relatively young and healthy population, recreational noise exposure from personal audio devices may be associated with early auditory symptoms. Such symptoms should not be

overlooked, as they may represent the initial manifestations of noise-induced cochlear damage and highlight the need for early preventive interventions [16,23,33–35].

An important finding of the present study was the high level of willingness (96.1%) among participants to adopt safer listening practices following hearing-health education. This emphasizes the positive impact of educational interventions and suggests that increasing awareness regarding safe listening recommendations may substantially improve listening behaviours and reduce the long-term risk of recreational noise-induced hearing loss. These observations are consistent with the objectives of the World Health Organization's "Make Listening Safe" initiative, which advocates safe listening practices as an effective strategy for hearing conservation [37,38,40].

As future healthcare professionals, medical students have an important responsibility not only to protect their own hearing but also to promote hearing-health awareness among patients and the wider community. Incorporating hearing conservation and safe-listening education into undergraduate medical training may therefore have both individual and broader public health benefits.

Despite the limitations of a single-centre pilot study with a relatively small sample size and reliance on self-reported data, the present study provides important preliminary evidence regarding listening behaviours and hearing-health awareness among medical students. The findings may serve as baseline data for future investigations and contribute to the development of preventive hearing-health programmes in educational institutions.

In conclusion, the present study highlights the widespread use of personal audio devices among undergraduate medical students and underscores the importance of promoting safe listening practices to prevent recreational noise-induced hearing loss. Early hearing-health education, regular awareness programmes, and adherence to internationally recommended safe-listening guidelines should be encouraged to preserve hearing health among young adults. Future multicentre longitudinal studies incorporating objective audiological assessments, such as pure-tone audiometry, otoacoustic emissions, and high-frequency audiometry, are recommended to further clarify the long-term effects of personal audio device use on hearing health and to guide evidence-based preventive strategies [23,33,37,38,40].

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