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Assessment Of Hearing Loss Associated With Headphone Usage Among Medical Students Using Pure Tone Audiometry

Dr Syed Sadiq Ul Ameen[1], Dr Ashwini S Doddamani[2], Dr K L Shivakumar[3], Dr Rachna Shetty[4],Mr Yadunandan M J[5]

[1]*Junior Resident, Department Of Ent, Shridevi Institute Of Medical Sciences And Research Hospital, Tumakuru, Karnataka.*
[2]*Assistant Professor, Department Of Ent, Shridevi Institute Of Medical Sciences And Research Hospital, Tumakuru, Karnataka.*
[3]*Professor And Head Of Department, Department Of Ent, Shridevi Institute Of Medical Sciences And Research Hospital, Tumakuru, Karnataka.*
[4]*Junior Resident, Department Of Ent, Shridevi Institute Of Medical Sciences And Research Hospital, Tumakuru, Karnataka.*
[5]*Consultant Audiologist, Department Of Audiology, Shridevi Institute Of Medical Sciences And Research Hospital, Tumakuru, Karnataka.*

Abstract
Background: *The study aimed to assess and identify factors causing noise-induced hearing loss among medical students using headphone, emphasizing the need for promoting awareness and analyzing listening habits.*
Materials and Methods: *A two-month cross-sectional study was conducted on 180 medical students at Shidevi Institute of Medical Sciences and Research Hospital, Tumakuru, Karnataka, focusing on socio-demographic details. In this study 23-item questionnaires were given to the participants regarding demographic and earphones and their usage patterns and the relationship between the uses of headphone and also additionally 18-item questionnaires were given to the participants regarding hearing assessment questions of headphone and their usage. The participants underwent a clinical examination for external auditory canal pathology and were prepared for PTA.*
Results: *The study involved 180 participants aged 18-30 years, with a significant association between gender and hearing loss scores. The majority were single and lived in their parents' homes. Among the subjects, 169 (94%) had normal PTA, and 13 (7.22%) had 4K dips in PTA. Hearing problems were prevalent, with 58 (32.22%), mild (25.56%), moderate (11.11%), and severe (3.6%) scores. The majority were using earphones (93.33%), with a significant association between usage and hearing loss. The volume of earphones used was also significant, with 18.45% using high volume (75% and above) and a higher score of hearing loss. About 72.02% of participants had been warned about the dangers of loud music, leading to 63.39% changing their behavior. The frequency of using headphones per week was highest among participants (61.90%), with 32.74% using them more than 4 days per week. Over half of the participants experienced nothing regarding hearing problems. Hearing from behind was reported by 14.29%, while soft sounds were experienced by 89.29%.*
Conclusion: *The study reveals high hearing loss rates among medical students in Shidevi Institute of Medical Sciences and Research Hospital, Tumakuru, Karnataka due to earphone usage. The findings suggest the need for further research on interventions and strategies to improve students' awareness and attitude towards personal listening devices, as noise exposure can have cumulative negative effects on hearing.*
Keywords: *Medical students, Personal listening devices (PLDs), Pure Tone Average(PTA).*

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I. Introduction

This study investigates the impact of headphones usage on hearing among medical college students, examining daytime, nighttime, driving, and sleep patterns and determining knowledge about noise-induced hearing loss.[1] The increasing use of personal listening devices (PLDs) like headphones has led to a significant increase in exposure to high sound levels during leisure time.[2] Most youngsters are currently using headphones, with an average usage of 2 hours per day.[3-6] Headphone usage among medical students can significantly

influence their academic performance, health, psychological well-being, professionalism, technology integration, and cultural and generational trends.[7]

Excessive use of headphones can lead to distraction, reduced focus, and lower academic achievement. Prolonged headphone use can also contribute to hearing loss and other auditory issues, raising awareness about potential health risks and promoting healthier listening habits.[8, 9] Psychological effects of headphone use can include increased stress levels or social isolation, requiring further investigation.[10] Professionalism and patient care are also affected by headphone usage, affecting communication and maintaining professionalism in clinical settings.[11]

Pure-tone audiometry is a widely used audiological examination to determine hearing normality or impairment. It measures air conduction and bone conduction thresholds at frequencies ranging from 0.125 kHz to 8 kHz using headphones. The resulting graph, called a "pure-tone audiogram," is plotted and connected in dB HL units. Noise-induced hearing loss is a cumulative process, often appearing as temporary or permanent notch around 3, 4, or 6 kHz, but higher frequencies can also be affected.[12, 13] The study aimed to assess the prevalence and factors associated with noise-induced hearing loss among medical students using earphones, emphasizing the importance of promoting awareness among adults.[14] Technology integration in medical education can be guided by understanding how students use headphones, and understanding broader cultural and generational trends in technology adoption and usage habits can help inform future educational strategies.

II. Materials And Methods

A cross-sectional study was conducted on 180 young adults at Shridevi Institute of Medical Sciences and Research Hospital, Tumakuru, Karnataka, for two months. The study received Scientific Research Committee and Institutional Ethics Committee clearance, and informed consent was obtained before conducting a pure tone audiometry test.

Inclusion criteria:
- Medical students at SIMS AND RH
- Post graduate and undergraduate students

Exclusion criteria:
- Prior history of any hearing problem
- Childhood meningitis
- Chronic use of ototoxic medication
- Family history of hearing loss

Sampling method: Purposive sampling method.

Sample size: The sample size is calculated using a study conducted in India by Kannan K et al.[15] in 2019. The prevalence rates indicate that 32% of them reported ear disease associated with prolonged use of headphone . At a 95% confidence level and an absolute allowable error of 5%. The sample size is calculated using below formula,

Sample size (n) = =
= 163.54 + 10% non-response rate
= 164.3 + 16.36
= 179.92 ≈ 180 participants

Method of collection of data: To explain all the questions to all the participants and then prepare google form a structured questionnaire consisting of questions related to the pattern of headphone usage, duration of usage, volume levels, any associated symptoms (like ringing in ears or difficulty in hearing), and hearing problems among medical students. And to include questions about the types of headphone used (in-ear, over-ear, wireless, etc.) and whether students use them while studying, commuting, exercising, etc details will be sent to participants by email or by WhatsApp. The questionnaire was based on a validated questionnaire that had previously been published (Mohammad poora sl et al., 2018)[16]. To assess the validity of the questionnaire, the results of hearing loss questionnaire were compared with the results of audiometry (as a gold standard) in a sample of 180 participants. Pure-tone air conduction audiometry was performed to determine the hearing thresholds at the frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 Hz for both ears of all subjects using an audiometer with earmuffs. The subjects were considered to have NIHL in either ear if an average threshold shift at high frequency (2000, 4000, and 8000 Hz) had been recorded for more than 25 dB in each ear.

Statistical Analysis plan: The study will use Microsoft Excel to analyze data using statistical software R version 4.3.2 (R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/). Descriptive statistics will be used to

summarize demographic characteristics like age, gender, and marital status. The study will assess the association between factors like gender, headphone usage, and hearing loss scores. Statistical tests like t-test and ANOVA will be used to determine the significance of these associations. The null hypothesis will be tested at a significance level of 0.05, indicating statistical significance.

III. Results

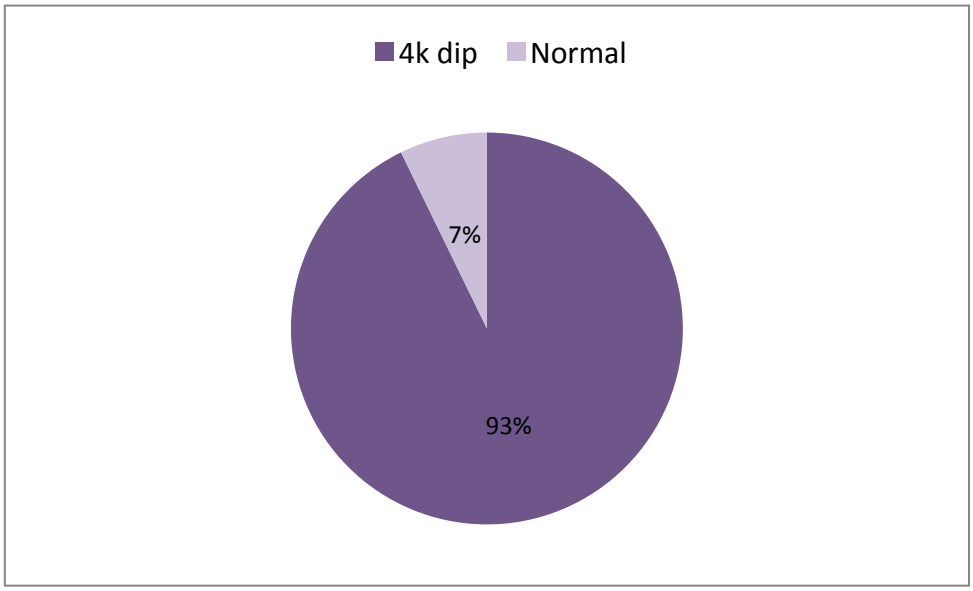

Figure 1: Personal listening devices of PTA distribution among the participants

The Figure 1 presents the results of a hearing test, specifically a Pure Tone Average (PTA) test, which measures hearing sensitivity across different frequencies. The PTA is the average hearing threshold across multiple frequencies, and the number of participants is the number of individuals who took the test. The 4k dip, a common indicator of noise-induced hearing loss (NIHL), indicates that 92.78% of participants showed some degree of hearing loss at 4000 Hz, indicating potential damage. A small percentage (7.22%) had normal hearing across all frequencies tested. The 4k dip is a common indicator of NIHL, which can occur due to exposure to loud noises, music, or other hazardous sounds. The table suggests that nearly 93% of the participants may have been exposed to harmful sounds, leading to some degree of hearing loss.

Table 1: Characteristics of the participants and their association with the hearing loss questionnaire (n=180).

Variable	N (%)	Hearing Loss score (Mean ± SD)	P- value
Age (years)			
18-20	98 (54.44%)	20.3 ± 3.1	0.850
21-23	67 (37.22%)	21.6 ± 4.4	
24-26	11 (6.11%)	21.1 ± 3.0	
27 - 29	4 (2.22%)	21.2 ± 4.2	
Gender			
Male	86 (47.78%)	20.6 ± 3.5	0.007
Female	94 (52.22%)	22.3 ± 3.9	
Marital status			
Single	177 (98.33%)	21.5 ± 3.8	0.208
Married	3 (1.67%)	20 ± 0.3	
Divorced	0 (0.00%)	0.00 ± 0.00	
Where do you live?			
Parental home	168 (93.33%)	21.1 ± 3.7	0.419
Private student dormitory	3 (1.67%)	17.9 ± 0.13	
Single house	9 (5.00%)	21.5 ± 4.92	

A total of 180 respondents were involved in this study. Our results found that almost more than half of the respondents were aged between 18 and 20 years, and 54.44% were aged between 18 and 20 years. Moreover, our findings revealed that there is a significant association between the gender and hearing loss score. Females were (52.22%) and their score was 22.3 ± 3.9 (P value =.007). On the other hand, males were 47.78% and their score was 20.6 ± 3.5. Regarding the marital status of our participants, we found that the majority of them were

single (98.33%) and lived in their parents' homes. As demonstrated in Table 1, the average GPA of our participants was 4.5 ± 0.4 (range 2.2–5.1).

The prevalence of hearing problems among the study participants: 58 (32.22%) mild: 46 (25.56%), moderate: 11 (6.11%), and severe: 3 (1.67%). Additionally, we found that the majority of our participants were using earphones (93.33%). When we checked the association between using earphones and hearing loss, we found that there was a significant association between the usage of earphones and hearing loss with a p-value < 0.005. About 83% of earphones were dual, and 78.57% of them were connected to a mobile device (Table 2). When we assessed the duration of usage of earphones, we found that the participants (49.40%) were using earphones for more than 4 years, 16.67% for 3 years, and only 4.76% reported usage for less than one year, and this found to be significantly associated with hearing loss score (P value= 0.039). More than half of the participants (66.07%) preferred to use their earphones while they were at home.

Table 2: Earphones and their usage patterns and the relationship between the use of earphone and hearing loss.

Variable	Categories	N (%)	Hearing Loss score (Mean ± SD)	P - value
Do you use headphones	Yes	168 (93.33)	21.4±3.90	< 0.005
	No	12 (6.67)	17±0.01	
If Yes (n=168)				
Are your headphones dual or single	Dual	140 (83.33)	21.4±3.5	0.061
	Single	28 (16.67)	23 ± 4.2	
If single which ear do you use most often (n=26)	Right ear	12 (46.15)	22.1 ± 3.7	0.427
	Left ear	4 (15.38)	21.2 ± 4.3	
	Not sure	10 (38.46)	24.7 ± 5.5	
What are the most devices that your headphones are connected to(n=168)	Computer	29 (17.26)	21.8±4.2	0.281
	Mobile	132 (78.57)	21.5 ± 3.6	
	MP3 player	1 (0.60)	27.1 ±0.00	
	Other	6 (3.57)	22.2 ± 3.9	
How long have you been using headphones(n=168)	< 1 year	8 (4.76)	24.1 ± 5.5	0.039
	1 year	12 (7.14)	23.2 ± 5.2	
	2 years	22 (13.10)	21.8 ± 4.3	
	3 years	28 (16.67)	22.4 ± 3.7	
	4 years	15 (8.93)	21.6 ± 3.1	
	> 4 years	83 (49.40)	21.1 ± 3.2	
What is your favorite place to wear headphones	Gym	24 (14.29)	21.1 ± 3.7	0.172
	Dormitory	4 (2.38)	24.2 ± 4.4	
	Home	111 (66.07)	21.5 ± 4.0	
	Street	27 (16.07)	21.3 ± 2.7	
	Other	2 (1.19)	21.92 ± 0.0	
When you use headphones, what volume do you use most often	Very low (< 25%)	5 (2.98)	20.1 ± 2.3	0.033
	Below the middle range (25% to 50%)	22 (13.10)	21.2 ± 2.6	
	In the middle range (50%)	45 (26.79)	22.5 ± 3.2	
	Above the middle (50% to 75%)	65 (38.69)	21.1 ± 3.3	
	High volume (75% and above)	31 (18.45)	22.8 ± 4.8	
When you use headphones, do you hear the people around you	Yes	115 (68.45)	21.3 ± 2.9	0.075
	No	53 (31.55)	21.5 ± 3.8	
When using headphones, do you turn up the volume after a while	Always	21 (12.5)	23.6 ± 4.8	0.021
	Most of the times	47 (27.98)	22.5 ± 3.6	
	Sometimes	75 (44.64)	20.5 ± 3.2	
	Very little	19 (11.31)	20.6 ± 3.2	
	Never	6 (2.98)	20.8 ± 3.4	
When using Headphones, do you Turn the volume Down after a while-After a while	Always	11 (6.54)	26.5 ± 5.3	0.000
	Most of the times	22 (13.10)	21.5 ± 4.0	
	Sometimes	69 (41.07)	20.7 ± 3.5	
	Very little	61 (36.31)	21.2 ± 2.9	
	Never	5 (2.98)	21.4 ± 4.5	
When using headphones, do you pause to rest your ears	Always	29 (17.26)	23.7 ± 5.5	0.006
	Most of the times	35 (20.83)	22.2 ± 3.5	
	Sometimes	38 (22.62)	21.5 ± 3.9	
	Very little	41 (24.40)	21.5 ± 3.8	
	Never	25 (14.88)	20.9 ± 3.4	
Has anyone ever warned you that listening	Yes	121 (72.02)	21.1 ± 3.6	0.011

to loud music for long periods is dangerous for your hearing				
	No	47 (27.98)	23.0 ± 4.1	
Has such a warning (meaning the previous question) affected your behaviour (for example, reducing the volume of music or reducing the duration of use) (n=112)	Yes	71 (63.39)	20.9 ± 4.2	0.075
	No	41 (36.61)	20.5 ± 2.4	
How many days per week do you use headphones on average	< 1 day	25 (14.88)	21.9 ± 5.3	0.182
	1 day	9 (5.8)	22.1 ± 4.1	
	2 days	30 (14.6)	21.8 ± 3.9	
	3 days	28 (17.5)	20.9 ± 4.1	
	4 days	21 (9.7)	21.1 ± 2.7	
	> 4 days	55 (32.74)	21.3 ± 3.4	
How many times per day do you use headphones on average	Once	38 (22.62)	21.2 ± 3.3	0.012
	Twice	49 (29.17)	22.3 ± 4.1	
	3 times	36 (21.43)	21.5 ± 5.0	
	4 times or more	45 (26.79)	21.5 ± 2.2	
How many hours per day do you use headphones on average	< 1 hour	33 (19.64)	21.8 ± 3.9	0.067
	1 hour	34 (20.24)	22.2 ± 3.8	
	2 hours	38 (22.62)	21.9 ± 4.5	
	3 hours	35 (20.83)	22.3 ± 4.3	
	> 3 hours	28 (16.67)	20.2 ± 2.5	
What kind of headphones do you usually use	In-ear headphones	31 (18.45)	21.1 ± 4.2	0.079
	Ear buds (Ordinary headphones)	99 (58.93)	21.5 ± 4.0	
	Overhead headphones	38 (22.62)	22.3 ± 3.9	
Have you ever had tinnitus (a sound sensation in your head) after using headphones	Yes	43 (25.60)	23.3 ± 4.5	0.025
	No	125 (74.40)	20.5 ± 3.0	
If your answer is yes, how much do you suffer from this situation (n= 39)	Always	4 (10.26)	26.1 ± 5.5	0.521
	Sometimes	14 (35.90)	24.2 ± 3.7	
	Rarely	21 (53.85)	21.9 ± 4.7	
How do you rate your hearing	No hearing problem	119 (70.83)	21.7 ± 3.5	0.005
	Mild hearing problem	42 (25.00)	22.8 ± 2.9	
	Moderate hearing problem	5 (2.98)	25.5 ± 4.4	
	Severe hearing problem	2 (1.19)	21.6 ± 2.5	
If you have hearing problems, have you ever seen a doctor because of your problem (n= 42)	Yes	13 (30.95)	23.4 ± 4.1	0.466
	No	29 (69.05)	23.5 ± 3.8	

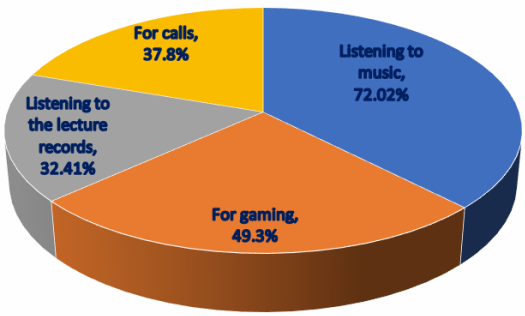

Figure- 2: The reasons for using headphones (n=168)

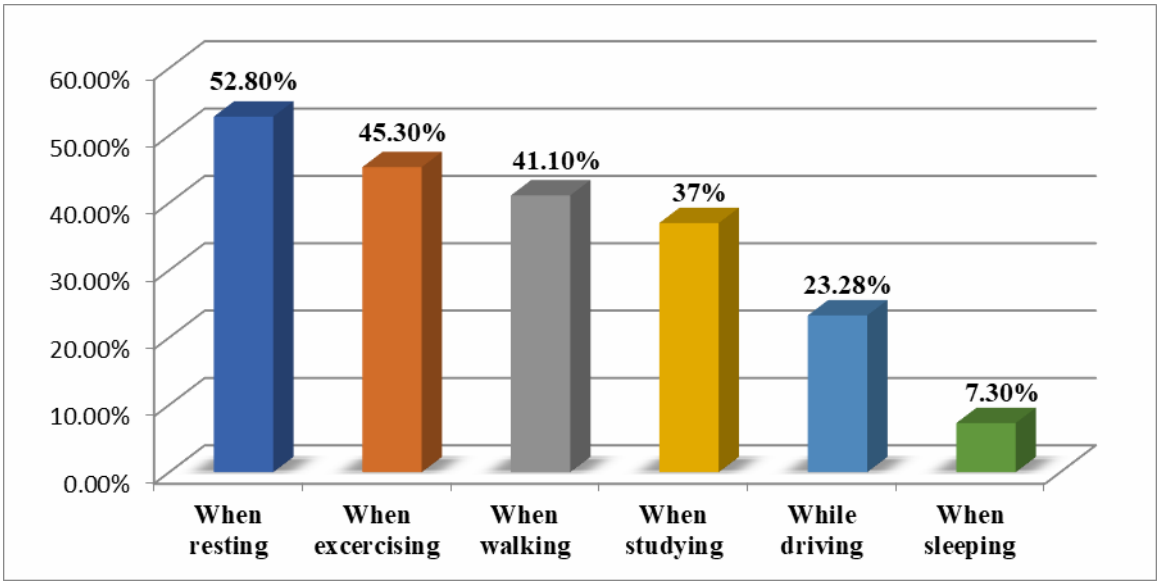

Figure- 3: Times of wearing headphones (n=168)

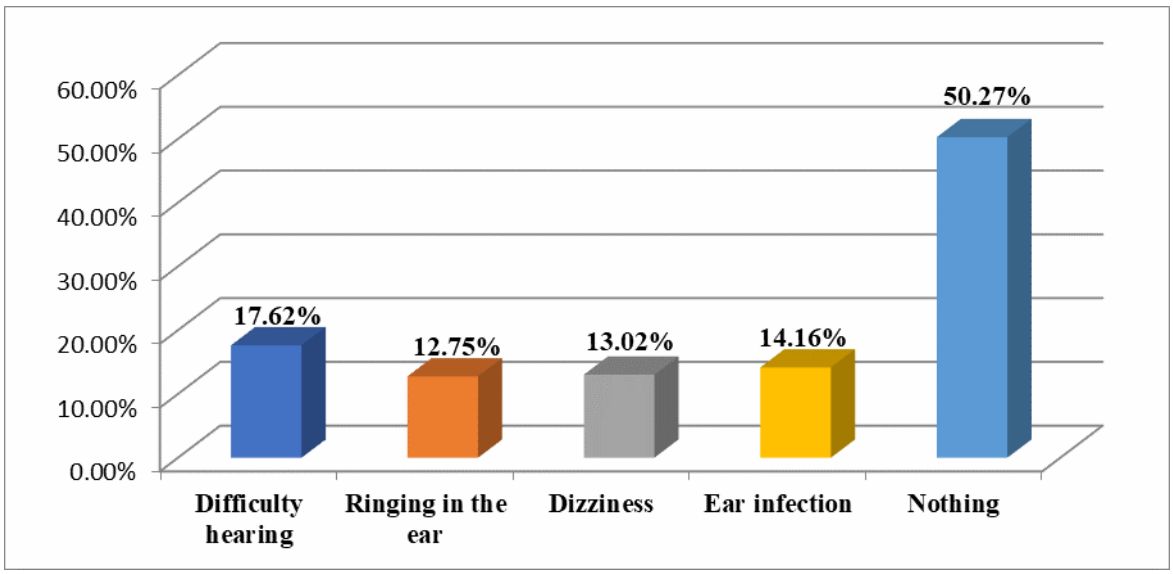

Figure- 4: Hearing problems caused by headphones usage (n=168)

When looking at the volume they often use to listen, we found that 18.45% used high volume (75% and above), and this was significantly associated with a higher score of hearing loss (P value 0.015) (Table 2). There is a significant association between turning down the volume after using earphones and affection for hearing loss, with a p-value (0.033). There was also a significant association between turning the volume up and hearing loss with a p-value equal to 0.021. Our results showed that about 72.02% of participants had already been told by someone that listening to loud music for a long period is dangerous to their hearing, and this resulted in about 63.39% of them changing their behavior after this warning (Table 2). Regarding the frequency of participant use of their headphones per week, most of the participants (61.90%) use those 3 days or more, and 32.74% of respondents use headphones more than 4 days per week. Moreover, we found that 29.17% used headphones two times per day, 21.43% used headphones three times per day, and the same percentage used headphones four times or more, and this was found to be significantly associated with hearing loss (P value 0.033).

In order to investigate the experience of tinnitus among participants, we found that about one-third of participants experienced tinnitus, and this showed a significant association with hearing loss (P value= <0.025). Concerning the rate of hearing in participants, (70.83%) rate themselves as having no hearing problems. The rest (29.17%) had problems (P value= <0.005). About 69.05% of them never see a doctor because of this problem (Table 2).

Table 3 Hearing assessment questions

Question	Yes	No
Do you suffer from hearing problems when talking on the phone	18 (10.71)	150 (89.29)
When two or more individuals are speaking at once, do you find it difficult to keep up with the conversation	46 (27.38)	122 (72.62)
Do people frequently complain that your TV is too loud	26 (15.48)	142 (84.52)
Do you struggle to follow conversations	32 (19.05)	136 (80.95)
Do you have problems hearing when the background is noisy	43 (25.60)	125 (74.40)
Do you need people to repeat their words until you hear and understand them	51 (30.36)	117 (69.64)
Do you think that many people do not speak clearly (in a clear voice)	41 (24.40)	127 (75.60)
Do you frequently misinterpret what people are saying and have improper responses	33 (19.64)	135 (80.36)
Do you feel you have a hearing problem that is getting worse over time	29 (17.26)	139 (82.74)
Is it difficult for you to hear the TV or radio because of a hearing problem	30 (17.86)	138 (82.14)
If someone is speaking to you behind you, do you miss it	25 (14.88)	143 (85.12)
Do you having difficulty hearing your alarm	24 (14.29)	144 (85.71)
Are the doorbells or phone not audible to you	18 (10.71)	150 (89.29)
Are gentle noises, like birds singing, no longer audible for you	22 (13.10)	146 (86.90)
Do you believe that people (on TV, friends, doctors) speak too quickly	29 (17.26)	139 (82.74)
Has any of your family or friends told you that they are concerned about your hearing	35 (20.83)	133 (79.17)
Do you comprehend male voices more easily than female voices	32 (19.05)	136 (80.95)
To understand what is being said, do you need to cut your ear or turn toward the speaker	47 (27.98)	121 (72.02)

When looking for reasons why participants use their headphones, most of them (72.02%) use them to listen to music, and about (49.3%) use them to listen to lecture records (figure 2). Regarding the time of usage of headphones, most use them when resting (52.8%) and exercising (45.3%) (figure 3). In general, more than half of the participants (50.27%) experienced nothing regarding hearing problems (figure 4), analyzed in detail in table 3.

When we look at the hearing assessment, the majority of participants (89.29%) do not suffer from any hearing problems during a phone conversation. When two or more persons were talking, approximately one third of the participants had difficulty following the conversation, whereas (72.62%) did not. More than 15.48% of them experienced someone who told them that they turned the TV volume too high. Regarding straining to understand a conversation, 19.05 percent of participants needed to strain. Most of the participants do not need people to repeat their words and do not think that people are not speaking clearly. Most of them do not think that the hearing problem is getting worse and is not causing problems with listening to the radio or the TV. Concerning hearing from behind, 14.29 percent reported a problem, and the same percentage of participants experienced trouble hearing the alarm clock. Regarding hearing soft sounds, 89.29% experienced no problems. When looking for family or friends who told participants that they were concerned about their hearing, (20.83%) of participants have been through this observation. When assessing the hearing of men's voices better than women’s, more than 19.05% of participants have experienced this type of hearing problem (Table 3).

IV. Discussion

The study aimed to investigate the frequency of hearing loss linked to headphones, their usage patterns, and the correlation between earphone usage and hearing loss among medical students at Shridevi Institute of Medical Sciences and Research Hospital. Hearing loss is a health condition that can significantly impact one's quality of life.[17, 18] The study found that 34.2% of people suffer from hearing loss, with mild (27.9%), moderate (4.5%), and severe (1.8%) being the most common. Mild hearing loss significantly impacts communication, with 50% of audible information missed by individuals with minor hearing loss. Moderate hearing loss distorts conversational level speech even at close range, while severe hearing loss renders close speech inaudible.[19] The study's results are lower than a previous Iran study's 60% prevalence, which found that portable music players can negatively impact participants' hearing threshold, as demonstrated in a previous study.[20]

The impact of headset use on hearing function, focusing on duration, frequency, and volume. It highlights the use of headsets for relaxation and work concentration, as they help avoid interference and enhance concentration. It emphasizes the importance of understanding the influence of music and headset use on workers' performance and safety.[1] A study at Qazvin University of Medical Sciences found that 60.2% of students have a history of hearing loss and impairment, and 86.4% have used an earphone in the past. Most students listen to music on cell phones, with 89.6% using headphones. Earphone users use earbud-style, supra-aural, and headphones, with higher hearing loss scores among those who use them more frequently and for longer periods.[16] A study in a private engineering college found that 66% of students, especially day scholars,

use earphones, with females being more frequent (62%). 17% of students have ear-related diseases and continue using them, while 12% reported accidents. The study suggests proper health education and attention are needed to protect future generations from the harmful effects of earphone usage.[11] A study involving 200 students aged 17-25 found that 28 out of 200 had mild hearing loss, and only 6 used headphones with low volume. The findings suggest that headphones usage can be a significant factor in hearing loss, and addressing this issue can improve overall well-being. The majority of students use headphones for extended periods and use high and medium volumes while hearing with headphones. [21]

V. Conclusion

The study found high hearing loss rates among medical students in Shridevi Institute of Medical Sciences and Research Hospital, Tumakuru, Karnataka due to earphone usage. The higher hearing loss scores among headphone users require further investigation for interventions and strategies to improve students' awareness and attitude towards personal listening devices like headphones. High-level exposure to noise can cause permanent hearing damage, with 4K dip/ boilermaker's notch being a precursor. The young generation should be aware of potential health hazards and make lifestyle modifications to prevent these diseases, as exposure to noise can have cumulative negative effects on hearing.

Limitation: Data collected was solely based on participants' self-reported measures regarding the duration of headphone usage among medical students using pure tone audiometry.

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