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Impact of Earphone Usage on the Auditory Perception of Medical Undergraduates: A Cross-Sectional Study Using Pure Tone Audiometry

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Background: Hearing is essential for communication and professional life, especially for medical practitioners. Noise-induced hearing loss (NIHL) is a growing concern among young adults due to unsafe listening practices, particularly the prolonged use of earphones/Bluetooth devices. This study investigates the impact of earphone usage on the hearing ability of undergraduate medical students. **Methods**: A cross-sectional study was conducted at Mamata Academy of Medical Sciences, involving 100 undergraduate medical students. Data collection included a semi-structured questionnaire on earphone usage practices and pure tone audiometry (PTA) to assess hearing thresholds. **Results**: The study found that 7% of participants exhibited signs of noise-induced hearing loss, characterized by 4k dips in their audiograms. Prolonged earphone use (more than 1 hour per day) was associated with a higher risk of NIHL. Additionally, 1.1% of participants showed signs of sensorineural hearing loss. **Conclusions**: The study concludes that prolonged and unsafe earphone use can lead to hearing impairments in medical students. It emphasizes the importance of raising awareness among medical students about the risks associated with earphone use and promoting safe listening practices to prevent irreversible hearing damage.

Keywords: Earphones, Hearing Loss, Medical Students, Noise-Induced Hearing Loss, Pure Tone Audiometry.

Introduction:

Hearing is a crucial sense that facilitates unique forms of communication unparalleled by other senses. According to WHO, hearing loss can be mild, moderate, severe, or profound and can affect one or both ears, the symptoms presented depend on the grade of hearing loss. [1] Recent estimates indicate that around 360 million individuals worldwide, constituting 5.3% of the population experience some form of auditory loss [2]. The Global Burden of Disease Study discovered that hearing loss is the fourth leading cause of disability worldwide [3].

Over 1 billion young adults are at risk of permanent, avoidable hearing loss due to unsafe listening practices [1]. This type of hearing loss caused due to chronic exposure to loud, harmful noises that damage sensitive structures in the inner ear is called Noise-induced hearing loss [4]. By 2050, nearly

2.5 billion people are projected to have some degree of hearing loss and at least 700 million will require hearing rehabilitation. [1]

The main attribute to noise-induced hearing loss in students especially, is chronic usage of earphones/Bluetooth. Three in five individuals carry earphones along with them most of the time, due to their advantages of easy portability, comfort, avoiding social interaction, music, e-learning, etc. but the main point to be noted here is that not all of them are aware of the potential risks like tinnitus, otalgia, hyperacusis, dizziness or vertigo in case of vestibular damage [5].

As individuals age, there is a natural decline in auditory acuity and this can significantly impact professional responsibilities, particularly for medical students who require effective communication with patients, colleagues, and staff [6]. If these earphones are going to affect the auditory mechanism early in the life of medical students it might be a bane to their professional life. Consequent evaluation of the hearing ability of medical students through regular screenings and consented ENT examinations becomes imperative. With the above background, we have attempted research on the effect of chronic use of earphones and the hearing ability of undergraduate medical students. The lack of awareness among young adults about auditory impairments due to chronic exposure to recreational sounds makes the purpose of the study extremely relevant to current times.

OBJECTIVES

1. To determine the earphone usage practices among medical students using earphones.
2. To assess the effect of earphone usage on the hearing ability of medical students

METHODOLOGY

Study design: A cross-sectional study

Study setting: Mamata Academy of Medical Sciences

Study period: 3 months

Study population:

Inclusion criteria: participants of phases 1, 2, and 3 undergraduate medical students who have given consent for pure tone audiometry.

Exclusion criteria:

- **I.** Diagnosed ear pathologies
- **II.** Recent Upper respiratory tract infections

Sample size: Taking into account a 6.3% prevalence of hearing impairment with a 95% confidence interval, 80% power, 5% absolute precision, 5% alpha error, and 10% non-response rate, the minimum sample size required is 90 according to the formula $(Z\acute{a}/2)\ 2pq/l^2$.

Data collection: A predesigned semi-structured questionnaire was issued among the subjects and the ones who gave the consent were taken for otoscopic examination to rule out ear pathologies, followed by pure tone audiometry.

Pure-tone audiometry: Pure-tone audiometry is the standard gold method of determining the type, degree, and configuration of hearing loss due to its widespread availability, inter-test reliability, and relative ease of execution. The results of pure-tone audiometry provide context for diagnosis, reassurance, monitoring, or further investigation of ear concerns. Repeated assessments track changes in hearing as an indicator of changes in ear health over time. [7]

Pure-tone audiometry was performed using an audiometer (Hermes PC Diagnostic Audiometer) connected to headphones and a bone vibrator in a soundproof room (≤10 dB HL) by an Audiologist at the ENT Department of Mamata Academy of Medical Sciences.

The students were examined by otoscopy for the presence of ear discharge or wax before PTA measurement. First, air conduction hearing thresholds were assessed for tonal stimuli throughout a frequency range of 250 Hz to 8000 Hz by using headphones. Then, bone conduction hearing thresholds were assessed for tonal stimuli

throughout a frequency range of 250 to 4000 Hz. by using headphones with a bone conduction oscillator. Using PTA, the ENT consultant could adjust the frequency, stimulus level, and sound routing to different transducers (headphones and a bone vibrator), and turn the signal on and off. The response was graphed on the standard graph and then interpretation of the results was done.
Abnormal hearing threshold was determined as hearing threshold ≥20 Hz at one or more frequencies of 250 Hz, 500 Hz, 1000 Hz, 4000 Hz, and 8000 Hz.

Statistical analysis: Categorical data was presented as frequencies and percentages. Data was analyzed using MS Excel and SPSS software version 20. The statistical association was tested using chi-square. P value <0.05 is considered significant.

Operational definitions:
4k notch: In pure tone audiometry, 4k notching is a characteristic pattern of hearing impairment where there is a dip or notch in the audiogram at 4000Hz. This is said to be usually associated with Noise-induced hearing loss.[15]
Sensorineural hearing loss: Sensorineural hearing loss results from damage to the hair cells within the inner ear, the vestibulocochlear nerve, or the brain's central processing centers.[14]

Results
Table 1: Baseline characteristics of study participants (n=100)

Variable	Frequency	Chi-Square	P value
Duration of usage			
Less than 30minutes /day	17	13.2	**0.001**
30 minutes -1hour/day	37		
More than 1hour/day	46		
Type of earphones			
Bluetooth in-earphones	86	51.8	**<0.001**
wired earphones	14		
Age			
18years	7	31.0	**<0.001**
19years	23		
20years	19		
21years	20		
22years	29		
23years	2		

Variable	Frequency	Chi-Square	P value
Duration of usage			
PTA on Right Ear			
Normal Hearing	93	74	**<0.001**
Noise-induced Hearing Loss	7		
PTA on Left Ear			
Normal Hearing	92	155	**<0.001**
Noise-induced Hearing Loss	7		
Sensory Neural Hearing Loss	1		

Table 1 shows the baseline characteristics of the study participants. Most of the participants were 22 years old (29%). Most participants used earphones for more than 1 hour (46%), and the highest percentage(86%) of them used Bluetooth earphones.

Table 2: Duration of earphone usage and right ear pure tone audiometry findings

Duration of usage	Normal	4k	Total	Chi-square/ P value
<30mins/day	16(94.2%)	1(5.8%)	17	0.119 0.942
30mins-1hr	34(91.8%)	3(8.2%)	37	
>1hr/day	43(93.5%)	3(6.5%)	46	
Total	93	7	100	

Table 2 shows the distribution of earphone usage duration and the findings from the right ear pure tone audiometry. The majority of participants (46) used earphones for over 1 hour. Out of the total participants, 91% had normal hearing, while only 7% who used earphones for 30 minutes to over 1 hour per day, showed 4K dips indicating noise-induced hearing loss in pure tone audiometry.

Table 3: Duration of usage and left ear pure tone audiometry findings

Duration of usage	Normal	4k	SNHL	Total	Chi-square/ P value
<30mins/day	16(94.2%)	1(5.8%)	0	17	1.55 0.818
30mins-1hr	35(94.5%)	2(5.5%)	0	37	
>1hr/day	41(89.1%)	4(8.5%)	1(2.4%)	46	

Duration of usage	Normal	4k	SNHL	Total	Chi-square/ P value
Total	92	7	1	100	

Table 3 depicts the distribution of the duration of earphone usage and the findings observed in the left ear pure tone audiometry. The highest number of participants, 46 in total, reported using earphones for more than 1 hour per day. Among the total participants, 90% had normal hearing in the left ear, with only 8 participants exhibiting other findings. Of these 8 participants, 7 individuals who used earphones for durations ranging from 30 minutes to over 1 hour per day showed 4K dips indicative of noise-induced hearing loss in pure tone audiometry. Additionally, a single participant (2.7%) who used earphones for more than 1 hour per day exhibited sensory neural hearing loss in the left ear.

Table 4: Type of earphones and right ear findings in the pure tone audiometry

Type of earphones	Normal	4k	Total	P value
Bluetooth in earphone	80(93.1%)	6(6.9%)	86	5.10 0.982
wired earphones	13(92.8%)	1(7.2%)	14	
Total	93	7	100	

Among the Bluetooth and wired earphone users around 93% had normal hearing, whereas 6.9% of Bluetooth users have findings of 4k dips suggestive of noise-induced hearing loss in pure tone audiometry (right ear)

Table 5: Types of earphones and left ear findings in the pure tone audiometry

Type of earphones	Normal	4k	SNHL	Total	P value
Bluetooth in earphone	80(92%)	5(5.7%)	1(1.1%)	86	1.47 0.480
wired earphones	12(85.8%)	2(14.2%)	0	14	
Total	90	7	1	100	

Of the total participants, 93% of the Bluetooth earphone users and 85.7% of wired earphone users had normal hearing. Among the 7 participants, 5 participants (5.8%) who used Bluetooth earphones showed findings of 4K dips indicating noise-induced hearing loss in pure tone audiometry. Additionally, a single participant (1.1%) who used Bluetooth earphones experienced sensory neural hearing loss in the left ear.

Discussion:

Noise-induced hearing is one of the most common and preventable types of hearing impairments seen nowadays in young adults, mainly due to exposure to loud and recreational noises. The World Health Organization (WHO)

has regarded recreational noise exposure as a great threat to the hearing of young people with about 1.1 billion at risk.

In the present study, one-third of medical students demonstrated sensorineural hearing loss upon PTA (6). More than 40% of them listen to music through earphones every day and more than 70% of them use Bluetooth in-ear earphones, more than 35% of them suffer from intermittent ear pain, which can be considered a precursor symptom for noise-induced hearing loss. More than 20% of them also suffer from slight difficulty in hearing. But not most of them are aware of the auditory impairments caused by the usage of earphones for a prolonged duration.

Among all the participating students, about 7 students are found to be at risk for noise-induced hearing loss showcasing the classic 4k dip on their audiogram. Sunny Sachdeva et al in their study concluded that 14% of the headphone users had hearing problems.[8] In contrast to the present study, Balachandran R et al in their research they found that there were no statistically significant changes in hearing, following either exposure type.[9]
Noise-induced hearing loss is a well-researched topic, and often, no significant link has been found between noise exposure and the use of earphones. In a study done by Pinsonnault–Karenina et al, they found no proper significance between noise exposure and auditory brainstem response outcomes, this was done to detect cochlear pathologies in young factory workers with normal hearing capacity.[10] In a study done by Saba Asghar, about one-third of medical students revealed mild sensorineural hearing loss at lower frequencies (250Hz and 500 Hz), and similar patterns were seen in most of the other studies also.[11]
In the present study, it was found that in about 7% of individuals, mild noise-induced hearing loss was detected and in 1.1% of subjects, sensorineural hearing loss was noted, they are at risk for permanent hearing impairment and it can be prevented by simple measures like decreased duration of usage, listening with reduced volume and ear hygiene. In line with this study, Zeinab A. Abd-El.haleem et al stated that left ears were more affected than the right ears. Hearing threshold > 40dB HL was observed in the left ear. [12]
There was no significant statistical association found between the duration of earphone usage and the type of earphones with hearing impairment in the present study.
According to the 1972 Noise Control Act, there are some established federal noise emission standards for commercial products and the brand must provide information about the noise emission levels and ways of reducing them, this helps to raise awareness and reduce the damage caused due to noise.
When enquired about the awareness of health hazards of earphone usage among young adults, it was noted that not all of them had enough knowledge, most of them either ignored it due to lack of knowledge or got used to earphone usage. A research article done in 2020 by U Jib and Jyoti Das concluded that there is good knowledge among young adults about the hazards caused due to earphone usage in terms of parameters like the feeling of ringing sounds through ears, ear wax, ear stress, and ear pain[13]. The individuals should be able to self-assess and self-evaluate, if there is any hearing impairment or tinnitus and also bring awareness among the non-medical society.

Conclusions:
This study has concluded that prolonged use of earphones can lead to significant hearing impairments like sensorineural hearing loss. It was found that almost 7% of students had 4k dips on the pure tone audiogram indicating the risk for Noise-induced hearing loss, which if neglected might cause irreversible permanent hearing impairment. This study also highlights the need for medical students to be aware of the potential risks associated with earphone usage and to take preventive measures to prevent permanent abnormalities that might affect their professional lives in the future. Regular screening through hearing tests, keeping the volume low, and taking regular breaks from earphone usage will preserve the auditory functioning of the individuals.

Limitations:

This study lacks a control group of non-earphone users, making it difficult to compare. It was also limited to a single setting with a small sample size of only medical students, which might have affected the generalizability of the study.

References:

1. Hopkins, S. (2017). *Deafness and hearing loss*. https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss
2. *Why do we need to hear?* (2018, July 11). Hearing Link Services. https://www.hearinglink.org/your-hearing/about-hearing/why-do-we-need-to-hear/
3. Jiang CY, Han K, Yang F, Yin SY, Zhang L, Liang BY, et al. Global, regional, and national prevalence of hearing loss from 1990 to 2019: a trend and health inequality analyses based on the global burden of disease study 2019. Ageing Res Rev. 2023; 92:102124. https://doi.org/10.1016/j.arr.2023.102124.
4. Broomfield, S. (2015). Noise-induced hearing loss. *Definitions*. https://doi.org/10.32388/jcqocw
5. Wikipedia contributors. (n.d.). *Noise-induced hearing loss*. Wikipedia, The Free Encyclopedia. https://en.m.wikipedia.org/wiki/Noise-induced_hearing_loss
6. Occupational hearing loss. The significance of asymmetrical hearing thresholds. Alberti PW, Symons F, Hyde ML. Acta Otolaryngol. 1979;87:255–263. [PubMed] [Google Scholar]
7. Carl, A. C., Hohman, M. H., & Cornejo, J. (2024). Audiology pure tone evaluation. In *StatPearls*. StatPearls Publishing.
8. Sachdeva S, Kumar M. Study on health impacts of ear and head-phones among students lives in Chandigarh. Int J Res Appl Sci EngTechnol, 2018; 6(3). https://doi.org/10.22214/ijraset.2018.3738
9. Balachandran R, Prepagaran N, Rahmat O, Zulkiflee AB, Hufaida KS. Effects of Bluetooth device electromagnetic field on hearing: pilot study. The Journal of Laryngology & Otology. 2012;126(4):345-348. doi:10.1017/S0022215112000047
10. Pinsonnault-Skvarenina A, Moïn-Darbari K, Zhao W, Zhang M, Qiu W, Fuente A. No effect of occupational noise exposure on auditory brainstem response and speech perception in noise. Front Neurosci. 2022 Jul 22;16:915211. doi: 10.3389/fnins.2022.915211. PMID: 35937884; PMCID: PMC9354017
11. Asghar S, Khan H, Parveen S, Rafi ST. Frequency of hearing loss among medical students using electroacoustic device. Pak J Med Sci. 2022 Mar-Apr;38(3Part-I):668-673. doi: 10.12669/pjms.38.3.4927. PMID: 35480535; PMCID: PMC9002430
12. Zeinab A. Abd- El.haleem et al.Bluetooth versus non-Bluetooth earphones and their potentially harmful effect on hearing: a cross-sectional study conducted among undergraduate medical students, Saudi Arabia. International Journal of Early Childhood Special Education (INT-JECSE) ISSN: 1308-5581 Vol 14, Issue 03 2022
13. Das, J. J. (2020). Assessment of knowledge regarding the consequences of using earphones among higher secondary and non-medical postgraduate students. International Journal Of Community Medicine And Public Health, 7(10), 3924–3930. https://doi.org/10.18203/2394-6040.ijcmph20204355
14. Tanna, R. J., Lin, J. W., & De Jesus, O. (2024). Sensorineural hearing loss. In *StatPearls*. StatPearls Publishing.

15. *Noise-induced hearing loss clinical presentation*. (2023, November 28). Medscape.com. https://emedicine.medscape.com/article/857813-clinical