ORIGINAL RESEARCH ARTICLE

Smart Screening: Using The hearWHO App to Assess Hearing Health in South Indian Medical Students Using Personal Listening Devices (PLDs)

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ABSTRACT

Background: Hearing loss represents a significant global public health challenge, with young individuals increasingly at risk due to preventable causes such as unsafe listening practices. This study aims to estimate the prevalence of likely hearing impairment among medical students who use personal listening devices and to identify the factors associated with this impairment.

Materials and Methods: 650 medical students from a tertiary care hospital in South India participated in this cross-sectional analytical study. Data was gathered using a semi-structured questionnaire and hearWHO application was employed to screen participants for likely hearing impairment based on their test score. Data analysis was done using SPSS Software Version 22.

Results: About 56.5% of students used PLDs for educational purposes and 85.5% use Bluetooth earphones. Overall based on hearWHO app screening, 26.1% were likely to have some degree of hearing impairment and 49.4% need screening regularly for hearing impairment. Family history of hearing problems, prolonged PLD use, high-volume listening and lack of breaks during prolonged use were significantly associated with likely hearing impairment.

Conclusion: Educational programs should be developed to raise awareness on the effects of noise-induced hearing loss. Students with high-risk behaviors identified in this study must be targeted for such programs.

Keywords: Noise, Hearing loss, Earphone, Headphone

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INTRODUCTION

Noise-induced hearing loss (NIHL) is a major form of sensorineural impairment caused by prolonged exposure to high-intensity sound.[1] It is the second most common cause of sensorineural hearing loss after ageing, with damage influenced by noise type, intensity and duration.[2] Globally hearing loss affects hundreds of millions and is projected to rise sharply to 1 in 4 persons by 2050.[3] Over one billion young individuals worldwide are at risk due to unsafe listening practices.[3] India is significantly affected with an estimated 63 million individuals experiencing severe hearing impairment, emphasizing the need for strong public health measures.[4]

Personal listening devices (PLDs) deliver sound directly to the ear through accessories such as headphones, earphones and earbuds.[5] The National Institute for Occupational Safety and Health (NIOSH) recommends a maximum daily exposure of 85 dB over eight hours with each 3 dB increase reducing the safe exposure time by half. Prolonged exposure to higher sound levels can lead to temporary or permanent hearing damage.[6]

World Health Organisation released the hearWHO app, a mobile application in 2018 which is a critical public health tool for combating hearing loss globally. Available for free on both iOS and Android, this app provides a preliminary hearing screening using a "digits-in-noise" test and it is not a confirmatory diagnostic test.[7,8] This accessible and easy-to-use method helps individuals check their hearing from home, overcoming barriers like cost and location. Its main role is to promote early detection and intervention, encouraging users of this app who fail the screening to seek professional care thereby preventing the severe consequences of untreated hearing impairment.[9]

In the post-COVID-19 era, medical students' reliance on online platforms for both academics and recreation have led to a concerning public health issue.[10] The frequent and often prolonged use of PLDs poses a serious threat to their well-being. This can result in noise-induced hearing loss and beyond auditory damage it also disrupts sleep patterns and diminishes interaction with family/friends contributing to social isolation. Addressing this requires a concerted effort from the academic community to promote responsible technology use, ensuring the health of our future healthcare professionals.[11,12]

Evidence on unsafe listening practices and use of screening tools among medical students remains limited. Their increased reliance on personal listening devices after COVID-19 highlights an underexplored vulnerability. This gap necessitates focused assessment of hearing health in this high-risk group. With this available background, this study was planned to estimate the likely hearing impairment prevalence and the factors associated with it among medical students using Personal Listening device.

METHODOLOGY

Study design and Study setting: A tertiary care hospital in Tamilnadu's Salem district served as the study setting for this cross-sectional analytical study. The study population identified were undergraduate medical students from First year MBBS to CRMIs.

Study Period: The study was conducted March to August 2025

Sample Size and Sampling technique: Sample size was calculated using the formula $n = Z^2PQ / L^2$, where Z corresponds to the standard normal deviate at a 95% confidence level (1.96), giving $Z^2 = 3.8416$. The expected prevalence (P) was taken as 26.7% based on the study by Kirubasankar et al[13] with $Q = 1 - P = 73.3\%$. A precision level (L) of 4% was chosen to obtain narrower confidence limits because the prevalence reported in reference study (26.7%) was moderate and precise estimates were required in the study setting. A non-response rate of 20% was added based on previous institutional surveys where non-response ranged between 15-22%, ensuring adequate final sample availability. The stepwise calculation and derived sample size have been presented in a supplementary table for transparency. Although the calculated sample size (after adjusting for non-response) was 564, a total of 650 participants were finally recruited to account for potential incomplete responses and to provide sufficient representation for all the subgroups.

The 650 participants were selected using a probabilistic sampling method. Stratified random sampling with equal (disproportionate) allocation was employed. There were 750 MBBS students and CRMIs in the college which formed the sampling frame. Each academic year/CRMI is considered as a stratum and 130 students were randomly selected from each stratum ensuring representation across batches. From each stratum, 130 were selected using simple random sampling with the help of computer-generated random numbers.

Inclusion and Exclusion criteria: First year MBBS to CRMIs who use earphones for both professional and personal uses were included after informed consent. Students with a current history of ear infection were excluded.

Study Tool and Data collection process: A pre-tested semi-structured questionnaire comprising Baseline details, Personal Listening Device usage related characteristics and hearWHO App findings was used for data collection after obtaining informed consent. After a content validity assessment by experts, the questionnaire was pre-tested on 30 MBBS students who were excluded from the final sample. Minor changes, such as rearranging for better flow and clarifying unclear items were made in response to pre-test comments. Internal consistency was confirmed with a Cronbach's alpha of 0.82 indicating good reliability.

The hearWHO app was used to screen for likely hearing impairment. It is a screening tool and not diagnostic tool. hearWHO app shows three digits in 23 sets across a variety of background noise levels with scores ranging from 0 to 100 the test determines the hearing ability. Hearing assessment was conducted in a quiet room with low ambient noise and external disturbances were minimized to maintain testing accuracy. Students were instructed to use personal listening device at different volume levels and had their results noted.

hearWHO score goes from 0 to 100, with 3 categories as per the scores (i) above 75 denoting good hearing, (ii) 50-75 denoting need screening regularly for hearing impairment and (iii) below 50 denoting the likelihood of some form of hearing impairment.[13] In comparison to pure tone audiometry, the hearWHO app has 82% sensitivity and 95% specificity.[14] Students with score below 50 were counseled to undergo pure tone audiometric assessment in the future for confirmation as hearWHO app-based assessment is only for screening.

Data Analysis: SPSS Version 23 was used for data analysis and Chi-square test was done for univariate analysis. Variables were dichotomized to enhance clarity, simplify analysis and avoid sparse data issues. Variables found to be statistically significant (p value <0.05) in univariate analysis were included in the regression model. Bivariate logistic regression analysis using enter method was done to identify significant associations variance Inflation Factor (VIF) was assessed for the independent variables in the regression analysis and values were found to be within 5 indicating absence of problematic multicollinearity. There were no missing data in the dataset, as all questionnaires were complete.

Informed consent and Ethical approval: Prior to administering the questionnaire, each study participant gave their informed consent. Institutional Ethical Clearance (Ref No: VMKVMC&H/IEC/25/012) was obtained.

Operational definitions:

Tobacco user: Tobacco users were defined as individuals who had used any form of tobacco in the last 30 days.[15]

Alcohol user: Alcohol users were those who had consumed at least one standard drink of alcohol (30 ml of spirits, 285 ml of beer or 120 ml of wine) in the last 12 months.[15]

Sharing PLD: Study participants who share PLD with others often and always was considered as sharing PLD.

High volume listening: Study participants were considered as listening in high volume if they regularly have the habit of adjusting the volume in PLD to 75% or 3/4th of the maximum volume available.

Prolonged PLD use: >4 hours/day of PLD usage.

RESULTS

The study enrolled 650 participants, the majority being female (63% (409) with a mean age of 21.37±1.82 years (Table 1).

Table 1: Baseline characteristics among the study participants (n=650)

Characteristics	Participant(%)
Gender	
Female	409 (63)
Male	241 (37)
Family history of hearing problems	87 (13.4)
Tobacco user	135 (20.7)
Alcohol user	185 (28.5)
History of ear infection in the past 1 Year	23 (3.5)

Table 2: Personal listening device usage related characteristics (N - 650)

Characteristics	Participants (%)
Purpose for which Personal listening device is used*	
Education	368 (56.6)
Listening Music	250 (38.5)
Gaming	72 (11.1)
Watching Movie/Series	380 (58.5)
Others	40 (6.2)
Years of using Personal listening device	
<5 Years	476 (73.2)
5 - 10 Years	143 (22)
>10 Years	31 (4.8)
Type of Personal listening device used*	
Earphone Wired	176 (27.1)
Earphone Bluetooth	556 (85.5)
Headphone Wired	82 (12.6)
Headphone Bluetooth	147 (22.6)
All of these	38 (5.8)
Time of the day when Personal listening device used*	
Daytime	248 (38.1)
Evening	308 (47.4)
Night	278 (42.8)
Daily hours of Personal listening device usage	
≤4 Hours a day	318 (49)
>4 Hours a day	332 (51)
Maximum volume regularly used	
<50	160 (24.6)
50 - 75	353 (54.3)
>75	137 (21.1)
Presence of active noise cancellation feature in Personal listening device	
Yes	402 (61.8)
No	248 (38.2)
Will you share your Personal listening device	
Yes	310 (47.7)
No	340 (52.3)
Complications faced due to Personal listening device usage*	
Ear pain	148 (22.8)
Ear discharge	47 (7.2)
Ear infection	36 (5.5)
Hearing difficulties	32 (4.9)
Tinnitus	26 (4)
Numbness	21 (3.2)
None of the above	453 (69.7)

*Multiple responses

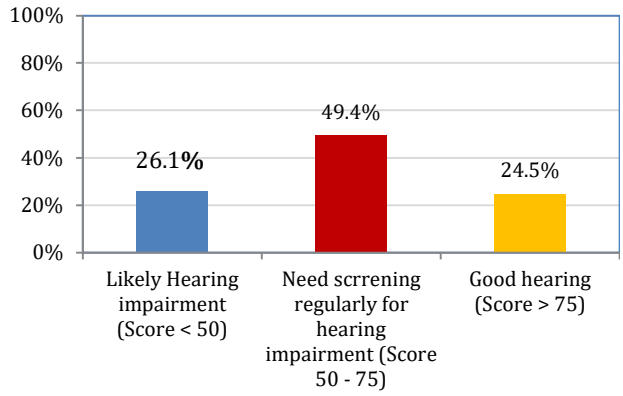

Figure 1: hearWHO app-based hearing assessment score

Descriptive analysis identified key behavioral risks in Personal Listening Device (PLD) usage, revealing that 51.1% (332) reported exposure for more than 4 hours per day and 21.1% (137) listened at greater than 75% of the maximum volume which are thresholds associated with noise-induced damage. These concerning usage patterns were paralleled by subjective responses, with one fourth of the respondents (25.2%) agreeing that their hearing had worsened over time (Table 2).

Hearing assessment using the hearWHO application revealed that 26.1% (170) likely have some degree of hearing impairment score <50 and only 24.5% (159) had good hearing with score >75 (Figure 1).

Table 3: Association between likely hearing impairment and selected variables among the study participants

Variable	Likely Hearing Impairment		P value	Odds Ratio (95% CI)
	Present (170) (%)	Absent (480) (%)		
Gender				
Female	100 (58.8)	309 (64.4)	0.198	0.79 (0.55 - 1.13)
Male	70 (41.2)	171 (35.6)	ref	
Family history of hearing problems				
Yes	51 (30)	36 (7.5)	**<0.0001***	5.28 (3.29 - 8.47)
No	119 (70)	444 (92.5)	ref	
Tobacco use				
Yes	30 (17.6)	105 (21.9)	0.625	0.89 (0.57 - 1.41)
No	120 (70.6)	375 (78.1)	ref	
Alcohol use				
Yes	40 (23.5)	145 (30.2)	0.098	0.71 (0.47 - 1.06)
No	130 (76.5)	335 (69.8)	ref	
Years of PLD usage				
≥ 5 Years	101 (59.4)	73 (15.2)	**<0.0001***	6.16 (4.13 - 9.17)
< 5 Years	69 (40.6)	307 (64)	ref	
Daily hours spent using PLD				
≥ 4 Hours	121 (71.2)	211 (44)	**0.0006***	1.98 (1.34 - 2.92)
< 4 Hours	49 (28.8)	169 (35.2)	ref	
Presence of active noise cancellation feature in PLD				
No	75 (44.1)	173 (36)	0.759	0.94 (0.66 - 1.36)
Yes	95 (55.9)	207 (43.1)	ref	
Regular usage of PLD at high volume (≥ 75% of the maximum volume)				
Yes	91 (53.5)	46 (9.6)	**<0.0001***	5.86 (3.79 - 9.07)
No	79 (46.5)	234 (48.8)	ref	
Take breaks in between long listening periods				
No	56 (32.9)	34 (7.1)	**<0.0001***	3.55 (2.19 - 5.75)
Yes	114 (67.1)	246 (51.3)	ref	
Sleeping with PLD on play				
Yes	31 (18.2)	78 (16.3)	0.533	0.86 (0.54 - 1.37)
No	139 (81.8)	302 (62.9)	ref	
Facing complications due to PLD usage				
Yes	80 (47.1)	117 (24.4)	**0.0003***	2.01 (1.38 - 2.90)
No	90 (52.9)	263 (54.8)	ref	

Table 4: Binomial logistic regression analysis findings

Variable	Hearing impairment		
	P value	Adjusted Odds Ratio (AOR)	95% CI
Family history of hearing problems	**0.012**	1.56	1.15 - 2.00
≥ 5 years of PLD Use	0.132	0.77	0.55 - 1.08
Prolonged PLD use	**0.003**	1.67	1.20 - 2.32
High volume listening	**0.001**	2.57	1.77 - 3.61
Lack of breaks during prolonged use	**0.011**	1.45	1.10 - 1.91
Facing complications due to PLD usage	0.211	0.87	0.70 - 1.10

Binomial logistic regression analysis identified four factors independently and significantly associated with likely hearing impairment (Table 4): High-volume listening {AOR: 2.57, P = 0.001), prolonged PLD use {AOR: 1.67, P =0.003), family history of hearing problems {AOR: 1.56, P = 0.012) and lack of breaks during prolonged use {AOR: 1.45, P = 0.011). These findings collectively underscore the primary contribution of modifiable behavioral habits and non-modifiable genetic predisposition to the burden of likely hearing impairment in this population.

Discussion

About 63% of the participants in this study were female with mean age of 21.37±1.8 years. Numerous studies have shown a similar female preponderance.[13,16-20] However some research studies have reported male preponderance.[4,21-24] The majority of studies evaluating PLD related hearing outcomes concentrate on young adult populations as indicated by the mean age across similar literature which broadly agrees with our findings.[17,19,20,22] About 13.4% had family history of hearing problems in this study. Similar to our study 15.6% had family history of hearing problem in Mogan KA et al[4] study and Kirubasankar M et al[13] study reported that 35% had family history of hearing problem.

PLD usage for five to ten years was reported by nearly one-fifth in this study. There was a clear academic emphasis since the majority of individuals utilized personal listening devices (PLDs) for academic purposes followed by music. Though the percentages vary similar trend was noted across studies.[4,13,17,25] The preference for Bluetooth earphones and prolonged exposure to PLDs is representative of the broader trend among student populations toward wireless, portable listening devices. The usage habits of young adult PLD users reported in the literature are largely in line with these findings.[13,16,24,25] With 51% using PLDs for at least four hours a day and 21.1% listening at more than 75% of the maximum volume, prolonged listening behavior was clearly appreciable. Kirubasankar M et al[13], Mogan KA et al[4], Ramya MR et al[17], Floria C et al[22], Mokhatrish MM et al[24] and Srihari A et al[25] studies have also noted similar patterns of prolonged daily listening habit and high-volume exposure varying depending on context.

According to hearWHO app assessment around one fourth of research participants showed strong hearing nearly half needed regular monitoring and 26.1% most certainly had likely some degree of hearing impairment. Kirubasankar M et al[13] study showed similar distributions; Mogan KA et al[4] reported lower impairment levels Studies by Masthi NRR et al[19], Floria C et al[22], Gilliver M et al[23] and Mokhatrish MM et al[24] reported higher levels of hearing impairment. These discrepancies might be caused by changes in ambient noise exposure, device usage habits, evaluation instruments and demographic traits.

In our study, likely hearing impairment was significantly associations with High-volume listening, prolonged PLD use, family history of hearing problems and lack of breaks during prolonged use. Kirubasankar M et al[13] have observed similar findings along with the impact of tobacco usage, daytime listening and the absence of noise cancelling features additional associated factors. Studies by Alshamrani R et al[21] and Mokhatrish MM et al[24] have also confirmed the importance of listening hours and volume levels as high-risk behaviours for hearing impairment. While studies such as Floria C et al[22], Mogan KA et al[4] and Mokhatrish MM et al[24] found that male gender was a risk factor but our study found no gender connection perhaps because men and females had similar listening habits.

Due to logistic constraints, hearWHO screening tool was used in this study to assess hearing status, which is a key limitation as it lacks the calibration and frequency-specific thresholds of diagnostic audiometry. Therefore, these results should be taken with caution and in order to improve accuracy and give a more accurate picture of hearing condition, future research should include a follow-up audiometric assessment. Recall bias and the use of self-reported exposure data including subjective estimates of listening volume could possibly have an impact on the study results. Furthermore, generalizability of the study findings may be limited as it a single institution-based study.

Conclusion

According to this study, a significant percentage of medical students may be at risk for hearing impairment. The main modifiable behaviors associated with worse hearing scores include extended device usage, high volume listening and few breaks. The high-risk behaviors found in this study should be especially addressed by awareness campaigns with major focus on the significance of following safe listening practices.

The results indicate need for future research as causal associations cannot be deduced from this cross-sectional study. Future research should include objective evaluations of sound exposure, interventional trials assessing the effects of awareness or behavior-change practices and longitudinal follow-up to monitor changes in hearing status. The hearWHO app's son-invasive design makes it a perfect tool for routine, general screening for hearing loss.

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Availability of Data: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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