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Original Article

Public Health Section

App-based Assessment of Hearing Impairment among Undergraduate Medical Students in Chengalpattu District, Southern India: A Cross-sectional Study

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ABSTRACT

Introduction: Hearing loss is a significant global health issue, affecting over 430 million people worldwide, including 6.3% of the Indian population. Risk factors include excessive use of audio devices, high volume levels, and prolonged noise exposure. Early identification through accessible and cost-effective screening methods is essential, and mobile applications offer a promising approach for hearing assessment.

Aim: To determine the prevalence of hearing loss among medical students and identify associated risk factors using the World Health Organisation (WHO)'s hearWHO app.

Materials and Methods: A cross-sectional study was conducted between May 2024 and October 2024 among 250 undergraduate students from two medical colleges in the Chengalpattu district, Tamil Nadu, India. A pretested semi-structured questionnaire was used to collect sociodemographic details and information on various risk factors associated with hearing impairment among students aged above 18 years. The hearWHO app was used to assess hearing loss through a digits-in-noise test, categorising scores as >75, 50-75, and <50. Participants with scores <50 were classified as having hearing loss. Data analysis was performed using SPSS version 22. Statistical analysis included Chi-square tests, bivariate analysis, and multivariate logistic regression, with a significance threshold of $p<0.05$.

Results: The prevalence of hearing loss among participants was 69 (27.6%). Significant associated factors were age >22 years (AOR=2.372, p=0.007), female gender (AOR=4.011, p<0.001), prolonged audio device usage >4 hours/day (AOR=4.216, p<0.001), listening at volumes >50% (AOR=2.866, p=0.006), and media usage during sleep (AOR=3.055, p=0.022). Symptoms such as ear discomfort or fullness and a history of ear infection were also associated with hearing loss.

Conclusion: This study highlights a high prevalence of hearing loss among medical students, emphasising the need for early screening, education, and interventions. Addressing modifiable risk factors such as device usage habits and listening volume is crucial in mitigating hearing loss and promoting auditory health among young adults.

Keywords: Hearing loss, hearWHO app, Screening, Students

INTRODUCTION

Hearing loss is defined as a partial or complete inability to hear sounds in one or both ears. It may be mild, moderate, severe, or profound. According to the WHO, hearing loss is considered disabling when it exceeds 35 decibels (dB) in the better-hearing ear [1]. The Public Work Department (PWD) Act, 2016, defines hearing impairment as either being deaf or hard of hearing. Deafness is defined as a hearing loss of 70 dB or more in both ears, while being hard of hearing is defined as a hearing loss of 60-70 dB in both ears [2].

Globally, over 5% of the population (approximately 430 million people, including 34 million children) require rehabilitation for disabling hearing loss. By 2050, this number is projected to rise to over 700 million, or 1 in 10 individuals [1]. In India, approximately 63 million people suffer from significant auditory impairments, accounting for 6.3% of the population [3]. The NSSO survey indicates that 291 individuals per 100,000 suffer from severe to profound hearing loss [3]. In Tamil Nadu alone, 305 individuals per 100,000 are affected, contributing to 19% of the state's total disability burden [4].

The prevalence of hearing loss among specific groups is also noteworthy. Data from the National Deaf Center in the United States indicate that around 1.4% of college students experience hearing loss [5]. Among college students in general, the prevalence is 19%, while among medical students it is even higher, at 27.1% [6,7].

Several factors may contribute to hearing loss, including increasing age, prolonged exposure to loud noises, head injuries, excessive headphone use, malnutrition, smoking, genetic predisposition, and the use of earbuds. Beyond the physical impairment, hearing loss can significantly affect social interactions, academic and job performance, and overall quality of life. Individuals may experience difficulties in understanding speech, frequent miscommunication, and social withdrawal. The fear of being perceived as less competent or of missing important details further complicates these challenges [8-10].

Addressing hearing loss at an early stage is crucial. Self-screening plays a vital role, as it is simple, time-efficient, and can be done at home. The WHO has developed the hearWHO application, which enables individuals to self-assess their hearing [11]. However, very few studies have examined hearing impairment among medical students using the hearWHO app.

There is a lack of studies in India, particularly in Tamil Nadu, assessing hearing impairment among undergraduate medical students using modern, scalable, and easily accessible tools such as mobile applications. Furthermore, most published studies have not used app-based hearing tests validated for screening, nor have they addressed the feasibility of such digital tools for early detection. To address this gap, the present study aims to estimate the prevalence of hearing loss and identify associated risk factors among undergraduate medical students.

MATERIALS AND METHODS

A cross-sectional study was conducted from May 2024 to October 2024 among 250 undergraduate students from two medical colleges in the Chengalpattu district, Tamil Nadu, India. Ethical clearance for this study was obtained from the Institutional Human Ethics Committee of the Chettinad Academy of Research and Education (Ref. No: IHEC-I/2273/23). Written informed consent was obtained from all participants.

Sample size calculation: The sample size was calculated based on a prevalence of 9.4% for hearing impairment reported by Mogan KA et al., with a 95% Confidence Interval (CI), 80% power, 5% absolute precision, and a 5% alpha error [12]. To account for potential non-responses, a 10% non-response rate was included. Using the formula , the minimum required sample size was determined to be 145. To further strengthen the study's power, the sample size was increased to 250.

Among the eight blocks in Chengalpattu district, four blocks were randomly selected using the lottery method. A list of medical colleges in each block was obtained from the college database, and two colleges were randomly chosen by lottery.

Inclusion and Exclusion criteria: The sampling frame included undergraduate medical students above 18 years of age from the selected colleges. Simple random sampling was used to select participants. A total of 250 students were randomly chosen from the sampling frame. Students already diagnosed with hearing impairment were excluded from the study, as the app is designed for screening rather than diagnostic purposes.

Study Procedure

The hearWHO application, developed by the World Health Organisation (WHO), was used to assess hearing impairment [11]. This app provides a hearing screening tool that allows users to check their hearing status and track changes over time. Compatible with both iOS and Android devices, the app uses a "digits-in-noise" test. The app is pre-validated by WHO and intended for individuals aged 12 years and above, with reported sensitivity and specificity of over 85%. Participants were presented with 23 sets of three digits amid varying levels of background noise. The app calculates the Signal-to-Noise Ratio (SNR), a measure of hearing ability, with scores ranging from 0 to 100. Scores were categorised into three groups: >75, 50-75, and <50. Participants with scores below 50 were classified as having potential hearing loss. In addition to the hearing assessment, a pretested semi-structured questionnaire was administered to collect demographic details and risk factors associated with hearing impairment. Data collection was conducted by trained postgraduate medical students from the Department of Community Medicine, who served as both data collectors and interviewers. They underwent a two-day training session covering the study objectives, tools, and methodology. On average, 10-15 minutes were required per participant to complete the questionnaire.

A pilot study was conducted among 30 undergraduate students using the pretested semi-structured questionnaire. The results of the pilot study were not included in the final analysis. Based on feedback, the questionnaire was refined. Participants completed the questionnaire independently, ensuring privacy and minimising interviewer bias. However, in cases requiring clarification, interviewers provided assistance to ensure accuracy and understanding. The internal validity of the questionnaire was assessed through reliability analysis. The Cronbach's alpha was 0.71, indicating good internal consistency [Questionnaire].

The hearWHO app was installed on participants' devices, and the hearing test was conducted in a quiet, separate room using over-the-ear headphones or earbuds. To maintain consistency and reduce variability in results, the same brand of headphones/earbuds was used for all participants. Before starting the test, participants adjusted the volume to ensure they could hear all digits. The app provided instructions for the screening, and participants' age and gender were recorded for self-monitoring purposes. To minimise information bias, strict adherence to the app's instructions was ensured, and standardised equipment was used. Allowing participants to adjust the volume during the initial trial further enhanced the precision of the results.

STATISTICAL ANALYSIS

Data were entered into MS Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 22. Categorical variables were presented as frequencies and percentages. The significance of categorical variables was assessed using the Chi-square test, with a p-value<0.05 considered statistically significant. Bivariate logistic regression was performed to determine the unadjusted odds ratios. Variables with a p-value<0.05 in the bivariate analysis were included in a multivariate model to calculate Adjusted Odds Ratios (AORs). A 95% CI was used to estimate the effect size.

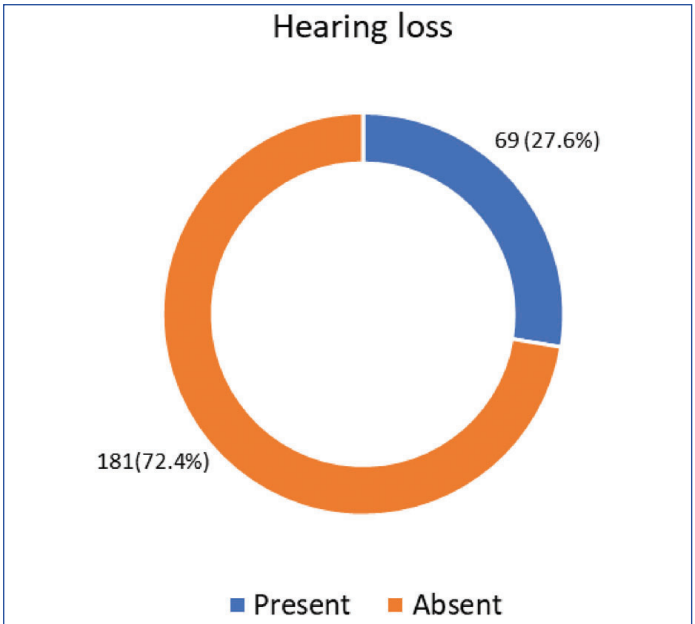
RESULTS

[Table/Fig-1] presents the sociodemographic characteristics of the study participants. Among the 250 participants, 153 (61.2%) were females and 97 (38.8%) were males. Participants were nearly evenly distributed by age, with 126 (50.4%) being over 22 years of age. Second-year students constituted the largest group (104; 41.6%), followed by fourth-year students (68; 27.2%). Most participants (225; 90%) reported no family history of hearing problems.

S. No.	Variables	Frequency (n=250)	Percentage %
1.	**Gender**		
	Male	97	38.8
	Female	153	61.2
2.	**Age**		
	>22 years	126	50.4
	≤22 years	124	49.6
3.	**Year of study**		
	First year	36	14.4
	Second year	104	41.6
	Third year	42	16.8
	Fourth year	68	27.2
4.	**Family history of hearing problem**		
	Yes	25	10
	No	225	90
5.	**Type of personal audio device used (multiple responses)**		
	Earphones	153	61.2
	Headphones	84	33.6
	Other devices (portable/ Bluetooth speakers and headsets)	48	19.2
6.	**WHO hearing app assessment score**		
	<50	69	27.6
	50-75	155	62
	>75	26	10.4

[Table/Fig-1]: Sociodemographic variables of the study participants.

Regarding the type of personal audio devices used, 153 (61.2%) preferred earphones, 84 (33.6%) used headphones, and 48 (19.2%) used other devices such as speakers and headsets. The WHO hearing app assessment revealed that 155 (62%) of participants scored between 50-75, 69 (27.6%) scored below 50, and only 26 (10.4%) scored above 75. [Table/Fig-2] shows the prevalence of hearing loss. It was found that 69 (27.6%) of the 250 participants



[Table/Fig-2] Shows the prevalence of hearing loss. It was found that 69 (27.6%) among 250 study participants had hearing loss when assessed by using hearWHO app.

had hearing loss when assessed using the hearWHO app. [Table/Fig-3] shows the association between hearing loss and various demographic and lifestyle variables. Participants aged over 22 years had higher odds of hearing loss (odds ratio=2.315, 95% CI: 1.30-4.11, p=0.004). Females had significantly higher odds of hearing loss compared to males (odds ratio=2.982, 95% CI: 1.57-5.67, p<0.001). Listening to audio at a volume >50% was significantly associated with hearing loss (odds ratio=2.355, 95% CI: 1.16-4.72, p=0.014).

Other significant associations included listening to music or media while sleeping (odds ratio=3.269, 95% CI: 1.41-7.58, p=0.004), experiencing discomfort or fullness in the ears after using personal listening devices (odds ratio=1.982, 95% CI: 1.12-3.52, p=0.019), and a current history of ear infection (odds ratio=11.077, 95% CI: 1.2-24.6, p=0.021), suggesting strong links between these behaviors and hearing loss.

[Table/Fig-4] presents the adjusted analysis of factors associated with hearing loss. Participants aged above 22 years had higher odds of hearing loss compared to younger individuals (AOR=2.372, 95% CI: 1.2-4.4, p=0.007). Females were significantly more likely to experience hearing loss than males (AOR=4.011, 95% CI: 1.9-8.3, p<0.001). Listening to audio at a volume greater than 50% (AOR=2.866, 95% CI: 1.3-6.1, p=0.006), listening to music or media while asleep (AOR=3.055, 95% CI: 1.1-7.9, p=0.022), and using audio devices for more than four hours per day (AOR=4.216, 95% CI: 1.9-9.1, p<0.001) were also significantly associated with hearing loss.

S. No.	Variables	Hearing loss (N=250)		Total (N=250)	Chi-square	Unadjusted odd's ratio (95% CI)	p-value
		Yes n (%) n=69 (27.6%)	Adequate n (%) n=181 (72.4%)				
1.	**Age**						
	>22 years	45 (65.2%)	81 (44.8%)	126 (50.4%)	8.370	2.315 (1.30-4.11)	0.004*
	≤22 years	24 (34.8%)	100 (55.2%)	124 (49.6%)		1	
2.	**Gender**						
	Female	54 (78.3%)	99 (54.7%)	153 (61.2%)	11.682	2.982 (1.57-5.67)	<0.001*
	Male	15 (21.7%)	82 (45.3%)	97 (38.8%)		1	
3.	**Family history of hearing loss**						
	Yes	7 (10.1%)	18 (9.9%)	25 (10%)	0.002	1.022 (0.41-2.56)	0.962
	No	62 (89.9%)	163 (90.1%)	225 (90%)		1	
4.	**Hours of device usage/day**						
	>4 hours	26 (37.7%)	41 (22.7%)	67 (26.8%)	5.752	2.065 (1.13-3.75)	0.016*
	≤4 hours	43 (62.3%)	140 (77.3%)	183 (73.2%)		1	
5.	**Volume level while listening to audio on your personal listening device**						
	>50 % volume	57 (82.6%)	121 (66.9%)	178 (71.2%)	6.049	2.355 (1.16-4.72)	0.014*
	≤50 % volume	12 (17.4%)	60 (33.1%)	72 (28.8%)		1	
6.	**Living in noisy environment**						
	Yes	19 (27.5%)	44 (24.3%)	63 (25.2%)	1.276	1.183 (0.63-2.21)	0.599
	No	50 (72.5%)	137 (75.7%)	187 (74.8%)		1	
7.	**Listening to music or other media while sleeping**						
	Yes	13 (18.8%)	12 (6.6%)	25 (10%)	8.276	3.269 (1.41-7.58)	0.004*
	No	56 (81.2%)	169 (93.4%)	225 (90%)		1.334 (0.63-2.79)	
8.	**Discomfort, pain, or fullness in your ears after using personal listening devices**						
	Yes	45 (65.2%)	88 (48.6%)	133 (53.2%)	5.528	1.982 (1.12-3.52)	0.019*
	No	24 (34.8%)	93 (51.4%)	117 (46.8%)		1	
9.	**Current history of ear infection**						
	Yes	4 (5.8%)	1 (0.6%)	5 (2%)	7.011	11.077 (1.2-24.6)	0.021*
	No	65 (94.2)	180 (99.4%)	245 (98%)		1	
10.	**History of ear surgery**						
	Yes	4 (5.8%)	3 (1.7%)	7 (2.8%)	3.145	3.651 (0.79-16.76)	0.076
	No	65 (94.2%)	178 (98.3%)	243 (97.2%)		1	

[Table/Fig-3]: Association between hearing loss and related variables among study participants.
*p-value <0.05 - Statistically significant at 95% CI: Confidence Interval, OR: Odd's Ratio, χ^2 - Chi-square

S. no.	Variables	p-value	Adjusted Odds Ratio	95% CI
1.	Age above 22 years	0.007*	2.372	1.2-4.4
2.	Females	<0.001*	4.011	1.9-8.3
3.	Discomfort/fullness of ears	0.052	1.865	0.9-3.5
4.	Current history of ear infection	0.124	4.485	0.56-12.9
5.	Volume >50 %	0.006*	2.866	1.3-6.1
6.	Listening while asleep	0.022*	3.055	1.1-7.9
7.	> 4 hours/day of device usage	<0.001*	4.216	1.9-9.1

[Table/Fig-4]: Multiple logistic regression analysis to find out the association between hearing loss and related variables.
"Enter method" was used for binomial logistic regression.
*Statistically significant at 95% CI: Confidence interval, OR: Odd's ratio; AOR: Adjusted odd's ratio

DISCUSSION

In the present study, the prevalence of hearing loss among medical students was found to be 27.4%, which is lower than that reported in studies conducted by Aljeraisi TM et al., (2022) — 34%, Gahlot A et al., (2024) — 34.1%, and Yusni Y et al., (2021) — 34.57% [13-15]. The lower prevalence in our study may be attributed to demographic and geographical differences, variations in study design, and behavioral factors. Differences in cultural practices, noise exposure, and earphone usage patterns, along with greater awareness of hearing health among medical students, likely contributed to the observed disparity. Advancements in technology, such as safer audio devices, and recent health awareness initiatives may also play a role. These findings highlight the importance of implementing routine hearing screenings in educational institutions. Public health initiatives should focus on promoting safe listening practices, regulating permissible sound exposure levels, and encouraging the use of hearing protection devices.

In contrast, the prevalence of hearing loss in this study (27.4%) was higher than the 19% prevalence reported in a meta-analysis conducted by Kornisch M et al., (2024) among college students [7]. This difference may be explained by the broader and more heterogeneous populations included in the meta-analysis, resulting in a lower overall prevalence estimate compared to our focused cohort.

Our study also found that women were more likely than men to experience hearing loss. This finding contrasts with the results of Agrawal Y et al., (2008) and Wang Q et al., (2021), who reported that men were more likely to develop hearing loss [16,17]. According to Nolan LS (2020), hormonal influences, such as estrogen signaling, may protect against Age-Related Hearing Loss (ARHL) [18]. Additionally, structural and functional differences in the cochlea between males and females also influence susceptibility to hearing loss. Nolan LS further reported that while women may demonstrate a higher prevalence, men often develop more severe hearing loss at an earlier age, highlighting the complexity of sex-related differences in auditory health. These biological factors, along with health-seeking behavior, likely contribute to the observed gender disparity in our study.

Frequent and prolonged use of personal hearing devices was also associated with hearing loss. A study conducted in Pakistan reported that 19.5% of medical students used personal hearing devices for more than three hours per day [19]. In our study, 26.8% of participants reported using headphones for more than four hours per day, which is higher than the usage rates reported by Aljeraisi TM et al., (2022) and You S et al., (2020) [13,20]. However, a study by Gajendran A et al., (2024) found that nearly 50% of participants used headphones for more than four hours daily, a much higher proportion compared to our findings [21]. To minimise the risk of hearing loss, experts recommend limiting personal audio device use to 60 minutes per day at no more than 60% of maximum volume [22].

These findings emphasise the urgent need for awareness campaigns, particularly among young adults, regarding the risks associated with prolonged and high-volume headphone use.

In the present study, 71.2% of participants reported using volume levels above 50%, which is comparable to the findings of Aljeraisi TM et al., (2022), where 78.1% of participants reported similar usage patterns [13]. However, Asghar S et al., (2020) found a higher proportion (92%) of participants using medium to high volume levels when operating electroacoustic devices, suggesting a trend toward more frequent high-volume usage [19]. For safe listening, the WHO advises limiting volume to less than 60% of the maximum, particularly when using headphones or earbuds [22]. Extended exposure to noise levels above 85 dB can damage hearing, and this threshold can frequently be exceeded when listening at volumes higher than 50%, especially with in-ear devices [23].

Listening to media or music while sleeping was also found to be significantly associated with hearing loss in this study. Prolonged exposure to loud sounds during sleep, particularly at high volumes, may damage the cochlea and contribute to Noise-Induced Hearing Loss (NIHL) [24]. Moreover, the auditory system is more vulnerable to high-intensity sound during sleep due to reduced protective mechanisms [25]. Repeated exposure, coupled with a lack of awareness of the risks of loud music, further increases the likelihood of hearing loss. These findings underscore the importance of safe listening practices and the need for increased awareness.

The strengths of the present study included use of a validated WHO screening tool enhanced the reliability of the hearing assessment. The sample size was calculated based on prior prevalence and increased from 145 to 250 to improve statistical power and account for non-response. Random methods were used for both college and participant selection, thereby reducing selection bias and improving representativeness.

Limitation(s)

This study employed a cross-sectional design, which inherently limits the ability to establish causal relationships between hearing impairment and associated risk factors. While the study effectively estimated the prevalence of hearing loss and identified potential contributing factors, longitudinal or cohort studies would be more appropriate to assess incidence, progression, and long-term effects of hearing impairment among young adults. Self-reported data on risk factors and lifestyle habits may also be subject to recall bias or social desirability bias, potentially affecting the accuracy of the associations observed. Additionally, the study was conducted among undergraduate medical students from a limited number of institutions in the Chengalpattu district, which may restrict the generalisability of the findings to other populations or regions.

CONCLUSION(S)

A total of 27.6% of medical students screened with the hearWHO app were found to have hearing loss. Several factors were significantly associated with hearing loss, including age above 22 years, female gender, device usage exceeding four hours per day, listening to audio at volumes above 50%, and listening to media while sleeping. These findings highlight the importance of early screening, awareness, and interventions targeting modifiable risk factors, particularly among young adults in high-risk settings such as medical colleges, to prevent and reduce hearing loss. Future recommendations include incorporating routine hearing examinations into student health check-ups, implementing educational campaigns on safe listening practices, and developing guidelines for responsible gadget use.

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- Plagiarism X-checker: Apr 02, 2025
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An App-based Assessment of Hearing Impairment among Undergraduate Medical Students in Chengalpattu District-A Cross-Sectional Study

PART A

Socio-demographic profile

1. Partcipant ID number:
2. Age:_____ years
3. Gender:
   - Male
   - Female
4. Year of study:
   - First
   - Second
   - Third
   - Fourth
5. Family history of hearing loss?
   - Yes
   - No
6. Type of personal audio device used (Select all that apply)
   - Earphones
   - Headphones
   - Other devices (portable/Bluetooth speakers and headsets)

PART B

Scores of hearWHO app

7. Score obtained on hear WHO app?
   - Less than 50
   - Between 50 to 75
   - More than 75

PART C

Personal Audio device usage among the study participants

8. What is your average duration of device usage per day?
   - Less than or around 4 hours
   - More than 4 hours
9. Volume you use while listening to audio on your personal listening device
   - Less than or around 50 % volume
   - More than 50 % volume
10. Do you live in a noisy environment (e.g., near traffic, train station, factory, airport, construction site)?
    - Yes
    - No
11. Do you have the habit of listening to music or other media while sleeping?
    - Yes
    - No
12. Have you ever felt any discomfort, pain, or fullness in your ears after using personal listening devices
    - Yes
    - No
13. Are you currently experiencing an ear infection?
    - Yes
    - No
14. Do you have a history of ear surgery in the past?
    - Yes
    - No