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Original Research Article

A smartphone-based assessment of hearing impairment among medical students of a medical college, Bidar: a cross-sectional study

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ABSTRACT

Background: Hearing loss is increasingly prevalent among young adults, often due to frequent use of personal audio devices. Early assessment is essential for identifying hearing impairment and implementing preventive strategies. This study evaluated hearing levels among medical students using the hearWHO application. Objective was to estimate the prevalence of hearing impairment using a smartphone-based tool and to assess the associated factors among medical students.
Methods: A cross-sectional study was conducted among 140 medical students selected through stratified random sampling. Each academic year (1st, 2nd, 3rd, and final year) constituted a stratum. Hearing was assessed using the hearWHO application, with scores categorized as >75 (excellent), 50-75 (moderate), and <50 (low hearing).
Results: Total 140 study participants were included. On assessment with hearWHO application, 28 (20%) were in the score category of >75, 109 (77.9%) in score category 50-75 and 3 (2.1%) in score category <50. Among the earphone users, 85 (60.7%) did not adhere to volume alert notification.
Conclusions: Most students had moderate hearWHO scores, while a small proportion exhibited low scores suggestive of hearing impairment. These findings highlight the importance of regular auditory assessment and preventive strategies, particularly among personal listening device users, for early detection and timely intervention.

Keywords: Hearing impairment, HearWHO application, Medical students, Personal listening devices, Smartphone-based screening

INTRODUCTION

Hearing is one of the most important senses for effective communication, learning and social interaction. Hearing impairment is a major public health problem worldwide, with an increasing burden in both developed and developing countries. According to the World Health Organization (WHO), more than 5% of the world's population suffers from disabling hearing loss and the numbers are steadily rising. It is estimated that by 2050 over 700 million people or 1in every 4 people will have disabling hearing loss.[1]

While hearing loss is often associated with older age, younger populations are also becoming vulnerable due to lifestyle factors including the excessive usage of earphones, exposure to high noise levels and lack of awareness regarding ear health. Medical students represent a unique group at risk of early hearing problems, as their academic routines often involve prolonged use of personal listening devices and exposure to noisy environments, applications such as the "hearWHO" app developed by WHO allow rapid, community level screening and early identification of hearing impairment.[2]

Many studies on PLDs usage have shown that nearly half of the surveyed teenagers and young adults are at risk of unsafe exposure to continuous loud volume during the usage of PLDs, while only a few of them have safe listening habits or attitudes.[3] Personal listening devices (PLDs) deliver sound directly to the ear through accessories such as headphones, earphones and earbuds.[4] 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.[5] The National Programme for Prevention and Control of Deafness (NPPCD) was launched in the year 2008 in India and the aim of this program is to reduce preventable causes of hearing loss and reduce the prevalence of deafness to below 1% by 2030 at the national level.[6]

Economic benefits of reducing the prevalence and severity of hearing loss show that a 5% reduction in prevalence could reduce the global monetary loss of hearing loss by, conservatively, around 50 billion dollars per annum.[7] The World Report on Hearing (2021) has recommended the use of innovative screening measures and telehealth to make hearing care more accessible.[8]

This study aimed to assess the prevalence of hearing impairment among medical students using a smartphone-based application and to assess the factors associated with hearing impairment, thereby highlighting the utility of mobile health technology in screening and prevention of hearing disorders in young adults.

Objectives

To estimate the prevalence of hearing impairment using a smartphone-based tool and to assess the associated factors among medical students.

METHODS

A descriptive cross-sectional study was undertaken among undergraduate medical students studying at an autonomous government medical institution, Bidar Institute of Medical Sciences (BRIMS) Bidar, Karnataka, India from March 2026 to May 2026 (3 months) after receiving approval from the institutional ethics committee (Ethical approval: 344/BRIMS/IEC2026-1 on 03/02/2026). The required sample size was calculated using Cochran's formula by considering a previously reported prevalence of hearing impairment of 9.4%, with a confidence level of 95%, an absolute precision of 5%, and an additional 5% allowance for anticipated non-response.[2] The estimated sample size was rounded off to obtain a final sample of 140 participants.

Study participants were selected through a stratified random sampling approach. Undergraduate students were first grouped according to their year of study (first year, second year, third year, and final year). Thereafter, by using probability proportionate sampling, 36 students from the first year, 34 from the second year, 34 from the third year, and 36 from the final year were included. Within each stratum, individual participants were chosen using a lottery method, ensuring simple random selection.

After written informed consent from all participants, screening for hearing capacity was carried out using the "hearWHO" mobile application developed by the World Health Organization (WHO). The "hearWHO" employs a digits-in-noise testing method, wherein sets of three numbers are presented under varying levels of background noise across 23 sequences. Hearing performance is estimated based on the signal-to-noise ratio (SNR). Previous studies have demonstrated that the application possesses sensitivity and specificity values exceeding 85%. The obtained scores range from 0 to 100 and are classified into three categories: scores >75, scores between 50 and 75, and scores <50. Participants scoring below 50 are considered more likely to have hearing impairment.

Students with a prior diagnosis of hearing loss were excluded from participation. The application was installed on investigator's mobile devices and hearing scores generated during assessment were documented. Screening procedures were conducted individually in a separate quiet environment to minimize background interference. Over-the-ear BOAT Rockerz 480 headphones were used during testing and participants were allowed to adjust the volume settings before initiation of assessment to ensure adequate perception of the test digits. All procedures were performed according to the standardized instructions embedded within the application.

After examination by the investigator a google form containing semi-structured questionnaire was circulated to study participants to collect socio-demographic information and variables potentially associated with hearing impairment. To reduce information bias, standardized assessment procedures were followed, including adherence to application guidelines and uniform use of over-the-ear headphones during screening.

Collected data was retracted from google sheets to excel sheet and reviewed for completeness, checked for errors and missing values, and subsequently analysed using JAMOVI version 2.6.44. Logistic regression analysis was performed using two outcome models. In Model 1, hearing scores were dichotomized as >75 and ≤75, whereas in Model 2, scores >50 and ≤50 were considered as outcome categories. Associations were expressed using odds ratios (OR) along with 95% confidence intervals (CI).

RESULTS

A total of 140 participants were included in our study. The study population predominantly comprised of participants aged >20 years i.e., 92 (65.7%), while 48 (34.3%) were aged ≤20 years. Males and females were equally

represented i.e., 70 each (50%). Participants were distributed almost equally across all four academic years. Only 13 (9.3%) participants had undergone previous hearing screening, while only 16 (11.4%) had family history of hearing impairment.

Table 1: Basic demographic profile of participants (n=140).

Characteristics	Frequency	Percent (95% CI)
Age (years)		
≤20	48	34.3 (26.5-42.8)
>20	92	65.7 (57.2-73.5)
Academic year of student		
First year	36	25.7 (18.7-33.8)
Second year	34	24.3 (17.4-32.2)
Third year	34	24.3 (17.4-32.2)
Final year	36	25.7 (18.7-33.8)
Sex		
Male	70	50 (41.4-58.6)
Female	70	50 (41.4-58.6)
Previous screening for hearing impairment		
No	127	90.7 (84.6-95.0)
Yes	13	9.3 (5.0-15.4)
Presence of hearing impairment in family		
No	124	88.6 (82.1-93.3)
Yes	16	11.4 (6.7-17.9)
Duration of audio device usage		
<4 hours	78	55.7 (47.1-64.1)
>4 hours	62	44.3 (35.9-52.9)
Current episode of ear infection		
No	131	93.6 (88.2-97.0)
Yes	9	6.4 (3.0-11.9)
Current episode of nose infection		
No	136	97.1 (92.8-99.2)
Yes	4	2.9 (0.8-7.1)
Current episode of throat infection		
No	137	97.9 (93.9-99.6)
Yes	3	2.1 (0.4-6.1)
History of cerebral trauma in the past		
No	135	96.4 (91.9-98.8)
Yes	5	3.6 (1.2-8.1)
History of ear surgery		
No	138	98.6 (94.9-99.8)
Yes	2	1.4 (0.2-5.1)
Adherent to volume alert notification		
No	85	60.7 (52.1-68.9)
Yes	55	39.3 (31.1-47.9)
Place of residence		
Hostel	122	87.1 (80.4-92.2)
Home	18	12.9 (7.8-19.6)

Most participants 78 (55.7%) used audio devices for fewer than 4 hours per day. Majority of participants reported no current ear, nose, throat infections, no history of cerebral trauma and ear surgery. Similarly, 85 (60.7%) participants did not adhere to volume alert notifications. Most participants resided in hostel i.e., 122 (87.1%) (Table 1).

Hearing assessment using hearWHO score showed that 28 (20%) participants scored >75, while 109 (77.9%) showed 50-75 score and 3 (2.1%) participants scored <50. The largest proportion of participants was observed in the 50-75 score category (77.9%) (Table 2).

Table 3 presents the association between hearWHO scores and participant characteristics. Male participants had higher mean hearWHO score as compared with female and mean hearWHO score was almost similar in ≤20 years and

> 20 years of age groups. Second- and third-year students had higher mean hearWHO scores than first- and final-year students. Participants with previous history of hearing screening and those with family history of hearing impairment also had higher mean hearWHO scores. Mean hearWHO scores were similar among participants with and without current ear, nose and throat infections. Participants residing at home had higher mean hearWHO score than those residing in hostel.

Table 2: Profile of hearWHO scores among participants (n=140).

Category of hearing	N	% (95% CI)	Mean±SD
>75	28	20 (80.0-82.8)	81.4±3.56
50-75	109	77.9 (54.1-57.1)	55.6±7.87
<50	3	2.1 (40.0-40.0)	40.0±0.00

Univariate logistic regression analysis was performed using two outcome models: model 1 (hearWHO score >75 versus ≤75) and model 2 (hearWHO score >50 versus ≤50). In model 1, none of the study variables showed a statistically significant association with the outcome. In model 2, no statistically significant association was observed for age, gender, previous hearing screening, family history of hearing impairment, current ear, nose or throat infection, history of cerebral trauma, ear surgery, duration of audio devise usage, adherence to volume alert notifications or place of residence. However, academic year was significantly associated with the outcome, with second, third and final year students demonstrating lower odds of having hearWHO scores ≤50 compared with first year students. Estimates for nose infection and ear surgery could not be reliably calculated because of the very small number or absence of participants in certain categories.

Table 3: Association of hearWHO score with demographic features (n=140).

Parameters	N (%)	Mean±SD of hearing score	Model 1(75 and ≤75) Odds ratio (95%CI)	Model 2 (>50 and ≤50) Odds ratio (95%CI)
Age (years)				
≤20	48 (34.3)	60.6±13.7	Ref (1.0)	Ref (1.0)
>20	92 (65.7)	60.3±12.5	1.31 (0.56–3.08)	0.81 (0.40-1.63)
Gender				
Male	70 (50)	60.9±12.6	Ref (1.0)	Ref (1.0)
Female	70 (50)	60.0±13.3	1.20(0.52-2.74)	1.06 (0.55-2.05)
Academic year of student				
I	36 (25.7)	56.4±11.7	Ref (1.0)	Ref (1.0)
II	34 (24.3)	62.9±13.4	0.35 (0.10-1.26)	0.35 (0.13-0.93)
III	34 (24.3)	62.1±12.5	0.41 (0.11-1.50)	0.35 (0.13-0.93)
IV	36 (25.7)	60.6±13.5	0.52 (0.14-1.95)	0.35 (0.13-0.93
Previous screening for hearing impairment				
No	127(90.7)	60.3±12.8	Ref (1.0)	Ref (1.0)
Yes	13(13)	61.5±14.1	0.52 (0.15-1.85)	1.15 (0.37-3.61)
Presence of hearing impairment in family				
No	124 (88.6)	60.0 ±12.7	Ref (1.0)	Ref (1.0)
Yes	16 (11.4)	63.8±14.5	0.36 (0.12-1.09)	0.55 (0.19-1.59)
Current episode of ear infection				
No	131 (93.6)	60.5±13.1	Ref (1.0)	Ref (1.0)
Yes	9 (6.4)	60.0±11.2	2.08 (0.25-17.33)	0.76 (0.20-2.97)
Current episode of Nose infection				
No	136 (97.1)	60.7±13.0	Ref (1.0)	Ref (1.0)
Yes	4 (2.9)	50.0±0.00	4.06e+6 (0-∞) Not estimable	1.61e+7 (0-∞) Not estimable
Current episode of throat infection				
No	137 (97.9)	60.5±12.8	Ref (1.0)	Ref (1.0)
Yes	3 (2.1)	56.7±20.8	0.49 (0.04-5.62)	1.97 (0.18-22.25)
History of cerebral trauma in the past				
No	135 (96.4)	60.4±12.8	Ref (1.0)	Ref (1.0)
Yes	5 (3.6)	62.0±16.4	0.36 (0.06-2.25)	1.48 (0.24-9.13)
History of ear surgery				
No	138 (98.6)	60.1±12.8	Ref (1.0)	Ref (1.0)
Yes	2 (1.4)	80.0±0.0	1.64e-7 (0-∞)	4.03e-8 (0-∞)

Continued.

Parameters	N (%)	Mean±SD of hearing score	Model 1(75 and ≤75) Odds ratio (95%CI)	Model 2 (>50 and ≤50) Odds ratio (95%CI)
Duration of audio device usage				
<4 hours	78 (55.7)	60.0±12.9	Ref (1.0)	Ref (1.0)
>4 hours	62 (44.3)	61.0±13.0	0.75 (0.33-1.72)	0.75 (0.39-1.47)
Adherent to volume alert notification				
No	85 (60.7)	61.5±13.5	Ref (1.0)	Ref (1.0)
Yes	55 (39.3)	58.7±11.9	1.81 (0.73-4.45)	1.64 (0.83-3.26)
Place of residence				
Hostel	122 (87.1)	60.2±13.1	Ref (1.0)	Ref (1.0)
Home	18 (12.9)	62.2±11.7	1.29 (0.35-4.80)	0.58 (0.21-1.59)

DISCUSSION

This study was conducted to assess the hearing status among undergraduate medical students using hearWHO application. In the present study 2.1% of participants had hearing impairment. A study conducted by Mogan et al, reported prevalence of hearing impairment as 9.4% among undergraduate medical students in Delhi.[2] A study conducted by Masthi et al, reported hearing impairment prevalence as 35.8%, higher prevalence because they included other professional college students.[9] A community based study conducted by Garg et al, found the hearing impairment prevalence as 25.1% because they included general population as the participants.[10]

In the present study, hearing assessment using hearWHO score showed that 28 (20%) participants scored >75, while 109 (77.9%) showed 50-75 score and 3 (2.1%) participants scored <50. The largest proportion of participants was observed in the 50-75 score category (77.9%), similar finding of hearing assessment score was found in study conducted by Kumaran et al showing 62% of students in score category of 50-75.[11]

In the present study, higher hearWHO scores were observed with increasing duration of earphone usage. Similar findings were reported by Mogan et al. among health care workers.[2] In the present study, participants with a history of cerebral trauma and ear surgery had higher hearWHO scores, similar findings were reported by Mogan et al.[2]

In present study, participants who did not adhere to volume alert notifications had higher hearWHO scores. This finding is consistent with the study conducted by Gupta et al.[12] However; it contrasts with the findings of Mogan et al, who reported lower hearWHO scores among participants who did not adhere to volume alert notifications.[2] These differences may be due to variations in listening habits, audio device usage patterns and study populations.

The strengths of this study are the present study demonstrated the utility of the simple, accessible, and cost-effective smartphone-based application i.e., hearWHO for hearing screening among medical students. The study also assessed the association between hearing status and factors such as audio device usage and ear related conditions, contributing to a better understanding of hearing health in this population.

This study also has some limitations. The cross sectional design limits casual inference, in addition, hearing status was assessed using a screening tool rather than confirmatory audio logical tests. As the study was conducted among medical students, who have greater awareness of the hazards of prolonged earphone use and hearing health, the findings cannot be generalizable. Furthermore, the relatively small sample size and inclusion of participants from a single professional college may limit the generalizability of the results to students from other professional institutions.

CONCLUSION

The majority of participants had hearWHO scores between 50 and 75, indicating the need for periodic screening, while a small proportion were at higher risk for hearing impairment.

These findings highlight the importance of promoting safe listening practices among medical students, as hearing is essential in the medical profession. Educational initiatives should emphasize the risks of excessive earphone use and encourage moderate volume levels, limited daily usage and regular breaks during listening. Adherence to volume alert notifications should be promoted.

Recommendations

Regular hearing screening and awareness programs in educational institutions, along with the use of the hearWHO application for early detection, may facilitate timely intervention and help prevent long term hearing damage among young adults.

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