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Use of Personal Listening Devices and Their Effect on Hearing among Young Adults of a North Indian City

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ABSTRACT

Background: Prolonged exposure to high decibel sounds is one of the leading causes of hearing loss and has been related with use of personal music players by youngsters.
Aim: to assess the use of personal listening devices (PLDs) among young adults and the association between intensity and duration of sound exposure from personal listening devices to hearing loss.
Materials and Methods: 150 young healthy subjects (68 male, 82 female) were asked about usage of PLDs and complaints of Tinnitus and/or hearing loss. Pure Tone Audiometry (PTA) was performed in all subjects to find the pattern of hearing loss.
Results: Mild hearing loss in the form of bilateral Sensory-neural Hearing Loss (SNHL) was observed in 23.3% of subjects. Self-reported volume and duration of PLD use were significantly associated with hearing loss. All cases of bilateral SNHL always experienced tinnitus after PLD use while "Frequently experiencing tinnitus" was reported by 2.7%.
Conclusion: PLD use seems to be associated with SNHL and the risk depends on loudness, duration and frequency of noise exposure.

Keywords: personal listening devices, noise-induced hearing loss, sensorineural hearing loss, tinnitus

INTRODUCTION

Auditory system is one of the mechanically most sensitive organs of the human body since it can detect vibrations as small as the diameter of a hydrogen atom and respond a thousand times faster than the photoreceptors[1].

Human ear is sensitive to sound frequencies from 20 Hz to 20,000 Hz. Hearing loss denotes a cumulative, permanent impairment of hearing that develops gradually after months or years of exposure to high levels of sound. Adults with hearing loss suffer from difficulty in communication and the problem has socio-psychological and economic ramifications.

Current trends indicate that the prevalence rate of disabling hearing loss (hearing loss

greater than 40 decibels) is increasing, with as many as one in four people projected to be living with some degree of hearing loss by 2050 (WHO, 2021) [2].

Unsafe listening practices are common worldwide, particularly among adolescents and young adults. Recreational noise exposure is largely attributed to the use of personal listening devices (PLD's e.g. MP3 players, Bluetooth, headphones, earphones etc) (WHO, 2019) [3]. Given the increasing popularity of such devices, concerns have been raised over the possible impact on the hearing of listeners [4].

Although researchers agree that PLDs are capable of producing hazardous output levels [4], the actual risk of hearing loss due to PLD use remains a subject of debate. While some studies demonstrated that hearing thresholds are significantly elevated in teenagers and young adults who use PLDs [5], others did not observe an association between PLD use and hearing at the conventional frequencies [6].

The present study aimed to assess the use of personal listening devices among young adults and to determine association between intensity and duration of sound exposure from PLDs to hearing loss. A review of literature shows that no such study has been carried out earlier in the union territory of Jammu and Kashmir which is located in northern most part of India.

MATERIALS AND METHODS

The study was conducted in the Postgraduate Department of Physiology in collaboration with the Postgraduate Department of ENT, Govt Medical College, Jammu (UT of Jammu and Kashmir) from 1st August 2023 to 31st July 2024 for a period of one year. A total of 150 subjects chosen from young adult male as well as female attendants visiting various outpatient departments (OPDs) at SMGS Hospital, Jammu, (Jammu & Kashmir) were covered.

Inclusion Criteria:

1. Young healthy adults, age 18 – 24 years.
2. no underlying pathology pertaining to hearing dysfunction.
3. willing to participate in the study.

Exclusion Criteria:

1. history of pre-existing hearing loss.
2. History of chronic middle ear disease.
3. Active middle ear infection on day of testing.
4. Subjects working in factories or industries with chronic noise exposure.
5. History of intake to ototoxic drugs.
6. Any previous history of ear surgery.
7. Any tympanic membrane abnormality on otoscopy
8. Subjects not willing to participate in the study.

The study was approved by the Institutional Ethics Committee of Government Medical College Jammu vide their no: IEC/GMCJ/2023/1515.

The study purpose and design were explained to all eligible subjects and they signed an informed consent.

In addition, they were asked about the presence of the following five symptoms immediately after using PLDs: tinnitus, difficulty in hearing others, ear pain, headache, and neck stiffness.

Personal Listening Device and Hearing Questionnaire: A modified form of questionnaire developed by Danhauer JL *et al*.,[7] was used to record:

1. Knowledge about hearing loss and hearing conservation
2. Self-evaluation for hearing status and the experience of noise exposure
3. PLD preference
4. Used pattern for PLDs
5. Reasons for using PLDs
6. Hearing related effects of PLD use: tinnitus, difficulty in hearing others, ear pain, headache, and neck stiffness.
7. duration (hours) of listening to portable music players
8. usual listening volumes by marking on a 1-10 scale
9. Opinion on PLD use

10. Knowledge and attitude towards regulations
11. Preference for education

Pure Tone Audiometry (PTA): - Hearing thresholds of all 150 subjects were tested using Elkon 3N3 Multi-Diagnostic Audiometer at speech frequencies between 0.25 and 8 kHz with TDH39P Headphones as per Hughson-Westlake Ascending Technique modified by Cahart and Jerger [8].

Statistical Analysis

Collected data was analysed using SPSS-25. Chi-square test was used to test the significance of association between qualitative variables and independent t-test was used for quantitative variables. A 'p' value <0.05 was considered as 'significant' and all the 'p' values were two tailed.

RESULTS

Present study was cross-sectional investigation about the auditory related symptoms in regular PLD users (n = 150, 68 males and 82 females). Mean age of our sample population was 21.09±1.6 years.

PLD Preferences: The most preferred PLD was AirPods (46.66%), followed by overhead earphones (26.66%) and earphones with cords (20%).

PTA findings: Participants using PLDs for up to one hour per day only exhibited predominantly normal hearing, while those using them for 5 to 9 hours showed increasing levels of hearing loss. Out of total 150 subjects, bilateral SNHL in the form of mild hearing loss was found in 35 (17 male and 18 female) subjects. 68.6% of participants who used their devices at very loud volumes had mild hearing loss (33.3% of total subjects) and 28.5% of those who listened at loud volumes also had mild hearing loss (12% of total subjects).

Volume Levels: Mean volume level of PLD used for participants with mild hearing loss was significantly higher (8.37 ± 1.16) compared to those with normal hearing (6 ± 1.94). The association between higher volume and mild hearing loss was statistically significant ($p \leq 0.0001$). However, there was no significant difference between males and females in volume levels ($p = 0.901$).

Duration of PLD Use: Participants with mild hearing loss used PLDs for significantly longer durations (mean 5.37 ± 2.24 hours) compared to those with normal hearing (mean = 2.51 ± 1.99 hours, $p \leq 0.0001$).

Tinnitus and hearing loss: All the participants who reported "always experiencing tinnitus" after PLD use, suffered from mild hearing loss, representing 23.3% of the total participants. Other subjects who reported experiencing tinnitus occasionally (30%) or never (34%) did not show evidence of hearing loss (Table 1).

Table 1. Volume and duration of PLD use vs hearing loss

	Hearing loss	Subjects (N)	Mean ± S.D.	p-value
Sound volume on PLD scale	Normal	115	6.15±1.94	≤0.0001
	Mild	35	8.37±1.16	
Duration of listening (hours)	Normal	115	2.51±1.99	≤0.0001
	Mild	35	5.37±2.22	

PLD usage pattern and hearing loss: 80% of respondents were using PLDs for last more than two years. 73.33% used PLDs for more than 12 hours per week, indicating prolonged exposure to potential risk factor.

In our study, female subjects used PLDs for slightly longer period (mean 3.48 hrs) compared to male counterparts (mean 2.83 hrs), but the difference was not statistically significant ($p = 0.093$).

Reasons for PLD use: Common reason for PLD use was found to be for listening to music, followed by usage for relaxation, at the gym, and while traveling.

Awareness of Safe Listening Practices: 73.33% of participants had never considered the safe duration for maximum volume use, and 50% had not thought about the maximum safe volume.

Perception of Risks: While 26.67% of the subjects acknowledged that high-volume and prolonged PLD use increase the risk of hearing loss, a large majority (66.67%) did not believe PLD use was directly causing NIHL, indicating a disconnect between perception and reality. In a matter of concern, 80% of respondents were not interested in learning about the impact of PLDs on hearing, presenting a challenge for public health education efforts.

DISCUSSION

Availability of various music apps in the cell phones itself has increased the use of PLDs among young adults, raising concerns about potentially hazardous effects of recreational noise exposure on hearing. The current study intended to investigate the auditory related symptoms in regular PLD users and risk of hearing loss in them.

WHO in 2015 estimated that 1.1 billion adolescents and young adults were at potential risk of hearing loss from voluntary recreational noise exposure, referred to further as Unsafe Listening Practices [3].

Our study had a balanced gender distribution, with a slightly higher proportion of females (55%) than males (45%). Interestingly, gender did not show a statistically significant association with hearing loss ($p = 0.56$). This finding is comparable to the work of Ansari et al.,[9].

Mean age of participants was 21.09 ± 1.667 years, suggesting a young adult cohort, aligning with the population most likely to use PLDs extensively.

In the present work, PTA results indicated that 35 out of 150 subjects (23.3%) had mild hearing loss in the form of bilateral SNHL. AlQahtani et al., have proposed that when wearing headphones for an extended period, the high-intensity sound will be transmitted to the inner ear, causing damage to the hair cells in the vestibule of the cochlea leading to sensorineural hearing loss [10].

Hearing loss denotes a cumulative and permanent loss of hearing that develops gradually after months or years of exposure to high levels of sound. Recurrent or even single instances of unsafe listening may cause physiological damage to the auditory system, presenting as transient or permanent hearing damage or tinnitus (Serra MR et al.,) [11].

Present study found that volume setting on individual PLD was strongly associated with hearing loss. Among those with mild hearing loss, the majority (68.5%) were exposed to very loud PLDs. In contrast, a significant proportion (54.8%) of the normal hearing group used PLDs at a soft intensity. The significant Chi-square result (p-value ≤ 0.0001) suggests that higher intensity of PLD use is a major risk factor for hearing loss. Our findings are supported by Peng JH et al [12].and Byeon et al.,[13].

Tinnitus, commonly associated with hearing damage, was shown to have a significant ($p \leq 0.0001$) relationship with hearing loss in this study (Table 2). All those participants who "always experienced tinnitus" after PLD use, had mild hearing loss as recorded on PTA; while those who "never or rarely experienced tinnitus" tended to have normal hearing. Hence, tinnitus could serve as an early warning sign of auditory damage. Our results are in agreement with growing body of evidence linking tinnitus to excessive noise exposure (McNeil K. et al., Susan E Shore and Calvin Wu) [14,15].

Table 2: Tinnitus after PLD use and Hearing loss

		Mild Hearing loss	Normal hearing	Number of cases (percent of total)
Tinnitus after PLD use	Always	35	0	35 (23.3%)
	Frequently	0	4	4 (2.7%)
	Sometimes	0	51	51 (34.0%)
	Rarely	0	15	15 (10.0%)
	Never	0	51	51 (34.0%)
Total		35	115	150

Chi-Square:150.0, p-value: ≤0.0001

The duration of PLD use was also significantly associated with hearing loss, with longer usage correlating with more severe hearing impairment. Participants using PLDs for one hour exhibited predominantly normal hearing, while those using them for 5 to 9 hours showed increasing levels of hearing loss. Naik et al.,[16] have reported that 5-10% of subjects listening to music using PLDs for >2 hours per day and 1-5% of subjects using PLDs for <1 hour per day had high-frequency hearing loss, supporting a strong correlation between PLD use and hearing loss.

There were no significant differences in the volume of PLD use between males and females ($p = 0.901$); similarly, PLD usage durations on average did not show any significant difference between male and female respondents ($p = 0.093$). This suggests a gender parity in PLD usage.

Our data indicates a significant relationship between subjective hearing changes after PLD use and consequent hearing loss. All those participants who consistently reported hearing changes ("always" category) exhibited mild hearing loss, conversely, those who "never experienced" hearing changes after PLD use had normal hearing (54.8%). This suggested that subjective awareness of hearing changes after PLD use may be an early indicator of hearing damage. Although the damage from noise exposure is first seen in the region of the outer hair cells at the basal end of the cochlea, sufficient intensity and sound duration can lead to damage along the entire organ of Corti (Le TN et al.,) [17].

Once exposure to damaging noise levels is discontinued by limiting the time spent engaging in headphones/headset, further significant progression of hearing loss stops [18]. Therefore, use of unsafe PLD among young adults who constitute an important section of society, needs to be regulated.

CONCLUSION

This study highlights significant associations between the use of PLDs and the development of mild hearing loss, particularly in users who listen at higher volumes and for longer durations. The study also revealed that while there is no significant difference in PLD use between genders, the preference for PLDs like Air Pods and the tendency to use PLDs for over two years and more than 12 hours per week pose substantial risks for hearing loss.

Given these findings, it is essential to promote educational initiatives that raise awareness about the risks of PLD use and encourage safer listening habits. Additionally, PLD manufacturers could play a pivotal role in mitigating these risks by incorporating volume-limiting features into their devices.

Declaration by Authors

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