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The prevalence and awareness of personal listening devices use and hearing loss among medical students in Saudi Arabia

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ABSTRACT

Background: NIHL results from irreparable damage to the inner ear's cochlear hair cells. In addition, a potential consequence of using prevalent PLDs puts the users at greater risk of hearing loss when misusing these devices. *Objectives:* This study evaluates the prevalence and awareness of PLDs and NIHL among medical students in Saudi Arabia. *Materials and Methods:* We conducted a cross-sectional study with a representative random sample of 600 medical students in Saudi Arabia. A self-administered questionnaire was distributed through social media. We collected data regarding participants' awareness of NIHLcaused by PLDs and its risk factors and symptoms. *Results:* 608 students completed the questionnaire, whose mean age was 23.1±3.7 years. 27.1% of the participants reported that they were suffering from hearing loss. All of the participants reported using at least one type of PLD. The most familiar type of PLDs was Earphones (32.1%), followed by headphones (26%). The overall knowledge about NIHL was low. However, moderate to high knowledge about the causes and symptoms of NIHL was found. We found a statistically significant connection among hearing damage and: Region of residence and academic year and type of PLD, level of device volume and most common purpose of device use. *Conclusion:* The study showed that PLD use and NIHL awareness are widespread among Saudi Arabian medical students. Medical students need to pay more attention, enhance their level of concentration and use less PLDs as they prepare to offer healthcare in the future.

Keywords: Noise-induced, hearing loss, headphones, medical students, awareness, listening devices, Saudi Arabia.

1. INTRODUCTION

Noise is an "unwanted sound" that harms one's health. Various factors contribute to noise-induced hearing loss (NIHL). Exposure to loud sounds can cause damage to cochlear hair cells and related synaptopathy. Reversible damage to hair cells contributes to Transient Threshold Shift (TTS), which represents defensive purinergic hearing adaption. Permanent Threshold Shift (PTS) refers to the irreversible loss caused by the destruction of hair cells and synapses (Kurabi et al., 2017). The buildup of reactive oxygen species and the active activation of intracellular stress pathways, which leads to programmed or necrotic cell death, are among the substrates of hair cell damage (Seidman and Standring, 2010). Exposure to loud sound for an extended period causes damage to the hair cells, which leads to sensorineural hearing loss (Azizi, 2010). NIHL can be unilateral or bilateral and the severity is determined mainly by the duration and intensity of noise exposure. The intense loud sound for an extended period can result in irreversible hearing loss (Seidman and Standring, 2010). For example, prolonged listening to 60% of the volume for more than 60 minutes can lead to NIHL. Furthermore, people who listen to 85db for 8 hours per day may develop permanent hearing loss (You et al., 2020).
Hearing loss is usually unnoticed until it becomes so severe that conversing becomes impossible (Delgiacco et al., 2015). NIHL is a significant social and public health issue, even though it is almost entirely avoidable (Chung et al., 2005; Alnuman and Ghnimat, 2019). Without adequate hearing protection, widespread personal listening devices (PLDs) potential consequences put users at greater risk of hearing loss when misusing these devices (Abbey et al., 2016).

Few university students knew about the impact of noise exposure and NIHL. However, the most common sources of information on noise exposure and NIHL were parents/relatives/peers, high school education and the Internet (Delgiacco et al., 2015). The possibility of reduced awareness experienced by listeners in noisy or other environments is a significant concern regarding the use of headphones among college students (Rekha et al., 2011). The explanation could be ineffective education in this area and the failure of most students to use hearing protection (Delgiacco et al., 2015). Therefore, early and consistent educational programs on hearing health and conservation are required to raise awareness of hearing damage caused by noise exposure, particularly at the elementary school level (Delgiacco et al., 2015).

WHO recommends limiting the user's time or sound volume of PLDs (Rekha et al., 2011). In addition, long-term headphones users should learn detecting e to detect early symptoms of hearing loss and take appropriate action to prevent further deterioration (Basu et al., 2019). The first step toward prevention understands which loud sounds can harm the hearing system (Ehlert, 2017). Tinnitus usually accompanies the presence of NIHL and frequently occurs immediately after exposure to excessive noise (Delgiacco et al., 2015). Long-term baseline shifts, tinnitus, sound hypersensitivity and distort are linked to intense and prolonged streaming music, which may upsurge the likelihood of lasting hearing damage (Zhao et al., 2010). In Saudi Arabia, there is a paucity of literature about using noise-induced hearing problems caused by PLDs. Thus, our study aims to assess the prevalence and awareness of PLDs use and NIHL among medical students in Saudi Arabia.

Objectives

In this study, we aimed to decide the prevalence of NIHL and PLDs use among medical students in Saudi Arabia, identify the factors associated with NIHL among the study population, identify the factors associated with PLD use among the study population, assess the knowledge about NIHL and to explore concerns and opinions related to NIHL.

2. MATERIALS AND METHODS

Study design

Observational, cross-sectional study

Study area

This research was steered in different regions of Saudi Arabia.

Study population

Medical students from different universities in the Kingdom of Saudi Arabia were included in this study.

Inclusion Criteria

All medical students who agreed to participate in the study.

Exclusion Criteria

Participants other than medical students and those who disagreed toparticipate

Sample size

A convenience sample of 608 medical students, fulfilling the inclusion criteria was included in the study.

Study period

From 5th October to 15th December 2021

Sampling technique

A convenience sample was selected through the distribution of an online questionnaire was used. The questionnaire was distributed on social media such as WhatsApp groups and Facebook accounts.

Instrument

The data was collected using an author-designed questionnaire developed from previous research. The questionnaire consisted of multiple-choice questions assessing socio-demographic data (age, sex, education level, job, place of residence, use of PLDs), awareness of risk factors of NIHL, symptoms of NIHL and protection against NIHL. The questionnaire also contained questions about the PLDs used by the medical students. This questionnaire was distributed among participants, preceded by a brief explanation of the aim of the study. After the validation, we sent the questionnaire to the participants through various social media platforms (WhatsApp, Twitter, etc.).

Pilot study

A pilot study was performed on ten students to ascertain the tool's feasibility, applicability and clarity and we made no modifications. However, we excluded students in the pilot study from the final analysis.

Statistical analysis

All data were coded, entered and examined using the statistical sequencer of Statistical Package for Social Science (SPSS) version 25. Qualitative data were expressed in terms of percentages. The Chi-square (χ^2) test of independence was used to examine and compare the qualitative data between the two groups. Differences were considered statistically significant if the P value was less than or equal to 0.05.

Ethical consideration

Ethical approval was obtained from the research ethics committee of Taif University application No (43-547).

3. RESULTS

Features of the contributors

A whole of 608 students were involved in this study. Of them, 52.6% were males and 47.4% were women. The mean (±SD) age of the students was 23.1 ± 3.7 years; nearly half of them (45.4%) were sixth-year medical students. More than 50% of the participants were residents of the Western region of Saudi Arabia.

Prevalence of NIHL and PLDs use

Interestingly, 27.1% of the participants reported that they were suffering from hearing loss. All of the participants reported using at least one type of PLD. The most familiar type of PLDs was earphones (32.1%), followed by headphones (26%) and external speakers (2.1%). In addition, about two-thirds of the participants (35.9%) reported using multiple PLDs. A total of 301 participants (49.5%) used PLDs for more than 2 hours daily and 120 (39.9%) used PLDs for more than 5 hours daily. Furthermore, 425 (69.9%) participants stated that they listen from their PLDs at a volume of 60% or more of the total volume. The most typical reason for PLD use was entertainment (45.9%) and education (25%).

The knowledge about NIHL and its causes

Regarding the general knowledge about NIHL, only 18.3% of the participants correctly knew that NIHL is not a type of conductive hearing loss. On the other hand, 61.2% correctly knew thata significant amount of hearing loss must affect speech and language comprehension negatively. Interestingly, only two-thirds of the participants (67.3%) believed that NIHL is a preventable disease. In addition, 23% of the participants thought that the minimum duration of listening to a loud noise source that could negatively affect one's hearing is 30 minutes. Finally, only 12% of the participants correctly knew that the volume level that could negatively affect hearing is more than 80 dbs. So overall, the general knowledge about NIHL was inadequate and many participants have misconceptions about this condition.

Regarding the knowledge about the possible causes of NIHL, the level of knowledge was muchbetter. More than two-thirds of the participants attributed NIHL to a high volume (77.1%). In addition, other participants attributed it to excessive noise exposure (65%) and repeated and prolonged exposure to loud noises (57.2%). More information about the knowledge of NIHL and its symptoms are summarized in (Table 1), while (Figure 1) summarizes the sources of information about the effects of noise exposure and NIHL.

Table 1 knowledge about NIHL and its symptoms among medical students in Saudi Arabia (n = 609)

Knowledge	Category	Frequency	Percent
1- General knowledge about NIHL			
NIHL is a type of conductive hearing loss.	I do not know	195	32.1%
	No	111	18.3%
	Yes	302	49.7%
A significant amount of hearing loss must occur to negatively affect speech, language comprehension, overall communication, and social development.	I do not know	140	23.0%
	No	96	15.8%
	Yes	372	61.2%
Noise-induced hearing problems are preventable	I don't know	119	19.6
	No	80	13.2
	Yes	409	67.3
The minimum duration of listening to a loud noise source that could negatively affect one's hearing is	30 minutes	140	23.0%
	1 hours	108	17.8%
	> 1 hour	177	29.1%
	I don't know	183	30.1%
The minimum volume level that could negatively affect hearing is	> 80 dB	73	12.0%
	Other	322	52.9%
	I don't know	213	35.0%
The time you need to adapt to surrounding environmental sound when exposed to loudness (in hours)	1 hour	138	22.7%
	> 1 hour	194	31.9%
	I don't know	276	45.4%
2- Causes of NIHL			
One of the most common causes of hearing loss is excessive noise exposure	I don't know	105	17.3
	No	104	17.1
	Yes	399	65.6
High volume levels affect hearing	I don't know	54	8.9
	No	85	14.0
	Yes	469	77.1
Repeated and prolonged exposure to loud noises can cause irreversible hearing loss	I don't know	156	25.7
	No	104	17.1
	Yes	348	57.2

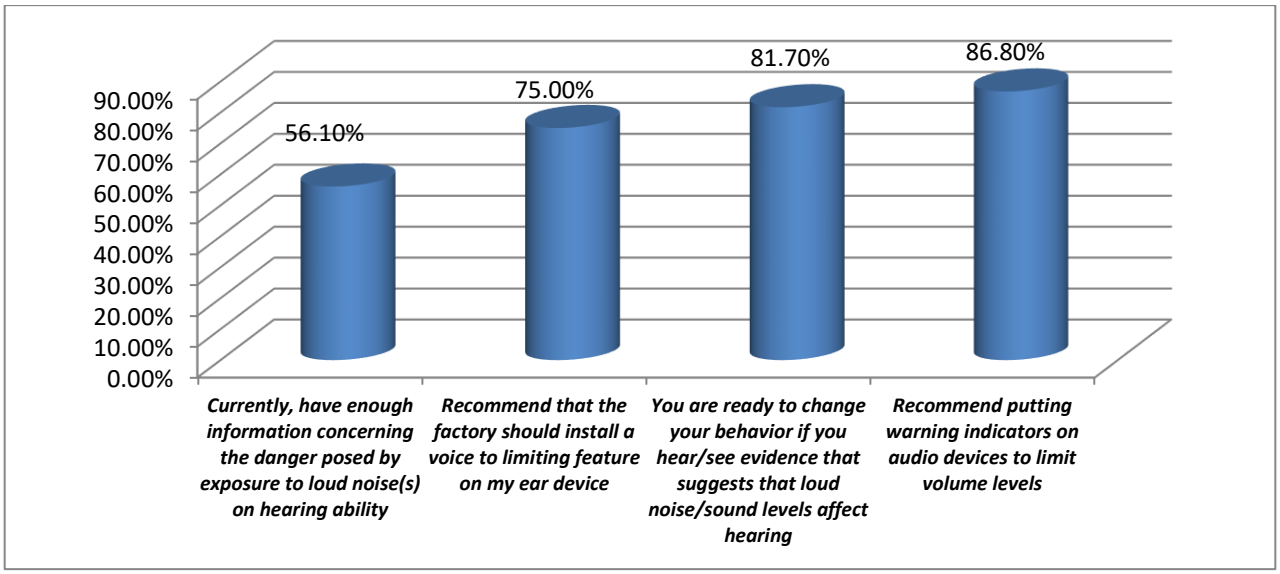

Figure 1 Concerns and opinions related to NIHL among medical students in Saudi Arabia

Knowledge of symptoms of NIHL and impacts of using PLDs

Knowledge about the symptoms of NIHL was moderate. 316 (52%) participants agreed thathearing low/muffled voices during daily conversation indicates early hearing impairment, another 316 (52%) also agreed that sensation of ringing in the ear is a sign of hearing impairment and 401 (66%) agreed that frequent increasing of TV or radio volume. Regarding the impact of PLD use, 433 (71%) of the students stated that sharing PLDs like earphones increases the risk of ear infection and 368 (60.5%) students reported that the use of PLD while driving is dangerous. In addition, two-thirds (405 / 66.6%) said that PLDs could cause headaches.

The relationship between hearing loss and socio-demographic characteristics

A chi-square test of independence revealed a statistically significant relationship between hearing loss, region of residence and academic year. The region of residence that was associated with high hearing loss was the Western Region (35.5%), followed by the Northern Region (25%) ($p< 0.05$). In addition, a high percentage of hearing loss was found among 5th-year graders (39.6%) compared with other groups ($p<0.05$). However, gender was insignificantly associated with hearing loss ($P>0.05$) (Table 2).

Table 2 The relationship between hearing loss and socio-demographic characteristics of medical students in Saudi Arabia (n = 609)

Socio-demographic characteristic	Categories	Hearing loss		P value
		No (n=443)	Yes (n=165)	
Gender	Female	219 (76.0%)	69 (24.0%)	0.094
	Male	224 (70.0%)	96 (30.0%)	
Region	Central	51 (85.0%)	9 (15.0%)	<0.001
	Eastern	113 (83.7%)	22 (16.3%)	
	Northern	30 (75.0%)	10 (25.0%)	
	Southern	36 (81.8%)	8 (18.2%)	
	Western	213 (64.7%)	116 (35.3%)	
Academic year	First year	27 (73.0%)	10 (27.0%)	0.009
	Second year	21 (75.0%)	7 (25.0%)	
	Third year	74 (79.6%)	19 (20.4%)	
	Fourth year	47 (64.4%)	26 (35.6%)	
	Fifth year	61 (60.4%)	40 (39.6%)	
	Sixth year	213 (77.2%)	63 (22.8%)	

The relationship between hearing loss and practices related to PLDs use

A chi-square test of independence revealed a statistically significant relationship between hearing loss and type of PLD, level of device volume and most common purpose of device use ($p < 0.05$). In comparison, the duration of the listening session/per day and typical volume level were insignificantly associated with hearing loss among participants ($P>0.05$). In addition, higher percentages of hearing loss were noticed among those who use multiple PLDs (37.2%) and those who use out-ear headphones (38.1). More information about the relationship between hearing loss and practices related to PLDs use is provided in (Table 3).

Table 3 The relationship between hearing loss and practices related to PLDs of medical students in Saudi Arabia (n = 609)

PLD-related practices	Categories	Hearing loss		P value
		No	Yes	
Type of PLDs used	Headphones	118 (74.7%)	40 (25.3%)	<0.001
	Earphones	155 (79.5%)	40 (20.5%)	
	Ear buds	20 (90.9%)	2 (9.1%)	
	External speakers	12 (92.3%)	1 (7.7%)	
	Car audio system	1 (50%)	1 (50%)	
	Multiple devices	137 (62.8%)	81 (37.2%)	
Duration of listening session per day	<1 hours	96 (76.8%)	29 (23.2%)	0.300
	1-2 hours	131 (72%)	51 (28%)	
	3-5 hours	124 (68.5%)	57 (31.5%)	
	>5 hours	92 (76.7%)	28 (23.3%)	
How often are the people surrounding you affected by the noise from your PLDs?	Always	28 (77.8%)	8 (22.2%)	<0.001
	Usually	33 (55%)	27 (45%)	
	Never	236 (80%)	59 (20%)	
	Sometimes	146 (67.3%)	71 (32.7%)	
Level of device volume	High	115 (76.7%)	35 (23.3%)	0.018
	Intermediate	282 (74%)	99 (26%)	
	Low	46 (59.7%)	31 (40.3%)	
Typical level of volume used (%) in percent	0-49	50 (65.8%)	26 (34.2%)	0.079
	50-59	83 (77.6%)	24 (22.4%)	
	60-69	78 (64.5%)	43 (35.5%)	
	70-79	83 (79%)	22 (21%)	
	80-89	72 (75%)	24 (25%)	
	90-100	77 (74.8%)	26 (25.2%)	
Most common purpose of device use	Education	97 (63.8%)	55 (36.2%)	<0.001
	Entertainment	231 (82.8%)	48 (17.2%)	
	Relieving loneliness (socialization)	60 (58.3%)	43 (41.7%)	
	Research or studying	23 (88.5%)	3 (11.5%)	
	Others	32 (66.7%)	16 (33.3%)	
Type of earphone	In ear	318 (78.3%)	88 (21.7%)	<0.001
	Out ear	125 (61.9%)	77 (38.1%)	

Concerns and opinions related to NIHL

When asked about their opinions, only 56.1% of students had enough information concerning the danger posed by exposure to loud noise on hearing ability. However, 75% of students recommended that the factory should install a voice-limiting feature on their ear devices. An 81% of students are ready to change their behavior if they hear/see evidence that suggests that loud noise/sound levels affect hearing. An 86.8% of the students recommended warning indicators on audio devices to limit volume levels. Table 4 and Figure 1 summarize these results.

Table 4 Concerns and opinions related to NIHL among medical students in Saudi Arabia (n = 609)

Concerns and opinions related to NIHL	N	%
Currently, have enough information concerning the danger posed by exposure to loud noise(s) on hearing ability	341	56.1%
Recommend that the factory should install a voice to limiting feature on my ear device	456	75.0%
You are ready to change your behavior if you hear/see evidence that suggests that loud noise/sound levels affect hearing	497	81.7%
Recommend putting warning indicators on audio devices to limit volume levels	528	86.8%

4. DISCUSSION

Hearing loss or impairment has become a major social and public health issue that affects 6.1 percent of the global population (Olusanya et al., 2019). Furthermore, it is projected that more than 100 million young people aged 12 to 35 are at an elevated hazard of audible range damage due to misuse of PLDs and listening to sounds at harmful levels in noisy entertainment (Ehlert, 2017). In addition, the increased usage of cell phones and the increasingly widespread practice of using headphones to hear music pose a threat (Beach et al., 2013). In our study, the prevalence of NIHL among students was 27.1%. It was insignificantly higher in males ($P>0.05$). A Jordan study reported that 53% of male and respondents who were female claimed to have at least one sign of noise-related deafness or 62.8% of them, with a significantly higherrate in females ($P<0.05$) (Alnuman and Ghnimat, 2019). According to a previous Nigerian study, the prevalence of earpiece use amid scholars and particular tinnitus stayed 95.6% and 20.6 percent, respectively, which is relatively high in comparison with other studies (Seidman and Standring, 2010; Sunny et al., 2012; Chung et al., 2005; Alnuman and Ghnimat, 2019). Nevertheless, this work was achieved on medical scholar, while the other encompassed newer high schoolscholars. Another recent study done in 2020 aimed to analyze the risk of using PLDs and hearingloss in college and school-going students by utilizing an audiometry mobile application followed by a questionnaire; they stated that 3.2% of participants were identified to suffer from HL (Basu et al., 2019).

In the current study, about half (49.7%) think NIHL is a type of conductive hearing loss. However, only 12% reported that the minimum volume level that could negatively affect hearingis 81-90 dB, indicating little awareness about NIHL amongst medicinal scholars in KSA. Another study conducted in India discovered that 18% of the study population knew that wearing headphones could harm their health and 24.1% believed it could cause ear problems (You et al., 2020). Another recent study done in 2020 aimed to analyze the risk of using PLDs and hearing loss in college and school-going students by utilizing an audiometry mobile application followed by a questionnaire. The study contained a total of 3000 students, with 72% of them unaware of NIHL (Basu et al., 2019). In another study in Hail, there is a deficiency of cognizance about hearing loss and its causes. > 50% of the respondents have unhealthy habits in listening to sounds through their PLDs (Alqahtani et al., 2021).

In the current study, noise-induced hearing problems are preventable in the opinion of 67.3%. However, only 56.1% had enough information concerning the danger of exposure to loud noise(s) on hearing ability. While in Hail, there is 58.7% think that this type of hearing loss is preventable and only 35% had enough information concerning the danger posed by exposure to loud noise(s) on hearing ability (Alqahtani et al., 2021). In the current study, 65.6% stated that noise exposure is one of the most common causes of hearing loss, 77.1% knew that high volume levels affect hearing and 57.2% reported that prolonged exposure to loud noises could cause irreversible hearing loss. The results of Jordan's study were consistent with ours, as most of their participants acknowledged awareness of the link involving loud noises and deafness. Parallel findings were made by Joubert et al., (2017), Alnuman and Ghnimat, (2019) which both showed that as more over two-thirds of the respondents had a solid understanding of NIHL. Both studies stated that 89% (n=265) of the population claimed to understanding about just the connection involving loud noise and auditory impairments.

In the current study, the duration of the listening per day and the typical volume level were insignificantly associated with hearing loss among participants. This was similar to findings in Hail, Saudi Arabia, which reported that the duration of listening /per day for > 5 h was meaningfully associated with higher proportions of hearing problems among contributors ($P=.001$) (Alqahtani et al., 2021). In the current study, earphones were the greatest mutual kind of PLDs used by 32.1% of the students, headphones used by 26% and external speakers by 2.1%. As regards the duration of PLDs usage per day, 29.9% used PLDs for 1-2 hours/day and

approximately the same proportion (29.8%) used it for 3-5 hours daily. While in Hail study, earphones were the most reported preferred type of audio device in 60.5% of the contributors, headphones in 11.9% and External speakers in 10.5%. As for the duration of the session/per day in hours, 400 (36.8%) participants used it for less than one hour, 325 (29.9%) used it for 1–2 hours and 168 (15.5%) used it for ≥5 h (Alqahtani et al., 2021). In another recent study done in 2020, 50% of those reported using PLDs for more than six hours per day. Most of the participants identified with HL were headphone users (81%) (Basu et al., 2019).

Study strengths and limitations

There are several strengths in the study: The subject is essential; The questionnaire included questions concerning all the needed data according to the study objectives; The study objectives were fulfilled throughout the results and discussion sections. There are some limitations: The respondents were medical students in Saudi Arabia, who do not represent the whole population; Using a self-reporting questionnaire which can lead to reporting bias

5. CONCLUSION

In conclusion, the study revealed the prevalence and awareness of PLDs use and NIHL amid medicinal scholars in KSA. As future healthcare providers, medical students need to improve their awareness and reduce the usage of PLDs that can be achieved by discussing this issue in the medical colleges in Saudi Arabia and focusing on lectures and campaigns, exploiting connected broadcasting besides college web pages. Such additional classes, even if time-consuming, can help improve students' fitness and diminish the upcoming fee of NIHL. However, the cognizance besides earshot teaching lectures are not enough alone. Preventive and awareness classes increase the usage of earshot safety in addition to diminution the negative attitude toward loud sounds.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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We thank the participants who were all contributed samples to the study. Author contributions we certify, as authors, that we have participated sufficiently in the intellectual content, conception and design of this work or the analysis and interpretation of the data, as well as the writing of the manuscript, to take public responsibility for it and have agreed to have our name listed as a contributor. All persons who have made substantial contributions to the work reported in the manuscript.

Ethical approval

Ethical approval was obtained from the research ethics committee of Taif University application No. (43-547).

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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