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Public Perception and Behavior Toward Personal Listening Device Usage: Outcome of World Hearing Day Screening in a Tertiary Centre

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ABSTRACT

Unsafe personal listening device (PLD) usage has recently been linked to noise-induced hearing loss (NIHL). This study aims to investigate the public's behavior toward PLD usage and raise awareness about its adverse effects on users. A total of 100 participants were surveyed to obtain information about their PLD usage behavior and its effects on hearing levels using pure tone audiometry. In our study, out of 100 participants, 67 used PLD, and 47.7% of them were under 25 years old. Additionally, 4.28% of PLD users reported experiencing hearing loss, while 34.3% reported vestibular symptoms. The long-term effects of PLD usage, particularly among young people, require further investigation. Therefore, this study highlights the importance of promoting safe listening practices, particularly among younger generations.

Keywords: Personal listening device, recreational noise exposure, noise-induced hearing loss, vertigo

INTRODUCTION

Over the past few decades, the use of personal listening devices (PLDs) has increased tremendously. Additionally, PLD usage has risen even more during the Coronavirus disease 2019 (COVID-19) pandemic, which began in December 2019. Unfortunately, many people are unaware of the detrimental effects of PLD usage, particularly hearing loss. The sound output from PLDs can reach 100–120 decibels on the A-weighted decibels scale (dBA), which is comparable to the noise level of a jackhammer or a chainsaw (1). It is no surprise that an estimated 5–10% of PLD users may eventually develop some form of irreversible hearing dysfunction after years of PLD use. With hundreds of millions of PLDs sold worldwide, even a small percentage of users listening at higher-than-safe levels could potentially put countless individuals at risk of noise-induced hearing loss (NIHL) (2).

The relationship between PLD usage and hearing damage is concerning, especially for younger people. In 2007, Ahmed et al. (3) demonstrated that as many as 82% of students owned PLDs. Additionally, Portnuff et al. (4) showed that young people tended to listen to music at higher volumes without realizing the potential hazards of intense sound. The recent Coronavirus pandemic has disrupted traditional means of education, resulting in an increase in online learning. A significant increase in the number of college students using PLDs more frequently and for longer periods during the pandemic has been reported (5).

PLD use has been linked to several symptoms, including otalgia (51.4%), tinnitus (42.9%), hearing loss (37.1%), headache (8.6%) and neck stiffness (5.7%). NIHL resulting from prolonged exposure to sound levels above 85 dBA is a gradual process, and it may take at least five years of exposure before it becomes noticeable (6). However, a listening duration of more than five hours per day was significantly associated with a higher incidence of hearing problems among subjects (7).

In addition to hearing loss, PLD usage has also been linked to vestibular impairment. For instance, Dan-Goor et al. (8) reported a case of a relatively young and healthy woman who experienced a sudden onset of severe vertigo after using digital noise-cancelling headphones (DNCHs) for an extended period one night prior to the onset of symptoms. Furthermore, the constant noise may negatively affect the movement of tympanic membranes and middle ear ossicles due to the enclosed air chamber surrounding the ears. Additionally, repetitive mechanical disturbance or vibration confined to the vestibular system could displace otoliths into the posterior semi-circular canal lumens (9).

Efforts to address the inappropriate use of PLD, as well as standard hearing screenings, need to be initiated early in schools in order to recognize the early emergence of NIHL. Better outcomes have been demonstrated when knowledge of NIHL and appropriate habits were instilled in younger versus older children (10). Speech-language pathologists and audiologists must continue collaborating as both professions are well-informed about the consequences of noise on hearing, the poor outcome of hearing loss, as well as the deterioration of health conditions concerning communication and occupational issues (11).

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MATERIALS AND METHODS

This cross-sectional survey was conducted among healthy participants who visited a single tertiary center in Malaysia after receiving ethics approval from the University of Malaya Medical Center Ethics Committee (MECID No. 20221216-11813).

Participant Recruitment

Advertisements about the World Hearing Day (WHD) screening were posted on various platforms to invite the public to participate. Participants were invited to complete a questionnaire about their perception and behavior regarding PLD usage and their hearing habits. The questionnaire also included a component to gather information about patients' subjective vestibular symptoms.

Pure Tone Audiometry (PTA)

Participants underwent hearing assessment using Pure Tone Audiometry (PTA) to determine their hearing levels.

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) software version 28. Descriptive statistics were used to summarize the collected data. Numerical variables were reported as mean standard deviation (SD) for parametric data or median (Interquartile Range) for non-parametric data. Categorical variables were described as frequency and percentage. The Chi-Square Test was used for normally distributed data, while Fisher's Exact Test was used for abnormally distributed data to examine the association of categorical variables.

RESULTS

A total of 100 respondents participated in the study, with 33 reporting no history of PLD use. Among the non-PLD users, 12.1% were under 25 years old, 60.6% were aged 25-60, and 27.2% were over 60. Among the remaining 67 respondents who reported PLD use, 47.7% of were under 25 years old, while the majority (52.2%) were aged 25-60. No PLD users were over 60 years old (9 respondents). Most respondents reported using PLD for 1–3 hours per day (58.2%). Of the PLD users, 59.7% were female, while 40.3% were male.

Out of the 75 respondents with a tertiary education level, 81.3% reported using PLDs, accounting for 91% of all PLD and 78.1% of all respondents. The percentage of respondents with primary and secondary education levels was 4.2% and 17.7%, respectively. Among the remaining 98 respondents who provided information on PLD use, 71.4% reported using PLDs. Although all participants were invited for pure tone audiometry (PTA), only 43.9% completed examination.

Of the PLD users, 4.28% reported hearing loss, and these respondents were in the 25-60 years age group (Table 1). Additionally, 34.3% of PLD users reported vestibular symptoms. When examining PLD types individually, 54.2% of PLD with vestibular symptoms used in-ear PLDs, while 20.8% used a combination of in-ear and over-the-ear PLDs.

DISCUSSION

Various campaigns and programs promoting safe listening practices have been implemented globally. Similarly, this year's World Hearing Day theme is "Safe Listening for All," which aims to raise awareness about the importance of hearing and safe listening practices, especially among the younger generation.

Our study found that 4.28% of PLD users reported some degree of hearing loss, and these respondents were in the 25-60 age group. However, it is unclear whether the hearing impairment was a direct result of PLD use, as there was no baseline hearing assessment for comparison. Additionally, up to 50% of respondents who did not use PLDs also reported hearing loss. It is unclear whether this could be attributed to other factors such as age or environmental factors, or simply because PTA results were unavailable for many respondents.

NIHL occurs as a result of two mechanisms: direct mechanical trauma and metabolic changes to the cochlea. At noise intensities above 140 dB, such as during an explosion, mechanical trauma alone can cause NIHL. In contrast, metabolic stress is believed to be responsible for cochlear damage resulting from lower noise intensities, such as workplace noise. Reactive oxygen species (ROS), reactive nitrogen species (RNS), and other free radical molecules are produced in the cochlea in response to this stress. These toxic products can damage DNA and cell membranes, leading to the upregulation of apoptotic cell death genes and resulting in cochlear damage and loss of function (12).

Of the PLD users in our study, 34.3% reported experiencing vertigo symptoms. Intense impulse noise exposure can cause vertigo or imbalance in some individuals, a phenomenon known as the Tullio phenomenon. This condition is caused by vestibular activation following acoustic stimulation, such as from gunshots, which can cause the otolith to detach from the organs and result in paroxysmal vertigo with repeated exposure. Additionally, prolonged exposure to very high-intensity noise can cause acoustic trauma, which can produce abnormal vestibular-evoked myogenic potentials (VEMPs) due to damage to the saccule (13).

When comparing individual PLD types, 54.2% of PLD users who experienced vertigo symptoms were using ear-type PLDs. Meanwhile, 20.8% of PLD users with vertigo symptoms used a combination of in-the-ear and over-the-ear PLDs. Interestingly, respondents who used all three types of devices (in the ear, EarPods, and over-the-ear headphones) did not complain of vertigo symptoms. The data describing vertigo symptoms based on different types of PLD and the number of PLDs used did not show a significant correlation (p-value of 0.225 and 0.137, respectively).

A study by Fligor and Ives in 2006 described how different types of earphones used in various background noises affected listening behavior. The different types of earphones provided varying levels of background noise isolation. Two of the earphones used in this study (the Sony MDR-EX51LP and the ER-6i) had some amount of background noise isolation, while the other two earphones (Koss KSC11 and the Apple iPod earbud) did not block out background noise. As subjects listened in a noisy environment, the majority of those who normally listened at safe levels turned up the volume to markedly higher levels in noisy conditions. However, this behavior was diminished when background noise-isolating earphones were used (14).

Table 1. Descriptive distribution of personal listening device types and hearing level

	Hearing level								Chi-square test (p-value)
	Hearing loss								
	Normal		Mild		Moderate		Severe		
	n	%	n	%	n	%	n	%	
Type of PLD									0.695^b
No PLD use	7	50.0	3	21.4	3	21.4	1	7.1	
In-the-ear	11	84.6	–	–	2	15.4	–	–	
EarPods	4	100.0	–	–	–	–	–	–	
Over-the-ear headphone	2	66.7	–	–	1	33.3	–	–	
In-the-ear & EarPods	4	100.0	–	–	–	–	–	–	
In-the-ear & over-the-ear headphone	4	100.0	–	–	–	–	–	–	
EarPods & over-the-ear headphone	–	–	–	–	–	–	–	–	
In-the-ear, EarPods & over-the-ear headphone	1	100.0	–	–	–	–	–	–	
Number of PLD types used									0.121^b
No PLD use	7	50.0	3	21.4	3	21.4	1	7.1	
1 device only	17	85.0	–	–	3	15.0	–	–	
2 devices	8	100.0	–	–	–	–	–	–	
3 devices	1	100.0	–	–	–	–	–	–	

Reject Ho is p-value <0.05. a: Results derived for Chi-square; b: Fisher-Exact Test; PLD: Unsafe personal listening device

Limitation

There was a major limitation to this study. The data on the public's perception and behavior toward PLDs and the results on hearing loss were solely based on subjective assessment obtained via a questionnaire. Additionally, no objective vestibular assessment was carried out to quantify the vestibular function among the respondents with vestibular symptoms. Nonetheless, noise-induced vestibular loss has been well-established (13). However, no studies have shown that headphone usage results in vestibular loss or imbalance.

Recommendations

Given the significant weight of hearing loss and vertigo symptoms consequent to PLD use, preventive measures need to be taken in order to create awareness to curb this potential public health issue. Moreover, written materials educating readers on this subject have to be made available in waiting rooms in hospitals, airports and other public places. Users should also seek warning functions on PLDs that would alert them when listening at a higher-than-recommended volume.

In conjunction with the World Health Organisation's (WHO) 'Make Listening Safe' initiative in 2019, a recommendation called 'Toolkit for Safe Listening Devices and Systems' was published in collaboration with the International Telecommunication Union (ITU). This standard aims to enhance listening practices, particularly for youths, as they listen to audio content through PLDs (15).

Among the recommendations is the dosimetry function: the PLD should include software that monitors the level and duration of the

user's sound exposure. The user can select one of two modes that dictate the overall sound dose: Mode 1 for adults: 80 dB for 40 hours weekly, or Mode 2 for children: 75 dB for 40 hours weekly.

In addition, PLDs should also generate an individualized listening profile based on the user's listening habits. This profile informs the user whether they have been listening to music safely through the device and provides suggestions for steps based on this information.

Moreover, there should also be volume-limiting options either via automatic volume reduction or parental volume control. Automatic volume reduction immediately reduces the volume of the PLD if it is used at unsafe levels for an excessive duration. Meanwhile, the parental volume control enables parents to choose the volume intensity by using a password protected control.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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