

AUDITORY EFFECTS OF PERSONAL MUSIC SYSTEMS IN YOUNG ADULTS: A QUESTIONNAIRE BASED STUDY

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Contributions:

A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

Abstract

Background: Noise exposure damages cochlear hair cells resulting in sensorineural hearing loss along with other symptoms like tinnitus and vertigo. One source of loud sound exposure in young adults is personal music systems (PMS). The present study investigated the auditory-related symptoms in regular PMS users by administering a questionnaire on PMS usage and associated symptoms in individuals who were regular users of PMS and compared results with non-regular PMS users.

Material and methods: There were 260 young adults who participated in the study. Individuals who used PMS for ≥ 1 hour per day at a volume control setting of $\geq 60\%$ for ≥ 2 years were considered regular PMS users, while other participants were considered non-regular PMS users. A custom-made questionnaire with a total of 24 questions was administered to all participants.

Results: Statistical analysis indicated that the occurrence of symptoms such as reduced hearing and vertigo were significantly higher in regular PMS users than in non-regular users. However, other symptoms such as tinnitus, difficulty in perception of speech in noisy situations, ear pain, and headache were not significantly different between the groups.

Conclusions: The findings substantiate the harmful effects of regular PMS usage on hearing and related functions. They also document the incidence of associated symptoms.

Key words: questionnaire • auditory symptoms • noise exposure • personal music system • leisure noise

WPŁYW PERSONALNYCH SYSTEMÓW MUZYCZNYCH NA SŁUCH U MŁODYCH DOROSŁYCH: BADANIE KWESTIONARIUSZOWE

Streszczenie

Wprowadzenie: Ekspozycja na hałas uszkadza komórki słuchowe w ślimaku, powodując niedosłuch odbiorczy oraz inne objawy, takie jak szumy uszne i zawroty głowy. Jednym ze źródeł ekspozycji na głośne dźwięki u młodych osób dorosłych są personalne systemy muzyczne (PMS). W niniejszej pracy, za pomocą kwestionariusza dotyczącego korzystania z PMS i występowania powiązanych z tym objawów ze strony narządu słuchu, zbadano grupę osób regularnie korzystających z PMS, a wyniki porównano z wynikami grupy osób niekorzystających regularnie z PMS.

Materiał i metody: W badaniu uczestniczyło 260 młodych osób dorosłych. Osoby używające PMS ≥ 1 godzinę dziennie z głośnością ustawioną na $\geq 60\%$ przez ≥ 2 lata były uważane za regularnych użytkowników PMS, pozostałych uczestników zaliczono do nieregularnych użytkowników PMS. Wszyscy wypełnili specjalnie opracowany do tego badania kwestionariusz zawierający 24 pytania.

Wyniki: Analiza statystyczna pokazała, że objawy, takie jak pogorszenie słuchu i zawroty głowy, występowały znacznie częściej u regularnych użytkowników PMS niż u nieregularnych użytkowników. Jednak występowanie innych objawów, takich jak szumy uszne, trudności z percepcją mowy w hałaśliwych sytuacjach, ból uszu i ból głowy, nie różniło się znacząco w tych grupach.

Wnioski: Wyniki potwierdzają, że regularne korzystanie z PMS ma ujemny wpływ na słuch i pokrewne funkcje. Dokumentują także występowanie powiązanych objawów.

Słowa kluczowe: kwestionariusz • objawy słuchowe • narażenie na hałas • osobiste systemy muzyczne • hałas rekreacyjny

Introduction

Exposure to loud noise is a common cause of hearing loss in humans. Noise exposure damages cochlear hair cells resulting in sensorineural hearing loss along with associated symptoms like tinnitus and vertigo [1,2]. Occupational noise is one of the major causes of such noise-induced hearing loss (NIHL) and related disturbances. The major hearing-related difficulties after noise exposure include temporary or permanent hearing loss, tinnitus, giddiness, headache, etc. [2–4]. WHO has stated that exposure to high levels of noise is a major but avoidable

cause of hearing impairment [5]. They also consider it as one of the most common occupational hazards across the globe. In its report WHO estimated that in 2005 there were around 278 million people worldwide with occupational hearing loss [6].

However, the auditory signal resulting in hearing loss need not always be noise. Like noise at the workplace, loud sounds elsewhere may also result in similar symptoms to occupational noise. Such situations may be amplified music concerts or personal music systems (PMS). The sale and usage of PMS are growing exponentially. It

is alarming that the incidence of such noise exposure has increased among young adults where PMS usage is popular [7,8]. The maximum loudness levels in a PMS can reach up to 105 dB, a level which is alarmingly high and sufficient to cause permanent hearing loss over a long time. The undue use of PMS can be expected to be a factor that contributes to the increased incidence of hearing loss in young adults [9–11].

The preferred volume levels of PMS depend on the environmental noise and the type of transducer used with the PMS [12]. Earlier research has found that 11% of 111 participants used their PMS at a level greater than 85 dBA [13] and that 10% listened to music at 90–100 dB, even while sleeping [14]. It has also been reported that tinnitus and hearing loss are significantly associated with the volume level [15,16]. Similarly, it has been reported that a large proportion of young adults use a PMS at levels that exceed the limits prescribed by regulatory bodies [17]. These risky patterns of PMS usage have been substantiated by other researchers in settings which include school children and young adults [18–20].

Earlier studies have reported the deleterious effect of music on hearing. One study examined the effect of loud music on otoacoustic emissions and threshold shift in normal-hearing individuals [21]. They presented a play list consisting of popular songs to normal hearing individuals and observed temporary elevation in hearing sensitivity and alterations in otoacoustic emissions after exposure. Another study [4] tried to correlate leisure habits with the incidence of headaches in teenagers; according to this study, 489 teenagers out of 1035 reported headaches, and it suggested that loud exposure to music was associated with the headaches. However, awareness among teenagers about the deleterious effects of music on health is low [22].

Nevertheless, there are contradictory findings in the literature on the effect of music through PMS on the auditory system. One earlier study monitored the output SPL of the transducer at the desired volume setting and reported that those output levels may not be hazardous as the duration of usage was 1–3 h [13]. Similarly, it has also been reported that listening to PMS at an intensity of 86.6 dBA for 30 min does not affect pure tone thresholds or transient and distortion product otoacoustic emissions (OAEs) [23]. Furthermore, there is a report that pure tone thresholds and OAE amplitudes do not vary between young adults who were exposed to low, intermediate, and high recreational music levels [24].

Although there are some studies on the deleterious effect of PMS on hearing, the specific factors that affect hearing and give rise to related symptoms are still not clear. Earlier experimental work has focused on hearing acuity and related symptoms immediately after PMS usage. There are also efforts to associate the output of PMS with such symptoms. However, it is also important to understand the subtle auditory symptoms exhibited by regular PMS users, since there are contradictory reports in the literature on the effect of PMS on hearing. Hence, the present study was planned to understand the listening habits of young adults and study the auditory and related symptoms exhibited by regular PMS users and compare them

with non-regular PMS users. The objectives were to administer a questionnaire on PMS usage and associated symptoms in young adults and compare the results between regular and non-regular PMS users.

Material and methods

The study was conducted in the city limits of Mysuru, India. The methodology adopted was reviewed and approved by the research review board of the institution. All participants were randomly recruited on a non-payment basis and provided written informed consent. The participants were native Kannada speakers with good knowledge of the English language. Initially, a total of 300 participants were considered for the study. A detailed questionnaire was administered to each of the participants to rule out any history of long-standing hearing loss, ear pain, ear discharge, neurological deficits, family history of hearing loss, and exposure to loud noise other than PMS. There were 40 individuals who exhibited at least one of these conditions and were excluded from the study. This left a study population of 260 young adults within the age range of 17 to 30 years (mean 21.2 years). We prepared a questionnaire (see Appendix) based on custom-made questionnaires used in earlier studies and revised it as per our clinical experience [3,7]. To the best of our knowledge there are no standardized questionnaires available to assess the auditory effects of PMS in the Kannada language. The questions were in English and were sent to the participants as Google forms. Participants submitted their responses online using the link provided.

The questionnaire shown in the Appendix includes 24 questions: 8 about the way PMS is used, 15 relating to the auditory symptoms exhibited, and 1 question about the user's awareness of the harmful effects of PMS on hearing. Information was collected on the type of PMS used, the ear in which it was used, duration of usage, duration of exposure per day, type of music heard, and the situations where they were used. A rating scale (1 to 5) was used to identify the approximate volume level at which the participants listened to music.

Information was also collected on the self-perceived hearing and related difficulties experienced by these individuals. The questions were framed to identify the presence of hearing loss after noise exposure, whether it was temporary and if so its duration, the presence of tinnitus and if so the ear in which it was present, its duration, and type. Moreover, the presence of giddiness was also considered. If giddiness was present, its duration and type were also documented. Questions also probed the blocking sensation that may be felt after exposure to loud music or noise. If a blocking sensation was present, assessment of the ear in which it was present and its duration was also asked for. A final question asked about the participant's knowledge of hearing related difficulties caused by loud exposure to noise or music. Responses from all the participants were analyzed so as to identify regular PMS users.

In the current study, participants who used PMS for more than 1 h per day at a volume control setting exceeding 60% of the maximum volume, and for at least 2 years, were considered regular PMS users (group 1). This criterion was adopted based on previous research studies [3,10].

Table 1. Usage of personal music systems in regular and non-regular users

Group	Duration of exposure per day (n = 260)				Duration of usage (n = 260)				Type of transducer used (n = 260)		Type of music heard (n = 143)		
	<1 hour	1–2 hours	2–5 hours	>5 hours	1–3 years	3–6 years	6–10 years	>10 years	Headphones	Earphones	Rock	Classical	Other
Regular PMS users (n = 87)	–	57	24	6	–	61	15	11	5	82	28	13	22
Non-regular PMS users (n = 173)	141	26	3	3	93	51	18	11	36	137	29	18	33

Abbreviation: n, number of responses. Note that the last column is based on only 143 responses.

The other participants were considered non-regular PMS users (group 2). The data were subject to further statistical analysis using Statistical Package for the Social Sciences (SPSS) version 16.0. The significance level was set at 5%.

Results

The percentage and proportion of subjects answering each question were computed in both the groups. Of the 260 participants, 87 (33.5%) were identified as regular PMS users in terms of the criteria mentioned earlier. There were 174 participants (66.9%) who were aware of the potential damage to their ears due to prolonged PMS usage. Numbers of the regular and non-regular PMS users reported various auditory symptoms. Table 1 shows the PMS usage pattern in both groups. Note that only 143 responses could be elicited for the question “type of music heard”.

The data was further subjected to Chi-square test to understand the significance of differences between percentages of occurrence of each symptom. The results showed that the occurrence of reduced hearing ($\chi^2(1, N = 260) = 59.91, p < 0.01$) and vertigo ($\chi^2(1, N = 260) = 186.96, p < 0.01$) was significantly higher in the regular PMS users. However, the percentage of occurrence of other symptoms – tinnitus ($\chi^2(1, N = 260) = 0.80, p > 0.05$), difficulty in perception of speech in noisy situations ($\chi^2(1, N = 260) = 0.98, p > 0.05$), ear pain ($\chi^2(1, N = 260) = 2.39, p > 0.05$), and head ache

($\chi^2(1, N = 260) = 1.93, p > 0.05$) – were not significantly different between the groups.

Figure 1 shows the percentage of occurrence of reduced hearing and vertigo in both the groups; both these symptoms were significantly higher in group 1 (regular PMS users). Figure 2 shows the percentage of occurrence of symptoms that were not significantly different between the groups according to a Chi-square test: difficulty in understanding speech in presence of noise, tinnitus, ear pain, and headache.

Discussion

The current study was carried out to identify the percentage of occurrence of various hearing-related symptoms in individuals who were regular or non-regular PMS users and compare the two groups. Because music, as with other noises, has been reported to be harmful to the auditory system unless within safe limits, we felt it would be worthwhile to study the music listening behaviors of young adults. Previous studies have reported prolonged and unsafe music listening behaviors in this group [1,3,11]. A few studies in the literature have reported reduced hearing and vestibular dysfunction exhibited by individuals who use PMS regularly [1,3]. However, a comprehensive estimate of hearing-related symptoms in regular PMS users is lacking in the literature.

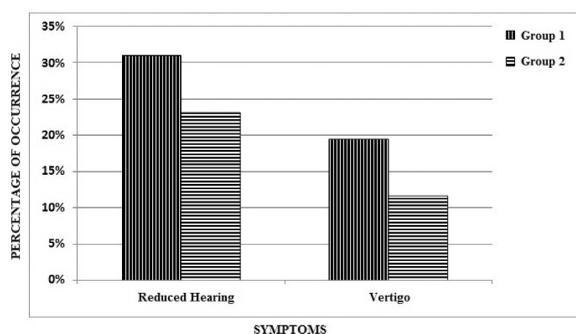


Figure 1. Comparison of the percentage of occurrence of reduced hearing and vertigo in regular PMS users (group 1) and non-regular users (group 2). The differences were statistically significant

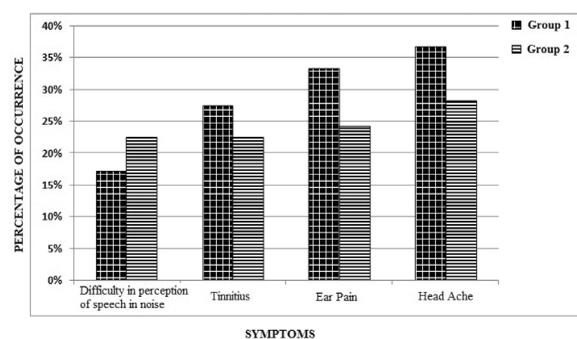


Figure 2. Comparison of the percentage of occurrence of difficulty in perception of speech in noise, tinnitus, ear pain, and headache in regular users (group 1) and non-regular users (group 2). The differences were not statistically significant

Regular PMS users were here identified by analyzing the PMS usage data obtained through the questionnaire. It was noted that 33% of participants were regular PMS users which shows the potential extent of unhealthy listening habits in younger adults. Similar statistics have been reported by previous researchers [8]. The various symptoms considered in the study were reduced hearing sensitivity, difficulty in perception of speech in noise, tinnitus, vertigo, ear pain, and headache. The above-mentioned symptoms were considered as these are common difficulties observed in individuals exposed to loud noise as reported in the literature [7]. Statistical analysis revealed that the percentage of occurrence of reduced hearing sensitivity and vertigo in the regular PMS group was significantly higher than in the non-regular PMS group. The occurrence of the other symptoms was not statistically significantly different between the groups.

Vestibular system problems in PMS users has been reported in the literature, although infrequently. The saccolocolic reflex, which is essential in maintaining balance, has been demonstrated to be affected in regular PMS users [3]. Singh and Sasidharan demonstrated a reduction in amplitude of cervical vestibular evoked myogenic potentials in individuals who used PMS at very high intensities for a long time, levels which exceeded safe limits for sound exposure. The vestibular inefficiency noted by Singh and Sasidharan may be one reason for the incidence of vertigo reported by regular PMS users in our study. The reduction we saw in hearing sensitivity among regular PMS users accords with previous reports [1,7,11]. Similarly, temporary threshold shift, which is an early indicator of permanent damage to hearing and an early sign of noise-induced hearing loss, has also been reported [1,7].

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Appendix

PERSONAL MUSIC SYSTEM QUESTIONNAIRE

NAME:

AGE:

GENDER:

1. Are you aware about the hearing related problems caused due to prolonged usage of personal music system?
 - Yes
 - No
2. Type of transducer used
 - Headphones
 - Earphones
3. Using Personal music system in
 - One ear
 - Both ears
4. Using Personal music system since
 - 1–2 years
 - 2–4 years
 - 4–8 years
 - >8 years
5. Duration of listening to music per day
 - <1 hours
 - 1–2 hours
 - 2–5 hours
 - >5 hours
6. Type of music listened to on personal music system
 - Rock
 - Electronic
 - Classical
 - Other Please specify
7. Music is listened daily on personal music system
 - Continuously
 - Intermittently/with break
8. When is personal music system usually used
 - At home
 - In public transport
 - At work place
 - Other Please specify
9. The volume level at which music is heard on personal music system in a scale of 10 (1 is minimum volume, 10 is maximum volume)
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
10. After prolonged usage of personal music system
 - A. A sense of decreased hearing
 - Present
 - Absent
 - ▶ If present, present in
 - One ear
 - Both ears
 - ▶ If present, lasts for
 - <20 seconds
 - 20–40 seconds
 - >40 seconds
 - B. Difficulty in understanding speech in noisy situations
 - Present
 - Absent

- C. A sense of ringing in ears
- Present
 - Absent
 - ▶ If present, present in
 - o One ear
 - o Both ears
 - ▶ If present, type of sound heard
 - o Buzzing
 - o Ringing
 - o Roaring
 - o If other, specify
 - ▶ If present, lasts for
 - o <20 seconds
 - o 0–40 seconds
 - o >40 seconds
- D. A sense of dizziness
- Present
 - Absent
 - ▶ If present, then in what way it is present
 - o A sensation of movement of yourself in the room: spinning, tilting or wave like movement
 - o Lightheadedness or feeling that you are going to faint
 - o Loss of balance
 - o Disassociation or disorientation with the world
- ▶ If present, lasts for
 - o <20 seconds
 - o 20–40 seconds
 - o >40 seconds
- E. A sense of ear pain or blocking sensation
- Present
 - Absent
 - ▶ If present, present in
 - o One ear
 - o Both ears
 - ▶ If present lasts for
 - o <20 seconds
 - o 20–40 seconds
 - o >40 seconds
- F. Presence of headache
- Present
 - Absent