Correlation between Hearing Thresholds and Habitual use of Headphones/Earphones among Students of Tertiary Institutions in Northwestern Nigeria

Haruna, K.[1], Salisu, A.D.[2], Labaran, S.A.[3], Fufore, M.B.[4]

[1]Department of Otorhinolaryngology, Murtala Mohammed Specialist Hospital, Kano, Nigeria.
[2]Department of Otorhinolaryngology, Bayero University/Aminu Kano Teaching Hospital, Kano, Nigeria.
[3]Department of Clinical Services, National Ear Care Centre, Kaduna, Nigeria.
[4]Department of Otorhinolaryngology, Modibbo Adama University/Modibbo Adama University Teaching Hospital, Yola, Nigeria.

Article Info

Article type:
Original Article

Article history:
Received: September 5, 2023
Accepted: September 20, 2023
Published: February 16, 2024

Keywords:
Earphone, headphone, hearing loss, hearing threshold, noise induced hearing loss.

Corresponding author:
Fufore, M.B.
drbellofufore@yahoo.com

The article can be accessed at:
www.rjhs.org

http://dx.doi.org/10.4314/rejhs.v12i1.4

Abstract

Background: There has been ongoing concern that prolonged use of headphones/earphones that amplify the sound intensity can lead to noise induced hearing loss. This study therefore aimed at determining the correlation between hearing thresholds and habitual usage of headphones/earphones among undergraduates of tertiary institutions in Northwestern Nigeria.
Method: A cross-sectional study was conducted on young adults, who are undergraduate students of tertiary institutions, to assess the hearing thresholds of individuals who frequently use headphones or earphones. Ethical clearance was obtained, and participants who met specific criteria were selected. A multi-stage sampling technique was used, and 272 participants (representing 544 ears) with equal number of controls were recruited. They completed questionnaires and underwent otoscopic examination and pure tone audiometry (PTA). Those having wax or foreign bodies in the ears had it removed before performing PTA. The data was recorded and analyzed using SPSS version **20.** Frequency tables and variable relationships were examined to determine significance, which was set at a p-value of <0.05.
Result: The study involved 272 users of headphones/earphones (representing 544 ears) and an equal number of age- and sex-matched controls. The participants' ages ranged between 18 and 33, with 50.4% being male. The pure tone average among the headphones/earphones users and the controls ranged from 11.0 – 43.8dB, with a mean of 20.2±6.0 and 10.6 – 43.2dB, with a mean of 19.6 ± 4.5, respectively. More than half, 280/544 ears (51.5%) of the participants used headphones/earphones for over 4 years, and of these, 222/280 ears (79.3%) used them for 1 – 4 hours daily. Moderate volume was the preferred listening mode for 63.2% of the users. A moderate positive correlation was observed between hearing thresholds and hours of headphone/earphone use, and a weak positive correlation between hearing thresholds and preferred level of loudness ($r = 0.290$, $p < 0.0001$) while no correlation was found between hearing threshold and long-term use ($r = 0.003$, $p = 0.937$).
Conclusion: This study suggests that individuals who use headphones or earphones for prolonged periods of listening hours daily or at higher listening levels tend to have poorer hearing thresholds.

INTRODUCTION

Noise–induced hearing loss (NIHL) is a sensorineural hearing deficit, and is also the most frequently occurring preventable disability.[1,2] It is a significant social and public health problem.[1] NIHL can be caused by recreational or occupational sources of sound. NIHL begins at higher frequencies (3,000 to 6,000Hz) and develops gradually as a result of repeated exposure to excessive sound levels.[3] A major risk factor for NIHL is prolonged, unprotected exposure to levels of noise above 85 decibels.[3] High frequency noise is more damaging than low frequency noise and continuous noise is often more damaging than intermittent noise.[4]

Many scientific studies have investigated the potentially harmful effects of noise and its consequences and many of them focused on the hearing damage caused on adults that are exposed to a noisy environment at their working places.[5,6,7] There are also leisure time activities that can produce hazardous noise levels as well.[8] These leisure exposures are for example the sound emitted by some electronic devices such as toys or mobile phones, the sound in cinemas or the music in concerts. Music players used with headphones is one of these leisure activities. The use of these devices offers a convenient way to listen to music at high listening levels as the user likes without disturbing others. Some of these music players are portable, for instance MP3 players or pocket computers and some are not, such as HI-FI equipment.[9]

A popular reason for the increase of users of music players with headphones or earphones is the popularity of MP3 players in the last few years. The reason of this success is its portability. As technology advanced, with greater music storage and longer battery life, it is possible that people will choose to listen for longer periods of time than ever before.[9]

The use of personal audio devices is becoming increasingly more popular in educational environment as well. These portable devices make distribution of educational materials easier, particularly to students in remote locations.[10,11,12] They offer flexibility, allowing students to access information such as lecture materials at any time and while participating in other activities such as commuting, exercising or doing house work.[13,14,15] They have been particularly beneficial in learning languages and music.[14,16,17] Currently, as many as 88% – 90% of teenagers and young adults report listening to music through earphones on personal music players.[18,19]

Though the period of use of earphones represents only a small fraction of the total annual hours for each subject on the average, they however constitute the primary source of overexposure among the majority of urban residents and workers.[20] Scientific studies suggests that these music players may cause hearing damage if they are not used with a degree of caution.[21,22] The exposure time and the loudness level are the main factors believed to influence the possible hearing damage.[23] With the increased availability and use of personal audio devices and mobile phones for listening to music and the risky behavior pattern of their use at high volume over long periods especially among the youths, the threats of hearing loss due to this recreational noise exposure is real. This study aimed at determining the correlation between hearing thresholds and habitual use of headphones/earphones among students of selected tertiary institutions in Northwestern Nigeria.

MATERIALS AND METHODS

Ethical approval for the study was obtained from the Health Research Ethics Committee (HREC) of Ministry of Health and Human Services, with protocol number MOH/ADM/744/VOL.1/467. Approval was also obtained from the managements of the selected tertiary institutions. Informed consent was obtained from all participants before enrolment and participation was voluntary.

This was a prospective cross-sectional study of hearing thresholds of selected young adults (18 – 35 years) with prolonged headphone/earphone usage in selected tertiary institutions in Northwestern Nigeria (prolonged usage defined in this study as usage for at least an hour a day for at least 1 year). Non-headphone/earphone users, who were matched for age and sex, were also recruited as controls from the same institutions. The study was carried out over nine month period, from May 2017 to January 2018. Those that satisfied the selection criteria were included in the study.

The sample size was calculated using Fisher's formula:[24] $n = Z^2pq/d^2$, where n = desired sample size, Z = standard normal deviation (which is 1.96 at 95% confidence interval), p = prevalence = 0.2 (Ogbe et al),[25] d = degree of precision at 95% confidence interval, q = 1 – p. Thus: $n = Z^2pq/d^2 = 1.96^2 \text{ x } 0.8 \text{ x } 0.2 \div 0.05^2 = 3.8416 \text{ x } 0.8 \text{ x } 0.2 \div 0.0025 = 3.8416 \text{ x } 0.16 \div 0.0025 = 0.614656 \div 0.0025 = 245.86 \approx 246$. The minimum sample size required for the study was

246 (representing 492 ears); however, to make up for attrition approximately 272 participants were recruited for the study (representing 544 ears).

Those with chronic ear discharge, recent ear surgery, continuous exposure to loud noise other than through headphones/earphones, chronic medications in the last three months, refusal to consent and those below 18 years or above 35 years were all excluded from the study.

Two faculties and two colleges were randomly chosen from the two institutions. Individuals who met the inclusion criteria were selected from these departments, leading to a total of 272 participants (representing 544 ears). Those who answered "yes" on the prepared papers were given questionnaires and consent forms, and only those who met the selection criteria were recruited for the study. Non-headphone/earphone users were also recruited as controls from the same institutions, using same selection criteria.

Following detailed explanation of the procedure and time commitment, structured questionnaires were distributed to the participants that elicited information on demographic characteristics such as age, sex, history of ear discharge, chronic use of medications, usage of headphones/earphones and duration per day, years of usage, repeated exposure to noise other than through headphones/earphones and preferred level of loudness (low, moderate, and high volume). The loudness level was determined by using the percentage of the headphones/earphones devices' maximum volume capacity. Low volume was defined as around 30% – 50% of the maximum volume, moderate volume fell within the range of 50% – 70%, and high volume was considered anything above 70% of the maximum volume. Those that satisfied the selection criteria were given study numbers for identification which were also recorded on their corresponding questionnaires and their phone numbers were also collected. The participants underwent physical and ear examinations at their respective institutions. Those having wax or foreign bodies in the ears had it removed. Selected participants found to have tympanic membrane perforation, retracted or bulging tympanic membrane were excluded from the study and replaced with other participants randomly selected from the study population using the same sampling technique.

Twenty four hours after last exposure to noise through headphones/earphones, pure tone audiometry was carried out in a sound proof booth using a clinical audiometer (Model MAICO MA42, Japan) calibrated to ISO standard. Modified Hughson-Westlake ascending technique was adopted. Pure tone audiometry was done at frequencies 250, 500, 1000, 2000, 4000, 6000 and 8000Hz for air conduction and at 500, 1000, 2000 and 4000Hz for bone conduction; this was done with patient comfortably seated in a sound proof booth. The threshold was determined based on the American National Standard Institute (ANSI 1978, 1986).

The pure tones were delivered via circumaural headphones for air conduction and bone vibrators for bone conduction and participants responded by pressing on the response switch. The tone presented initially at a decibel easily detected by the participant (at 30dB, 1 kHz and if there is no response, this was increased by 10dB till there was response). The tone was then reduced by 10dB until there was no response; and then increased in 5dB until there was response. The lowest decibel at which participant consistently responded in 2/3 attempts was then taken as the threshold for that frequency.

The results obtained were charted on the audiogram. The pure tone average for each ear was calculated. This was determined by summating the thresholds for air conduction at 500, 1000, 2000 and 4000Hz and dividing it by four (4).[26] The average for each ear was used to determine the hearing level for that ear. Hearing loss was classified based on the WHO grading of hearing impairment; No impairment (≤25dB), Slight impairment (26 – 40dB), Moderate impairment (41 – 60dB), Severe impairment (61 – 80dB) and Profound impairment (≥81dB).[26] Participants were classified into three (3) groups (A, B and C). Group A was those who have used headphones/earphones for 1 – 2 years, group B used headphones/earphones for more than 2 years and up to 4 years and group C used it for over 4 years.

The data collected was analyzed using statistical product and service solution (SPSS) version 20. Qualitative data was summarized using frequencies and percentages, while quantitative variables were summarized using measures of central tendencies and dispersion (standard deviation and range). Chi-square was used to test for associations, and Pearson's correlation was used to examine relationships between variables. Level of statistical significance was set at p-value of <0.05.

RESULTS

Two hundred and seventy two headphones/earphones users (representing 544 ears) with equal number of non-headphone/earphone users (as controls) participated in this study. The age range of the headphone/earphone users was 18 – 33 years with the mean age of 22.6 ± 3.4, while that of the non-headphone/earphone users ranged between 18 – 35 years with mean age of 23.2 ± 4.2. Majority of the participants (in both groups) were in the age range of 18 – 23 years. There were almost similar proportion of males and females in both groups. **Figure 1** shows age and sex distribution of the participants.

The range of pure tone average (PTAv) of the assessed ears of the headphone/earphone users and non-headphone/earphone users was 11.0 – 43.8dB, with a mean PTAv of 20.2±6.0 and 10.6 – 43.2dB, with a mean PTAv of 19.6 ± 4.5, respectively. Out of the 544 ears assessed in each group, 104 (19.1%) of the headphone/earphone users and 38 (7.0%) of the non-headphone/earphone users were found to have hearing loss.

Table 1 provides details on duration of headphone/earphone usage and number of hours of usage per day. Out of the 280 ears (51.5%) that used headphone/earphone for more than 4 years, 222 (79.3%) used them for 1 – 4 hours per day. Among the 144 ears (26.5%) that used headphone/earphone for 2 – 4 years, 116 (80.6%) used them for 1 – 4 hours per day. One hundred and twenty ears (22.0%) used the headphones/earphones for 1 – 2 years, and of these, 108 (90.0%), used them for 1 – 4 hours per day. There was a statistically significant association between duration of headphone/earphone usage and number of hours of usage per day ($\chi^2 = 14.596$, $p = 0.006$).

Figure 2 shows details of duration (in years) of headphone/earphone use and degree of hearing thresholds. Pearson's correlation coefficient between duration of use of headphone/earphone in years and hearing thresholds revealed no correlation ($r = 0.003$) which was not statistically significant ($p = 0.937$). However, there was a moderately positive correlation between hearing thresholds and hours of use of headphone/earphone per day, and was statistically significant ($r = 0.468$, $p < 0.0001$) (see **Table 2**).

Similarly, there was a statistically significant association between hearing thresholds and number of hours of usage per day ($\chi^2 = 171.837$, $p < 0.0001$). **Table 3** shows the hearing thresholds of the ears based on number of hours of daily use of headphone/earphone. Seventy five participants (i.e. 150 ears, 27.6%) preferred listening at high volume, and out of which, 57 ears (38.0%) had abnormal hearing thresholds. One hundred and seventy two participants (i.e. 344 ears, 63.2%) preferred listening at moderate volume, out of which, 45 ears (13.1%) had abnormal hearing thresholds. Out of the 25 participants (i.e. 50 ears, 9.2%) who preferred listening at low volume, only two (4.0%) had abnormal hearing thresholds. Pearson correlation coefficient between hearing thresholds and preferred level of loudness revealed weak positive correlation, and was statistically significant ($r = 0.290$, $p < 0.0001$).

Figure 3 shows details of the hearing thresholds and the preferred listening level. Similarly, of the 150 ears that preferred listening at high volume, 93 ears (62.0%) had normal hearing thresholds, 47 ears (31.3%) had mild hearing loss, and the remaining 10 ears (6.7%) had moderate hearing loss. Out of the 344 ears that preferred listening at moderate volume, 299 ears (86.9%) had normal hearing thresholds, 44 ears (12.8%) had mild hearing loss, and only one ear (0.3%) had moderate hearing loss. **Figure 4** gives details of preferred listening level and degree of hearing thresholds.

Table 4 gives details of hearing thresholds and ear preference. Two hundred and eighteen participants (i.e. 436 ears, 80.1%) preferred to use both ears when using headphone/earphone, out of these, 351 (80.5%) had normal hearing thresholds, and 85 ears (19.5%) had abnormal hearing thresholds. Thirty four participants (i.e. 68 ears, 12.5%) preferred right ear when using headphone/earphone, out of these, 52 ears (76.5%) had normal hearing thresholds and the remaining 16 ears (23.5%) had abnormal hearing thresholds. Twenty participants (i.e. 40 ears, 7.4%) preferred left ear when using headphone/earphone, out of these, only 3 ears (7.5%) had abnormal hearing thresholds. There was no statistically significant association between hearing thresholds and ear preference ($\chi^2 = 4.388$, $p = 0.111$).

DISCUSSION

Several studies have investigated the hazardous effects of headphone/earphone on hearing; however they have reported conflicting results.[27,28] Some researchers are of the opinion that personal listening devices pose a risk whereas others claim that their effect is not so harmful.[27,28,29,30,31,32,33] In general it is agreed that there is some level of possible risk to hearing in certain conditions such as prolonged exposure and listening at high volume setting. With the increased availability and use of personal audio devices and mobile phones for listening to music and the risky behavior pattern of their use at high volume over long periods especially among the youth, the threats of hearing loss due to this recreational noise exposure is real. Many studies have reported that prolonged exposure to hazardous noise level through headphone/earphone use by the subjects predisposes them more to hearing damage.[1,22,34,35,36]

The degree of hearing loss depends on the individual characteristics; Genetic susceptibility to noise, duration of exposure, listening volume and type of music listened to, however, most studies reported mild degree of hearing loss among the users of headphones.[36,37,38,39]

Mild hearing loss was the commonest pattern of hearing loss recorded in this study irrespective of years of usage of headphone/earphone. About 90% of hearing loss in this study was of mild degree and this could partly be due to relatively shorter daily exposure from the headphone/earphone use noted among majority of the participants in this study (1 – 4 hours per day). The finding in this study is similar to that reported by Suleiman et al.[40] that found 92.3% of those with hearing loss to have mild form of hearing loss. Similarly, a Pakistan study by Sadaf et al.[41] reported 73.2% of the participants to have mild hearing loss.

Despite the finding in this study that most affected participants had mild hearing loss, majority of the participants, however, used headphone/earphone for more than 4 years. There was no statistically significant correlation between hearing thresholds and number of years of exposure in this study. Some studies have reported similar findings on the poor correlation between hearing thresholds and duration of exposure in years. Manisha et al.[1] reported poor correlation between hearing thresholds and duration in years. A French study by Job et al.[42] found no significant correlation between hearing thresholds at conventional frequency range and duration of exposure.

Similarly, prolonged usage of headphone by subjects was similarly reported by Sunny et al.[43] who reported that more than 90% of earphone users among the students have used it for 3 – 6 years, but found no statistically significant relationship between duration of usage of headphone/earphone and development of tinnitus.

However, Kim et al.[44] found a significant relationship between hearing thresholds especially at 4 kHz and duration of exposure in years. Similarly, Aline et al.[45] in their study also found a significant correlation between the duration of exposure (in years) to personal stereo player devices and development of tinnitus, suggestive of early noise induced hearing damage. In the same vein, Schmuziger et al.[46] showed good correlation between the exposure duration and auditory thresholds of non-professional pop/rock musicians with repeated exposure to loud sound levels for at least 5 year duration. This could be due to relatively smaller sample sizes used in some of these studies and the subjects used their headphones/earphones for a longer duration and at subjectively higher levels.

There is significant correlation between hours of exposure to noise from personal listening devices and risk of hearing damage and researches revealed that 1 – 2 hours exposure in a day is enough to allow subsequent appearance of deterrents to the individual hearing health.[47,48] Sulaiman et al.[40] reported that the longer the duration of personal listening device usage as well as the intense levels the worse the hearing thresholds.

This study found a significant positive correlation between hearing threshold and hours of use of headphone/earphone in a day. This study showed that majority of the participants (446 ears, 82.0%) used headphone/earphone for 1 – 4 hours per day; out of which, 41 ears (9.2%) had hearing loss. Only 10 ears (1.8%) used headphone/earphone for more than 8 hours per day, out of which, 2 ears (20.0%) had hearing loss. Similar findings were reported by Manisha et al.[1] where 65.6% of their subjects used headphone for 1 hour a day and only 2.0% used it for 4 hours. They reported a prevalence of hearing loss of 36.1% among the subjects. The high prevalence noted in their study might be as a result of relatively smaller sample size used in the study. Similarly, Carolina et al.[49] in Brazil reported 80.0% of the subjects to have used headphone for 1 – 2 hours a day and noted reduced otoacoustic emission amplitude despite normal pure tone audiometry. Also US studies by Hoover et al.[50] and McNeill et al.[51] revealed that the participants used their listening devices for an average of 1 – 2 hours a day.

Sadaf et al.[41,52] found a good correlation between hearing loss and hours of exposure in a day through headphones. Similarly, Sahoo et al.[53] and Ramya et al.[54] in separate studies reported good correlation between sensorineural hearing loss and hours of exposure among habitual mobile phone users. Hearing loss among participants who have relatively short daily duration may be due to fatigue of hair cells following exposure to loud noise.[8,55]

The findings in this study, however, contrast with findings by other researchers who have reported a poor or no correlation between hearing threshold and daily exposure duration.[1,42] Other studies however, in contrast to this study, reported higher number of participants using headphones for longer durations daily. Sadaf et al.[41] in Pakistan reported that 64.3% subjects used headphones for 5 – 6 hours compared to only 0.7% that used it for 1 – 2 hours a day. The authors pointed out that even though 75.0% of the participants in their study have some knowledge about the dangers of noise to hearing, they are not applying protective measures such as short listening duration. In their study 66.6% of those that used headphone/earphone for 1 – 2 hours a day had mild hearing loss while 77.7% of those with 5 – 6 hours daily exposure to personal music device through headphone/earphone had mild hearing loss. In this study, 93/104 ears (89.4%) of the affected participants had mild hearing loss, and majority of them, 57/93 (61.3%) used headphones/earphones for 4 – 8 hours daily.

Fontana et al.[56] found bilateral notched audiograms in participants with 6 – 10 hours daily exposure to media players. It is believed that prolonged daily exposure to loud noise results in to hair cells getting exhausted and unable to have enough time for recovery resulting in hearing loss.[26,57]

This study found weak positive correlation between hearing threshold and preferred level of loudness, and was statistically significant. Almost all the participants with hearing loss in this study, 98.1% preferred listening at moderate to high volume, suggestive of increase risk of hearing damage with higher listening levels. A study by Manisha et al.[1] showed a good correlation between the hearing thresholds and preferred level of loudness. Montoya et al.[58] reported statistically significant relationship between exposure to loud sound levels from MP3 use and subsequent development of hearing loss.

However, in contrast, Epstein et al.[59] found no correlation between sound pressure levels and hearing loss. In their study, though a relatively small sample size was used when compared to this study, the study was however more objective with measurement of listening level recorded and measured. Then the average threshold was estimated using the measured listening level.

It has been suggested that ambient noise level may play a role in the choice of listening levels of individuals. It is possible that the environmental noise level in the tertiary institutions may have influenced the preferred listening levels of the participants' studied. Hoover et al.[50] reported that more than 90% of the university students preferred louder volume than the background noise when using personal music device.

The finding in this study is similar to findings in Jos in a study by Chagok et al.[60] where the sound pressure levels of headphones/earphones were measured immediately after use by the students and 62.9% of the participants were over exposed to moderate to high sound pressure level. Similarly, Aline et al.[45] in Brazil found that participants in the study listened to their MP3 at high volume. The study showed notching at 6 kHz despite normal air conduction threshold. Hodgetts et al.[38] noted that noisy environment significantly affects the preferred listening level which is in the range of moderate to high volume. Wong et al.[61] reported a preference sound level by the users of personal music devices to be in the range of 50 – 120dB.

The limitation for this study was that the sound delivery into the ear by headphone use may not be of same intensity as earphone use for any given preferred listening level, this study however did not differentiate between whether a participant uses a headphone or an earphone. Another limitation of this study was that we did not differentiate between the use of noise-cancelling headphones and the regular headphones.

CONCLUSION

This study suggests that individuals, who use headphones or earphones for prolonged periods of listening hours daily or at higher listening levels, are more likely to experience poorer hearing thresholds. Therefore, it is important to develop safe listening habits and exercise responsible electronic device usage to safeguard the auditory system.

Presentation at a meeting: The complete work was presented to the West African College of Surgeons as a partial requirement for the award of Fellowship in Otorhinolaryngology, April 2019

Ethical approval: Ethical approval for the study was obtained from the Health Research Ethics Committee (HREC) of Ministry of Health and

Human Services, Kaduna State with protocol number MOH/ADM/744/VOL.1/467, approved on 11th October, 2016. Approval was also obtained from the managements of the selected tertiary institutions. Informed consent was obtained from all participants before enrolment and participation was voluntary.

Conflicting Interest: Nil

Acknowledgement: We appreciate the cooperation and support of all the participants, the lecturers and the managements of Kaduna Polytechnic and Kaduna State University (KASU).

Authors' Contributions: Kabir Haruna (KH); Abubakar Danjuma Salisu (ADS); Solomon Abimiku Labaran (SAL); Mohammed Bello Fufore (MBF).
Concepts – KH, ADS and SAL; **Design** – KH , ADS, SAL and MBF; **Definition of intellectual content** – ADS and SAL; **Literature search** – KH, ADS, SAL and MBF; **Clinical studies** – KB and MBF; **Data acquisition** – KB and MBF; **Data analysis** – KB and MBF; **Statistical analysis** – KB, ADS, SAL and MBF; **Manuscript preparation** – KB and MBF; **Manuscript editing** – ADS and SAL; **Manuscript review** – KB, ADS, SAL and MBF.

REFERENCES

1. Manisha N, Mohammed NA, Somayiji G, Hebin K, Mubeena D. Effects of personal music players and mobile phones with Ear phones on hearing in students. J Dental Med Sci 2015;14:31-5.
2. Rabinowitz PM. Noise-induced hearing loss. Am Fam Phys 2000;61:2759-60.
3. ACOM Noise and hearing conservation committee. Occupational noise-induced hearing loss. J Occup Med 1989;31:996. doi:10.1097/00043764-198912000-00012.
4. Pourbakht A, Yamsota T. Cochlear damage caused by continuous and intermittent noise exposure. Hear Res 2003;178:70-8.
5. Carter L, Williams W, Black D, Bundy A. The leisure noise dilemma: Hearing loss or hear? What does literature tell us? Ear Hear 2014;35:491-505.
6. Sliwinska-Kowalska M, Davis A. Noise-induced hearing loss. Noise Health 2012;14:274-80.
7. Zhao F, Manchaiah VK, French D, Price SM. Music exposure and hearing disorders: an overview. Int J Audiol 2010;49:54-64.
8. Serra MR, Biassoni EC, Hinalaf M, Abraham M, Pavlik M, Villalobo JP et al. Hearing and loud music exposure in 14-15 year old adolescents. Noise Health 2014;16:320-30.
9. Chung JH, Des Roches CM, Meunier J, Eavey RD. Evaluation of noise induced hearing loss in young people using a web based survey technique. Paediatric 2005;115:861-7.
10. Aqib JM, Asim M. M-learning education trends are popular in students through ipod. Int. J Eng Technol 2012;4:8-10.
11. Greenfield S. Podcasting; a new tool for student retention? J Nurs Educ 2011;50:112-4.
12. Davis MR. Devices deliver learning in Africa. Technol Counts 2010;29:32-3.
13. Donnelly KM, Berge ZL. Podcasting; co-opting MP3 players for education and training purposes. Online Journal of distance learning administration 2006;9:1-7.
14. Wang M, Shen R, Novak D, Pan X. The impact of mobile learning on students learning behaviours and performance; report from a large blended classroom. Br J Educ Technol 2009;40:673-95.
15. Chute PM. Music MP3 players and hearing health. Hearing loss magazine. 2009; may/june 26 (http://www.hearing loss.org/sites/default/files/mngs/ music MP3 Hearing may/june 2009_HLM.pdf accessed 15 march 2016)
16. Fraga L, Harmon JM, Wood KD, Buckelew-Martins E. Digital wood walls and vocabulary learning: The use of iPods to facilitate vocabulary instruction with ESL students. J Res centre Educ Technol 2011;7:38-57.
17. Baseda J, Machat Z, Palecek K. M-learning as a trend Technology Transfers and innovation International conference 5 November 2012. PRADEC interdisciplinary conference proceedings 2012;1:32-8.
18. Vogel I, Brug J. Vander Ploeg CP, Raat H. Adolescents risky MP3 player listening and its psychosocial correlates. Health Educ Res 2011;26:254-64.
19. Palegrino E, Lorini C, Allodi G, Buonamici C, Garofalo G, Bonaccorsi G. Music listening habits with MP3 player in a group adolescents: A descriptive survey. Ann Ig 2013;25:367-76.
20. Neitzel RL, Gershon RR, McAlexander TP, Magda LA, Pearson JM. Exposures to transit and other sources of noise among New York City residents. Environs Sci Technol 2012;46:500-8.
21. Noise and hearing loss. NIH consensus statement. 1990;8:1-24. http://consensus.nih.gov/1990/1990Noise Hearing Loss076html.htm, accessed 22 March 2016.
22. Clark WW, Bohne BA. Effects of noise on hearing. JAMA 1992; 281:1658-9.
23. Gilles A, Van Hal G, De Ridder D, Wouters K, Van de Heyning P. Epidemiology of noise induced tinnitus and the attitudes and beliefs towards noise and hearing protection in adolescents. Plos one 2013;8:e70297.
24. Kasiulevicius V, Sapoka V, Filipaviciute R. Sample size calculation in epidemiological studies. Gerontologija 2006; 7:225-31.
25. Ogbe SE, Akor-Dewu MB, Saleh MI, Eze ED,

Olufunke O, Shaibu A et al. Effects of headphones on hearing acuity of students of Ahmadu Bello University, Zaria, Nigeria. Annals Biol Sci 2014;2:7-9.
26. Potential Health Risks of exposure to noise from personal music players and mobile phones including a music playing functions. Brussels: Scientific committee on emerging and newly identified health risks (SCENIHR). e2008. Available from: http://ec.europa.eu/health/ph-risk/committees/04_scenihr_0_018.pdf. accessed 16 march 2016.
27. Huh DA, Choi YH, Moon KW. The effects of earphone use and environmental lead exposure on hearing loss in the Korean population: Data Analysis of the Korea National Health and Nutrition Examination Survey (KNHANES), 20102013. PLoS One 2016;11(12). doi:10.1371/journal.pone.0168718
28. Haruna K, Salisu AD, Labaran SA, Fufore MB. Prevalence and pattern of hearing loss among young adults in tertiary institutions with habitual headphone/earphone usage in Kaduna metropolis. J West Afr Coll Surg 2023;13:98-105
29. Cohen RW, Koening AH, Lebo CP. The effects of noise on telephone operators. J Occup Med 1979;21:21-5.
30. Clark W. Noise exposure from leisure activities: a review. J Acoust Soc Am 1991;9:175-81.
31. Flanagan AG, Whitney LH, Guttman N. Hearing studies of noise on telephone operators. J Speech Hear Res 1969;12:169-78.
32. Fligor BJ, Cox LC. Output levels of commercially available portable compact disc players and the potential risk to hearing. Ear Hearing 2004;25:513–27.
33. Widén SE, Möller C, Kähäri K. Headphone listening habits, hearing thresholds and listening levels in Swedish adolescents with severe to profound HL and adolescents with normal hearing. Int J Audiol 2018;57:730–6.
34. West PD, Evans EF. Early detection of hearing damage in young listeners resulting from exposure to amplified music. Br J Audiol 1990;24:89-103.
35. Serra MR, Biassoni EC, Richter V, Minoldo G, Franco CI, Abraham S et al. Recreational noise exposure and its effect on the hearing of adolescents part 1: an interdisciplinary long term study. Int J Audiol 2005;44:65-73.
36. Haruna K, Salisu AD, Labaran SA, Fufore MB. Prevalence and pattern of hearing loss among young adults in tertiary institutions with habitual headphone/earphone usage in Kaduna metropolis. J West Afr Coll Surg 2023;13:98-105.
37. Peng J, Tao Z, Huan Z. Risk of damage to hearing from personal listening devices in young adults. J otolaryngol 2007;36:181-5.
38. Hodgetts WE, Szarko R, Rieger JM. The effect of listening environment and earphone style on preferred listening levels of normal hearing adults using an MP3 player. Ear Hear 2007;28:290-7.
39. Kiran N, Sunil P. High frequency hearing loss in students used to earphone music: A randomized trial of 1000 students. Indian J Otol 2014;20:29-32.
40. Suleiman AH, Seluakumaran K, Husain R. Hearing risk associated with usage of personal listening devices among urban high school students in Malaysia. Public Health 2013;127:710-5.
41. Sadaf Z, Mehboob AJ, Mohammed B, Tooba F, Fateema L, Lubna T. et al. Noise-induced hearing loss related to personal music players- Awareness level among the young users in a developing country. J Dow Uni Health Sci 2004;8:11-5.
42. Job A, Raynal M, Tricoire A, Rondet P. Hearing status of French youth aged 18-24 years in 1997: a cross-sectional epidemiological study in the selection centres of the army in Vincennes and Lyon. Rev Epidemiol Sante Publique 2000;48:227-37.
43. Sunny OD, Asoegwu CN, Abayomi SO. Subjective tinnitus and its association with the use of earphones among students of college of medicine, university of lagos, Nigeria. Int Tinnitus J 2012;17:169-72.
44. Kim MG, Hong SM, Shim HJ, Kim YD, Cha CI, Yeo SG. Hearing threshold of Korean adolescents associated with the use of personal music players. Yonsei Med J 2009;50:771-6
45. Aline H, Daniella G, Maria C, Martinelli L. Hearing habits and audiological evaluation in adults. ACR 2013;18:179-85.
46. Schmuziger N, Patscheke J, Probst R. Hearing in non-professional pop/rock musicians. Ear Hear 2006;27:321-30.
47. Vogel I, Brug J, Van der Ploeg CPB, Raat H. Estimating adolescents risk for hearing loss based on data from a large school-based survey. AJPH 2010;100:11095-100.
48. Levey S, Levey T, Fligor BJ. Noise exposure estimates of urban MP3 player users. J Speech Lang Hear Res 2011;54:263-77.
49. Carolina LG, Fernanda AS. Audiological findings in young users of headphones. CEFAC 2014;16:1097-1108.
50. Hoover A, Krishnamurti S. Survey of college students' MP3 listening habit, safety, issues, attitudes and education. Am J Audiol 2010;19:73-83.
51. McNeill K, Keith SE, Feder K, Konkle AT, Michaud DS. MP3 player listening habits of 17-23 year old university students. J Acous Soc Am 2010;128:646-53.
52. Sadaf Z, Umaima A, Syed AA, Haris B, Madeeha N, Fouzia O. et al. Earphone usage and recreational noise-induced hearing loss based on audiograms assessment. J Liaquat Uni Med Health Sci 2016;15:191-8.
53. Sahoo GC, Sebastian H. Prevalence of sensorineural deafness in habitual mobile phone users. Indian J Otol 2011;17:97-100.
54. Ramya GS, Karthiyanee K, Vinutha S. Effect of

mobile phone usage on hearing threshold: A pilot study. Indian J Otol 2011;17:159-61.
55. World Health Organization (WHO). Hearing loss due to recreational exposure to loud sound: a review. Geneva: World Health Organization. e 2 0 1 5 . (http://www.who.int/iris/handle/10665/154589). Accessed 21 october 2017.
56. Fontana ZM, Morata TC, Marques JM, Corteletti LJ. Brazilian young adults and noise: attitudes, habits and audiological characteristics. Int J Audiol 2009;48:692-9.
57. Borg E, Canlon B, Engstrom B. Noise –induced hearing loss- Literature review and experiments in rabbit, morphological and electrophysiological features, exposure parameters and temporal factors, variability and interactions. Scand Audiol 1995;24:1-147.
58. Montoya FS, Ibarguen AM, Vences AR, del Rey AS, Fernandez JM. Evaluation of cochlear function in normal hearing young adults exposed to MP3 player noise by analyzing transient evoked otoacoustic emissions and distortion products. J Otolaryngol Head Neck Surg 2008;37:718-24.
59. Epstein M, Marozeau J, Cleveland S. Listening habits of iPod users. J speech Lang Hear Res 2010;53:1472-7.
60. Chagok NMD, Ichukwu RI, Gadong EP. Predicted hearing damage in young people using Headphones/ Earphones to listen to music. NJP 2014;25:66-9.
61. Wong TW, Van Hasselt CA, Tang LS, Yiu PC. The use of personal cassette players among youth and its effects on hearing. Public Health 1990;104:327-30.

Table 1: Duration of headphone/earphone usage and number of hours of usage per day

	Use of Headphone/earphone per hour per day				
Duration of HP/EP use	**1 – 4 hours**	**>4 – 8 hours**	**>8 hours**	**χ^2**	**P-value**
1 – 2 years	108 ears (90.0%)	12 ears (10.0%)	0 ears (0.0%)	**14.596**	**0.006**
>2 – 4 years	116 ears (80.6%)	28 ears (19.4%)	0 ears (0.0%)		
>4 years	222 ears (79.3%)	48 ears (17.1%)	10 ears (3.6%)		
Total	**444**	**90**	**10**		

HP/EP = headphone/earphone

Table 2: Pearson's correlation coefficient between hearing thresholds and hours of usage of headphone/earphone per day

		Hearing thresholds	Hours of daily use
Hearing thresholds	**Pearson correlation**	1	0.468
	Sig. (2-tailed)		0.000
	N	544	544
Hours of daily use	**Pearson correlation**	0.468	1
	Sig. (2-tailed)	0.000	
	N	544	544

Table 3: Hearing thresholds versus number of hours of daily use of headphone/earphone

	Hearing Thresholds					
	Normal (=25dB)		Abnormal (>25dB)			
Hours of usage per day	**No. of ears**	**Percent**	**No. of ears**	**Percent**	**χ^2**	**P-value**
1 – 4 hours	405	90.8%	41	9.2%	**171.837**	**<0.0001**
>4 – 8 hours	27	30.7%	61	69.3%		
>8 hours	8	80.0%	2	20.0%		
Total	**440**		**104**			

Table 4: Ear preference for headphone/earphone use versus hearing thresholds

	Hearing Thresholds					
	Normal (=25dB)		Abnormal (>25dB)			
Ear Preference	**No. of ears**	**Percent**	**No. of ears**	**Percent**	**χ^2**	**P-value**
Right ear	52	76.5%	16	23.5%	**4.388**	**0.111**
Left ear	37	92.5%	3	7.5%		
Both ears	351	80.5%	85	19.5%		
Total	**440**		**104**			

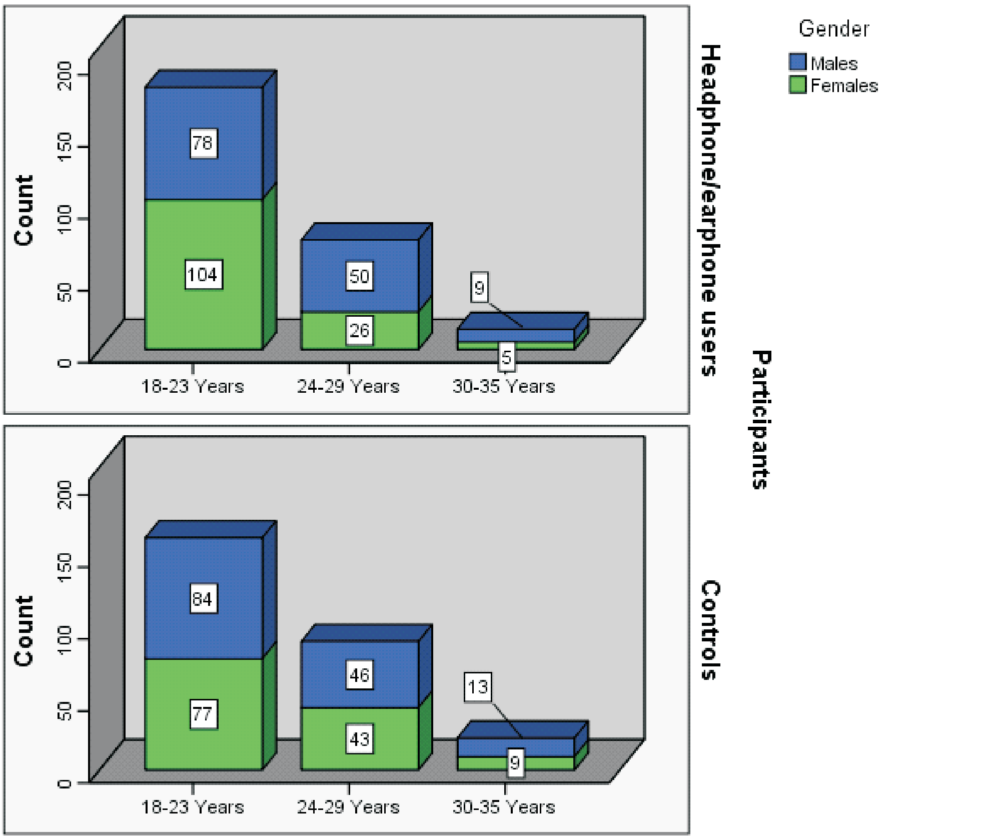

Figure 1: Age and sex distribution of participants (subjects and controls)

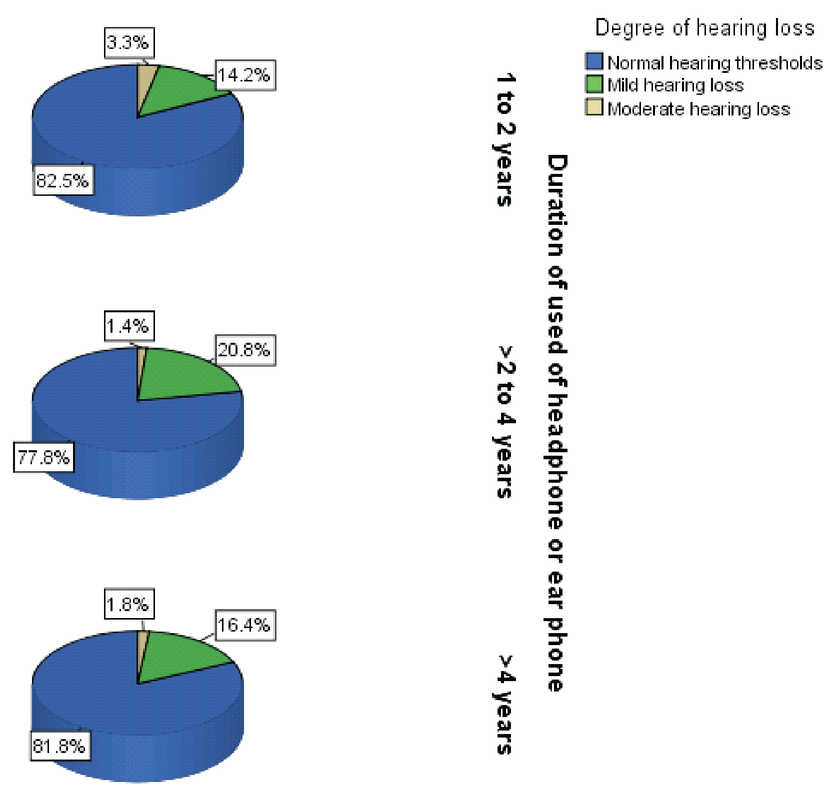

Figure 2: Duration of headphone/earphone use and degree of hearing thresholds

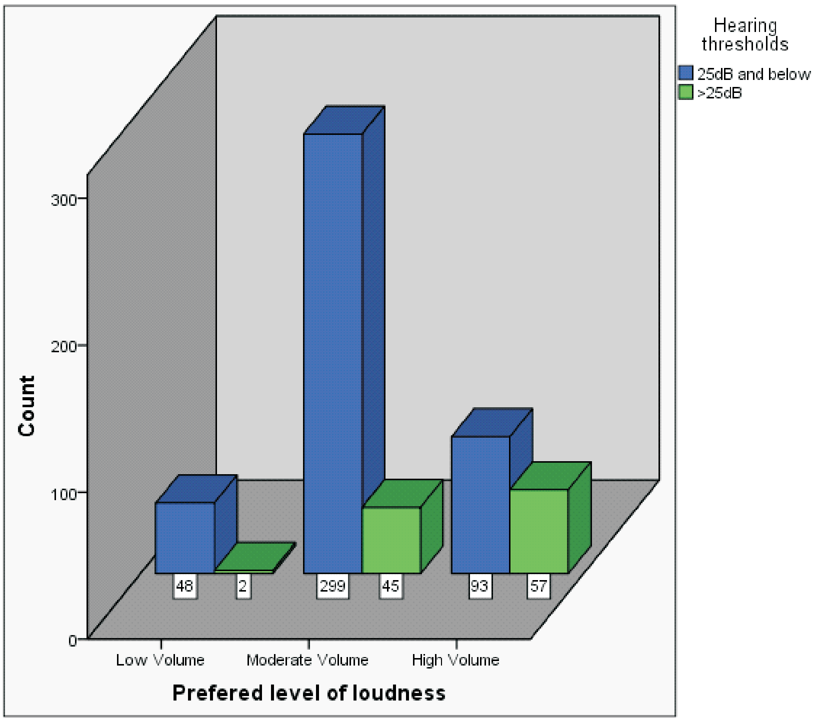

Figure 3: Preferred listening volume and hearing thresholds

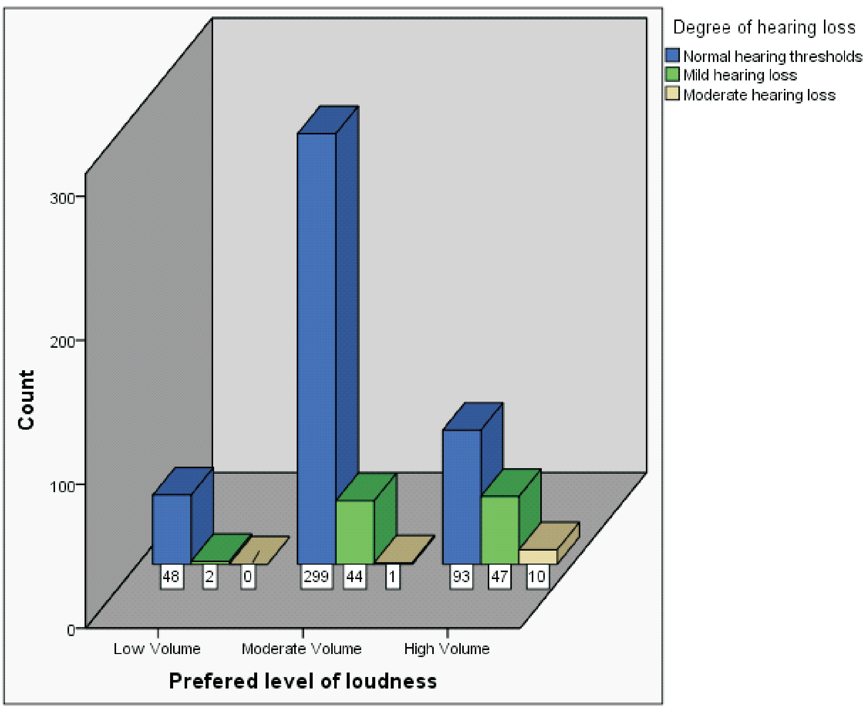

Figure 4: Preferred listening level and degree of hearing thresholds

►*Please cite this article as:*
Haruna, K., Salisu, A.D., Labaran, S.A., Fufore, M.B. Correlation between Hearing Thresholds and Habitual use of Headphones/Earphones among Students of Tertiary Institutions in Northwestern Nigeria Research Journal of Health Sciences, 2024; 12(1): 22-33