Correlation between earphone usage and visiting game centre with hearing threshold

S N Wicaksono¹, L Dewanti¹, and N Purnami¹

¹Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Universitas Airlangga-Dr. Soetomo General Hospital, Surabaya 60231 Indonesia

E-mail: simon_nathanael_95@yahoo.com

Abstract. Noise-induced hearing loss is affecting more people than in the past. For the young adult NIHL is related to noises produced during recreational and leisure activity. In Surabaya, there are still little to no data regarding hearing loss related to recreational and leisure activity. The objective of this study was to know the correlation between earphone usage and visiting game centre with hearing threshold. This observational analytic with cross sectional design study involved 16 students who visited game centre in November 2016-January 2017 and fulfilled the inclusive criteria and exclusive criteria. The data collected using questionnaire and hearing threshold examination and analysed using Spearman’s rho test with p-value (p) <0.05 and confidence interval (CI) 95%. There were no significant correlation between volume of earphone usage with hearing threshold. There was no significant correlation between duration of earphone usage with hearing threshold. There was no significant correlation between frequency of earphone usage with hearing threshold. There was no significant correlation between duration of visiting game centre with hearing threshold. There was no significant correlation between frequency of visiting game centre with hearing threshold. There was no correlation between earphone usage and visiting game centre with hearing threshold.

1. Introduction

Hearing is the neural perception of sound [1]. Sound is produced by everything in our surrounding that is capable of producing a disturbance pattern in air molecules [1]. There is a special receptor inside our body that is capable to transduce fluid movement into neural signals. This special receptor is auditory hair cell in the organ of Corte inside the cochlea. There are approximately 15,000 hair cells within each cochlea [1]. Hearing loss, or deafness, may be temporary or permanent, partial or complete [1]. Hearing loss is classified into two types, conductive hearing loss and sensorineural hearing loss. In sensorineural hearing loss, sound waves are transmitted to the inner ear, but they are not translated into nerve signals that are interpreted by the brain as sound sensation. This condition can be caused by defect in organ of Corte, in the auditory nerves, or rarely in the ascending auditory. One of the common causes of partial hearing loss is a degenerative, age-related process that occurs to the hair cell called neural presbycusis. This process of partial hearing loss is unavoidable because exposure to even ordinary modern-day sounds eventually damages hair cells. The sensorineural hearing impairment that develops over years of exposure to noise at moderately high levels is called noise-induced hearing loss (NIHL) [2]. Unfortunately, partial hearing loss due to the excessive exposure to loud noises is affecting more people than in the past. This phenomenon happens because we live in an increasingly noisy environment. In Australia, 1 in 6 people have some degree of hearing loss [3]. Around 10 million people, about 1 in 6 people, in the United Kingdom suffer from some...
degree of hearing loss [4]. And this number is expected to get higher. Not only that the number is increasing but partial hearing loss also affect younger people. There is audiological evidence of hearing loss in 40% of students between the ages of 16 and 25 years, and 12.5% of students between the ages of 6 to 19 years already suffer from noise-induced threshold shifts [5]. NIHL doesn’t only affected the daily activities, but also reduce physical and social execution behavior status and may induce psychological symptoms of feeling of isolation and exclusion, anxiety, depression, and cognitive disorder [5]. So NIHL is a very disabling condition for younger people in studying period. Fortunately, this process can be prevented, unlike the neural presbycusis, partial hearing loss due to excessive exposure to loud noise can be prevented by simply avoiding the source of the noise or cover the ear with protective devices, such as earplug and other devices. This fact leads to several studies to identify the source of noise. One of the well-known source being workplace with noisy machinery or technological processes in industrial settings [2]. But for the young people, teenagers and young adults who don’t have to work, NIHL is related to noises produced during recreational and leisure activity [5]. One of the major sources of noise exposures in teenagers and young adults is music, whether it is from personal music player or other devices with music player function [6].

One of the common type of portable music player is the MP3 player and the most common type of headphone is the earphone [5]. The noise produced by personal music player can range widely from 60 to 120 dB, with weekly exposure time from <1h to 14h [6]. These indicate that up to 25% of this population is at risk of developing hearing loss when listening to music at this level for 8h, over a long period of time [6]. The other source of noise that can affect the teenagers and young adults is game center. One of the studies to determine the noise exposure level of game center shows that the background noise of a game center was recorded at 61 dBA. When the electronic games where performed, the level of noise reached to 88-90 dBA. This result indicates that game center is one of the possible sources of excessive noise [7].

In Surabaya, there are still little to no data regarding hearing loss related to recreational and leisure activity. After understanding the possible effect of recreational and leisure activity to hearing loss, we assessed the correlation of the use of earphone and playing in game center with hearing threshold.

2. Conceptual Framework

Hearing loss can be caused by either age, ototoxic drug, heredity, disease and infection, and noise. This study focusses on noise, which is one of the possible cause that can be prevented. There are two main source of noise that can cause hearing loss: workplace, leisure activity, and living environment. There are already several studies involving the workplace and living environment but very little to no data about the leisure activity. This study concentrates on leisure activity as the risk factor, and try to minimize the exposure to the other risk factor.

Two of the common leisure activity done by teenagers or young adults are earphone usage and visiting game center. Both can affect the hearing threshold depend on the volume or the loudness of the sound, duration of time spends per usage or visit, and the frequency. This study concentrates on collecting data for the volume, duration, and frequency of both earphone usage and visiting game center and the effect of those factors to hearing threshold.

3. Methods

This research was an observational analytic study, with the purpose of finding the correlation between earphone usage and visiting game center with hearing threshold. The research design used was cross sectional study design.

3.1. Population, Sample, and Sample Size

The population that was reached through this research was a group of students that visited a game centre in Surabaya. Total sampling of a group of students that visits game centre in the last three months at least one times who were willing to participate in this research. There were 16 respondents. The age of the subjects ranges from 19 to 22 years old with a mean age of 20.44 and standard deviation of 2.03. The distribution of gender is 10 (62.5%) male and 6 (37.5%) female. All of the subjects live in Surabaya and do not exposed to noisy environment. The distribution of the occupation is 15 (93.75%) students and 1 (6.25%) worker. All of the subjects do not expose to noisy workplace.
3.2. Location
This research was conducted in Ear Nose and Throat Head and Neck Surgery (ENT-HNS) Department’s outpatient clinic RSUD Dr. Soetomo Surabaya during November 2016 – January 2017.

3.3. Procedure
The data of this research was taken by:

3.3.1. Measuring the sound level inside the game center. Measure the sound intensity level inside the game center using the sound level meter.

3.3.2. Giving informed consent. Introducing name, institution, and purpose of the research to the respondents should be done before doing the research. Moreover, approval to be respondents is the most important thing that should be obtained.

3.3.3. Doing the interview. Asking the respondents about identity, exclusion criteria, earphone usage, and visiting game center habit.

3.3.4. Measuring the degree of hearing loss. Measure the hearing threshold in anechoic chamber, RSUD Dr. Soetomo, data collection and record.

4. Results

4.1. Earphone Usage
Based on the data collected from the questionnaire, the most frequent data (25%) of the volume of earphone usage is 0%. The mean volume of earphone usage is 41.25% with a standard deviation of 27.958. The result of Saphiro-Wilk, test of normality, for the volume of earphone usage is 0.015 (p<0.05) which mean the distribution is not normal. The characteristics of respondent’s duration of earphone usage can be observed on table 2. The most frequent data of the duration of earphone usage is 0 minutes (25%). The mean duration of earphone usage is 108.75 minutes/day with a standard deviation of 114.302. The result of Saphiro-Wilk, test of normality, for the duration of earphone usage is 0.016 (p<0.05) which mean the distribution is not normal.

The most frequent data of the frequency of earphone usage is 30 x/months (56.3%). The mean frequency of earphone usage is 19.88 x/month with a standard deviation of 13.594. The result of Saphiro-Wilk, test of normality, for the frequency of earphone usage is 0.000 (p<0.05) which mean the distribution is not normal.

4.2. Visiting Game Center
Based on the data collected from the questionnaire, the characteristics of respondent’s duration of visiting game centre can be observed on table 4. The most frequent data of the duration of visiting game centre are 1 hour/visit (25%) and 2 hours/visit (25%). The mean duration of visiting game centre is 3 hours/visit with a standard deviation of 2. The result of Saphiro-Wilk, test of normality, for the duration of visiting game centre is 0.032 (p<0.05) which mean the distribution is not normal.

The most frequent data of the frequency of visiting game centre is 4 x/months (25%). The mean frequency of visiting game centre is 5.19 x/months with a standard deviation of 3.885. The result of Saphiro-Wilk, test of normality, for the frequency of visiting game centre is 0.024 (p<0.05) which mean the distribution is not normal. The mean maximum volume of the game centre is 87.7417 dBA with a standard deviation of 7.6914. The mean minimum volume of the game centre is 77.5167 dBA with a standard deviation of 3.56392.

4.3. Correlation between Volume of Earphone Usage with Audiometry Result
Based on the data collected from the audiometry test, the correlation between volume of earphone usage with audiometry result on 4000 Hz can be observed on table 1. Due to the distribution data of
the volume of earphone usage being not normal, the correlation test used for testing the correlation between volume of earphone usage and audiometry result on 4000 Hz is Spearman’s rho. The result for both, right ear 0.766 and left ear 0.238 is not significant (p>0.05).

Table 1. Correlation between Volume of Earphone Usage with Audiometry Result on 4000 Hz

| Volume of Earphone Usage (%) | Right Ear (dBA) | Left Ear (dBA) |
|-----------------------------|-----------------|----------------|
| 0  | 1  | 0  | 2  | 1  | 0  | 1  | 2  | 1  | 0  | 0 |
| 25 | 0  | 0  | 1  | 0  | 0  | 0  | 1  | 0  | 0  | 0 |
| 30 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0 |
| 50 | 0  | 0  | 2  | 0  | 0  | 2  | 1  | 0  | 0  | 0 |
| 55 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 60 | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  | 1  |
| 65 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0 |
| 75 | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 1  |
| Total | 1  | 5  | 7  | 3  | 0  | 4  | 5  | 3  | 3  | 1 |

4.4. Correlation between Duration of Earphone Usage with Audiometry Result

Based on the data collected from the audiometry test, the correlation between duration of earphone usage with audiometry result on 4000 Hz can be observed on table 3. Due to the distribution data of the duration of earphone usage being not normal, the correlation test used for testing the correlation between duration of earphone usage and audiometry result on 4000 Hz is Spearman’s rho. The result for both right ear 0.582 and left ear 0.802 is not significant (p>0.05).

Table 2. Correlation between Duration of Earphone Usage with Audiometry Result on 4000 Hz

| Duration of Earphone Usage (minutes/day) | Right Ear (dBA) | Left Ear (dBA) |
|------------------------------------------|-----------------|----------------|
| 0  | 1  | 0  | 2  | 1  | 0  | 1  | 2  | 1  | 0  | 0 |
| 30 | 0  | 0  | 1  | 0  | 0  | 0  | 1  | 0  | 0  | 0 |
| 45 | 0  | 0  | 1  | 2  | 0  | 0  | 1  | 0  | 0  | 0 |
| 120 | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 1  | 0  | 0 |
| 150 | 0  | 0  | 0  | 2  | 0  | 0  | 0  | 0  | 1  | 1  |
| 180 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| 195 | 0  | 0  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  |
| 240 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0 |
| 420 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| Total | 1  | 5  | 7  | 3  | 0  | 4  | 5  | 3  | 3  | 1 |

4.5. Correlation between Frequency of Visiting Game Centre with Audiometry Result

Based on the data collected from the audiometry test, the correlation between frequency of visiting game center with audiometry result on 4000 Hz can be observed on table 3. Due to the distribution data of the frequency of visiting game center being not normal, the correlation test used for testing the correlation between frequency of visiting game center and audiometry result on 4000 Hz is Spearman’s rho. The result for right ear 0.028 is significant (p<0.05). The result for the left ear 0.908 is not significant (p>0.05).

Table 3. Correlation between Frequency of Visiting Game Center with Audiometry Result on 4000 Hz

| Frequency of Visiting Game Center (x/months) | Right Ear (dBA) | Left Ear (dBA) |
|---------------------------------------------|-----------------|----------------|
| 0  | 5  | 10 | 15 | 20 | 0  | 5  | 10 | 15 | 20 |
5. Discussion

5.1. Correlation between Volume of Earphone Usage with Audiometry Result
According to the result of the correlation test between volume of earphone usage with audiometry result, there is no correlation (p>0.05) between volume of earphone usage with audiometry result. Well know that the greater the intensity, or in this case volume, the greater is the risk of permanent damage [8]. The result of this study is in contradiction with the result of the study done by Jiang et al., on 2012 which mention that there is a correlation between the volume of earphone usage with audiometry result [9]. This contradiction might be cause by the different level of objectivity in measuring the volume. This study uses the percentage of volume in the personal music device, while the study done by Jiang et al. used the sound level of the device.

5.2. Correlation between Duration of Earphone Usage with Audiometry Result
Based on the data collected in this study and the result of the correlation test, there is no correlation (p>0.05) between duration of earphone usage with audiometry result. Based on the theory noise can affect hearing in a variety way, one of them being the duration of the exposure. While a loud but short duration of noise can cause a temporary reduction in hearing ability, a moderate but long duration of noise can cause a permanent reduction in hearing ability [8]. The possible explanation of the result of this study is because duration is not a single factor for hearing ability. This possibility is also supported by another study done by Kim et al., on 2012, which found that student who had used these player for more than 5 years with cumulative usage time of 15 hours x years had significantly elevated hearing thresholds [5]. Hearing ability is affected by volume, frequency and duration at the same time. Unfortunately, in this study the volume, frequency and the duration cannot be analyze using statistic due to the abnormal data distribution.

5.3. Correlation between Frequency of Earphone Usage with Audiometry Result
Based on the result of the correlation test between frequency of earphone usage with audiometry result, there is no correlation (p>0.05) between frequency of earphone usage with audiometry result. It is well known that hearing loss is associated with repeated daily exposure to noise [8]. The basic factor associated with hearing loss are intensity, duration, or in this study represent by the duration of earphone usage and frequency of earphone usage, and spectrum. These factors interact with each other in a complex way [8]. It is possible that the cause of the result is because in this study the correlation between frequency of earphone usage with audiometry is analyze separately with the other factor.

5.4. Correlation between Duration of Visiting Game Centre with Audiometry Result
Based on the data collected in this study and the result of the correlation test, there is no correlation (p>0.05) between duration of visiting game center with audiometry result of left ear on 4000 Hz. But the duration of visiting game center, based on the correlation test, has correlation (p<0.05) with the audiometry result of the right ear on 4000 Hz. The study done by Pangemanan, et al., on 2012 stated that there is no correlation between noise and hearing threshold among game center worker in Manado [10]. Even though both study stated that there is no correlation between the duration of visiting game
center with audiometry result. It is well known that duration is one of the important factor of hearing loss [8]. The possible explanation is that in this study the duration only measures the duration spend on each visit. The study done by Kim et al., mention that student who had used these player for more than 5 years with cumulative usage time of 15 hours x years had significantly elevated hearing thresholds [5]. So, it is possible if there is also a data about how many years the exposure had taken place there will be a correlation between the duration and the hearing threshold.

5.5. Correlation between Frequency of Visiting Game Centre with Audiometry Result
Based on the result of the correlation test between frequency of visiting game center with audiometry result, there is no correlation (p>0.05) between frequency of visiting game center with audiometry result. It is well known that the main factor for hearing loss is the intensity of the noise, and the next factor is the duration of the exposure [8]. In this study the duration of exposure is measure into how long do the subject stays in the game center every time the subject visits the game center (duration of visiting game center) and how many time the subjects visit the game center in a month (frequency of visiting game center). In this definition duration of visiting game center have more impact to the duration of exposure, which in turn the hearing loss, than frequency of visiting game center.

6. Conclusions
The conclusions of this study are there is no correlation between earphone usage with hearing threshold and There is no correlation between visiting the game center with hearing threshold.

References
[1] S. L., Human Physiology: From Cells to Systems 7th edition, Cengage, 2010.
[2] Pawlacyzk-Luszczynska, Z. A., Z. K., Z. M. K. and M. Sliwinska-Kowalska, "Noise induced hearing loss: Research in central, eastern, and south-eastern Europe and newly independent states," Noise Health, vol. 15, no. 62, pp. 55-66, 2013.
[3] S. Bullock and M. Hales, Principles of Pathophysiology, Australia: Pearson Australia, 2013.
[4] NHS, "Hearing Loss," [Online]. Available: http://www.nhs.uk/conditions/Hearing-Impairment/Pages/Introduction.aspx. [Accessed 17 January 2016].
[5] M. G. Kim, S. M. Hong, H. J. Shim, Y. D. Kim, C. I. Cha and S. G. Yeo, "Hearing threshold of Korean adolescent associated with the use of personal music players," Yonsei Med. Journal, vol. 50, no. 6, pp. 771-776, 2009.
[6] M. Sliwinska-Kowalska and A. Davis, "Noise-induced hearing loss," Noise Health, vol. 14, no. 61, pp. 274-280, 2012.
[7] S. M. Mirbod, R. Inaba, H. Yoshida, C. Nagata, Y. Komura and H. Iwata, "Noise Exposure Level While Operating Electronic Arcades Games as A Leisure Time Activity," Industrial Health, vol. 30, pp. 65-76, 1992.
[8] J. Katz, L. Medwetsky, R. Burkard and L. J. Hood, Handbook of Clinical Audiology 6th Edition, America: Lippincott Williams & Wilkins, 2009.
[9] W. Jiang, F. Zhao, N. Guderley and V. Manchaiah, "Daily music exposure dose and hearing problems using personal listening devices in adolescent and young adult: A systematic review," International Journal of Audiology, vol. 55, no. 4, pp. 197-205, 2016.
[10] D. H. Pangemanan, J. N. Engka and A. F. Kalesaran, "Pengaruh Pajanan Bising terhadap Pendengaran dan Tekanan Darah pada Pekerja Game Center," Jurnal Biomedik, vol. 4, no. 3, pp. 133-140, 2012.