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College Students' Hearing Ability through Pure Tone Audiometry

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Abstract

Modern people live under lots of pollution. Especially, pollution due to noise is actually at the level threatening the health of modern people. noise induced deafness, according to hobbies like listening to music and concerts via earphones, is worried in young generations, due mainly to electronic equipment and media development, rather than hearing loss according to age. This study examined hearing ability, according to college students' exposure to earphones through pure tone audiometry and speech audiometry targeting 50 healthy college students. This study investigated the exposure time and number of exposure to earphones through a questionnaire survey, identified the effects of noise caused in everyday life on young people's hearing ability through correlations between hearing ability and smoking and drinking. This study was carried out to prevent deafness through the recognition of hearing loss problems, and to use the findings as health education data.

Among the participants in the experiment, 76.5% were females, and mean age was 22. 13% felt tinnitus in everyday life, and 3.9% smoked. Concerning subjective earphone volume level, 62.7% used medium level volume, and 9% drank alcohol. Mean hearing threshold was revealed with a 3 divided method, 4 divided method and 6 divided method, which are widely used in general. As for correlations with each factor, positive correlations were revealed among the status of drinking, drinking amount and daily earphone use duration. Although, young people participated in this experiment, tinnitus implies that it is related with daily earphone use duration and subjective earphone volume level. Especially, a positive correlation between drinking and drinking amount is considered to be a factor of hearing reduction, due to neuro-generation mechanism according to noise and alcohol, rather than deafness according to age.

Keywords: *hearing ability, pure tone audiometry, speech audiometry.*

1. Introduction

Modern people live in lots of pollution. Above all, pollution caused by noise is closely related with human's everyday life (1, 2). People are always exposed to noise in the environment of listening to music via cellphones used by young people, and hobbies, owing to the development of electronic equipment and media development, as well as in everyday life including industrial sites, roads and airports (3, 4, 5). Human's hearing characteristics are different, according to individuals, and there is limitation in hearing by age. Noise induced deafness is gradually increasing to young college students, because hearing reduction cases due to noise are on the rise, in addition to ear's damage or aging, arising from electronic equipment and media development (5, 6). People feel satisfaction, as there are more exposure duration and more exposure frequency to very high tones in terms of general music level (7). Young college students are excessively exposed to high tone music, compared to other age brackets, as well as the ratio of music such as concert out of pop culture among hobbies increases. Therefore, the concern about noise induced deafness increases (5, 8). Universally

ISSN 2348 – 7968

diffused cellphones simultaneously play a role of a recorder and music device. If a person is exposed to maximum volume level, 130 dB, for a long time, noise induced deafness is forecast to be developed. Humans are most sensitive to audio frequency band, 2,000~4,000 Hz, and hearing loss can be caused potentially, when one uses such a band for a long time (9). Young people are exposed to noise with more than 85 dB, which is a dangerous noise level, set by the Occupational Safety and Health Act or the U.S. National Institute for Occupational Safety and Health, due to excessive use of personal portable devices. And, a study on permanent noise induced deafness risk of those users was introduced by Berger (1). In many cases, people listened to music through earphones for a long time, while they studied, worked, walked or used public transportation, and also listening to music as a hobby took up a high portion. More than 51 % of the U.S. adolescents were reported by Jokitulppo to be exposed to harmful noise level to hearing, due to leisure activities such as concerts and rock bands and also motor sports (11). However, general public are insensitive to hearing loss, except ear diseases, and they mostly visit a hospital, when their hearing becomes unrecoverable status, due to the quite progress of hearing loss. Hearing cannot be fundamentally recoverable, once damage or loss progresses. Prevention is the only treatment method before hearing loss occurs.

Maintaining living environment that can minimize exposure to noise in everyday life, and self-living control for protection of hearing are necessary. Pure tone audiometry and speech audiometry are the currently used audiometric methods. This study conducted pure tone audiometry and speech audiometry simultaneously targeting healthy college students of XX University in Busan. This study carried out a questionnaire survey on young people's exposure duration, and the number of exposure to noise through earphones. This study was carried out in order to identify modern young people's hearing ability using noise caused in everyday life through correlations between hearing ability and smoking and drinking, according to exposure to noise. The study was ultimately performed to use the data for the prevention of noise induced deafness and as health education data through the recognition of hearing loss problems.

2. Materials and Methods

2.1 Subjects

This study conducted a questionnaire survey targeting 50 healthy college students of XX University in Busan from March to June 2015. This study also carried out pure tone audiometry and speech audiometry, and measured the most comfortable hearing threshold and uncomfortable hearing threshold. To select the subjects in this study, the college students had ear diseases, due to high blood pressure, dyscrinism, vascular tumor and brain damage, or those who experienced otitis media excudative or eardrum hole were excluded from the experiment subjects. Concerning the questionnaire, this study revised and complemented the questionnaire developed by referring to preceding studies on participants' recognition, according to exposure degree to hearing diseases and exposure to noise, after identifying subjects' physical symptoms. The participants were sufficiently explained about the purpose of the study and future study utilization method in advance, their consent was gained, and the questionnaire survey was conducted through self-administered questionnaire. The questionnaire consisted of five questions on general characteristics and nine questions on hearing and earphones. This study conducted pure tone audiometry and speech audiometry, and measured most comfortable level and uncomfortable level.

ISSN 2348 – 7968

2. 2. Measuring Method of Hearing

As for general hearing examination, it is to examine the good ear first. However, which side of ear to be examined is a subjective selection of an examiner. For the experiment, a harp model basic diagnostic audiometer (Italy) supported by the Goodmorning Hearing, LTD was used. For performance analyzer, FP35A ANALYZER W/AUD/COMPO (USA) was used, and Hi-Pro 2 Programmer (Denmark) was used for programmer. As for the experiment sequence of ears, right ear was examined first, and then, the left ear. A participant was instructed to put on the headphone, and press the button in the soundproof room to listen and respond to the examiner, after entering the soundproof room. At first, most comfortable level and uncomfortable level were measured.

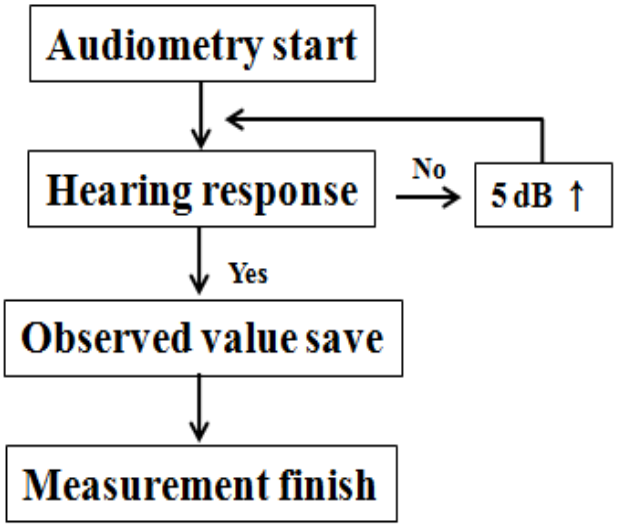

Figure 1. Experimental Diagram of Ascending Method of Pure Tone Audiometry

Figure 1 shows the outline of the experiment. Because 60~80 dB is heard most well in the case of a normal person, the measurement was conducted by tuning to dB basically heard starting from 60 dB, and the most comfortable level was measured by raising 5 dB each time. Comfortable level to hear the examiner becomes the most comfortable level, when a subject hears the examiner. After measuring the most comfortable level, the uncomfortable level was measured by raising 5dB each time, and the uncomfortable level was indicated as severely uncomfortable level on the part of ear, after hearing the examiner. Speech recognition threshold means the difference between uncomfortable level and the most comfortable level.

Next, this study conducted a pure tone audiometry test. Seven frequency bands, namely, 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz and 8,000 Hz were used. The frequency examined upon hearing measurement is the sound comfortable to hear, and it started from 1,000Hz that can ease the participant's tension and that is a hearing threshold. the subjects were measured in the order of 2,000 Hz, 4,000 Hz and 8,000 Hz. And then, measurement was conducted from 1,000Hz to 500 Hz, 250 Hz and 125 Hz again. As for dB, the finally heard dB was measured by reducing from 40 dB by 5 dB each time. Lastly, speech audiometry was conducted by instructing the participants to repeat the words that the examiner said with the most comfortable level dB. The measurement was made by writing the cases in which participants repeated the words that the examiner said. When measuring left ear and right ear, speech audiometry was conducted, after tuning to the most comfortable level.

2.3. Data Analysis

This study analyzed data using the ANONA, Pearson's correlation coefficients program, while the data was revealed with mean ± standard deviation using the SPSS Window 18.0 ver. Program (IBM Co., Armonk NY, USA).

ISSN 2348 – 7968

3. Results

Table 1. Participants' General Characteristics

Factor	N	Mean±S.D.		
Age	50	22.82±1.41		
Earphone wearing periods (year)	48	8.13±2.31		
Earphone number of use for a week	49	4.86±2.46		
Factor	**N**	**Question**	**Frequency**	**Missing value**
Gender	49	Male	11(21.6%)	1(2%)
		Female	39(76.5%)	
Occupied area	50	Busan	35(68.6%)	
		Gyeongnam	10(19.6%)	
		Etc.	5(9.8%)	
Tinnitus symptom	50	No	37(72.5%)	
		Yes	13(25.5%)	
Smoking	50	No	45(88.2%)	
		stoped	3(5.9%)	
		Yes	2(3.9%)	
Earphone hours of use for a day	49	nearly 1 hour	23(45.1%)	1(2%)
		nearly 2 hour	17(33.3%)	
		nearly 4 hour	8(15.7%)	
		nearly 8 hour	1(2%)	
Subjective earphone volume	49	Small	15(29.4%)	1(2%)
		Medium	32(62.7%)	
		Large	2(3.9%)	
Drinking	47	No	38(74.5%)	3(5.9%)
		Yes	9(17.6%)	

Table 1 shows the general characteristics of the participants. Mostly, the participants were the residents in Busan taking up 68.6 %, and females were 76.5 %. Although, participants' mean age was 22, and they were college students, 25.5 % of those suffered from tinnitus. Among the participants, 3.9 % smoked, and 45.1 % used earphones within an hour per day, followed by 33.3 % within two hours, and 15.7 % within four hours. 62.7 % used medium-high volume level in terms of subjective earphone volume. 17.6 % usually drank. The earphone use duration was eight years, and the number of earphone use days was 4.8 days per week. For mean hearing threshold, a method to reveal mean value by summing up hearing thresholds at 500 Hz, 1,000 Hz and 2,000 Hz, which are the frequencies of conversational range, was mainly used.

$$3\text{ divided method} = \frac{500\text{Hz} + 1\text{KHz} + 2\text{KHz}}{3}$$

$$4\text{ divided method} = \frac{500\text{Hz} + 2\cdot(1\text{KHz}) + 2\text{KHz}}{4}$$

$$6\text{ divided method} = \frac{500\text{Hz} + 2\cdot(1\text{KHz}) + 2\cdot(2\text{KHz}) + 4\text{KHz}}{6}$$

Figure 2. Calculation Methods of 3 Divided Method, 4 Divided Method and 6 Divided Method

Figure 2 shows the method of drawing mean hearing thresholds with a 3 divided method, 4 divided method and 6 divided method. The 3 divided method decided the value by adding 500 Hz, 1,000 Hz and 2,000 Hz and then dividing the added value by 3 as mean hearing threshold. The 4 divided method decided the value by adding the hearing thresholds of 500 Hz and 2,000 Hz and two times of the hearing threshold of 1,000 Hz and then dividing the added value by 4 as mean hearing threshold. The 6 divided method decided the value by adding the hearing thresholds of 500 Hz and 4,000 Hz and two times of 1,000 Hz and 2,000 Hz, respectively, and then dividing the added value by 6 as mean hearing threshold. The results are shown in Table 2.

Table 2. Participants' Mean Hearing Thresholds through 3, 4 and 6 Divided Methods

Factor	N	Left	Right
Pure Tone Audiometry			
3 Divided method	50	5.04±12.77	6.44±12.74
4 Divided method	50	5.32±12.91	6.5±12.7
6 Divided method	50	4.97±13.02	6.37±12.84

The hearing of the participants was mostly normal. However, the right ear result by the 4 divided method implied that hearing ability was slightly lower.

ISSN 2348 – 7968

Table 3. Speech Audiometry of the Participants

Factor	N	Left	Right
Speech Audiometry (dB)			
MCL	49	63.16±10.14	63.47±10.11
UCL	49	80.51±11.56	82.24±10.85
SRT	50	17.6±8.03	18.5±7.91
WRS(%)	49	97.45±6.3	96.84±4.29

MCL: Most comfortable level, UCL: Uncomfortable level, STR: Speech recognition threshold, WRS: Word recognition threshold .

Table 3 shows the speech audiometry results. The most comfortable level was 63 dB for left and right ears. Uncomfortable level was approximately 80 dB, similar for both left and right ears, which revealed the result similar to other study results.

Table 4. Correlation between Mean Hearing Thresholds and Factor Variables

Factor / Pure tone audiometry	Smoking	Earphone wearing periods	Earphone number of use for a week	Earphone hours of use for a day	Subjective earphone volume	Drinking	Amount of drinking
3 Divided method (Right ear)	-.065	.198	0.047	.252	.266	.279	.503**
3 Divided method (Left ear)	.045	.190	0.039	.253	.244	.217	.298*
4 Divided method (Right ear)	-.046	.180	-0.020	.166	.259	.291*	.449**
4 Divided method (Left ear)	.085	.196	.061	.205	.254	.211	.289*
6 Divided method (Right ear)	-.058	.156	.065	.246	.217	.239	.475**
6 Divided method (Left ear)	.032	.139	.047	.283*	.157	.264	.337*

*;p<0.05, **;p<0.01

Table 4 shows correlations between the mean hearing thresholds calculated with the 3, 4 and 6 divided methods and each factor item. The eft ear and the status of drinking by the 4 divided method showed a positive correlation(p0.01, p0.05), and all mean hearing threshold results and drinking amount showed also a positive correlation (p0.01, p0.05).

Table 5. Correlation between Speech Audiometry and Factor Variables

Factor / Speech Audiomnetry	Smoking	Earphone wearing periods	Earphone number of use for a week	Earphone hours of use for a day	Subjective earphone volume	Drinking	Amount of drinking
MCL (Right ear)	.157	.067	.049	.155	.089	.136	.228
MCL (Left ear)	.064	.026	.159	.193	.192	.112	.101
UCL (Right ear)	.175	.169	.029	.243	.209	.119	.184
UCL (Left ear)	.114	.192	-.013	.247	.229	.246	.244
SRT (Rightear)	.050	.155	-.020	.149	.184	-.003	-.029
SRT (Left ear)	.072	.234	-.236	.081	.058	.191	.203

MCL: Most comfortable level, UCL: Uncomfortable level, STR: Speech recognition threshold.

Table 5 shows the correlation between most comfortable level/ uncomfortable level in terms of speech audiometry, and each factor item, and a positive correlation (p0.01, p0.05) was revealed among the uncomfortable level, status of drinking and drinking amount.

4. Conclusion

Modern people are exposed to noise a lot (12, 13). This study carried out a questionnaire survey on factors in regards with hearing, and pure tone audiometry and speech audiometry, which are general hearing tests, targeting young and healthy college students.

ISSN 2348 – 7968

The earphone wearing duration of the participants was 8 years, and the number of earphone use days was 4.8 days per week. 25.5 % or 13 participants felt tinnitus. Due to tinnitus, namely, unknown sound heard from an ear, many appealed pain (14, 15, 16). Especially, tinnitus is clearly heard in quiet spaces or before sleeping, and tinnitus refers to a symptom of feeling sound, despite no external stimulus. Stress, noise, overwork and overdrinking are known to be the causes of tinnitus (17, 18). From the result, long term or long time exposure to noise is conjectured to be related with stress or the use of earphones. Long time exposure to noise may cause the damage of hair cells, and the damage of hair cells with continuous stimuli through long time and long-term cannot be recoverable, and thus may cause deafness, and hearing loss may be caused in a specific frequency band (19, 20). To young generations, uncertainties toward the future work as stress furthermore, and their exposure to noise, due to music and various leisure activities, is considered huge to relieve such stress.

Medium level of volume took up most. As for volume of MP 3 or a cellphone, it was 130 dB, highest, which is the volume level that can cause noise induced deafness even by a few hours of exposure. Although, general participants would not use such a volume level, overall participants were exposed to high volume level, and therefore, noise induced deafness is worried. A study result that exposure to noise through earphones may cause noise induced deafness or high blood pressure was released by Almeida-Verdu AC(21). Namely, long-term exposure to noise not only causes tinnitus and noise induced deafness, but increases the prevalence of high blood pressure and cardiovascular diseases. In this study, although alcohol drinker took up small portion of the participants in the experiment, a positive correlation was shown with mean hearing threshold. In preceding studies, Hernandez OH (22) reported drinking extends P2 latent period in hearing-evoked potential measurement.

Therefore, drinking alcohol harms vestibulocochlear nerve, which is cranial nerve of the central nervous system, and is considered to show relevance with hearing loss. Smokers were just 3 %, and there was no statistical significance. However, smokers showed 20 % increase of hearing threshold, compared with nonsmokers, according to Sumit AF (23, 24). Nicotine from smoking shows harmful effect similar to the large amount of alcohol, and is forecast to show more deafness prevalence. The experiment, however, targeted healthy college students in a specific area, and there is a limitation that no males and females were divided. For this reason, further studies encompassing various age brackets, and on relationship between smoking and alcohol drinking are judged to be needed.

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ISSN 2348 – 7968

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