

The Effects of Earphone Use on the Incidence of Noise-Induced Hearing Loss: An Empirical Study of Senior High School Students in Banda Aceh

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Abstract:-

Background: Noise-induced hearing loss (NIHL) is a sensorineural hearing loss in the form of a progressive and irreversible decrease in hearing functions due to noise exposure. This study aims to examine the effects of the use of earphones on the incidence of NIHL. Specifically, this study investigates the effects of the length of exposure, frequency, duration, and volume level in the use of earphones on the incidence of NIHL. **Method:** This study is an observational analytical study with a cross-sectional design and a sample of 378 students. Data were collected using the Hearing Handicap Inventory - Questionnaire (HHI-Q) to obtain primary data that have been developed and validated as a tool to identify the hearing loss of high school students in Banda Aceh. Multivariate analysis is used to test the hypothesis. **Results:** Our results found that the students who did not have a major hearing loss were using earphones for a period of exposure of < 2 years, and amounted to 72 students (51.43%), those using them every 1 to 3 days amounted to 116 students (82.86%), those using earphones for < 1 hour amounted to 110 students (78.57%), and having the volume at < 60% amounted to 116 students (82.86%). The majority of students (117 students or 65%) who had a degree of hearing loss used earphones for a period of > 5 years, 66 students (36.67%) used earphones for 6 to 7 days each week, 84 students (46.67%) used earphones for more than one hour a day, and 87 students (48.33%) had the volume on their earphones set at more than 60%. **Conclusion:** The length of exposure, frequency, duration, and volume in the use of earphones all significantly affect the incidence of NIHL. The longer the length of exposure to earphones, the more frequent the use of earphones, a longer duration of earphone use each day, and listening with a high volume level tend to cause the users to experience mild or even severe hearing loss.

Keywords:- Earphone, HHI-Q, Noise-induced hearing loss, Sensorineural.

I. INTRODUCTION

Noise-induced hearing loss (NIHL) is hearing loss in the form of sensory deficits that can cause sensorineural hearing loss due to continuous exposure to loud noises for a prolonged period [1]. NIHL is progressive and irreversible,

so it takes a long time to see the severity of the hearing loss. However, the permanent shift in the hearing threshold cannot return to normal because the hair cells in the Organ of Corti have been damaged by the noise [2]. Noise is an external factor and is the main cause of NIHL due to levels of sound that can cause ear discomfort. This noise can induce a temporary noise-induced threshold shift (NITTS) and a permanent noise-induced threshold shift (NIPTS) [3]. The prevalence of NIHL is high and is one of the health problems in the world, because the prognosis of permanent NIHL is poor and most often occurs in the community, especially among adolescents. So prevention is a very appropriate action to reduce the risk of NIHL in relatively young age groups, such as those in adolescence [4]. The World Health Organization (WHO) estimates that in 2019 there were 466 million people in the world experiencing hearing loss, 34 million of whom were children and adolescents. The percentage of hearing loss at a relatively young age caused by excessive noise exposure is 60% [5]. According to the National Committee for the Prevention of Hearing Loss and Deafness, in 2014, Indonesia was one of the countries in Southeast Asia that had a high number of cases of NIHL, amounting to 36 million people, or 16.8% of the total population [6]. According to the results of a study by Riskesdas, Aceh had a high prevalence of hearing loss in those aged over five years old in 2013, which affected 2.4% of the total population of 4.8 million people [5].

Based on the researchers' observations of the behavior of public high school teenagers in Banda Aceh, almost all high school students use earphones to listen to songs, play games, watch movie, make calls, and listen to learning material. However, the research found that the majority of the students of SMA Pasundan 8, Bandung City had sufficient knowledge about the use of earphones [7]. This sufficient level of knowledge can affect the pattern of use of the earphones, if it is poor this could lead to an increasing number of NIHL incidences [8]. The WHO has predicted that more than 1 billion adolescents in the world are at risk of impaired hearing functions because they are accustomed to listening to music for too long at a volume level that is too high. The Third National Health and Nutrition Examination Survey (NHANES III) in the U.S. found that 12.5% of children and adolescents aged 6 to 19 years old experienced a shift in the hearing threshold in one or both of their ears caused by excessive noise exposure [9]. Research conducted by Peng *et al* (2007) reported that the rate of incidences of

NIHL caused by listening to music through earphones over an extended period in adolescents aged between 19 to 23 years old at a university in China was 14.1% [10]. According to another study by Kim *et al* (2009), the incidence rate of hearing loss in adolescent girls in Seoul was 65.8%; this was higher than the number of boys affected, and 20.2% of them were only 18 years old [11]. Research conducted in India in 2015 showed that 36.06% of students who used earphones in a poor manner could experience NIHL [12].

Several research results show that the use of earphones over a period of more than two years and a frequency of more than three days a week can cause NIHL [13]. A study also states there is a relationship between the use of earphones for a minimum duration of 3 to 4 hours a day at a volume that produces a noise intensity > 85 dB and the incidence of NIHL. The use of earphones at the maximum volume over a five year period tends to cause NIHL [14]. Meanwhile, other research results show that there is no relationship between the patterns of earphone use and hearing loss [15]. Research conducted by Mohammadpooraslet *al* (2018) examined the effect of the length of exposure and frequency of earphone use on NIHL in college students. It did not comprehensively explained the variables in the use of earphones to NIHL [13]. According to the research by Setianiet *al* (2018), there is no relationship between the use of earphones and the frequency of exposure for 4 to 5 days or 6 to 7 days a week with the incidence of NIHL, due to the use of earphones for only one day with a sound volume that produces a noise intensity > 85 dB can cause NIHL [14]. Meanwhile, according to Sarah *et al* (2016), there is no relationship between the four variables of earphone use and the incidence of hearing loss in senior high school students [15]. This study confirmed the differences between the three research results above by re-examining the effect of the patterns of earphone use that can lead to NIHL in senior high school students through using a questionnaire as an initial screening tool. This research contributes to the development of the literature about detecting NIHL among adolescent students by using a questionnaire to show early indications of NIHL.

II. MATERIALS AND METHODS

This study used an observational analytical method with a cross-sectional approach. The research had been conducting at SMA Negeri 3, SMA Negeri 5, and SMA Negeri 7, in Banda Aceh with a total sample of 378 students. Sampling was undertaken using a probability sampling method with a stratified random sampling technique. The research instrument used was the HHI-Questionnaire (HHI-Q). The HHI-Q can be used for the early identification and screening of hearing loss [16]. The question items in this research instrument were adapted from question items developed by Mohammad pooraslet al(2018) [13]. While, the way interpretation in this questionnaire was adapted from a questionnaire developed by Weinstein and Ventry [17]. This study used chi-square analysis to show the relationship between earphone usage patterns and the incidence of noise-induced hearing loss (NIHL). Then a multivariate analysis with regression analysis was used to examine the effects of the length of exposure, frequency, duration, and volume level

in the use of earphones on the incidence of NIHL with the following formula:

$$NIHLi = \alpha_0 + \alpha_1 De_i + \alpha_2 Ve_i + \alpha_3 Fe_i + \alpha_4 Te_i + \epsilon_i$$

Where, NIHLi is the incidence of noise-induced hearing loss for each respondent i; De_i is the duration of earphone use by respondent i; Ve_i is the volume level using earphones by respondent i; Fe_i is the frequency of earphone use by respondent i; Te_i is the length of exposure to the use of earphones by respondent i; and 0, 1, 2, 3, 4 are regression coefficients that indicate the magnitude of the influence between the variables; and ϵ_i is the error term/residual term. Hypothesis testing was done using the f-test and t-test.

III. RESULTS

The general characteristics of the respondents in the study were their gender, age, class, and school origin.

Respondents Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	231	61.1%
Female	147	38.9%
Age		
15 Years	134	35.4%
16 Years	132	34.9%
17 Years	103	27.3%
18 Years	9	2.4%
Class		
Class 1	134	35.4%
Class 2	115	30.4%
Class 3	129	34.2%
School		
SMA Negeri 3	142	37.5%
SMA Negeri 5	105	27.8%
SMA Negeri 7	131	34.7%
Total	378	100%

Table 1: General Characteristics of the Respondents

Based on Table 1, it was found that the majority of the respondents were girls (231 or 61.1%) and there were 147 boys (38.9%). The Table 1 also shows that there were more respondents (134) who were 15 years old (35.4%) than there were respondents aged 16 years or 17 years old. In terms of their classes, there were 134 respondents from Class 1 (35.4%), while there were 115 respondents from Class 2 (30.4%) and 129 respondents from Class 3 (34.2%). The highest number of respondents came from SMA Negeri 3 with 142 (37.5%). The number of respondents from SMA Negeri 5 came to 105 (27.8%), and the respondents from SMA Negeri 7 amounted to 131 (34.7%).

Earphone Usage Pattern	Frequency (n)	Percentage (%)
Listening to Music	239	63.2%
Playing Game	97	25.7%
Listen to Learning Materials	23	6.1%
Watching Movie	17	4.5%
Calling	2	0.5%
Length of Exposure		
≤2 Years	102	27.0%
2-≤5 Years	80	21.2%
5 Years	196	51.8%
Frequency		
1-3 Days	211	55.8%
4-5 Days	65	17.2%
6-7 Days	102	27.0%
Duration		
≤1 Hour	175	46.3%
1-≤3 Hours	127	33.6%
3 Hours	76	20.1%
Sound Volume		
≤60%	192	50.8%
> 60%-≤80%	142	37.6%
> 80%	44	11.6%
Total	378	100%

Table 2: Distribution of Earphone Usage’s Pattern

From Table 2, the frequency distribution of the use of earphones showed the respondents’ habits when using earphones, including the length of exposure, frequency, duration, and the volume. Mostly the respondents used earphones to listen to music (239 respondents or 63.2%), followed by playing games (97 respondents or 25.7%), listening to learning materials (23 respondents or 6.1%), watching movie (17 respondents or 4.5%), and telephoning (2 respondents or 0.5%). Table 2 also shows that half of the total number of respondents; as many as 196 respondents (51.8%) had been exposed to earphones for > 5 years. There were 80 respondents who had been exposed to earphones for more than two years but not more than five years (21.2%), and the number of respondent exposure to earphones for two years amounted to 102 respondents (27.0%). From the Table 2, it can also be seen that, each week, 211 respondents (55.8%) used earphones for 1 to 3 days. There were 102 respondents (27.0%) who used earphones every day, and there were 65 respondents (17.2%) who used earphones for four or five days each week. The table above also shows the duration earphones were used for consecutively: 175 respondents (46.3%) used them for one hour, 127 respondents (33.6%) used them for between 1 to 3 hours and 76 respondents (20.1 %) used them for more than three hours. In addition, the table above also shows 44 respondents (11.6%) used earphones with the volume set at > 80%, while 192 respondents (50.8%) used earphones with the volume at 60%, and 142 respondents (37.6%) used earphones with the volume somewhere between 60% and 80%.

Hearing Loss Classification	Gender				Total	
	Male		Female		n	%
	n	%	n	%		
No hearing Loss (0-8)	65	46.43	75	53.57	140	100
Mild Hearing Loss (10-16)	59	32.78	121	67.22	180	
Moderate Hearing Loss (18-24)	21	42.86	28	57.14	49	
Severe Hearing Loss (26-40)	2	22.22	7	77.78	9	

Table 3: Distribution of NIHL

Table 3 shows an overview of the NIHL frequency distribution which includes normal/no hearing loss, mild hearing loss, moderate hearing loss, and severe hearing loss. The number of girls with a loss of hearing came to 156 (67.53%) while 82 boys (55.78%) experienced a hearing loss. Table 3 shows that 140 respondents (37.0%) were identified, using the HHI-Q, as having no impairment in their hearing function. For the classification of hearing loss, 180 respondents (47.6%) had a mild hearing loss. Those identified as having a moderate hearing loss numbered 49 respondents (12.9%). This study also identified nine respondents (2.4%) who had severe hearing loss.

Effect of the exposure time, frequency, duration, and volume level when using earphones with the incidence of noise-induced hearing loss (NIHL).

The length of exposure, frequency, duration, and volume level when using earphones had a significant relationship with, and affects the incidence of, NIHL. This was evidenced by the results of the chi-square test analysis, with $p < 0.001$ so that $p \leq 0.005$ and the linear regression results showed that the coefficient and t-statistical values of all the variables had a significant positive effect on the incidence of NIHL.

Variable	Coef.	t-stat.	Tolerance	VIF
Constant	.097	.847		
Tei	0.226***	6.375	.977	1.023
Fei	0.180***	4.594	.779	1.285
Dei	0.244***	5.372	.725	1.379
Vei	0.291***	6.259	.877	1.140
R-Square	0.635			
Adj.R-Square	0.403			
F-Stat.	62.912***			

Table 4: Regresion Linier Results

Note: The dependent variable NIHLi (Noise-Induced Hearing Loss) is the occurrence of progressive hearing loss that is sensorineural deafness in a person's ear caused by excessive noise exposure. Tei is the length of exposure in earphones used; Fei is the frequency of using earphones; Dei is the duration of using earphones; Vei is the volume when using earphones; and *** significant at the 1% level.

In Table 4, which shows the results of the linear regression, it can be seen that the coefficient and t-statistical values for all the variables, the duration of exposure when using earphones (coef. = 0.226; t-stat. = 6.375), the frequency of earphone use (coef. = 0.180; t-stat. = 4.594), the duration of earphone use (coef. = 0.244; t-stat. = 5.372), and volume level when using earphones (coef. = 0.291; t-stat. = 6.259) had a significant and positive effect on the incidence of noise-induced hearing loss (NIHLi) at the 1% level. The tolerance value of all the independent variables was above 0.1, meaning that there was no multicollinearity between the independent variables. The VIF value of all variables was below 10, which indicated that there was no multicollinearity in the regression model. The R-square value of 0.635 and the adjusted R square value of 0.403 referred to the variation of

the dependent variable determined by the independent variable of 63.5% and 40.3%. The F value of 62.91 was significant at the 1% level which indicated that the independent variables jointly affected the incidence of NIHL.

The significant positive effect of the duration of exposure to earphone use (Tei) on the incidence of NIHL indicated that the longer the respondents had been using earphones, especially if for longer than five years, the more likely they are to suffer from NIHL. The number of days they used earphones each week (Fei) also had a significant positive effect on the incidence of NIHL, which showed that the more often the respondents used earphones, for example on six or seven days each week, the greater the tendency was for the incidence of NIHL. The significant positive effect between the length of time spent using earphones each day (Dei) on the incidence of NIHL indicated the longer earphones were used each day (for more than three hours/day), the more likely a person was to suffer from NIHL. The volume level when using earphones (Vei) had a significant positive effect on the incidence of NIHL. This result showed that the louder the volume was, especially if it was 60% or louder, the more likely NIHL was to occur.

Hearing Loss Classification	Length of Exposure						Total	P
	≤ 2 Years		> 2 - ≤ 5 Years		> 5 Years			
	n	%	n	%	n	%		
No Hearing Loss (0-8)	72	51.43	25	17.86	43	30.71	140	< 0,001
Mild Hearing Loss (10-16)	21	11.67	42	23.33	117	65	180	
Moderate Hearing Loss (18-24)	9	18.37	11	22.45	29	59.18	49	
Severe Hearing Loss (26-40)	0	-	2	22.22	7	77.78	9	

Table 5: Correlation between Length of Exposure to earphones and NIHL

In Table 5, it can be seen that there was an increase in the number of respondents who experienced mild hearing loss along with the length of their history of exposure to earphones. This can be found again for the nine respondents (18.37%) experiencing a moderate hearing loss who were using earphones for at least two years, the 11 respondents (22.45%) who were using earphones for 2 to 5 years, and the

29 respondents (59.18%) who were exposed to earphones for more than five years. For those with severe hearing loss, seven respondents (77.28%) had an exposure of more than five years, while 72 respondents (51.43%) did not experience a hearing loss after an exposure to earphones of two years.

Hearing Loss Classification	Frequency in 1 week						Total	P
	1-3 Days		4-5 Days		6-7 Days			
	n	%	n	%	n	%		
No Hearing Loss (0-8)	11	82.86	14	10	10	7.14	140	< 0.001
Mild Hearing Loss (10-16)	79	43.89	35	19.44	66	36.67	180	
Moderate Hearing Loss (18-24)	16	32.65	12	24.49	21	42.86	49	
Severe Hearing Loss (26-40)	0	-	4	44.44	5	55.56	9	

Table 6: Correlation between Frequency and NIHL

The data in Table 6 shows that there were five respondents (55.56%) who used earphones six or seven days a week and experienced severe hearing loss. Using earphones for four or five days a week caused four respondents (44.44%) to experience severe hearing loss, and in the classification of severe hearing loss, there were no respondents who used earphones for only 1 to 3 days a week. A total of 116 respondents (82.86%), who used earphones for three days a week or less, did not experience a hearing loss. This number is more than the number of

respondents who used earphones for six or seven days a week and did not experience a hearing loss, as there were only 10 respondents (7.14%) in this classification, while only 14 respondents (10%) used earphones four or five days a week and reported no hearing loss. The respondents with a mild hearing loss were dominated by those who used earphones for 1 to 3 days a week, totaling 79 respondents (43.89%). However, this was not very different from the 66 respondents (36.67%) who had a frequency of use of 6 to 7 days a week, while 35 respondents (19.44%) used earphones

four or five days a week. Meanwhile, moderate hearing loss was dominated by the 21 respondents (42.86%) with a frequency of using earphones six or seven days a week, and

respondents having a frequency of 4 to 5 days and 1 to 3 days in a row are 12 people (24.49 %) and (32.65%), respectively.

Hearing Loss Classification	Duration in 1 day						Total	P
	≤ 1 Hour		> 1 - ≤ 3 Hours		> 3 Hours			
	n	%	n	%	n	%		
No Hearing Loss (0-8)	110	78.57	20	14.29	10	7.14	140	< 0.001
Mild Hearing Loss (10-16)	56	31.11	84	46.67	40	22.22	180	
Moderate Hearing Loss (18-24)	8	16.33	19	38.77	22	48.9	49	
Severe Hearing Loss (26-40)	1	11.12	4	44.44	4	44.44	9	

Table 7: Correlation between Duration and NIHL

Based on Table 7, it was found that nine respondents experienced severe hearing loss, consisting of four respondents (44.44%) who used earphones for > 3 hours, four respondents (44.44%) who used earphones for 1 to 3 hours, and one respondent (11.12%) who used earphones for one hour. This differed from the respondents who did not experience any hearing loss, which was dominated by the 110 respondents (78.57%) who used earphones for one hour. The 10 respondents (7.14%) who used earphones for > 3 hours and the 20 respondents (14.29%) who used earphones for more than one hour but no more than three hours show a very significant difference from those that used earphones for more than three hours in the classification of having no

hearing loss. Mild hearing loss was dominated by the 84 respondents (46.67%) who used earphones for more than one hour but no more than three hours, followed by the 56 respondents (31.11%) who used earphones for one hour and the 40 respondents (22.22%) who used earphones for more than three hours. Meanwhile, moderate hearing loss was dominated by the 22 respondents (48.9%) who used earphones for more than three hours, followed by the 19 respondents (38.77%) who used earphones for more than one hour but no more than three hours, and the eight respondents (16.33%) who only used earphones for one hour.

Hearing Loss Classification	Sound Volume						Total	P
	≤ 60%		> 60% - ≤ 80%		> 80%			
	n	%	n	%	n	%		
No Hearing Loss (0-8)	116	82.86	21	15	3	2.14	140	< 0.001
Mild Hearing Loss (10-16)	63	35	87	48.33	30	16.67	180	
Moderate Hearing Loss (18-24)	11	22.45	29	59.18	9	18.37	49	
Severe Hearing Loss (26-40)	2	22.22	5	55.56	2	22.22	9	

Table 8: Correlation between Sound Volume and NIHL

The data in Table 8 shows that nine respondents in total had severe hearing loss consisting of two respondents (22.22%) who had the volume at 60%, two more respondents (22.22%) who had the volume set at more than 80%, and five respondents (55.56%) who had the volume at greater than 60% but not more than 80%. The classifications of mild and moderate hearing loss were also dominated by respondents who used earphones with the volume set at greater than 60% but not more than 80%, with 87 respondents (48.33%) experiencing mild hearing loss, and 29 respondents (59.18%) having moderate hearing loss. In the classification of no hearing loss, there were 116 respondents (82.86%) who used earphones with the volume at 60%, while 21 respondents (15%) used earphones with the volume set at greater than 60% but not more than 80%, and three respondents had the volume set at more than 80%. This is inversely proportional to the classifications of mild and severe hearing loss which were dominated by respondents who set the volume at greater than 60% but not more than 80%.

IV. DISCUSSION

Based on gender as seen in Table 1, there were more female respondents in the sample where this research was

conducted, so that it had a greater probability of being selected as a sample. Based on previous research conducted by Kim *et al* (2009) in South Korea regarding the hearing threshold of Korean adolescents and their use of personal music players, the number of respondents was also dominated by women (with 323 or 65.8%) and only 167 men. (34.1%) [11]. In a study conducted by Patniet *al* (2014) with students of the Faculty of Medicine, University of Mataram regarding the effects of using headsets on ear disorders, it was found that there were 59 female respondents (54.6%) and only 49 males (45.4%) [18]. Based on age, the proportion of the number of the sample that have been set for Class 1 was 134 respondents (35.4%) which in general were students aged 15 years, while there were 132 respondents (34.9%) aged 16 years, and 103 respondents (27.2%) who were 17 years old. Based on the National Health and Nutrition Examination Survey (NHANES) 2005-2006, the number of respondents aged 16 to 17 years old should have been greater, but there was a slight difference in the number of differences between the 14 to 15 year-olds and 18 to 19 age group [19]. Only nine respondents (2.4%) were aged 18, because the sampling was carried out at the start of the new school year when the new students entered Semester 1, so most of the students were still 17 years old.

According to previous research conducted by Niskaret *al* (2001), the 12 to 19 age group in the United States experienced noise-induced hearing threshold shift (NITS) of 15.5%, this group had more members who experienced NITS than the 6 to 11 age group [9]. The number of respondents by class and school also has differences. This is due to the sampling method which was carried out with a stratified random sampling technique so that each school and class already had its percentage which would affect the number of sample proportions that were taken. SMA Negeri 3 has a higher number of students, 919, compared to the number of students at SMA Negeri 5 which amounted to 683, and the number of students in SMA Negeri 7 which amounted to 847, so this affected the proportion of the number of samples in this study. Previous research conducted by Zain *et al* (2016) on public high school students in Padang City regarding adolescent behavior toward the use of earphones found that the characteristics of the respondents in the study were mostly respondents who came from Class 1, amounting to 125 people (35.1%) [20].

The results of the study seen in Table 2 are based on the habit of using earphones. It was found that the use of earphones for listening to music was more popular among high school students than for playing games, watching movie, telephoning, or listening to learning materials. Listening to music using earphones is a simple habit and can be done anytime and anywhere, such as while doing tasks or waiting for buses/public vehicles. Listening to music while doing something can make people more enthusiastic and help them stay awake. People can even listening to songs while reading books or novels. This is what has made the use of earphones when listening to music more popular. The use of earphones to make calls is not very popular, only two respondents (0.5%) said they did this. Based on previous research conducted by Ansari *et al* (2014) regarding the pattern of using earphones and music players among Iranian teenagers, the use of earphones is more popular for listening to music, at around 83.5% [21]. However, improper use of earphones can cause problems. There are many complications for adolescents which have been described by Ansari *et al* (2016) in their research [22]. Another study by Hazazi (2016) regarding the description of hearing functions and the use of earphones by students at the one high school in Medan, found that 61 of the high school students (96.8%) said they were more likely to use earphones to listen to music [23]

A. *The effect of long exposure to earphones with the incidence of NIHL*

The results of the study, as seen in Table 5, show that the respondents who did not experience hearing loss were dominated by those respondents who had a history of exposure to earphones of only two years. Meanwhile, the respondents who experienced mild, moderate, and severe disorders were dominated by those respondents with a history of exposure of greater than five years. This is evidenced by previous research by Kim *et al* (2009) which found that adolescents who use earphones for more than five years tend to experience NIHL [11]. Another study conducted by Setianiet *al* (2018), found 77.8% experienced

NIHL with a history of exposure greater than five years and 22.2% with less than five years, so that using earphones for five years or more puts users at greater risk of experiencing NIHL by a factor of 5.7, compared to those who use earphones for less than five years [14]. Research conducted by Nurfitriyana *et al* (2020) on helicopter pilots found that hearing loss occurs in pilots who have worked for a period of more than five years [24].

B. *The time frequency effect of earphones used with the incidence of NIHL*

Based on the results of the study in Table 6 regarding the relationship between frequency and NIHL, Mohammadpooraslet *al* (2018) said that the use of earphones for more than three days a week tends to lead to NIHL [13]. Research conducted by Setianiet *al* (2018) also found 77.8% experienced NIHL with a history of using earphones for six or seven days a week. According to Setianiet *al* (2018), the frequency of using earphones each week did not significantly affect the incidence of hearing loss if earphones were used for only one day; however if only used for one day a week with the volume set to produce a noise intensity > 85 dB, this could cause NIHL [14].

C. *The duration effect of earphones used on the incidence of NIHL*

Based on the results of the study in Table 7 regarding the relationship between the duration of use and NIHL, Rizal *et al* (2017) found that 84.2% experienced hearing loss using earphones for more than two hours [25]. According to research by Shah *et al* (2009), the use of earphones for more than four hours in one day tends to result in NIHL [26]. This is supported by another study by Setianiet *al* (2018) who found that 88.9% of people who experience NIHL used earphones for more than four hours a day [14]. Research by Hazazi (2016) showed that those who used earphones for more than three hours a day had a tendency to experience mild to severe hearing loss, as evidenced by a tuning fork examination: negative results were obtained on the Rinne test, lateralization on the Weber test, and lengthening on the Schwabach test [23].

D. *The sound volume effect of earphones used with the incidence of NIHL*

Based on the results of the study, as seen in Table 8 regarding the relationship between the volume level and NIHL, and according to research by Setianiet *al* (2018), using earphones for only one day a week with the volume set to the level of > 85 dB can cause NIHL [14]. According to Kim's research and Vogel, high volume settings have the potential to cause NIHL [11], [27]. In the study by Sliwinska-Kowalska & Davis (2012) they found that listening to music through earphones at the maximum volume can produce a noise intensity of 94 dB to 110 dB [28]. This is, of course, greater than 85 dB so the use of earphones at a high volume tends to result in NIHL. According to the Regulation of the Minister of Manpower and Transmigration in 2011 regarding the threshold value of physical and chemical factors in the workplace, it was determined that the noise threshold value is 85 decibel A (dBA). Therefore, to use earphones correctly means the volume level must be set so that the earphones do not

produce a noise intensity of more than 85 decibel A (dBA) [29].

V. CONCLUSION

Based on the study's analysis and discussion results, it can be concluded that the length of exposure to earphones, the frequency of using earphones each week, the duration of use each day, and the volume level of the earphones have a significant effect on the incidence of NIHL. The longer a person has been exposed to earphones, the more frequently he/she uses earphones each week, the longer the earphones are used during a day, and the louder the volume level is set for the earphone all have a tendency to be identified with mild to severe hearing loss.

VI. CONFLICT OF INTERESTS AND AUTHOR CONTRIBUTION

There was no conflict of interest in this research. All the authors contributed equally to the content of the study, including data gathering, statistical analysis, and data synthesis.

SOURCE OF FINANCING

This study used independent costs.

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