

PREVALENCE AND POPULATION AT RISK FOR NOISE INDUCED HEARING LOSS (NIHL) IN ADOLESCENT STUDENTS

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ABSTRACT

Noise-Induced Hearing Loss (NIHL) is a global health problem, often underestimated, and leads to permanent hearing loss. The prevalence of NIHL in adolescents has increased in line with the increasing use of cell phones. This study aimed to determine the prevalence of NIHL and analyze the population at risk (age, gender, and school) in adolescent students. The study design was a cross-sectional study. A total of 510 students consisting of female, n=288 and male, n=222; junior high school, n=203 and senior high school, n=307 were used as research subjects. This study was conducted on August-October 2015 at Darul Ihsan School, Banda Aceh, Indonesia. An audiometry examination was performed to determine the diagnosis of NIHL. Data analysis was using descriptive analysis and independent sample t-test ($p < 0.05$). The results of this study were the prevalence of NIHL in adolescents aged 11-20 years was 18.88%. The highest percentage of NIHL was at the age of 15 years (34.57%). The number of NIHL was significantly higher ($p = 0.000^*$) in males (24.32%) compared to females (9.37%). The prevalence of NIHL was significantly higher ($p = 0.00^*$) in senior high school children (26.11%) compared to that in junior high school children (9.12%). In conclusion, the highest prevalence of NIHL was at the age of 15 years. NIHL was more common in male than in female students. NIHL was higher in high school students compared to junior high school students. The NIHL was related to age, gender, and school level.

Keywords: Prevalence; risk factor; noise induced hearing loss; adolescent; illness

ABSTRAK

Noise Induced Hearing Loss (NIHL) adalah masalah kesehatan global yang sering kali disepelkan dan mengakibatkan ketulian permanen. Angka prevalensi NIHL pada remaja mengalami peningkatan sejalan dengan meningkatnya penggunaan telepon seluler. Penelitian ini bertujuan mengetahui prevalensi NIHL dan menganalisis populasi risikonya (usia, jenis kelamin, dan sekolah) pada remaja sekolah. Desain penelitian ini adalah cross-sectional study. Sebanyak 510 siswa/siswi: wanita, n=288 dan pria, n=222; SMP, n=203 dan SMA, n=307 digunakan sebagai subjek penelitian. Penelitian dilaksanakan pada Agustus hingga Oktober 2015 di Sekolah Darul Ihsan, Banda Aceh, Indonesia. Pemeriksaan audiometri dilakukan untuk menentukan diagnosis NIHL. Analisis data menggunakan analisis deskriptif dan independent sample t-test ($p < 0,05$). Hasilnya adalah prevalensi NIHL pada remaja usia 11-20 tahun sebanyak 15,88%. Persentase NIHL yang terbanyak adalah pada usia 15 tahun (34,57%). Jumlah penderita NIHL lebih banyak secara bermakna ($p = 0,000^*$) pada pria (24,32%) dibandingkan dengan wanita (9,37%). Prevalensi NIHL secara bermakna lebih banyak ($p = 0,00^*$) pada anak SMA (26,11%) dibandingkan dengan anak SMP (9,12%). Kesimpulan: prevalensi NIHL tertinggi adalah pada usia 15 tahun. NIHL lebih banyak pada pria dibandingkan dengan wanita. NIHL pada anak SMA dengan NIHL lebih banyak dibandingkan anak SMP. NIHL berhubungan dengan usia, jenis kelamin dan tingkat sekolah.

Kata kunci: Prevalensi; faktor risiko; noise induced hearing loss; remaja; illness

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INTRODUCTION

Hearing loss is a public health problem today that does not only occur in adults, but also in adolescents (Gilles et al 2013). Lifestyle changes among adolescents in millennial era today have an impact on increasing use of electronic media such as cellphones, iPad, tablets, computers/laptops, online games, and portable music devices (Baranovskyj et al 2016). The main cause of hearing loss is excessive noise exposure (Sliwinska-Kowalska & Zaborowski 2017).

In addition, the habit of using earphones for more than 2 hours will have an impact on hearing loss that may lead to permanent deafness. A study by Cerquone et al (2006) showed that 78% of adolescents used earphones connected to music players from cellphones, 12% from MP3 players, and 35% from laptops. The use of earphones with loud noise (intensity > 85 dB) and long duration (around 1-3 hours or more) every day is one of the risk factors for hearing loss due to noise, called Noise Induced Hearing Loss (NIHL) (Azizi 2016, Gunny et al 2018, Mazlan et al 2018). As many as 36 million people in America experience hearing loss and around 1 in 3 is NIHL. Data from 2006 states that 1 in 5 adolescents aged 12-19 years in America experience NIHL.

NIHL is defined as a condition of hearing loss or sensorineural deafness induced due to continuous high noise exposure (> 80 dB) in a long term (Jumali et al 2013, Ding et al 2019). NIHL is the most common type of sensorineural deafness in adolescents (Baranovskyj et al 2016). NIHL is a health problem in school-age children that deserves attention because it affects daily learning activities and achievement at school (Absalan et al 2013). Generally, NIHL occurs gradually and progressively so that the sufferers are not aware (Azizi 2016).

Exposure to excessive noise results in damage to sensory cells in the inner ear or the cochlea, especially to outer hair cells (Sliwinska-Kowalska & Zaborowski 2017). NIHL is irreversible or, in other words, its hearing function cannot be reversed to its original state (Azizi 2016, Baranovskyj et al 2016). Therefore, early preventive measures are the main priority to reduce the number of NIHL incidents and reduce the risk of permanent deafness. Prevention from an early age can be done by screening school-age children from an early age. Therefore, it is important to conduct research on the prevalence of NIHL in school-age children, especially adolescents in the city of Banda Aceh, Indonesia.

The World Health Organization (WHO) estimates that as many as 360 million people, or 5% of the population worldwide, in 2017 suffer from deafness, and 1.1 million of them were at the age of 12-35 years (Sliwinska-Kowalska & Zaborowski 2017, Ding et al 2019). Meanwhile, the World Health Organization in 2015 indicated the prevalence of deafness in adolescents aged 12-19 years is 3.5% -5.3%. The prevalence of hearing loss in grade 11 children in Pennsylvania is 19% of a total of 282 (Sekhar et al 2014). The prevalence of hearing loss in adolescents aged 12-19 years in America has increased significantly from year to year. In 1988-1994, the prevalence rate was around 14.9%, but in 2005-2006 it increased to 19.5% (Shargorodsky et al 2010).

Based on National Adolescent and Young Adult Health Center in 2014, one in five adolescents aged 12-19 years in the United States experience deafness. Besides, World Health Organization data in 2018 showed the increased prevalence of deafness has an impact on increasing annual costs of more than 750 billion dollars. WHO data from 1998 reflects that the prevalence of deafness in Indonesia ranks 4th in Southeast Asia, with a percentage of around 4.6% and Sri Lanka has the highest prevalence at 8.8%, Myanmar 8.4%, and India 6.3% or affecting 63 million people (Singh 2015). However, 2014 the prevalence of NIHL in Indonesia was the highest in Asia, reaching 36 million people or around 16.8% of the total population (Septiana & Widowati 2017).

The prevalence of NIHL in school adolescents aged 11-20 years in Banda Aceh is unknown. Therefore, this study was conducted to analyze the prevalence of NIHL in junior and senior high school adolescents in Banda Aceh, Indonesia. Data from the results of this study were expected to be useful for early preventive measures to prevent the increased permanent deafness in adolescents.

MATERIALS AND METHODS

The materials in this study were examination forms and audiometry to examine hearing function (to detect NIHL). This study was an observational analytic study with cross-sectional design. This study aimed to compare the number of NIHL incidents between junior and senior high school students. Comparison of the incidents was also correlated with age and gender. The study sites were Darul Ihsan Junior High School and High School in Siem, Aceh Besar, Banda Aceh, Indonesia. This study was conducted on August to October 2015. Darul Ihsan School is an Islamic school with boarding school concept.

The population was all students of Darul Ihsan. The sample of the study was Darul Ihsan Junior and Senior High School students with some classifications, namely male and female students, adolescents between 11-20 years old, in healthy condition, willing to be the subjects in this study, and willing to undergo examinations. This study used a total population sampling method, meaning that all populations were subject to research. The total number of subjects was 510 students, with female n = 288 and male n = 222, while students attending Junior High School were n = 203 and Senior High School were n = 307.

The results of the examination were in the form of characteristic data, such as age and gender. Hearing function examination data were obtained using pure tone audiograms. Audiometry examination was performed to determine the diagnosis of NIHL. Audiometric examination and analysis were performed by specialists in ear, nose, throat, head and neck surgery. Data analysis was carried out using descriptive analysis (frequency and percentage) and independent sample t-test ($p < 0.05$) to analyze differences in NIHL prevalence based on age, gender, and school type.

This study was carried out after obtaining permission from the Research Ethics Committee of the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia, and the permission from the principals of each school. Before the examination, all students received an explanation of the objectives, benefits, and risks derived from this study. Furthermore, all subjects who were willing to volunteer were given an informed consent sheet to be signed.

RESULTS

The examination of the subjects yielded data on the subjects' characteristics (age and gender) and data from audiogram analysis to determine the diagnosis of NIHL. Characteristics of the subjects showed that from a total of 510 subjects, the number of Junior High School students was higher than that of Senior High School students. Likewise, related to gender, there were more female than male students, both in Junior and Senior High School.

Table 1. Distribution of adolescents by school and gender

School	Gender				Total
	Female		Male		
	n	%	n	%	
Junior High	169	55.05	138	44.95	307
Senior High	119	58.62	84	41.38	203
Total	288		222		510

The characteristics of subjects by age can be seen in Table 1. Most of the samples were 13 years old (114 students), and the least was 19 years old (1 student). The minimum age of the subject was 11 years (Junior High School) and the maximum age was 20 years (Senior High School). The mean age of the subjects was 12.81 years among Junior High School students and 15.50 years in Senior High School students.

Audiometry examination in Table 2 showed that the highest number of junior and senior high school students diagnosed with NIHL was 15 years of age (34.57% of total NIHL sufferers). The percentage of junior and senior high school children (aged between 11-20 years) who experienced NIHL was 15.88% of the total subjects.

Table 2. Prevalence of NIHL by age

Age (years)	Diagnosis				Total
	Normal		NIHL		
	n	%	n	%	
11	14	3.26	0	0	14
12	103	24.01	10	12.35	113
13	99	23.08	15	18.52	114
14	66	15.38	5	6.17	71
15	85	19.81	28	34.57	113
16	44	10.26	15	18.52	59
17	15	3.50	4	4.94	19
18	2	0.47	2	2.47	4
19	1	0.23	0	0	1
20	0	0	2	2.47	2
Total	429	100	81	100	510

The Table 3 described the analysis of audiometry examination by gender. It showed that NIHL was found in significantly ($p = 0.000$) higher number (24.32%) in male students compared to female students (9.37%). The number of students who experienced NIHL in both ears (left and right ear) in male and female students was higher than students with NIHL in one ear (left or right ear). NIHL in children aged 11-20 years mostly affected both ears (around 76.54%), while those who experienced NIHL in the right ear was around 17.28% and the left ear was 6.17%.

Table 3. Prevalence of NIHL by gender

Gender	Normal	Diagnosis			Total	Significance
		NIHL				
		AD	AS	AD+AS		
Female	261	6	5	16	0.000*	288
Male	168	8	0	46		222
Total	429	14	5	62		510

*Significant at 5% error ($p < 0.05$); AD=auricular dextra/right ear; AS = auricular sinistra/left ear

The comparison of NIHL students by type of school in Table 4 showed that the number of NIHL students was significantly higher ($p=0.000$) in Senior High School ($n=53$) compared to Junior High School ($n=28$). The percentage of NIHL students in Junior High School was 9.12%, while in Senior High School was almost 3 times higher (26.11%).

Table 4. Prevalence of NIHL by school

Type of School	Diagnosis				Total	Significance
	Normal	NIHL				
		AD	AS	AD+AS		
Junior	279	8	3	17	307	0.000*

High					
Senior High	150	6	2	45	203
Total	429	14	5	62	510

Table 5 showed that the number of students with NIHL in Senior High School was significantly higher ($p = 0,000$) in male students compared to female. Similarly, in Junior High School, the number of students with NIHL was higher in male than in female although it was not statistically significant ($p = 0.06$).

Table 5. Comparison of NIHL prevalence by school and gender

School	Gender	Diagnosis				Total	Significance
		NIHL					
		Normal	AD	AS	AD+AS		
Junior High School	Female	157	4	3	5	169	0.06
	Male	122	4	0	12	138	
	Total	279	8	3	17	307	
Senior High School	Female	104	2	2	11	119	0.00*
	Male	46	4	0	34	84	
	Total	150	8	2	45	203	

DISCUSSION

Noise-induced hearing loss is a serious health problem as it has caused hearing loss in 21% of worldwide population (Lie et al 2016). Hearing loss is the fourth cause of disability in the United States (Ropper et al 2017), and is a major disability problem in the world (Masterson et al 2016). NIHL is a frequently unrecognized problem, especially in non-workplace environments, such as children environment (Martin et al 2006). NIHL is more common among adolescents (Shargorodsky et al 2010, Sekhar et al 2014).

Exposure to noise in excess of 80 dB in the long term has increased the risk of deafness (Ijaz et al 2014, Gunny et al 2018). In addition, age, sex, and workplace are factors that influence the prevalence of NIHL (Strauss et al 2012, Musiba 2015, Sam et al 2017). NIHL is more common in adults compared to children (Lie et al 2016, Sułkowski et al 2017). Based on the National Adolescent and Young Adult Health Information Center in 2014, the increased use of cellular technology such as cell phones and portable music players has an impact on hearing loss in adolescents.

In this study, we found that the prevalence of NIHL in school adolescents aged 11-20 years was 18.88%. This prevalence rate was three times higher than WHO data in 2015. A study on workers in Tanzania has found that as many as 58.5% of the total 265 workers experienced NIHL and the prevalence in men (67.7%) was higher than in women (Abraham et al 2019). A study in America stated that one of four (24%) of adults experienced hearing loss due to noise and its prevalence was more in men (Carroll et al 2017). Long-term exposure to noise causes progressive apoptosis in hair cells and also results in the degeneration of spiral ganglion neurons which resulted in decreased hearing threshold which ultimately resulted in hearing loss or permanent deafness (Ding et al 2019).

Noise-induced hearing loss is more common in developing countries and decreases in industrialized countries (Jamal et al 2016, Lie et al 2016). The prevalence of hearing loss is 91% in adults and 9% in children (Taneja 2016). Hearing loss results in hearing disability (Taneja 2016). The prevalence of hearing disability in Southeast Asia was 2.4%; in adults aged <65 years was 9.5% and those aged >65 years was 48% (Taneja 2016). The main cause of deafness was due to

noise and as much as 15% due to noise at work or cell phone use (Taneja 2016).

Hearing loss is more common in men than women (Le et al 2017). The prevalence of NIHL in children and adolescents is increasing and impact on academic achievement (Martin et al 2006, Ehlert 2016). A study conducted in Iran on 1,500 Elementary School students showed that the prevalence of conductive hearing loss in boys was 8.8% and 7.1% in girls; this result was similar to sensorineural hearing loss of 1% in men and 0.7% in women (Absalan et al 2013). The results of the previous study were similar to our results that the prevalence of NIHL in male adolescents was higher than that in female. Besides, a study on 109 textile factory workers in Bandung, Indonesia, also found that the prevalence of hearing loss in men was higher than in women (Dewi & Agustian 2012).

More importantly, noise-induced hearing loss is a public health problem that is often underestimated. However, a study indicated the prevalence of NIHL continued to increase (Nyarubeli et al 2019). The prevalence of NIHL increased dramatically from 120 million people in 1995 to 466 million people in 2018 (Nyarubeli et al 2019). NIHL is a complex hearing loss disease that is caused by interactions between genetic and environmental factors, but generally occurs due to biological damage as a cause of noise (Le et al 2017). NIHL is progressive and irreversible (Li et al 2020). Many factors can cause NIHL, such as noise, not using ear protectors, organic solvents, alcohol, high temperature, genes and comorbidity (Li et al 2020). Hearing loss can occur due to damage to the inner ear, particularly in the part of the cochlea (Bazard et al 2021).

CONCLUSION

The prevalence of NIHL in school adolescents aged 11-20 years was 15.88%. The percentage was more in men (24.32%) compared to women (9.37%). The highest percentage of children with NIHL was 15 years old, consisting of 34.57% of all children. Senior High School children suffering from NIHL was higher compared to Junior High School children. Somehow, NIHL is related to age, gender and school level. On the other hand, this study remained that not all risk factors were examined in this study. We merely focused on three risk factors for NIHL, namely age, gender and level of school. Therefore, this study can followed-up by analyzing other risk factors, such as the type of work/workplace, and the use of earphones or similar devices.

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