

ORIGINAL ARTICLE

**RISK FACTORS ANALYSIS OF HEARING DISORDERS DUE TO NOISE
ON MACHINERY WORKERS AT UNIVERSAL STEEL FACTORY**
Elvira Kesuma, Muhammad Edy Syahputra Nasution*

Faculty of Medicine, University of Muhammadiyah Sumatera Utara, Indonesia

*Corresponding author: mhd.edysyahputra@umsu.ac.id

Abstract: Noise, being one of the threats towards occupational health, has exposed 600 million workers globally. The incidence of hearing loss caused by workplace noise is 16% in adults. There are various risk factors of hearing loss. The purpose of this study was to determine the effect of those risk factors on Universal Steel Factory's workshop workers. This is an analytical study with a cross-sectional design. Data were collected through history taking, physical examination and pure tone audiometry for 30 workers. The data obtained were analyzed using Chi-square and Fisher's exact. There was a correlation between hearing loss with age ($p = 0.001$), working period ($p = 0.001$), noise intensity ($p = 0.004$), and smoking habits ($p = 0.013$). Therefore, age, working period, noise intensity, and smoking habits have influences to the occurrence of noise-induced hearing loss.

Keywords: risk factors, noise-induced hearing loss, workshop workers

INTRODUCTION

Noise is a danger that occurs in the workplace with almost 600 million workers in the world exposed to continuous noise. This has a negative effect on the body's system, one of which is the hearing system.¹ Hearing loss can be caused by middle ear infections, presbycusis, ototoxic drug deafness, congenital deafness, and noisy deafness. Cases of hearing the loss in adults in the world due to noisy work environment reaching 16%.² If you experience sound exposure above 85 dB repeatedly, the cochlea will experience damage that affects almost all parts of the inner ear.³ Hearing loss is most common in men of productive age.⁴

Based on research conducted on 66 samples of workers of a company in Semarang, a significant relationship was found between hearing loss with age, years

of service, intensity of noise, and hypertension.⁵ Whereas in a study conducted on 66 samples of ferry engine operators, there was a significant relationship between hearing loss and length of exposure but not significant with the use of ear protectors and smoking habits.⁶

As far as the literature searches are conducted, research on the incidence and analysis of risk factors for Noise-Induced Hearing Loss (NIHL) in workers in North Sumatra is still very little published. Therefore, researchers are interested in researching it.

METHODS

This study is an observational analytic study that uses a cross-sectional design, which is only done one measurement of the variables. This research was conducted in April 2017

January 2018 in the Universal Steel Factory workshop, Tanjung Morawa, Deli Serdang, North Sumatra. The subjects of this study were all 30 factory workshop workers.

After the subject filled out the informed consent sheet, anamnesis, blood pressure examination, ear physical examination, and audiology examination were performed using a tuning fork and pure tone audiometer. NIHL is defined as hearing or deafness due to noise exposure in a fairly hard working environment and for a long period of time, which is indicated by the presence of a notch on the audiogram at a frequency of 3000, 4000, or 6000 Hz (high frequency) accompanied by improved hearing thresholds at a frequency of 8000 Hz.⁷

The hearing function is assessed using a calibrated Triveni TAM-25 pure tone audiometer (Lightning Enterprises, Limington, USA). Air conductivity measurements at frequencies of 125-8000 Hz and bone conductivity at a frequency of 250-4000 Hz. The threshold is defined as the average hearing threshold at frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. Data on the degree of hearing loss is taken from the heavier side of the ear. The degree of hearing loss is classified according to WHO.⁸

Increased blood pressure is defined as an increase in blood pressure after work compared to before. Blood pressure was measured using aneroid sphygmomanometer which was expressed in mmHg units and enforced based on JNC VII.⁹ Noise intensity is based on sound wave measurements using a sound level meter type WS1361 (ShenZhen wensn co. Ltd., ShenZhen, China) that has been calibrated. This research has been approved by number: 42 / KEPK / FKUMSU / 2017 from the Health Research Ethics Commission of the Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara.

Characteristics of workers based on age, working years, parts of the factory, noise intensity, exposure length, use of ear protection devices, smoking habits, blood pressure, and hearing loss are presented in the form of frequency distribution tables. The relationship between hearing loss and age risk factors was assessed by the Pearson chi-square test. Whereas the relationship between hearing loss and occupational risk factors, parts in the factory, noise intensity, duration of exposure, use of ear protectors, smoking habits, and blood pressure were assessed by the Fisher's exact test. If the value of $p < 0.05$, then it is stated statistically.

Table 1. Research Subjects Characteristics

Characteristics	n (%)
Age (years)	
15-40	16 (53.3)
41-64	14 (46.7)
Working years (years)	
≤ 10	10 (33.3)
> 10	20 (66.7)
Parts of the factory	
<i>Screw Press</i> making (> 85 dB)	10 (33.3)
<i>Digester</i> making (> 85 dB)	10 (33.3)
<i>Shredder</i> making (≤ 85 dB)	10 (33.3)
Noise intensity (dB)	
≤ 85	10 (33.3)
> 85	20 (66.7)
Exposure length (hour/weeks)	
≤ 40	0
> 40	30 (100)
Use of ear protection devices	
Yes	5 (16.7)
No	25 (83.3)
Smoking habits	
Yes	21 (70)
No	9 (30)
Hypertension	
Yes	6 (20)
No	24 (80)
Hearing loss	
Yes	18 (60)
No	12 (40)

RESULTS

Obtained as many as 30 subjects who followed the study to completion. The characteristics of the research subjects are shown in Table 1.

The relationship between hearing loss and risk factors for age, years of service, part of the factory, intensity of noise, duration of exposure, use of ear protection devices, smoking habits, and blood pressure are shown in Table 2.

DISCUSSION

There was a significant relationship between noise intensity and the occurrence of NIHL in this study, in line with Lumonang *et al.*¹⁰ conducted in 2015 on 20 workers in the port of Belitung.

The threshold for workers to be exposed to noise by 85 dB is 8 hours per day. If it exceeds this number, it will have an impact on hearing.¹¹ The NIHL mechanism involves damage to the cochlear hair cells due to noise exposure, especially at high frequencies.¹² High-frequency sound-related hair cells are located close to the basal part of the cochlea.

The severity of damage to hair cells depends on the amount of sound intensity received. The higher the intensity of the sound received, the more severe the damage will be. If it is damaged, these sensory cells cannot repair themselves and there is no medical procedure that can restore normal function.¹³

Obtained a significant relationship between age and the occurrence of NIHL in this study, in line with the research of Jumali, *et al.*⁶ carried out in 2013 on 66 ferry engine operators. Hearing loss due to sensorineural noise often occurs in productive age i.e. under 64 years where the case is purely due to noise exposure while working.¹⁴ We believe that this is not presbycusis because the average hearing threshold at a frequency of 500-

2000 Hz is obtained better than the average listening threshold at a frequency of 3000-6000 Hz (notch obtained) and is accompanied by improvements in the frequency of 8000 Hz. The notch is not obtained at presbycusis (Coles, Lutman, & Buffin, 2000).¹⁵

Table 2. Relationship between NIHL Risk Factors and NIHL Occurrences

	NIHL		p-value
	Yes n (%)	No n (%)	
Ages (years)			
15-40	5	11 (36,66)	0.001 ^a
41-64	(16,7)	1 (3,33)	
	13	(15,66)	
Working years (years)			
≤10	0	10 (33.3)	0.001 ^b
>10	18 (60)	2 (6.67)	
Noise intensity (dB)			
≤85	10	10 (33.3)	0.004 ^b
>85	(33,33)	2 (6.67)	
	8	(26,67)	
Exposure length (hour/weeks)			
≤40	0	0	0 ^b
>40	18 (60)	12 (40)	
Use of ear protection devices			
Yes	2	3 (10)	0.364 ^b
No	(6,67)	9 (30)	
	16	(53,33)	
Smoking habits			
Yes	16	5 (16,66)	0.013 ^b
No	(53,33)	7 (23,33)	
	2	(6,67)	
Hypertension			
Yes	4	2 (6,67)	1 ^b
No	(13,33)	10 (33.3)	
	14	(46,67)	

NIHL: Noise-induced hearing loss, ^a Based on the Pearson chi-square test, ^b Based on Fisher's exact test.

This study found a relationship between the length of exposure and the

number of NIHL events. This is in line with the research conducted by Eryani⁵ in 2016 against 62 people at a company in Bandar Lampung. The threshold value that can be received by workers with an average of 85 dB per day is no more than 8 hours/day or 40 hours/week so as not to cause hearing loss.¹⁶ We recommend that permanent workers work in accordance with these rules.

This study also found a significant relationship between years of service and the occurrence of NIHL in line with the research conducted by Marlina, et al.⁵ in 2016 towards 66 workers in a company in Semarang. The more often and continuously a person is exposed to noise, the more likely he is to experience hearing problems.¹⁷ Decreased hearing function caused by continuous noise exposure occurs at the earliest during the first 10-15 years of work and then decelerates. Noisy exposure that lasts continuously during working hours and for many years is more dangerous because the ear does not have time to rest.¹⁸

This study did not get a significant relationship between the use of ear protectors with the occurrence of NIHL. Whereas in the research conducted by Yadnya, et al.¹⁹ workers at the Ngurah Rai Airport Apron found a connection between the use of ear protectors and the occurrence of the NIHL. The use of ear protectors can reduce the frequency of sound that enters the ear so as to prevent hearing loss.²⁰ The company has provided ear protection equipment, but there are still undisciplined workers using it. Thus, adherence to using this protective equipment is still recommended.

This study found no significant relationship between smoking habits and hearing loss. However, this study did not calculate the number of cigarette butts consumed by workers. The results obtained are different from Waskito's research²¹ which is carried out on oil

company workers. In this study, we found a relationship between smoking habits and the occurrence of hearing loss due to noise. Cochlear ciliary damage is caused by continuous exposure to cigarette smoke, i.e. if someone has a smoking habit every day for 1 year.²²

The absence of a significant association between hypertension and the occurrence of NIHL in this study is not in line with a meta-analysis study. Noisy exposure can trigger an increase in blood pressure which is a risk factor for cardiovascular disease. Noise exposure can cause an increase in blood pressure through the neuroendocrine system which triggers an emotional response to cortical and subcortical structures by affecting concentration, relaxation, and sleep.²³ Brief exposure to noise for 10 minutes can cause a significant increase in blood pressure.²⁴ Patients suffering from hypertension experience damage to the inner ear which causes an increase in the hearing threshold.²⁵

This study uses a cross-sectional design so it is difficult to determine the cause and effect relationship between hearing loss due to noise and its risk factors with certainty. Further research is needed with a higher design to analyze this.

CONCLUSION

Factors that have a significant relationship with hearing loss are noise intensity, age, years of service, and smoking habits. Factors that do not have a significant relationship with hearing loss are the length of exposure, use of ear protection devices, and hypertension. Enforcement of an NIHL diagnosis is an important step to prevent more severe hearing loss

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