Article

Factors Related to Hearing Threshold of Workers at PT. X

Salsabila Liandra Putri [1*] and Nuzula Afianah [2]

[1] Politeknik Negeri Jember; salsabila.liandra@polije.ac.id
[2] Politeknik Negeri Jember; nuzula.afianah@polije.ac.id
* Correspondence: salsabila.liandra@polije.ac.id

Abstract:
Physical hazards are one of the several types of dangers in Occupational Health and Safety. Companies or industries that use machines in their work processes have the potential to cause a physical hazard. One of the physical hazards is noise. Noise exposure can have an impact on employee health, namely hearing loss. A decrease in hearing threshold values can cause communication disorders and concentration problems. Variables of sound intensity, period of work, age, and disease history can influence the reduction in hearing threshold values. The results of a preliminary study on workers at PT. X indicates the sound intensity is above the threshold value, namely 86dB and 16.6% of workers experience hearing loss. The aim of this research is to determine the factors related to the hearing threshold values of workers at PT. X. The methodology in this research uses a cross-sectional approach. This study had 30 workers as samples using total sampling techniques. The results showed that the sound intensity factors (ϱ = 0.030) and disease history (ϱ = 0.013) were related to the hearing threshold value. Meanwhile, the factors of work experience (ϱ = 0.704) and age (ϱ = 1.000) are not related to the hearing threshold value. The conclusion of this research is that there is a relationship between sound intensity and history of illness with the hearing threshold value of workers at PT. X.

Keywords: Sound intensity; hearing threshold; noise hazard

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1. Introduction

Implementing Occupational Safety and Health in the workplace is necessary to protect employees, assets, the environment and the reputation of the company. Physical hazards is one of the several types of dangers in Occupational Health and Safety. Companies or industries that use machines in their work processes have the potential to cause a physical hazards. One of the physical hazards is noise. Exposure to noise can have an impact on employee health, namely hearing loss[1]. Occupational noise exposure is the second most common risk factor in the workplace, behind workplace injuries[2].

Noise factors that can cause hearing loss include noise pressure, duration of exposure in a day and length of work, individual susceptibility, age, other disorders or diseases, nature of the noise environment, distance of the ear to the noise source and position of the ear to the sound source[3].

Hearing loss affects millions of people around the world and is estimated to be the fourth leading cause of disability globally[4]. According to the World Health Organization (WHO), more than 1.5 billion people experience some degree of hearing loss which could grow to 2.5 billion by 2050[5]. Hearing loss in the United States ranks third after hypertension and arthritis. About 12% of the working population in the United States is hard of hearing and about 24% of the hearing loss is attributable to occupational exposure[6]. Based on data from the Ministry of Health, the prevalence of deafness in Indonesia is quite high, namely 4.6%, namely ear disease 18.5%, hearing loss 16.8%, severe deafness 0.4%, the highest population is in the school-age group (7-18 years)[7].

Based on data from the Sight and Hearing Sense Health Survey, the morbidity rate for hearing loss was 41,162,450 people (18.55%), hearing loss was 37,279,200 people

(16.8%), mildness was 887,600 people (0.4%), and diseases other ears 2,884,700 people (1.3%)[8]. In the Riskesdas 2013, the highest prevalence of hearing loss was found in the age group of 75 years and over (36.6%), followed by the age group of 65-74 years (17.1%). The lowest prevalence rate was in the age group 5-14 years and 15-24 years (0.8% each). The prevalence of respondents with hearing loss in women tends to be slightly higher than that of men (2.8%:2.4%)[9].

Noise exposure intensity that exceeds the threshold limit value (TLV) (85dB) indicates a significant relationship with hearing loss and there is a significant relationship between the period of work and hearing loss[10]. Period of work, age, and length of work are related to the occurrence of hearing loss in workers due to noise in the work environment[11].

Clinically, exposure to noise in the hearing organ can cause an adaptation reaction, namely an increase in temporary threshold shifts and an increase in permanent threshold shifts. This is because after exposure to noise, the cochlea is immune and the inflammatory reaction occurs within 1-2 days, peaks in 3-7 days, and disappears slowly[12].

Apart from having an effect on hearing, excessive noise also has non-hearing effects such as interference with daily activities, speech disruption, concentration problems, sleep disorders that trigger stress, tinnitus, and difficulty understanding speech[13]–[15].

PT. X is an ice cube company that produces block ice, shaved ice, and crystal ice located in Purwokerto. This company has 30 employees, all of them male, and has a work shift system of 8 hours per day with a break of 1 hour. The employee's work schedule is 6 working days and 1 day off with alternate holiday schedules. Most of the ice cube production in this company uses machines that work 24 hours. From the initial survey of sound intensity at PT. X which is equal to 86 dB and 16.6% of 30 employees experience communication difficulties because of the noise generated from the machine. In the production workplace, personal protective equipment, especially ear protection, is not provided to reduce exposure to noise from production machines. This study aims to determine factors related to hearing threshold in PT. X.

2. Materials and Methods

The design of this research is analytical with a cross-sectional approach, collecting data directly at one time and then analyzing it to determine the correlation between the independent variable and the dependent variable. The Independent variables consist of noise intensity, period of work, age, and disease history. The dependent variable is a hearing threshold. Hearing threshold examination using audiometry and noise intensity measurement using a sound level meter. This research was conducted at PT. X in Purwokerto, data collection using a total sampling technique, namely 30 employees as research samples. Data analysis used the chi-square statistical test with a confidence level of 95%.

3. Results and Discussion

3.1. Univariate Analysis

Tabel 1. Hearing threshold category of respondent

No	Hearing Threshold	Total (n)	Percentage (%)
1.	Normal	18	60.0
2.	Mild Deafness	11	36.6
3.	Moderate Deafness	1	3.3
	Total	**30**	**100**

Based on the research results presented in Table 1, the majority of respondents were in the normal hearing threshold category (<25 dB) with a total of 18 respondents (60%).

Tabel 2. Sound intensity category of respondent

No	Noise Intensity	Total (n)	Percentage (%)
1.	Below TLV	16	53.3
2.	Above TLV	14	46.7
	Total	**30**	**100**

Based on the research results presented in Table 2, 16 respondents (53.3%) were exposed to a noise intensity of 74-85 dB which is in the category below threshold limit value (TLV). Meanwhile, 14 respondents (46.7%) were exposed to sound intensity above the TLV, which was 85-91 dB.

Tabel 3. Period of work category of respondent

No	Period of Work	Total (n)	Percentage (%)
1.	New	9	30
2.	Old	21	70
	Total	**30**	**100**

Based on the research results presented in Table 3, there were 21 respondents (70%) working for >3 years who were in the long period of work category.

Tabel 4. Age category of respondents

No	Age	Total (n)	Percentage (%)
1.	Adult	22	73.3
2.	Elderly	8	26.7
	Total	**30**	**100**

Based on the research results presented in Table 4, there were 22 respondents (73.3%) in the adult age category (25-45 years).

Tabel 5. Disease history category of respondents

No	Disease History	Total (n)	Percentage (%)
1.	Never had a disease history	17	56.7
2.	Had a disease history	13	43.3
	Total	**30**	**100**

Based on the research results presented in Table 5, as many as 17 respondents (56.7%), they never had a disease history of hearing.

3.2. Bivariate Analysis

Tabel 6. Relationship between sound intensity and hearing threshold

Sound Intensity	Hearing Threshold				Total		ϱ-value	Cc
	Normal		Abnormal					
	n	(%)	n	(%)	n	(%)		
Below TLV	13	43.3	3	10.0	16	53.3	0.030	0.011
Above TLV	5	16.7	9	30.0	14	46.7		
	18	60.0	12	40.0	30	100.0		

Based on the results of Table 6, the results of the chi square correlation test analysis show a value of ϱ = 0.030, which can be concluded that there is a relationship between sound intensity and hearing threshold (ϱ-value < 0.05) with Cc = 0.011, which means the strength of the relationship is weak. These results explain that there are 9 respondents (30%) who are deaf with sound intensity above the TLV.

Tabel 7. Relationship between period of work and hearing threshold

Period of Work	Hearing Threshold				Total		ϱ-value
	Normal		Abnormal				
	n	(%)	n	(%)	n	(%)	
New	6	20.0	3	10.0	9	30.0	0.704
Old	12	40.0	9	30.0	21	70.0	
	18	60.0	12	40.0	30	100.0	

Based on the results of Table 7, the results of the chi square correlation test analysis show a value of ϱ = 0.704, which can be concluded that there is no relationship between sound intensity and hearing threshold (ϱ-value > 0.05). These results explain that there are 9 respondents (30%) who experience deafness with long period of work.

Tabel 8. Relationship between age and hearing threshold

Age	Hearing Threshold				Total		ϱ-value
	Normal		Abormal				
	n	(%)	n	(%)	n	(%)	
Adult	13	43.3	9	30.0	22	73.3	1.000
Elderly	5	16.7	3	10.0	8	26.7	
	18	60.0	12	40.0	30	100.0	

Based on the results of Table 8, the results of the chi square correlation test analysis show a value of ϱ = 1.000, which can be concluded that there is no relationship between sound intensity and hearing threshold (ϱ-value > 0.05). These results explain that 3 respondents (10%) experienced deafness in old age.

Tabel 9. Relationship between disease history and hearing threshold

Disease History	Hearing Threshold				Total		ϱ-value	Cc
	Normal		Abnormal					
	n	(%)	n	(%)	n	(%)		
Never had a disease history	14	46.7	3	10.0	17	56.7	0.013	0.004
Had a disease history	4	13.3	9	30.0	13	43.3		
	18	60.0	12	40.0	30	100.0		

Based on the results of Table 9, the results of the chi square correlation test analysis show a value of ϱ = 0.013, which can be concluded that there is a relationship between sound intensity and hearing threshold (ϱ-value < 0.05) with Cc < 0.3 which means the strength of the relationship is weak. These results explain that 9 respondents (30%) experienced deafness and had a history of the disease.

3.3 Variables Related To Hearing Threshold

Respondents who were exposed to high sound intensity had a percentage of 46.7%, namely 14 respondents, and respondents who experienced hearing loss due to exposure to sound intensity had a percentage of 30%, namely 9 respondents. Based on Table 6 the results of the chi-square test analysis show the value of $\varrho = 0.030$. This means that the value of $\varrho < \alpha = 0.05$ which explains that there is a relationship between sound intensity and hearing threshold. Most of the respondents who experienced a reduced hearing threshold worked in production areas that were exposed to continuous machine noise with a sound intensity above the TLV, namely 85-91 dB. Conditions in the field workers in the production department do not use PPE, especially ear protection. Exposure to high intensity for 8 hours of work causes a decrease in the hearing threshold.

Based on the Regulation of the Minister of Manpower Republic Indonesia No. 05/2018 about Occupational Safety and Health the Threshold Limit Value (TLV) for an exposure time of 8 hours per day is 85dB. Continuous noise and impulsive noise can damage hearing if exposure is high enough. Impulsive noise may be more harmful than continuous noise at the same level of noise exposure[16].

The results of this study are in accordance with the research conducted by Septiana showing that there is a relationship between noise intensity and noise-induced hearing loss in workers exposed to noise at PT. Indonesia Power UBP Semarang. This is evidenced in the results of bivariate analysis obtained a p-value of 0.034 or less than 0.05. People who work in areas with sound intensity > 85 dBA have a risk of hearing loss due to noise 2.779 times greater than workers with an intensity below 85 dBA to experience hearing loss due to noise[17].

Respondents with a history of disease had a percentage of 43.3%, namely 13 people, and respondents who experienced hearing loss were 9 people with a mild deafness category of 8 people and 1 person with moderate deafness. Based on Table 9 the results of the chi-square test analysis show the value of $\varrho = 0.013$. It means that the value of $\varrho < \alpha = 0.05$ which explains that there is a relationship between the history of the disease and the hearing threshold. most of the respondents had a history of hearing disease received from their previous workplace.

From the interview results, respondents with a history of ear disease before working at PT. X has worked in other places that have exposure to high sound intensity, such as working in welding places, heavy equipment factories, and food factories so the respondent has experienced a decreased hearing threshold. Tarwaka et al stated that health conditions affect a person's hearing ability in capturing sounds[18]. According to the WHO-SEARO (South East Asia Regional Office) Intercountry Meeting, the causes of hearing loss are deafness from birth, use of ototoxic drugs, and exposure to noise[19]. The results of this study are in accordance with Marisdayana's research which shows that the variable history of ear disease proves that exposure to noise is a risk factor for suffering from hearing loss[10].

3.4 Variables That Are Not Related To Hearing Threshold

The distribution of the frequency of long periods of work has a percentage of 70%, namely 21 respondents. As many as 9 respondents (30%) who experienced deafness were grouped into the category of mild deafness of 8 respondents and the category of moderate deafness of 1 respondent. Based on Table 7 the results of the chi-square test analysis show the value of $\varrho = 0.704$. This means that the value of $\varrho > \alpha = 0.05$ which explains that there is no relationship between years of service and hearing threshold. Not all respondents

with long periods of work in production departments that have high-intensity exposure. So that the period of work is not a factor associated with decreased hearing thresholds. The results of this study are not in line with the research conducted by Septiana which shows that there is a relationship between length of work and noise-induced hearing loss in workers who have worked > 10 years at PT. Indonesia Power UBP Semarang. From the analysis results obtained an OR value of 3.656, meaning that workers who work > 10 years have a risk of hearing loss due to noise 3.656 times greater[17].

Adult age (12-45 years) has a percentage of 73.3%, namely 22 respondents, while elderly age (>46 years) has a percentage of 26.6%, namely 8 respondents. Based on Table 8 the results of the chi-square test analysis show the value of $\varrho = 1.000$. This means that the value $\varrho > \alpha = 0.05$ which explains that there is no relationship between age and hearing threshold. There were more respondents who were adults than the elderly. This is one of the factors that concludes that there is no relationship between age and hearing threshold. From the results of the chi-square test, 3 respondents who experienced deafness were aged 50-54 years with exposure to sound intensity above the NAB, namely 85-91 dB. This also means that the influence of the age variable is not related because the factor of decreasing the hearing threshold is not a degenerative effect but due to the high intensity of sound exposure. The results of this research are in accordance with the results of Darmawan and Mulyono's research which stated that there was no relationship between employee age and hearing threshold in PT Bangun Sarana Baja Gresik. Changes in hearing threshold values due to sound intensity are not related to the age of the worker, hearing loss can occur at any age (there is no tendency for susceptibility in either young or old age)[20].

This study has some limitations. A limitation of this study is that the researchers did not measure audiometry based on the ear (right ear & left ear). The research respondents were limited in number. This research did not reach the multivariate stage so it is not known what variables have a dominant influence on hearing threshold.

4. Conclusions

Variables that have a relationship to hearing threshold are sound intensity and history of illness. Meanwhile, variables that have no relationship are period of work and age.

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