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RELATIONSHIP OF NOISE INTENSITY WITH INCREASED BLOOD PRESSURE IN WORKERS IN THE TURBINE AND BOILER AREA MANUFACTURING COMPANY

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ABSRACT

Introduction: Manufacture company is a company focusing on the plantation located in Ogan Ilir Regency. In detail, this company is engaged in the agribusiness of sugar cane plantations and a sugar manufacturing factory. In the production/processing system in the manufacturing company, there is a large noise in the work area, namely the turbine and boiler. These workers are exposed to continuous daily noise in their work environment, which can cause health problems, including increased blood pressure. High blood pressure prevalence in workers exposed to noise levels greater than 75 dB(A) was 82,4%. **Aims:** To analyze the relation of noise intensity to blood pressure increase in workers in the Turbine and Boiler area of the manufacturing company. **Method:** The study uses a cross-sectional study. The number sample in this study is 80 workers. Data analysis was using univariate and bivariate analysis with Chi-square and Fisher's exact test. **Result**: The study shows that the majority of workers' blood pressure is not increased by 46 workers (57.5%) greater than workers whose blood pressure is increased by 34 workers (42.5%). Factors influencing the increase in blood pressure were noise intensity, age, years of service, length of exposure, and ear protection usage, and there is no relationship between smoking habits and sports habits with increased blood pressure. **Conclusion:** There are five variables related to noise intensity and blood pressure increase, and the area with the highest noise threshold value is the combustion kitchen boiler area.

Keywords: Noise Intensity, the Increase of Blood Pressure, Plantation Sector, Turbine and Boiler

INTRODUCTION

In general, noise is defined as the intensity of sound whose presence is not desired and can pose a health and safety risk to workers in various workplaces, one of which is sugarcane processing. There is consistent evidence that noise exposure causes multiple long-term impacts (Abbasi et al., 2015), both physiological and psychological impacts on humans, such as hearing loss (Thepaksorn et al., 2019), as well as communication disorders and distractions (Bion et al., 2018).

About more than 70% of the noise source comes from industrial activity in factories. These facts imply that the factory workers will be the first party to be exposed to intense noise and have a risk of being affected. The impact of noise on workers' health is divided between impact on hearing and non-hearing. Impacts on hearing include balance disorders, hearing loss and permanent hearing loss. Non-hearing effects include an increase in blood pressure, electrocardiographic abnormalities, psychological disorders, physiological disorders of the body, and behavior disorders.

The effects of prolonged exposure to noise can range from mild hearing loss to permanent deafness. Noise can also interfere with emotional health, triggering a significant increase in blood pressure. If this happens, it will cause a visceral effect to appear (Flint et al., 2019).

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The impact of noise on workers' health is in the form of disturbances in the senses of hearing and non-hearing. The impact of noise in the sense of hearing can cause progressive deafness. Initially, the effects of noise on human hearing are temporary, and would recover quickly after work where noise in the area is stopped. However, if workers work continuously in a noisy area, permanent and irreversible deafness will occur. Meanwhile, non-hearing disorders can cause physiological disorders, psychological disorders, communication disorders, and balance disorders (Darlani, 2017).

Noise can be related to increased blood pressure or hypertension. Someone who is exposed to noise has a disorder in his emotions which in turn has an impact on a person's stress level. The feeling of discomfort continues until the stress makes the hypothalamus send a signal to the sympathetic nervous system to be able to increase blood pressure directly with the sympathetic nerve endings in each tissue. This will release norepinephrine and then stimulate the heart and constrict veins and arterioles, or directly help of the release of the hormone adrenaline from the adrenal medulla which will also provide a stimulating effect that is almost the same as direct sympathetic stimulation to the circulation; when experiencing stress for a long period of time it will eventually result in blood pressure increase.

Noise intensity that exceeds the Threshold Limit Value (TLV) can damage hearing and increase blood pressure. Pathophysiologically, noise can cause hypertension because noise is hypothesized to be involved in the mechanism of dysfunctional stress. The auditory system is associated with the sympathetic nervous system. The neuroendocrine system reacts to sound stimuli through reflexes shown in the cardiovascular system such as changes in catecholamines, epinephrine, norepinephrine, and corticosteroid levels. Continuous exposure to noise can be pathogenic which leads to a continuous upregulation of vascular autoregulation that causes hypertension.

Blood pressure can be affected by cardiac output as well as peripheral resistance, both of which affect blood pressure. The brain will respond to noise as the basis for the emergence of stress hormones. When a person is stimulated to excessive stress, the sympathetic system is also overstimulated, which in turn produces peripheral vasoconstriction in every place in the body until hypertension occurs.

Exposure to noise produces stimuli that are associated with increased sympathetic nerve activity where, the body will recover quickly when the stimulus conditions are temporary, but if the stimulation occurs for a very long time, the changes in blood circulation will also persist and last a long time. A study conducted by Liu et al. (2016) in a steel factory in Zhengzhou, China showed the prevalence of noise exposure in men was 29.88% and women was 12.13% from the total of 3150 workers with cumulative noise exposure level of 95 to 113 dB.

Furthermore, prevalence of high blood pressure in De Souza, Périssé and Moura's (2015) study was 17.7% in workers exposed to noise <75 dB(A), 51.9% at noise levels of 75 to 85 dB(A), and 30.5% at noise levels greater than 85 dB(A). Higher rate of hypertension was found among workers exposed to occupational noise in Wuhan (21.0%) (Wang et al., 2022). The study by Wang et al. (2023), of the 4746 respondents (median age 43 years and 73.4% male), 9.57% (454/4746) had hypertension and 32.4% (1540/4746) had high noise exposure.

The study conducted by Rahmawati and Hariyono (2019) on workers at PT. Mataram Tunggal Garmen, Sleman Regency, showed that an increase in blood pressure was associated with noise intensity with a prevalence ratio of 16.667, meaning that workers who were exposed to noise exceeding the Threshold Value had a

risk of 16.667 times experiencing stage 1 and 2 blood pressure compared to others who were not exposed to the noise.

Manufacture company is a company in the plantation sector, located in Ogan Ilir Regency. In detail, this company is engaged in the agribusiness of sugar cane plantations and a sugar manufacturing factory managed by a manufacturing company, which is the most significant noise contributor, especially in the turbine area and the boiler area. Noise source at a manufacturing company is greatest in the processing, especially in the turbine and boiler area, not only physical sources but also can cause health problems and work accidents with an increase in blood pressure due to the sound emitted by the machine. Based on the noise monitoring report, it is known that the noise level received by workers in the turbine and boiler area exceeds the TLV (>85 dBA). Therefore, this study aims to determine whether a relationship between noise intensity and increased blood pressure exists in workers in the turbine and boiler area at the manufacturing company.

METHOD

This study uses a cross-sectional study. The population was workers in the processing section of the manufacturing company. Calculation of the sample using the Lemeshow (1997) method obtained a sample of 72 workers. The sample is added by 10% to avoid drop out so that a minimum sample of 80 workers is obtained.

Noise measurements using a Sound Level Meter. Referring to INS 7231:2009, noise measurement is carried out by two methods, namely measurement of noise sources and measurements of noise received by workers. Measurement of noise at the source is done by placing the tool as far as a meter from the noise source. Measurement of noise on workers is done by positioning the tool at the level of the worker's ear for ± 10 minutes every five seconds (Indonesian National Standards 7231:2009 Methods for Measuring Noise Intensity in the Workplace). The respondent's blood pressure was measured using a sphygmomanometer. This blood pressure measurement is done before work and after work. After that, data were collected through interviews and giving questionnaires.

This study uses univariate analysis to determine the distribution of frequency for each variable and bivariate analysis with chi square and Fisher's exact tests. This study has passed the ethical review issued by the Health Study Ethics Commission, Faculty of Public Health, Sriwijaya University No: 129/UN9.FKM/TU.KKE.2021.

RESULTS

Increased Blood Pressure

Table 1. Frequency Distribution of Workers' Blood Pressure

Blood Pressure	n=80	%
Increase	34	42.5
Not Increase	46	57.5

Source: Primary Data 2021

Table 1 shows that the majority of workers' blood pressure is not increased by 46 workers (57.5%) greater than workers whose blood pressure is increased by 34 workers (42.5%).

Noise Level Measurement

Table 2. Noise Intensity in the Turbine and Boiler Area

Noise Point	Tool's name	Noise Intensity (dBA)
Area Turbine		
Point 1	Generator	90.5
Point 2	Co Mill	84.5
Area Boiler		
Point 3	Burning Kitchen	91.0
Point 4	FD fan and ID fan	81.0

Based on the measurement results of noise intensity, there are four noise points, namely from the Generator, Combustion Kitchen, FD fan and ID fan. The measurement results are obtained at four points, namely the generator, co mill, combustion chamber and FD fan and ID fan. It is categorized into two, namely noise 85 dBA and < 85 dBA. From these data,two measurement points have a noise value of 85 dBA and two measurement points have a noise value of < 85 dBA (Table 2).

The lowest measurement results are found in the boiler area, namely the FD fan and ID fan points, which are 81.0 dBA and in the turbine area, namely the Co Mill point, which is 84.5 dB, when, in that situation, a worker is allowed to be in a work unit in the longest period of eight hours continuously without using ear protection (Minister of Manpower Regulation Number 5 of 2018 Keselamatan dan Kesehatan Kerja Lingkungan Kerja). The maximum noise intensity in the vicinity of the boiler, namely the Combustion Kitchen point, is 91.0 dBA and the turbine area, namely the Generator, is 90.5 dBA, in this situation a worker for a maximum of two hours can be exposed to continuous exposure by not wearing ear protection.

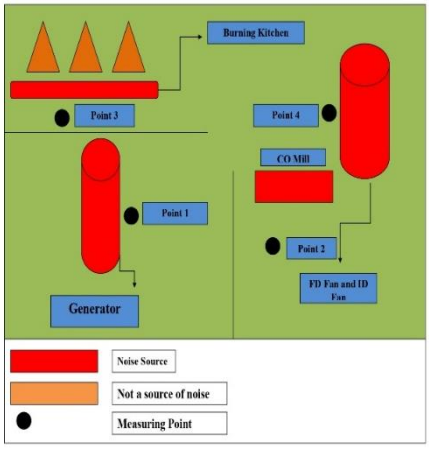

Figure 1. Measurement Layout

The results of noise measurement are compared with secondary data from the company with the same measurement points. The following points for measuring environmental noise can be seen in Figure 1.

Noise Intensity Frequency Distribution

Table 3 shows that the workers with a noise intensity of more than TLV 85 dB(A) were 40 workers (50.0%) as large as workers with a noise intensity of less than TLV 85 dBA lower, namely 40 workers (50.0%).

Table 3. Noise Intensity in Two Categories

Noise Intensity	n=80	%
≥ TLV 85 dBA	40	50.0
< TLV 85 dBA	40	50.0

Source: Primary Data 2021

Table 4 shows that workers who have an intensity below the TLV are 81.0 dBA as many as 18.7%, workers who have an intensity of 84.5 dBA are 31.3%, workers and workers who have an intensity above the TLV are 90.5 dBA as much as 30.0% and workers who have an intensity of 91.0 dBA as much as 20.0%.

Table 4. Noise Intensity in Workers

Noise Point	Noise Intensity (dBA)	n=80	%
Point 1	90.5	22	30.0
Point 2	84.5	29	31,3
Point 3	91.0	18	20.0
Point 4	81.0	11	18.7

Source: Primary Data 2021

Workers' Individual Factors

Table 5. Workers' Individual Factor

Variable	n=80	%
Age		
≥ 40 Year Old	35	43,8
< 40 Year Old	45	56,2
Years of Service		
≥ 4 Year	36	45,0
< 4 Year	44	55,0

Variable	n=80	%
Length of Exposure		
> 8 Time	48	60,0
≤ 8 Time	32	40,0
Ear Protection Usage		
Do not use	41	51,2
Use	39	48,8
Smoking Habits		
Smoking	43	53,8
Ex-Smoker	20	25,0
Not Smoking	17	21,2
Sports Habits		
< 3 times/week	38	47,5
≥ 3 times/week	42	52,5

Source: Primary Data 2021

Table 5 shows that the majority of workers aged less than 40 years old were 45 workers (56.2%), working years of less than four years were 44 workers (55.0%), duration of exposure less than eight hours were 32 workers (40.0%). In addition, the use of ear protection were 39 workers (48.8%), smoking habits with smoking category were 43 workers (53.8%) and the habit of exercising more than three times/week were 42 workers (52.5%).

Effect of Noise Intensity and Individual Factors with Increased Blood Pressure

Table 6 shows that there is a relationship between noise intensity (p-value = 0.041), age (p-value = 0.024), years of service (p-value = 0.013), length of exposure (p-value = 0.020), and use of ear protection (p-value = 0.001) with increased blood pressure. Workers whose status was exposed to noise intensity ≥TLV 85 dBA (PR = 1.833; 95%CI = 1.058-3.178) had a 1.8 times risk of experiencing a blood pressure increase compared to workers who were exposed to noise intensity <TLV 85 dBA. Workers with age 40 years (PR = 1.837; 95%CI = 1.091-3.092) are at risk of experiencing an increase in blood pressure of 1.8 times. Meanwhile, workers who worked four years (PR = 1.975; 95%CI = 1.091-3.365) had a risk of experiencing an increase in blood pressure of 1.9 times compared to those < 4 years. Workers whose exposure duration was > 8 hours (PR = 1.692; 95%CI = 1.068-2.681) had the risk of experiencing an increase in blood pressure of 1.6 times compared to those eight hours. Workers with poor use of ear protection (PR = 2.642; 95%CI = 1.417-4.927) had a risk of increasing blood pressure by 2.6 times compared to those who used ear protection properly. There is no relationship between smoking habits (p-value: 0.396) and sport habits (p-value: 0.258) with an increase in blood pressure.

Table 6. Bivariate Analysis

Variable	Increased Blood Pressure				Total		*p-value*	PR (95% CI)
	Increase		Not Increase					
	n	%	n	%	N	%		
Noise Intensity								
≥TLV 85 dBA	22	55.0	18	45.0	40	100	0.041	1.833 (1.058-3.178)
<TLV 85 dBA	12	30.0	28	70.0	40	100		
Age								
≥ 40 Year Old	20	57.1	15	46.0	35	100	0.024	1.837 (1.091-3.092)
< 40 Year Old	14	31.1	31	68.9	45	100		
Years of Service								
≥ 4 Year	21	58.3	15	41.7	36	100	0.013	1.975 (1.158-3.365)
< 4 Year	13	29.5	31	70.5	44	100		

Variable	Increased Blood Pressure				Total		*p-value*	PR (95% CI)
	Increase		Not Increase					
	n	%	n	%	N	%		
Length of Exposure							0.020	1.692 (1.068-2.681)
> 8 Jam	15	31.3	33	71.7	48	100		
≤ 8 Jam	19	29.4	13	40.6	32	100		
Ear Protection Usage							0.001	2.642 (1.417-4.927)
Not Use	25	61.0	16	39.0	41	100		
Use	9	16.6	30	22.4	39	100		
Smoking Habit								
Smoking	17	39.5	26	60.5	43	100	0.396	0.747 (0.418-1.335)
Ex-Smoker	8	40.0	12	60.0	20	100		
Not Smoking	9	32.9	8	47.1	17	100		
Sports Habits							0.258	0.778 (0.527-1.148)
< 3 times/week	19	50.0	19	50.0	38	100		
≥ 3 times/week	15	35.7	27	64.3	42	100		

Source: Primary Data 2021

DISCUSSION

In this study, measurements were carried out on four machines where each source was measured with a distance of a meter on the right and left sides so that, for each, measurements points were made on two sides from which would then be taken the average value. In determining the noise measurement point for workers and their area, it is based on INS 7321 of 2009.

Threshold Value is a workplace standard that can be accepted by workers without causing illness due to work carried out every day that does not exceed eight hours a day. The noise threshold value in the workplace is 85 dBA (Decree of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018). The measurement was carried out at four points, namely the Generator, Co Mill, Combustion Kitchen and FD fan and ID fan.

Based on the measurement results, the maximum value of the noise intensity around the boiler is at the point of the combustion chamber, which is 91.0 dBA and the turbine area, namely the generator, which is 90.5 dBA, in this section workers are allowed a maximum of two hours to be exposed to continuous exposure to not using ear protection. The measurement results of the lowest noise intensity are found in the boiler area, namely the FD fan point and ID fan, which is 81.0 dBA and in the turbine area, namely the Co Mill point, which is 84.5 dBA, when in that situation, a worker is only allowed a maximum of two hours is in a work unit continuously and does not use ear protection (Minister of Manpower Regulation Number 5 of 2018 Keselamatan dan Kesehatan Kerja Lingkungan Kerja).

In a certain period of time, if the noise is more than the TLV, it should cause mild hearing loss, but if it occurs for a long time, it will result in permanent deafness. In addition, noise plays a very important role in influencing emotional disturbances that lead to increased blood pressure. Noise is unwanted sound that can cause discomfort to the listener, which comes from natural activities and activities carried out by humans (Mehrparvar et al., 2017).

The study shows that total of workers who were exposed to noise >85 dBA were 40 workers (50.0%). Based on the Chi-square test, a relationship occurs between noise intensity and an increase in blood pressure. The results of this study are in

line with the studies by Souza and Rumerung which have the same results (Souza, Périssé and Moura, 2015; Rumerung, Maddusa and Sondakh, 2019).

Godfrey's study examining the relationship of noise to increased blood pressure in three industries in Nigeria stated that after noise exposure, the respondents' blood pressure (systolic and diastolic) increased in all three industries (Godfrey, 2021). According to a study by Liu et al. (2016), continuous noise exposure at a level of 80 dBA had a higher risk of hypertension than those exposed to <75 dBA, which resulted in a significant relationship between noise and blood pressure increase. The placement of workforce replacement into several parts of time can reduce the length of noise exposure so that it can reduce the risk of being exposed to noise for too long resulting in an increase in blood pressure .

It was determined in this study that there was an effect of the age variable on blood pressure increase. Age can affect the function of the auditory system. Older workers experience a decrease in sensitivity to sound stimuli due to risk factors for Presbycusis (Sahab, Madjid and Aminuddin, 1993). Presbycusis is defined as hearing loss associated with the aging process (Wang and Puel, 2020; Ario, Anggraeni and Aroeman, 2022). Wang and Puel's research showed a significant decrease in hearing function in the age group of 40 years and over (Wang and Puel, 2020). Ario, Anggraeni and Aroeman's (2022) research also grouped the minimum age for presbycusis from 40 and above Click or tap here to enter text..

Another study from Cayir et al. (2018) is in line with this study which states that there is a significant relationship between age and blood pressure whereby workers with age >40 years are four times more than those aged <40 years to experience increased blood pressure. This study also says that hypertension increases with age. As we age, blood vessels elasticity will decrease so that blood pressure will consequently rise. This shows that there is a relationship between age and blood pressure. Systolic blood pressure increase occurs in the age range of 70-80s. Meanwhile, diastolic increases when you are in your 50s and 60s and it is possible that it will decrease slightly (Cayir et al., 2018). This is in line with the results which state that someone who is >40 years old tends to be more at risk for an increase in blood pressure compared to someone young (18-40 years old), this can happen because the older a person gets, the elasticity of the arteries also decreases (Otoghile et al., 2019). The study by Pokobosky (2018) shows the same results. This study agrees with the theory that the more a person's age, the less flexible their blood vessels will be.

The systolic blood pressure will continue to rise slowly along with the increase in a person's age and will rise very sharply at the age of 40 years and over. Conversely, the diastolic blood pressure will continue to rise slowly when a person reaches the age of 60 years and then tends to decrease thereafter (Tjendera and Isramilda, 2020)

The study shows that there is a relationship between years of service and blood pressure increase. The majority of workers have a working period of <4 years as many as 44 people (55.0%). Meanwhile, the study results of Salmira, Silaban and Siregar (2018) contradict this study where there was no relationship between working period and blood pressure increase Click or tap here to enter text..

The effects that can be caused by noise are likely to be experienced by workers who have a longer working period. Where, the longer you work in a unit where there is noise, the higher the risk of exposure (Widya, Setiani and Dangiran, 2018). If a person continues to carry out activities such as working in a noisy area repeatedly, it will certainly make the health of the body quite disturbed. The form of disturbed health may be due to continuous physical stress

that makes muscle performance and health conditions worse.

Someone who works in the turbine and boiler area for a relatively long time can minimize noise exposure by rolling workers with different jobs from places that have high noise levels to places that are low in noise so as to minimize the occurrence of hypertension. Based on study results, there is a relationship between the variable length of exposure to blood pressure increase. The majority of workers with long exposure > 8 hours were 48 people (60.0%). This study is not in line with study of Zainudin, Harahap and Mirsiyanto (2020) where they found no relationship between length of exposure and blood pressure increase, where in this study it was found that the risk factor for changing blood pressure was not only duration of exposure.

However, there are other factors, such as working continuously for long periods of time in areas prone to noise exposure (Zainudin, Harahap and Mirsiyanto, 2020). The study by Zulharmans and Wahyuni (2014) states different results. If a person is exposed to noise for a longer time, it will cause an increase in stress hormones which cause an increase in heart rate, thereby increasing cardiac output and blood pressure.

Another study from Sumardiyono et al. (2017) is in line with this study where there is a relationship between length of exposure and an increase in blood pressure. Where, if a person's stress hormone increases, the heart rate will also increase, which results in high blood pressure due to being exposed to noise for too long (Sumardiyono et al., 2017).

Length of exposure is one of contributing factors for blood pressure change. Generally, this noise-induced disturbance can arise after years of continuous work in a noise-exposed workplace. This is considered very possible when someone who works does not get the right to have a break while working so that he gets continuous exposure to noise for eight hours.

This study shows a relationship between ear protection usage with blood pressure increase. In this study, the use of ear protection is the highest risk factor compared to other independent variables where it doubles the risk of having an increase in blood pressure. Based on descriptive analysis, the majority of workers do not use ear protection as many as 41 people (51.2%).

According to a study by Sumardiyono et al. (2017), there is a six-fold risk of blood pressure increase in workers who do not wear ear protection when using a single type of earplug. The findings of this study, however, are at odds with ear protection studies, which indicates that there is no connection between blood pressure and the use of ear protection.

One of the company's efforts to reduce noise exposure is to provide ear protection. However, observations show that some employees have not used ear protection according to the correct standards because it is uncomfortable to use for long periods of time at work, for example, employees wear only one ear plug.

In this study, it was found that there was no effect of smoking habits on increasing blood pressure with a p-value of 0.396. The majority of workers smoked as many as 43 people (53.8%). This study is in contrast to study conducted by Wang, the results showed that there was an effect of smoking habits on increasing blood pressure, where a group of individuals who smoked 2.54 times the risk of developing hypertension (Wang et al., 2018). This study is also not in line with study by Jannah, regarding the factors causing the occurrence of blood pressure, it was found that one of the factors that influence the incidence of blood pressure is smoking (Mirza et al., 2018)

The risk factor other than smoking is low physical activity. Physical activity begins to decrease with increasing living

habits that can increase the risk of high blood pressure. Inactive people tend to have higher heart rate, where their heart muscles have to work harder with each contraction and the more burden it puts on the arteries.

According to Umbas, Tuda and Numansyah (2019), smoking habits can increase the risk of blood pressure increase due to the content in a cigarette, such as nicotine, can activate free radicals. This result is supported by Talebi et al. (2017) who found that when a person experiences blood pressure increase, there will be a risk of hypertension and the formation of atherosclerosisClick or tap here to enter text..

The study by Reza (2021) found there is no significant correlation between smoking habits and blood pressure due to an insufficient sample size to show significance. Meanwhile, according to Jannah, Nurhasanah and Sartika (2017) one of the factors that cause blood pressure is smoking.

In this study, smoking was not the only risk factor for increased blood pressure. Another risk factor is lack of physical activity. People who are less or inactive, often have a higher heart rate where heart muscles need to work harder and consequently increase the workload of the arteries (Chen et al., 2017).

This study results show that there is no relationship between the variables of exercise habits and blood pressure increase. The majority of workers exercised more than three times/week. This study is in line with (Sharman, La Gerche and Coombes (2015)whose study also indicates no relationship among exercise habits and hypertension. Exercise habits that are carried out regularly and appropriately with the appropriate frequency and length of time will help a person in lowering his blood pressure (Sharman, La Gerche and Coombes, 2015). Where, a drop in blood pressure can occur when the heart works lightly or the heart rate is less (Zakariya, Defiana and Samodra, 2020).

In addition, a person will be more at risk of developing hypertension when they do less physical activity which results in excess weight (Wati and Simanjuntak, 2020). However, this study is not in line with the theory that explains the exercise variable. This theory is contrary to the results of this study which showed that there was no significant relationship between exercise and the increase of blood pressure. The results of Hadi's (2014) study show that people who do not exercise have a 1.9 times greater risk than people who exercise to experience high blood pressure. One of the health promotion efforts that can be done in the workplace is to apply exercise habits to workers three times a week and stretch while working every five minutes for one hour so that workers are in a fit and productive state.

However, this study is not in line with the theory that explains the exercise variable. The results of this study shows that there was no significant relationship between exercise and blood pressure increase. It is necessary to enforce regulations on physical activity and health promotion efforts in the work environment so that workers comply with work regulations that enforce exercise, such as three times a week to stretch after every five minutes in an hour.

An environmental factor that is very influential to increase in blood pressure and is exposure to noise in the workplace. Nerve Sympathetic stimulation will affect arterioles and veins causing vasoconstriction. The vasoconstriction occurs in the arterioles and will cause an increase in total peripheral resistance (total peripheral resistance) so blood pressure increases. When the veins also experience vasoconstriction, increased venous return will occur, so that the stroke volume and cardiac output increases. With increased cardiac output, this results in pressure blood increase. If this happens for up to five years, it can cause hypertension and have a 60% higher death risk from

cardiovascular disease over a 10-year period, compared to workers with no history of noise exposure.

CONCLUSIONS

The highest noise intensity is found in the boiler area, namely in the combustion chamber, which exceeds the threshold value. This study found that there was a relationship between noise intensity, age, years of service, duration of exposure to the use of ear protectors and increased blood pressure in workers in the turbine and boiler area of a manufacturing company. Workers who were exposed to noise more than TLV had a 1.8 times greater risk of experiencing an increase in blood pressure compared to workers who were exposed to noise less than TLV. Therefore, it is important to plan various preventive actions in preventing noise in the work environment so that the possibility of hypertension in workers does not increase.

REFERENCES

Abbasi, M., Monnazzam, M.R., Zakerian, S. and Yousefzadeh, A., 2015. Effect of wind turbine noise on workers' sleep disorder: A case study of manjil wind farm in northern Iran. *Fluctuation and Noise Letters*, 14(2), pp.1–16. https://doi.org/10.1142/S0219477515500200

Ario, M.M., Anggraeni, R. and Aroeman, N.A., 2022. Karakteristik penderita presbikusis di kota bandung tahun 2019. *Journal of medicine and health*, 4(1), pp.11–17. https://doi.org/10.28932/jmh.v4i1.3328

Bion, V., Lowe, A.S.W., Puthucheary, Z. and Montgomery, H., 2018. Reducing sound and light exposure to improve sleep on the adult intensive care unit: An inclusive narrative review. *Journal of the Intensive Care Society*, 19(2), pp.138–146. https://doi.org/10.1177/1751143717740803

Cayir, A., Barrow, T.M., Wang, H., Liu, H., Li, C., Ding, N., Li, Y., Kang, C.M., Guo, L., Li, P. hui and Byun, H.M., 2018. Occupational noise exposure is associated with hypertension in China: Results from project ELEFANT. *PLoS ONE*, 13(12), pp.1–10. https://doi.org/10.1371/journal.pone.0209041

Chen, S., Ni, Y., Zhang, L., Kong, L., Lu, L., Yang, Z., Yang, L., Zhang, X. and Zhu, Y., 2017. Noise exposure in occupational setting associated with elevated blood pressure in China. *BMC Public Health*, 17(1), pp.1–7. https://doi.org/10.1186/s12889-017-4050-0

Darlani, S., 2017. Kebisingan Dan Gangguan Psikologis Pekerja Weaving Loom Dan Inspection Pt. Primatexco Indonesia. *JHE (Journal of Health Education)*, 2(2), pp.130–137.

De Souza, T.C.F., Périssé, A.R.S. and Moura, M., 2015. Noise exposure and hypertension: Investigation of a silent relationship Environmental and occupational health. *BMC Public Health*, 15(1). https://doi.org/10.1186/s12889-015-1671-z

De Souza, T.C.F. De, Périssé, A.R.S. and Moura, M., 2015. Noise exposure and hypertension: Investigation of a silent relationship Environmental and occupational health. *BMC Public Health*, 15(1), pp.1–9. https://doi.org/10.1186/s12889-015-1671-z

Flint, A.C., Conell, C., Ren, X., Banki, N.M., Chan, S.L., Rao, V.A., Melles, R.B. and Bhatt, D.L., 2019. Effect of Systolic and Diastolic Blood Pressure on Cardiovascular

Outcomes. *New England Journal of Medicine*, 381(3), pp.243–251. https://doi.org/10.1056/NEJMoa1803180

Godfrey, O.O., 2021. The Effects of Industrial Noise Pollution on Blood Pressure and Pulse Rate of Workers in Some Industries in Nnewi North Local Government Area of Anambra State , Nigeria. *Journal of Geography and Environmental Management*, 7(1), pp.1–17.

Hadi, S., 2014. *Faktor – Faktor Yang Mempengaruhi Kenaikan Tekanan Darah Pada Pekerja Yang Terpajan Kebisingan di PT "X" Indonesia Tahun 2014*. Universitas Islam Negeri Syarif Hidayatullah Jakarta.

Indonesian National Standards 7231:2009, *Methods for Measuring Noise Intensity in the Workplace*.

Jannah, M., Nurhasanah, N. and Sartika, R.A., 2017. Analisis faktor penyebab kejadian hipertensi di wilayah kerja Puskesmas Mangasa Kecamatan Tamalate Makassar. *Jurnal Pena*, 3(1), pp.410–417.

Lemeshow, 1997. *Besar Sampel Dalam Penelitian Kesehatan*. Yogyakarta: UGM.

Liu, C.S., Young, L.H., Yu, T.Y., Bao, B.Y. and Chang, T.Y., 2016. Occupational noise frequencies and the incidence of hypertension in a retrospective cohort study. *American Journal of Epidemiology*, 184(2), pp.120–128. https://doi.org/10.1093/aje/kwv333

Mehrparvar, A.H., Heidari, F., Sharifabadi, M.S. and Javad, M., 2017. Prevalence and Pattern of Noise-induced Hearing Loss in Tile and Ceramic Industry. *International Journal of Occupational Hygiene*, 9(2), pp.60–65.

Minister of Manpower Regulation Number 5 of 2018. Keselamatan dan Kesehatan Kerja Lingkungan Kerja.

Mirza, R., Kirchner, D.B., Dobie, R.A. and Crawford, J., 2018. Occupational Noise-Induced Hearing Loss. *Journal of Occupational and Environmental Medicine*, 60(0), pp.498–501. https://doi.org/10.1097/JOM.0000000000001423

Otoghile, B., Ediale, J., Ariyibi, N.O., Otoru, O.O., Kuni, J.I. and Maan, N.D., 2019. Effects of Occupational Noise on Blood Pressure. *Global Journal of Health Science*, 11(3), p.63. https://doi.org/10.5539/gjhs.v11n3p63

Pokobosky, O., 2018. *Di Area Mesin Breaker Dan Hammer Mill Pt . Sunan Rubber Palembang Tahun 2018 Di Area Mesin Breaker Dan Hammer Mill Pt . Sunan Rubber Palembang Tahun 2018*.

Rahmawati, L.M. and Hariyono, W., 2019. Hubungan Intensitas Kebisingan dengan Tekanan Darah pada Karyawan PT Mataram Tunggal Garment Kabupaten Sleman. *Skripsi*, pp.1–8.

Reza, M., 2021. Hubungan Antara Merokok, Aktivitas Fisik Dan Riwayat Keluarga Dengan Kejadian Hipertensi Pada Keluarga Mahasiswa FK USU. pp.1–69.

Rumerung, M., Maddusa, S.S. and Sondakh, R.C., 2019. Hubungan antara Intensitas Kebisingan dengan Tekanan Darah dan Denyut Nadi pada Pekerja Industri Mebel di Desa Leilem. *Jurnal Kesehatan Masyarakat (e-Journal)*, 8(6), pp.583–591.

Sahab, S., Madjid, A.A. and Aminuddin, 1993. *Pedoman diagnosis dan evaluasi cacat karena kecelakaan dan penyakit akibat kerja*. Jakarta: Dewan Keselamatan dan Kesehatan Kerja Nasional.

Salmira, C.S., Silaban, G. and Siregar, F.A., 2018. Relationship Between The Intensity of Noise and Blood

Pressure of Operator at PT. Pupuk Iskandar Muda. *Proceedings of the 2nd Public Health International Conference (PHICo 2017)*, 9(PHICo), pp.90–94. https://doi.org/10.2991/phico-17.2018.36

Sharman, J.E., La Gerche, A. and Coombes, J.S., 2015. Exercise and cardiovascular risk in patients with hypertension. *American Journal of Hypertension*, 28(2), pp.147–158. https://doi.org/10.1093/ajh/hpu191

Sumardiyono, S., Hartono, H., Probandari, A. and Setyono, P., 2017. The Association between Risk Factors and Blood Pressure in the Textile Industry Workers. *Global Medical & Health Communication (GMHC)*, 5(3), p.228. https://doi.org/10.29313/gmhc.v5i3.2650

Talebi, H., Hasani, S., Khajeh, M. and Namdari, A.G., 2017. The Effect of Smoking on Noise-Induced Hearing Loss in one of the Tile Manufactories of Iran in 2016. *Annals of Otolaryngology and Rhinology*, 4(8), p.1194.

Thepaksorn, P., Koizumi, A., Harada, K., Siriwong, W. and Neitzel, R.L., 2019. Occupational noise exposure and hearing defects among sawmill workers in the south of Thailand. *International Journal of Occupational Safety and Ergonomics*, 25(3), pp.458–466. https://doi.org/10.1080/10803548.2017.1394710

Tjendera, M. and Isramilda, I., 2020. Hubungan Intensitas Kebisingan Dengan Tekanan Darah Pada Pekerja Area Workshop. *Zona Kedokteran: Program Studi Pendidikan Dokter Universitas Batam*, 9(1), pp.18–26. https://doi.org/10.37776/zked.v9i1.267

Umbas, I.M., Tuda, J. and Numansyah, M., 2019. Hubungan antara Merokok dengan Hipertensi di Puskesmas Kawangkoan. *Jurnal Keperawatan*, 7(1), pp.1–8. https://doi.org/10.35790/jkp.v7i1.24334

Wang, F., Song, X., Li, F., Bai, Y., Han, L., Zhang, H., Zhang, F., Luo, X., Shen, H. and Zhu, B., 2018. Occupational noise exposure and hypertension: a case-control study. *Journal of Public Health and Emergency*, 2, pp.30–30. https://doi.org/10.21037/jphe.2018.12.01

Wang, J. and Puel, J.L., 2020. Presbycusis: An update on cochlear mechanisms and therapies. *Journal of Clinical Medicine*, 9(1), pp.1–22. https://doi.org/10.3390/jcm9010218

Wang, J., Zhang, P., Wang, Y., Wang, H., Gao, Y. and Zhang, Y., 2023. Association of occupational noise exposure with hypertension: A cross-sectional study. *Journal of Clinical Hypertension*, 25(2), pp.158–164. https://doi.org/10.1111/jch.14619

Wang, S., Liang, J., Zhang, L., Chen, S., Chen, Z., Yin, W., Fu, W., Pan, Z., Yi, G. and Tan, X., 2022. Relationship between occupational noise exposure and hypertension: Cross-sectional evidence from real-world. *Frontiers in Public Health*, 10:1037246. https://doi.org/10.3389/fpubh.2022.1037246

Wati, I.D.P. and Simanjuntak, V.G., 2020. Characteristics Differences of Athlete Blood Pressure of Sports Pre Nasional Sport Event in West Kalimantan. *Jp.jok (Jurnal Pendidikan Jasmani, Olahraga dan Kesehatan)*, 4(1), pp.73–85. https://doi.org/10.33503/jp.jok.v4i1.1133

Widya, M., Setiani, O. and Dangiran, H.L., 2018. Hubungan Intensitas Kebisingan Dengan Tekanan Darah

Sistolik dan Diastolik Pada Pekerja Pertambangan Pasir dan Batu PT. X Rowosari Semarang. *Jurnal Kesehatan Masyarakat*, 6(6), pp.225–234. https://doi.org/https://doi.org/10.14710/jkm.v6i6.22180

Zainudin, M., Harahap, P.S. and Mirsiyanto, E., 2020. Analisis Intensitas Dan Lama Paparan Kebisingan Dengan Peningkatan Tekanan Darah Pada Karyawan Perusahaan Migas X di Jambi. *e-SEHAD*, 1(1), pp.65–76. https://doi.org/10.22437/esehad.v1i1.10767

Zakariya, A.F., Defiana, I. and Samodra, T.B., 2020. Noise Characteristics and Sound Pressure Level Prediction of Loggia Balcony in Apartment. *IPTEK The Journal for Technology and Science*, 31(2), p.178. https://doi.org/10.12962/j20882033.v31i2.5582

Zulharmans, S.R. and Wahyuni A., 2014. *Hubungan Kebisingan Dengan Tekanan Darah Pada Karyawan Bagian Produksi PT. Semen Tonasa*. *bagian Kesehatan dan Keselamatan Kerja*. Universitas Hasanuddin.