



The Effect of Noise and Pulse Rate on Blood Pressure Through Work Fatigue as an Intervening Variable in PT. Indonesian Ship Industry (PERSERO) Makassar

Nurul Maycfana Djameluddin¹, Atjo Wahyu², Suriah³, Syamsiar S. Russeng², Lalu Muhammad Saleh², Abdul Salam⁴

¹*Master Program in Occupational Health and Safety, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia

²Department of Occupational Health and Safety, Faculty of Public Health, Hasanuddin University, Makassar Indonesia, Institution.

³* Department of health promotion and behavioral science, Faculty of Public Health, Hasanuddin University, Makassar Indonesia

⁴Department of Nutrition Sciences, Faculty of Public Health, Hasanuddin University, Makassar Indonesia

(Received: 14 May 2024

Revised: 16 June 2024

Accepted: 30 July 2024)

KEYWORDS

Noise;
Pulse;
Work Fatigue.

ABSTRACT:

Introduction: Noise is a form of pollution that can harm humans and the environment if it exceeds the threshold value (NAV).

Objectives: The purpose of this study is to determine the effect of noise and pulse rate on blood pressure through work fatigue as an intervening variable in PT. Indonesian Ship Industry (Persero) Makassar.

Methods: Quantitative methods are carried out. A total of 75 production employees at PT. The Indonesian Ship Industry (Persero) Makassar became a sample using total sampling from April – May 2024. Primary data sources and data collection techniques are carried out by questionnaires, documentation, observation, and interviews. Data analysis was carried out using Bivariate Analysis, Univariate Analysis, and Multivariate Analysis.

Results: This study found that noise and pulse affect work fatigue and blood pressure. Noise increases work fatigue, leading to higher blood pressure. High pulse rates also contribute to fatigue and high blood pressure.

Conclusions: Based on the results, it concludes that there is an effect of noise and pulse on blood pressure through work fatigue in PT. Indonesian Ship Industry (Persero) Makassar.

1. Introduction

Around 250 million employees worldwide are exposed to noise, and noise-induced hearing loss is the most common occupational disease recorded in Europe. In the United States, about 30 million employees are exposed to harmful noise while working. Industries with high noise exposure include construction workers, transportation, agriculture, mining, manufacturing, and the military. Industrial noise is considered a very hard problem to monitor, and companies whose workers are exposed to excessive noise must protect their workers from the negative effects of noise. In addition, employers must apply a permanent and effective hearing protection program, as outlined in the Occupational Safety And Health Administration (OSHA) Noise Standards. A National For Occupational Safety and Health (NIOSH) study found that 90% of coal miners have hearing loss by age 52, compared to 9% of the general population. It shows that 70% of people with hearing loss are between the ages of 52 and 60. Workers have better

hearing than men, and almost half of construction employees experience some degree of hearing loss [1].

In the era of globalization, technology is developing very rapidly, along with the increasing needs of society. The activities of most residents who use technology can sometimes cause noise, sometimes these activities can disturb local residents [2]. There are several studies that discuss hearing loss due to noise that have been carried out for a long duration, including research found by Abdullah et al. They said that the work environment has the potential to cause deafness in workers, there is a relationship between noise and the type of deafness experienced by workers due to the condition of the work environment whose noise source is not optimally controlled [3].

Noise causes a number of health problems. In addition to causing hearing impairment, high sound intensity can also cause decreased consciousness, mental disturbances and balance, confusion, communication disturbances, sleep



disturbances, difficulty performing tasks, and confusion of bodily functions as well as other profound impacts such as changes in heart rate/increased pulse rate, changes in blood pressure and sweat levels [4].

Heart rate is a measure of the light weight of an activity that a person does. When you exercise with a heavy intensity, the body will get tired quickly. The heavier the load, the higher the heart rate; On the other hand, when resting, the heart rate will tend to decrease. In the research of Supriyono & Magdalena, it is said that the number of beats per minute varies from person to person and is influenced by several factors, including each person's age, fitness, temperature, stress, and body size, as well as the consumption of certain medications [5]. In adults, the heart rate varies from 60 to 100 beats per minute. In addition, during activity, the heart rate of people who regularly work is relatively slower, and vice versa, in people who do not work, the pulse rate will increase faster than in people who work.

In Indonesia, most industries use machinery and equipment in their production processes. The use of these machines and equipment can have both positive and negative impacts, especially if they are not managed properly. One of the negative impacts of using these machines and equipment is that it can be a source of noise for workers. In this case, some workers are exposed to noise [6].

Research in Iran also reported that employees exposed to noise above the threshold value (NAB) had a higher average blood pressure than employees exposed to noise below the threshold value (NAV), both in the systole and diastole [7].

The factors that cause work accidents are all influenced by humans, which is 80 to 85%. Often people commit dangerous actions at work because they feel tired. Work fatigue is a condition in which a person feels tired both mentally and physically, both of which can be affected by the mismatch between the workload given and a person's ability to work [8].

In addition, noise can also affect non-hearing health, such as physiological illness, psychological illness, and communication illness. Several studies have shown that there is a relationship between noise exposure and work fatigue in workers, and the result of this study also shows that noise exposure ranges from 55 to 65 dBA causing work fatigue disorders in the form of psychological disorders, comfort disorders, communication disorders and concentration disorders. Disturbances and prolonged exposure to noise can trigger health problems, including

cardiovascular system disorders. Indicators that can be used to check the health of the cardiovascular system are blood pressure and pulse rate [9].

High blood pressure or hypertension can be caused by disturbances in the blood pressure regulation system at the neurological, hormonal, and hemodynamic levels. Factors affecting essential hypertension are foods high in chloride salts, high protein content and alcoholic beverages. Deafness can be differentiated into conductive deafness, sensorineural deafness, and mixed deafness. Sensorineural hearing loss happens when the inner ear (cochlea) or nerves that run from the inner ear to the brain are damaged. A type of deafness that is usually permanent. In sensorineural hearing loss, the ability to hear slow sounds or sounds that are quite loud but still unclear or muffled is reduced. There are many possible causes of sensorineural hearing loss, including ototoxic drugs, genetics, aging, head trauma, inner ear defects, and noise exposure [10].

Blood pressure indicates the blood pressure exerted on the arteries when blood is pumped by the heart to all parts of the body. Systolic blood pressure can be thought of as the pressure created by the heart muscle while pushing blood from the left ventricle towards the aorta (pressure when the heart ventricular muscle contracts or closes), while diastolic blood pressure is the pressure exerted on the aortic wall, artery, and blood vessels due to relaxation or relaxation of the ventricular muscles of the heart, such as pressure when the atrial muscles of the heart contract and blood flows to the ventricles [11].

The relationship between blood vessels and the heart is understandable because the heart is an important organ that supplies blood to the body. As a person's physical activity increases, so does his need for oxygenated blood. Changes in heart rate are often used as the basis for medical examinations, where small or no changes indicate good regulation of the circulatory system [12].

Noise also has non-auditory effects that can cause depression or psychological disorders, reduce work productivity, and inhibit the ability to communicate and concentrate. In some people, sensitivity to noise can cause headaches, high blood pressure, dizziness, drowsiness, stress and depression, followed by heartburn and difficulty sleeping. Noise is multifactorial and can cause hearing loss, namely the duration of noise exposure, frequency of noise exposure, level/amount of exposure, daily exposure dose, noise spectrum and factors in the body [13].



Based on research conducted by Suma'mur, it concludes that there is a correlation between noise and fatigue while working at the Cepogo Boyolali Metallurgical Craft Center, where workers are faced with high noise levels, high levels of fatigue and the impact of noise that causes fatigue. while working is 14.1% [14]. Thus, the noise value ($B = 11.447$) means that if the noise increases by 1 dBA, the level of fatigue at work will increase by 11.447 times.

The impact of fatigue is a decrease in the ability to pay attention, cognitive lethargy and irritability, slow and difficult thinking, decreased work motivation, decreased alertness, decreased concentration and accuracy ability, decreased productivity, and decreased work performance, reduced work ability. the quality of work and the decrease in reaction speed and sensitivity of the circuit to fatigue changes. . The body receives enough energy to expend energy for each person [15].

PT. The Indonesian Shipping Industry Company (Persero) Makassar is a state-owned company engaged in activities such as repairing and manufacturing new types of ships. This shipbuilding industry is also the largest shipyard in Eastern Indonesia which is located on Paotere beach, Tallo district, north of Makassar city or 3.5 km from the city center. This shipyard received the approval of the Minister of Justice of the Republic of Indonesia on March 18, 1985 with Decree No. C2-1440-HT.01.04 of 1985 and recorded in the State Gazette of the Republic of Indonesia number. 73 September 10, 1985. The rapid development of the maritime sector today can lead to an increase in the risk of occupational risks and diseases. Potential hazards

arise from buildings, equipment, industries, materials, processes, working methods and work environments.

2. Methods

This study was carried out after receiving recommendations and permission from the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University of Makassar with number 945/UN4.14.1/TP.01.02/2024. The type of research used is quantitative method. Path Analysis was used in this study, specifically to test the effect of noise and pulse rate on blood pressure due to work fatigue with a cross-sectional design so that the search was carried out at a certain time or a certain period of time. Stage. short time [16]. This research was conducted at PT. Indonesian Navy Industry (Persero) Makassar. The researcher chose the location of this research because PT. Indonesia's shipping industry is one of the industries related to inter-island transportation in Indonesia. This shipbuilding industry has a positive impact such as improving the country's economy and negative impacts on the environment, one of which is the occurrence of mechanical noise and vibration due to shipbuilding. Production process. This research was carried out from April to May 2024. The subjects and samples of this study are 75 production workers at PT. Indonesian Navy Industry (Persero) Makassar. Sampling uses population sampling. The main data sources and data collection techniques were carried out using observations, interviews, questionnaires and documents. Univariate analysis, bivariate analysis, and multivariate analysis were carried out to analyze the data.

3. Results

Table 1. Significance Test of Direct Influence at PT. Indonesian Ship Industry (Persero) Makassar

	<i>Original Sample (O)</i>	<i>Sample Mean (M)</i>	<i>Standard Deviation (STDEV)</i>	<i>T Statistics (O/STDEV)</i>	<i>P-Values</i>
Noise -> Fatigue	0,284	0,276	0,080	3,567	0,000
Pulse -> Fatigue	0,451	0,462	0,065	6,999	0,000
Noise -> Blood Pressure	0,261	0,249	0,074	3,537	0,000
Pulse -> Blood Pressure	0,347	0,349	0,063	5,554	0,000
Fatigue -> Blood Pressure	0,383	0,391	0,092	4,175	0,000

Source : Primary Data, 2024



According to Table 1, it shows that 5 Research Hypotheses can be answered.

a. Noise Due to Fatigue

According to Table 1, it shows that the initial sample estimate value of the noise variable to the fatigue variable is positive, which is 0.284. Then it shows that the t-statistic is $3.567 > 1.96$ so it is concluded to have a significant effect [17]. Thus the H1 hypothesis of this study was declared accepted. All in all, noise has a positive and significant effect on fatigue.

b. Pulse in a Tired State

According to Table 1, it shows that the initial sample estimate value of the pulse rate variable to the fatigue variable is positive, which is 0.451. Then it shows that the t-statistics are $6.999 > 1.96$ so that it concludes to have a significant effect [17]. Thus the H2 hypothesis of this study was declared accepted. In conclusion, heart rate has a positive and significant effect on fatigue.

c. Noise for Blood Pressure

According to Table 1, it shows that the initial sample estimate value of the noise variable for the blood pressure variable has a positive value of 0.261. Then it shows that the t-statistics are $3.537 > 1.96$ so that it can be said to

have a significant effect [17]. Thus the H3 hypothesis of this study was declared accepted. All in all, noise has a positive and significant influence on blood pressure.

d. Heart Rate Versus Blood Pressure

According to Table 1, it shows that the initial sample estimate value of the fatigue variable to the blood pressure variable has a positive value of 0.383. Then it shows that the t-statistics are $4.175 > 1.96$ so that it can be concluded to have a significant effect [17]. Thus the H4 hypothesis of this study was declared accepted. In conclusion, pulse rate has a positive and significant influence on blood pressure.

e. Fatigue to Blood Pressure

According to Table 1, it shows that the initial sample estimate value of the fatigue variable for the blood pressure variable has a positive value of 0.383. Then it shows that the t-statistics are $4.175 > 1.96$ so that it can be concluded to have a significant effect [17]. Thus the H5 hypothesis of this study was declared accepted. All in all, fatigue has a positive and significant effect on blood pressure.

Table 2. Significant Test of Indirect Influence in PT. Indonesian Ship Industry (Persero) Makassar

	<i>Original Sample (O)</i>	<i>Sample Mean (M)</i>	<i>Standard Deviation (STDEV)</i>	<i>T Statistics (O/STDEV)</i>	<i>P Values</i>
Noise -> Fatigue -> Blood Pressure	0,109	0,112	0,051	2,140	0,033
Pulse -> Fatigue -> Blood Pressure	0,173	0,180	0,051	3,420	0,001

Source : Primary Data, 2024

According to table 2, it shows that the Research Hypothesis can be answered some aspects, such as:

a. Noise in blood pressure due to fatigue

According Table 2, it shows that the initial sample estimate value for the confounding variable in the fatigue blood pressure variable has a positive value of 0.109. Then it shows that the t-statistic is $2.140 > 1.96$ so that it can be said to have a significant effect [17]. Thus the H6 hypothesis of this study was declared accepted. All in all, noise has a positive and significant effect on blood pressure due to fatigue.

b. Heart rate versus blood pressure due to fatigue

According to Table 2, it shows that the initial sample estimate value of the heart rate variable versus blood

pressure due to fatigue is positive, which is 0.173. Then it shows that the t-statistic is $3.420 > 1.96$ so that it can be concluded to have a significant effect [17]. Thus the H7 hypothesis of this study was declared accepted. All in all, pulse rate has a positive and significant effect on blood pressure due to fatigue.

4. Discussion

The effect of noise on blood pressure in PT. Indonesian Navy Industry (Persero) Makassar

The sound intensity in this study is the average measurement of sound or sound monitored on machines in the workplace using a dosimeter. The criteria used as a reference follow the Regulation of the Minister of Manpower Number 13 of 2011 concerning the Value of the Threshold Limit (NAV). Noise measurements were



made using a mobile dosimetry app. The noise meter measures and stores the sound pressure level (SPL) by integrating measurements over time, providing a cumulative noise exposure measurement over a period of time, e.g. 8 hours of work a day.

In addition, measurements using sound level meters to measure noise in the work environment were also carried out at 5 locations of PT Industri Kapal Indonesia (Persero) Makassar. Measurements were carried out at five different points for approximately 15 minutes in the production area of PT. Indonesian Navy Industry (Persero) Makassar. The noise during the search is 72 dBC. The description of the noise level at each point was carried out in the production section of PT. The Indonesian Shipping Industry Company (Persero) Makassar initially entered the studio with a measurement of 68.9 dbA. The second point was carried out in a pipe workshop with a measurement result of 70.2 dbA. The third point is at the Platter Shop with an amount of 65.5 dbA. The fourth point of the installation and infrastructure workshop with a measurement result of 91.5 dBA and the fifth point of the electrical workshop with a measurement result of 66.5 dBA. Based on the measurement results, in the noise level analysis, there is a point that is not satisfactory because of the threshold limit (NAV) value.

The first hypothesis test of this study was analyzed using the T-test significance test where the original sample results were obtained with an estimate of the variable perverting variable of positive blood pressure which was 0.261. Then it shows that the t-statistics are $3.537 > 1.96$ so that it shows to have a significant effect [17]. Therefore, it is concluded that noise has a positive and significant influence on blood pressure.

Babisch developed the "Noise Effect Window Model" which explains that exposure to noise above a certain threshold can lead to an increased risk of hypertension and coronary heart disease [18].

This is in accordance with research conducted by Indriyanti et al. that there is a significant relationship between noise intensity and blood pressure [19]. It supports the research conducted by Hastuti et al. This shows that there is a relationship between noise and blood pressure in workers with the incidence of hypertension at noise intensity >85 dBA to 66.6% [20].

The effect of pulse rate on blood pressure in employees of PT. Indonesian Navy Industry (Persero) Makassar

In this study, pulse oximetry measurement uses a clip-shaped device called a transducer that is attached to a part of the body, such as a finger or earlobe. Oxygen saturation measurements are made by shining red and near-infrared

light at specific wavelengths through a tissue (most often at the base of the nail) and measuring it as it functions [21]. The oxygen meter can measure the oxygen concentration optimally, then wait for a while, the result showing the oxygen concentration in the body will be displayed on the pulse oximeter screen. The oxygen saturation level is considered normal if the number is between 5 and 100%. Oxygen saturation levels below 90% are considered very low and can be a clinical emergency.

The percentage in this study lies in the production area of PT. The Indonesian Shipping Industry (Persero) Makassar obtained the results by testing the hypothesis on the variables analyzed through the T significance test where the result was a positive original sample estimate value of 0.347. Then it can be concluded that the t-statistics are $5.554 > 1.96$ so that it concludes to have a significant effect [17]. Therefore, it can be concluded that heart rate has a positive and significant effect on blood pressure.

Consistent with the research of Setiawan et al. The results of the study show that there is an influence between heart rate and blood pressure, because if the heart rate and blood pressure increase or decrease at the same time, it will affect other body functions [22]. In line with the research conducted by Krisnawati et al. that there is an influence between heart rate and blood pressure on the effect of rehydration fluids [23].

Based on the researcher's analysis of the results of this study, the workers of the production department of PT. At the time of the examination, the Makassar Navy Company (Persero) experienced a slow heart rate because the cause was continuous activity due to the goals that had to be achieved every day, so the lack of rest time would have an impact on the heart. The speed slowed down and had an impact on lowering the blood pressure of workers.

The effect of noise on the work fatigue of PT. Indonesian Navy Industry (Persero) Makassar

The noise in this study was measured using a noise meter through a mobile phone application in the production area of PT. The Indonesian Shipping Industry Company (Persero) Makassar conducts eight hours of work with each worker to find out how many decibels a worker is exposed to noise. In this case, the threshold value (NAV) for normal noise is less than 85 dBA.

The results of the analysis of the relationship between noise and work fatigue show that most workers are exposed to normal noise and high levels of fatigue, meaning that there is a relationship between noise and employee fatigue of PT. Indonesian Navy Industry (Persero) Makassar.



The hypothesis test of this variable was analyzed using the T-test significance test where the results of the initial sample estimation of the noise variable to the fatigue variable had a positive value of 0.284. Then it can be seen that the t-statistic is $3.567 > 1.96$ so it can be said to have a significant effect [17]. Therefore, it can be concluded that noise has a positive and significant influence on fatigue.

This is in accordance with Afifah's research, one of the factors that affect fatigue at work is a noisy work environment, the intensity of sound exceeds the threshold value (NAV) > 85 dB, causing work productivity to be disrupted due to tinnitus. Disturbed feelings and psychological weakness lead to fatigue at work [24].

Noise can affect concentration or precision when performing activities and tasks. Noise can also cause psychological disorders in humans, for example difficulty sleeping which causes a lack of rest which increases fatigue at work. A study conducted by Fitria et al. It is known that the higher the noise intensity, the higher the level of work fatigue of the worker or employee [25]. The results of the analysis using the Mann Whitney statistical test showed that there was a significant relationship between noise intensity and work fatigue with p value = 0.001 (p value < 0.05).

The effect of pulse on work fatigue in PT. Indonesian Navy Industry (Persero) Makassar

Measure your pulse rate to find out how many times your heart beats in a minute. Pulse rate can be measured with a radial artery in the wrist or a carotid artery in the neck, but in this study it was measured with a pulse oximeter attached to the worker's finger in a resting state and calculated for a maximum of 60 seconds. Get heart rate results. Based on research analysis on PT. The Indonesian Shipping Industry Company (Persero) Makassar shows that the original sample estimate from t-statistics is $6.999 > 1.96$. The motivation in the fatigue variable has a positive value so that it can be said to have a significant influence [17].

The heart rate before work is lower than after work. When the body is exposed to heat, the body's blood vessels will dilate. This condition promotes an increase in the amount of blood transported to the muscles. In this activity, the heart pumps faster which is characterized by an increased heart rate. The pulse rate is the response of the cardiovascular system to the blood flow that the body needs. This average increase varies, and people in good physical condition experience a slight improvement. An

average of 180 to 200 times/minute is the maximum frequency in adulthood [26].

This study is in line with the research of Maulana et al. with the results of the study in the form of a relationship between heart rate and work fatigue in the household industry because some workers need to achieve their goals and some workers have to rest but are forced to work or may also be due to age factors and health history [27]. A study by Hjortskov et al. also stated that office workers often experience mental stress that can increase heart rate and decrease heart rate variability and is related to fatigue [28].

The effect of fatigue on blood pressure in workers at PT. Indonesian Ship Industry (Persero) Makassar

Fatigue in this study, specifically the decrease in efficiency and endurance of workers when doing work, was measured using a special industry questionnaire that must be filled out by workers as well as several open-ended questions given in the questionnaire explaining these conditions. Every worker in a weakened activity is subject to question. First, regarding physical fatigue, the majority answered that they often get sick in some places due to age but still have to work to support their families, and going to work is tiring. Continuously, there are people who maintain their endurance by having breakfast before work and stretching, but end up with headaches, muscle aches, heat and weakness.

The second question is whether they enjoy working or find it difficult to go to work. The majority answered no because they were happy with the work environment and good colleagues, there were also those who were like that. Not in good health but always working for the responsibilities given and having a purpose at work, sick. This is also one of the causes of lack of stretching activity before work, easy fatigue due to age, lack of respect for rights, and remote workers have to take their children to school first.

The third question about not caring about coworkers, but most of their answers are not caring about coworkers but only focusing on their respective jobs. Happiness is when workers feel happy when they are there because they find a trustworthy work environment.

Workers are depressed because they are too tired of monotonous work for a long time. The answer is that workers do not care about the surrounding environment but only care about the work they are assigned.

The fourth question was about happiness at work and they answered happy because they work in a comfortable



environment, colleagues are like family and feel useful in the team. There are also those whose answers are mediocre because they consider their position equal or equal to others. They also answered no because of monotonous work, excessive pressure, and unreliable co-workers.

In the fifth question about what achievements to pursue, the majority answered that lifting weights because there are goals to be achieved every day. They never feel tired because some of them are used to doing the job. Hard work is done because there are achievements that need to be achieved, so rest time is limited. Some answered that the workload was caused by high work demands and workers were easily tired. They also answered that the working time was due to the subject's need to complete the work so that the rest time was less and the final answer was like having to walk because of the location which was very far from the rest area. , reducing rest time.

The sixth question about job responsibilities, they answered that taking breaks to avoid unwanted tasks due to lack of concentration due to fatigue, some people choose to continue working as long as they complete daily tasks and can rest longer. Responses to taking breaks to eat or drink to recover energy before returning to work.

The hypothesis test of this variable was analyzed using the T-test significance test where the results of the initial sample estimation of the fatigue variable to the blood pressure variable with a positive value of 0.383 were obtained. Then it can be seen that the t-statistics are $4.175 > 1.96$ so that it can be said to have a significant effect [17].

Thus the H5 hypothesis of this study was declared accepted. In conclusion, fatigue has a positive and significant effect on blood pressure.

In this study, it was found that there was an effect between fatigue and blood pressure on PT. Indonesian Navy Industry (Persero) Makassar where the workers carry out their work until the end even though they feel tired but because of the goal they still have to complete it and some workers should take frequent breaks but still choose to work non-stop as long as the environment is good, they want to linger there, but they also think about their children and wives, who eat and drink a lot every day without stopping, but for the sake of work. They do not think about their health, including their blood pressure, because the results of the examination show that the majority have hypertension but they are not aware of it.

The effect of noise on blood pressure through work fatigue in workers at PT. Indonesian Ship Industry (Persero) Makassar

According to research, noise causes stress and physical weakness that leads to chronic fatigue. Fatigue causes a stress response in the body, including an increase in stress hormones in the body such as cortisol, which over time will increase blood pressure [29]. Meanwhile, according to Julistiawan's research, noise can increase stress and cause fatigue which can ultimately increase blood pressure. Continuous exposure to noise can increase blood pressure and other health problems [30].

This may refer to the theory of Lercher et al. who found that noise impacts cognitive function and stress, which can affect blood pressure. Noise has also been found to increase oxidative stress and inflammation in the body, which can damage blood vessels and increase blood pressure. Fatigue due to noise can also get worse. this condition [31].

The hypothesis testing of this variable was analyzed using the T significance test where the results of the initial sample estimation of the fatigue blood pressure noise variable were obtained with a positive value of 0.109. Then it can be seen that the t-statistic is $2.140 > 1.96$ so that it can be said to have a significant effect [17]. Therefore, it can be concluded that noise has a positive and significant effect on blood pressure due to fatigue.

This suggests that noise does not directly affect blood pressure through its impact on fatigue. Fatigue essentially causes physiological changes that can increase a worker's blood pressure, meaning that noise does not directly affect a person's blood pressure but makes workers tired due to machine noise that continuously exceeds the threshold so that it causes stress in PT. Indonesian Navy Industry (Persero) Makassar.

The effect of pulse rate on blood pressure through work fatigue in workers at PT. Indonesian Ship Industry (Persero) Makassar

In Adriyani's research, a persistently high heart rate may be a sign of excessive fatigue while working [32]. When the body feels tired, the heart rate tends to increase to meet the increased oxygen and energy needs. A constantly elevated heart rate can indicate excessive physical and mental stress that can affect blood pressure. When a person works continuously and then feels tired, this causes hypertension due to excessive workload on the cardiovascular system [33].



The hypothesis test of this variable was analyzed using the significance test of the T-test where the results of the initial sample estimation of the pulse rate variable for the fatigue blood pressure variable were obtained with a positive value of 0.173. Then it can be concluded that the t-statistic is $3.420 > 1.96$ so that it shows to have a significant effect [17]. Therefore, it is concluded that heart rate has a positive and significant effect on blood pressure through fatigue.

The theory of hypertension expert Stevo Julius revealed that fatigue can affect heart rate and blood pressure through various mechanisms, including activation of the sympathetic nervous system, stress baroreflex dysfunction and sleep disorders [34]. Overactivation of sympathy and decreased sympathetic activity are the main mechanisms that link fatigue to increased heart rate. This can be revealed in the Thayer & Lane research. Chronic fatigue can lead to neurological dysfunction of the autonomic nervous system, including the sympathetic and parasympathetic nervous systems and the baroreflex causes a poor response to changes in blood pressure, leading to a chronic increase in blood pressure [35].

5. Conclusion

According to the results, the effect of noise and heart rate on blood pressure due to work fatigue as an intermediate variable at PT. Indonesian Navy Industry (Persero) Makassar, the conclusion shows in detail as follows (1) Noise affects the work fatigue of PT. Indonesian Navy Industry (Persero) Makassar; (2) Circuit affects work fatigue in PT. Indonesian Navy Industry (Persero) Makassar; (3) Noise affects blood pressure in PT. Indonesian Navy Industry (Persero) Makassar; (4) The pulse affects blood pressure in the person undergoing surgery. Indonesian Navy Industry (Persero) Makassar; (5) Work fatigue affects blood pressure in PT. Indonesian Navy Industry (Persero) Makassar; (6) There is an indirect effect between noise on blood pressure and fatigue while working at PT. Indonesian Navy Industry (Persero) Makassar; (7) There is an indirect effect between heart rate and blood pressure due to fatigue at work. Indonesian Navy Industry (Persero) Makassar.

Acknowledgement

We would like to express our deepest gratitude to the individuals and organizations who supported and contributed to the completion of this research.

References

1. Chepesiuk R. Decibel Hell: The Effects of Living in a Noisy World. *Environ Health Perspect.* 2005; 113(1):A34–A41.
2. Wardani C, Zelviani S, Fuadi N. Effect of Noise Intensity on Blood Pressure Before and After Working in CV Printing. Rinjani Perkasa. *JFT J Fis and Ter.* 2021; 8(1):83. doi:10.24252/jft.v8i1.20072
3. Abdullah RPI, Purnomo SD, Ihsani IP. The Relationship between Noise and Working Period to the Type of Deafness and Stress in Workers of PT. Semen Tonasa. *UMI Med J.* 2020; 5(1):69–80. doi:10.33096/umj.v5i1.77
4. Tambunan STB. *Noise in the Workplace.* Yogyakarta: Andi Offset; 2005.
5. Supriyono S, Magdalena M. Relationship between Physical Activity, Pulse Rate and Nutritional Status of Basic Training Participants of Civil Servant Candidates in Central Java Province. *J Masy Health Sciences.* 2023; 12(05):337–345. doi:10.33221/jikm.v12i05.1864
6. Sari Vita. Effect of noise intensity. *Wind Public Heal J.* 2021; 2(6):1012–1022.
7. Sumardiyono S, Wijayanti R, Hartono H, Sri Budiastuti MT. Effect of Noise on Blood Pressure, with Work Stress as a Mediator Variable. *J Vocational Health.* 2020; 5(2):124. doi:10.22146/jkesvo.54088
8. Suryaatmaja A, Eka Pridianata V. The Relationship between Working Period, Workload, Noise Intensity and Work Fatigue at PT Nobelindo Sidoarjo. *J Heal Sci Prev.* 2020; 4(1):14–22. doi:10.29080/jhsp.v4i1.257
9. Kenwa MML, Wiranadha IM, Asthuta AR. The relationship between noise intensity and work stress levels in motorcycle repair shop workers and Dwijati motorcycle dealers in Denpasar. *J Med.* 2019; 8(5):2597–8012. <https://ojs.unud.ac.id/index.php/eum/article/view/51670>
10. Eryani YM, Wibowo CA, Saftarina F. Risk Factors for Hearing Loss Due to Noise. *Medulla.* 2017; 7(4):112–117.
11. Andari FN, Vioneery D, Panzilion P, Nurhayati N, Padila P. Reduction of Blood Pressure in the Elderly with Ergonomic Gymnastics. *J Telenursing.* 2020; 2(1):81–90. doi:10.31539/joting.v2i1.859
12. Ministry of Education and Culture. Student Physical Activity on Pulse Rate and Blood Pressure. *J Researcher.* Published online 2020:1–61.
13. Susiyati E, Imanto M. Effects of Earphone Use as a Risk Factor for Noise Induced Hearing Loss Events.



- Majority. 2020; 9(2):63–67. <https://jke.kedokteran.unila.ac.id/index.php/majority/article/viewFile/2848/2781>
14. Suma'mur. Corporate Hygiene and Occupational Health (HIPERKES). *Higeia J Public Heal Res Dev*. 2009; 1(2):58–64. <http://www.ejournal.sttmandalabdg.ac.id/index.php/JIT/article/view/23%0Ahttps://www.ejournal.sttmandalabdg.ac.id/index.php/JIT/article/download/23/23>
15. Sari V, Yuliati, Nurgahayu. The Relationship between Noise Intensity and Factory Work Fatigue at PT. X Correlation Between Noise Intensity and Work Fatigue on the Factory Workforces in PT. X. *Wind Public Heal J*. 2021; 2(6):1012–1022.
16. Sugiyono. *Qualitative and R&D Quantitative Research Methods (Vol. 8)*. Bandung: Alfabeta; 2012.
17. Ghozali I. *Structural Equation Modeling, an Alternative Method with Partial Least Square (PLS). Edition 4*. Vol 1. Semarang: Diponegoro University Publishing Board; 2014.
18. Babisch W. The Noise/Stress Concept, Risk Assessment and Research Needs. *Noise Heal*. 2002; 4(16):1–11.
19. Indriyanti LH, Wangi PK, Simanjuntak K. The Relationship of Noise Exposure to Increased Blood Pressure in Workers. *J Mask and Health*. 2019; 15(1):36. doi:10.24853/jkk.15.1.36-45
20. Hastuti E, Setiani O, Nurjazuli. Risk Factors for Increased Blood Pressure in Workers Exposed to Noise at Ahmad Yani Airport Semarang. *J Health of the Indones Environment*. 2020; 4(2):59–64.
21. Ministry of Health. Use of Oxymeter. 2021; (July): 1–23.
22. Setiawan WA, Greece, Kusyati E. The Relationship of Elderly Exercise Frequency to Blood Pressure and Pulse in the Elderly with Hypertension. *Pros Konf Nas II PPNI Jawa Tengah*. 2014; 2(1):229–236. <http://103.97.100.145/index.php/psn12012010/article/download/1147/1201>
23. Krisnawati D, Pradigdo SF, Kartini A. Effect of Rehydration Fluids on Pulse, Blood Pressure and Length of Recovery Period. *Indonesian Sports Science Media*. 2021; 1(2):133–138. <https://doi.org/10.15294/miki.v1i2.2028%0Ahttps://journal.unnes.ac.id/nju/index.php/miki/article/download/2028/2142>
24. Afifah NN. *The Relationship between Work Behavior and Low Back Pain Complaints in Porter Workers of PT. Sultan Hasanuddin Airport Makassar Space Gate in 2023*. Hasanuddin University, Makassar; 2023.
25. Fitria H, Fitradika A, Haryxon D, Marhaeni S. The Relationship between Noise Intensity and Work Fatigue in Workers at the Palm Oil Mill (PKS) PT. X Rokan Hulu. *J Gene Heal Pharm Sci Res*. 2023; 1(3):51–58. <https://jurnal.stikeskesosi.ac.id/index.php/TJGHPSR/article/view/203/217>
26. Novrianti D. *Factors Related to Health Complaints Due to Heat Pressure in Workers of Light Brick Production Section at PT. Bumi Sarana Beton = Factors Associated with Health Complaints Due to Heat Stress in The Light Brick Production Workers Section at PT. Bum*. Hasanuddin University; 2023.
27. Maulana I, Widhiarso W, Dewi Prof. Analysis of the Effect of Workload on the Fatigue Level of Tempeh Chips Household Industry Workers. *J INTECH Tek Ind Univ Serang Raya*. 2023; 9(1):33–41. doi:10.30656/intech.v9i1.5619
28. Hjortskov N, Rissén D, Blangsted AK, Fallentin N, Lundberg U, Sjøgaard K. The Effect of Mental Stress on Heart Rate Variability and Blood Pressure During Computer Work. *Eur J Appl Physiol*. 2004; 92(1–2):84–89. doi:10.1007/s00421-004-1055-z
29. Dianti Y. Causes of fatigue to blood pressure. *Angew Chemie Int Ed*. 2019; 6(11):5–24. http://repo.iain-tulungagung.ac.id/5510/5/BAB_2.pdf
30. Julistiawan MR. The Effect of Noise on Work Fatigue in Workers at PT Sunan Rubber Palembang. *J Health of the Indones Environment*. 2019; 4(1):1–24.
31. Lercher P, Evans GW, Meis M. Ambient Noise and Cognitive Processes among Primary School Children. *Environ Behav*. 2003; 35(6):725–735. doi:10.1177/0013916503256260
32. Adriyani R. The Relationship between Noise Exposure and Blood Pressure and Pulse Rate in Cement Packaging Industry Workers. *J Health of the Indones Environment*. 2017; 16(1):29. doi:10.14710/jkli.16.1.29-36
33. Irawan. Pulse Analysis against Fatigue. *J Edukara*. 2020; 9(1):19.
34. GBG Institution, Nadha KB, Iswari IS. Poor Cardiac Autonomic Response in Patients With Diabetes Mellitus After Acute Myocardial Infarction. *WMJ (Warmadewa Med Journal)*. 2017; 1(1):30. doi:10.22225/wmj.1.1.8.30-41
35. Thayer JF, Lane RD. The Role of Vagal Function in The Risk for Cardiovascular Disease and Mortality. *Biol Psychol*. 2007; 74(2):224–242. doi:10.1016/j.biopsycho.2005.11.013