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*Article*

## Impact of Work Environment Noise on Cardiovascular Conditions: A Study of Blood Pressure and Heart Rate in Workers (Heavy Equipment Manufacturing) in East Java

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### Abstract

Workplace noise is one of the physical factors that is often overlooked, although long-term exposure can have serious impacts on cardiovascular health. In workers exposed to noise, blood pressure and heart rate often increase as the body's response to physical stress. This physiological mechanism triggered by prolonged noise can result in an increased risk of cardiovascular disorders, including hypertension and heart rhythm disorders. The purpose of this study was to analyze the effect of noise on increasing blood pressure and heart rate in workers in the workshop area, especially the dynotest room. This type of research is observational with a cross-sectional research design. Conducted in December - May 2024 with the object of research on workers exposed to noise in the workshop area, especially the dynotest room. Data were analyzed using the Logistic Regression test. The total sample was 40 workers in the workshop area and dynotest room. Data were collected from observations, room noise measurements, blood pressure, and heart rate. Based on the results of the study, the average results for the dynotest area were 83.5 dBA, while for the dynotest room, the average results were 117.8 dBA. The results of statistical tests of blood pressure and pulse rate in workers obtained a sig value = 0.001. These results indicate an increase in blood pressure and pulse rate due to noise. It is recommended for the Company to monitor workers to find out the disorders caused by noise.

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### Key words:

1. Noise
2. Blood pressure
3. Pulse

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## Introduction

Hearing loss is a decrease in the function of the sense of hearing due to noise. Noise is a sound or noise that exceeds the threshold value (NAB) so that it has the potential to cause permanent damage to hearing and result in permanent deafness. While for low intensity noise can cause stress, headaches, and loss of concentration and decreased work productivity. In addition, noise has the potential to cause disorders in humans such as increased blood pressure, where high blood pressure can cause the heart to work harder and can produce symptoms such as fatigue, irritability, and increased stress in a person[1].

Research conducted by Lendo *et al* [1] against 60 respondents in furniture workers in Touliang Oki Village, the results were 86.6 dB. The average exceeds the NAB and there is a relationship between noise levels and blood pressure and pulse rate. High noise levels cause an increase in stress hormones that trigger the heart to pump harder, which can cause an increase in pulse rate. Research that has been conducted Wardani *et al*[2] against 15 respondents at CV Rinjani Perkasa printing showed a difference in blood pressure increase after and before exposure to noise. This is caused by an increase in hormones such as mental stress such as adrenaline, non-adrenaline, and cortisol in the human body which causes changes in pulse rate and blood pressure. Abnormal emotions cause the heart to pump blood throughout the body, if it occurs continuously it can cause increased blood pressure or hypertension.

Research conducted by Umaidah *et al* [3] against 45 respondents at PT. Rajawali Perkasa Furniture got a result of 93.3 dB(A). There is a relationship between noise levels and blood pressure and pulse rate. This is caused by narrowing of the blood vessels, which triggers the heart to work harder and triggers the hormones epinephrine and norepinephrine by the adrenal medulla to be high, so that it can affect several organs in the body which causes an increase in the pulse rate in the body.

According to R. Indrayani *et al* [4] Workers exposed to more than or equal to 85 dB(A) experienced an increase in systolic and diastolic blood pressure. The increase in blood pressure and pulse rate was influenced by individual characteristics including age, length of service, smoking habits, and use of ear protection. The increase in blood pressure and pulse rate was caused by some workers who did not use ear protection while working, therefore special attention was needed including the addition of barriers, ear protection, and smoking habits in workers. Noise in the work environment has become a serious concern in recent years because of its significant impact on workers' health. Recent studies have shown that excessive noise exposure can affect various aspects of health, including blood pressure and pulse rate. Septiana *et al.* [5] found that there was a significant relationship between noise intensity and increased blood pressure in workers. This study strengthens previous findings and emphasizes the importance of noise control in the workplace. Research at PT. Muroco Jember shows that acute noise exposure can cause significant increases in systolic and diastolic blood pressure and pulse rates of workers before and after work. This study emphasizes the importance of controlling other confounding variables to obtain more accurate results [6]. Based on these studies, it is clear that occupational noise exposure has a significant effect on workers' health. Therefore, prevention and control efforts for noise, as well as regular monitoring of workers' health, are essential to reduce the risk of noise-related health problems. Differences in the methodologies in noise measurement and the health parameters measured often result in inconsistent results between studies. Using a consistent and standardized methodology in future studies would be beneficial. Previous studies have shown an association between prolonged noise exposure and the risk of hypertension [7]. However, there is still a gap in understanding the specific mechanisms and factors that influence this relationship, especially in the context of the Indonesian industry. This study is expected to fill this gap by focusing on collecting data relevant to the specific work environment, using consistent methodology, conducting longitudinal studies, and controlling for confounding factors. This will make a significant contribution to our understanding of the effects of noise on health, increasing blood pressure and heart rate in workers. The purpose of this study was to analyze the effect of noise on increasing blood pressure and heart rate in workers in the workshop area and the dynotest room exposed to noise in workers (Heavy equipment manufacturing) in East Java region.

## Materials and Method

**Research Design.** This study uses an analytical method with observation and interviews. This study uses a cross-sectional approach because it has independent and dependent variables at one time. Using logistic regression tests to determine the influence between the variables studied. Subject in research These are workers who are exposed to noise in the workshop area and dynotest room.

**Noise intensity measurement.** Unwanted noise received in the workshop area and dynotest room originating from activities assembly, maintenance and testing of tools which produces noise up to 117.8 dB(A) for approximately 4 hours. The noise intensity is measured using *Sound Level Meter* (SLM) Svantek svan 971 with the noise measurement point determined at the position of the workforce when carrying out their work.

**Blood pressure measurement.** Workers' blood pressure obtained from the results of blood pressure measurements before and after work using a tensiometer. The blood pressure measurement points were carried

out before and after work, respondents were asked to rest for five to ten minutes before starting work or after doing work. Blood pressure measurements using Sinocare BA-801 digital tensiometer

**Pulse measurement.** The pulse rate of workers is obtained from the results of measurements before and after work. Measurement by calculating the rhythm and pulse on the worker's wrist.

**Data analysis.** Analysis collected from interview results with respondents, measurements blood pressure when using tensiometer, pulse measurement by feeling the wrist area, and noise intensity measurement using SLM. The test used to determine blood pressure and pulse rate using logistic regression test, to determine the effect of noise intensity with increased blood pressure and pulse rate and the effect between characteristics including age, length of service, smoking habits, and use of ear protection using the SPSS 16 application using logistic regression test.

**Research Ethics.** This research has passed the ethical test (Ethical Clearance) and received approval from the health research ethics committee of Poltekkes Kemenkes Surabaya with No. ethics 2329-KEPK. Written consent was obtained from all respondents.

## Results

This research was conducted in the workshop area and room with a research sample of 40 workers. The following are the results of noise intensity measurements:

**Table 1**  
Noise Intensity Measurement in Workshop Area and Dynotest

Work sector	Noise Measurement(dBA)	Percentage (%)
Nearby areas	82.5	53
Middle area	83	33
The furthest area	85	14
Dynotest room	117.8	100

In Table 1, the results for the smallest noise intensity are in the area closest to the office and based on the table results, 26 people (86%) of workers in the closest area and the middle area experienced noise below the threshold value. There were 4 people (14%) of workers receiving noise exposure of 85 dBA. Table 2 shows that the noise intensity in the dynotest room has a result of 117.8 dBA. There were 10 people (100%) experiencing noise above the threshold value. Noise is generated from testing the C9 engineering tool.

Blood pressure and pulse measurements in the workshop area were carried out before and after work. The following are the results of blood pressure and pulse measurements on workers.

**Table 2**  
Blood Pressure and Pulse Measurement in the Workshop Area and Dynotest Room

	Blood pressure	Frequency (n)	Percentage
workshop	Go on	16	53
	Down	14	47
	Total	30	100
	Pulse	Frequency	Percentage
	Go on	16	53
	Down	14	47
	Total	30	100
Dynotest	Blood pressure	Frequency (n)	Percentage
	Go on	6	60
	Down	4	40
	Total	10	100
	Pulse	Frequency	Percentage
	Go on	6	60
	Down	4	40
	Total	10	100

Table 2 shows that blood pressure and pulse measurements show an increase. Based on the table results, it can be seen that 16 people (53%) of workers in the workshop area experienced an increase in blood pressure and pulse after being exposed to noise and there were 4 people who had a history of hypertension. Blood pressure and pulse measurements showed an increase. Based on the table results, it can be seen that 6 people (60%) of

workers in the dynotest room experienced an increase in blood pressure and pulse after being exposed to noise and there were 4 people who had a history of hypertension.

The sample used in this study was 30 workers. In this study, the respondents were all workers in the workshop area. The following is a distribution table based on the characteristics of the respondents including age, length of service, smoking habits and use of ear protection.

**Table 3**  
Frequency Distribution of Respondent Characteristics in the Workshop Area

Variables	Respondent Characteristics	Frequency (n=30)	Percentage
Age	12 -19 Years	2	7
	20 – 60 Years	28	93
	61 Years	0	
Total		30	100
Years of service	≤1 Year	13	43
	1 to 10 years	9	30
	>10 years	8	27
Total		30	100
Smoking habit	Non-smoker	8	27
	1-4 sticks per day	12	40
	5-14 cigarettes per day	10	33
	15 Items per day	0	
Total		30	100
Use of ear protection	Always use	0	
	Rarely used	19	63
	Never used	11	37
Total		30	100

Based on table 3, it can be seen that the characteristics of each respondent show that the number of respondents with the largest age is 20-60 years with 28 people (93%), with the largest work period ≤ 1 year, namely 13 people (43%) and the lowest with a work period of > 10 years as many as 8 people (27%). These results also show that 40% of respondents are light smokers and data obtained as many as 63% of respondents rarely use ear protection.

The sample used in this study was 10 workers. In this study, the respondents were all workers in the dynotest room. The following is a distribution table based on the characteristics of the respondents including age, length of service, smoking habits and use of ear protection.

**Table 4**  
Frequency Distribution of Respondent Characteristics in the Dynotest Room

Variables	Respondent Characteristics	Frequency (n=30)	Percentage
Age	12 -19 Years	0	
	20 – 60 Years	10	100
	61 Years	0	
Total		10	100
Years of service	≤1 Year	5	50
	1 to 10 years	4	40
	>10 years	1	10
Total		10	100
Smoking habit	Non-smoker	0	
	1-4 sticks per day	1	10
	5-14 cigarettes per day	9	90
	15 items per day	0	
Total		10	100

Variables	Respondent Characteristics	Frequency (n=30)	Percentage
Use of ear protection	Always use	0	100
	Rarely used	10	
	Never used	0	
Total		10	100

Based on table 4, it can be seen that the characteristics of each respondent show that the number of respondents with the largest age is 20-60 years with 10 people (100%), with the largest work period of less than 1 year, namely 5 people (50%) and the lowest with a work period of >10 years as much as 1 person (10%). These results also show that 90% of respondents are moderate smokers and data obtained as many as 100% of respondents rarely use ear protection.

Analysis of differences in blood pressure and pulse rate in the workshop area using logistic regression test. This analysis test was conducted to see the effect of blood pressure and pulse rate before and after work. The following are the results of the analysis of differences in blood pressure and pulse rate before and after work:

**Table. 5**

Differences in Blood Pressure and Pulse Rate Before and After Entering the Workshop Area

Variables	Regression Coefficient	Significance
Noise	4.025	0.001
Constant	-6,664	0.002
Noise	3,651	0.002
Constant	-6,290	0.003

Based on table 5, it can be concluded that noise has a coefficient value of 4.025. This means that every 1 point increase in noise will increase the blood pressure value by 4.025. In addition, information was obtained that the sig. value is 0.001, this value is <0.05, meaning that noise has a significant effect on blood pressure.

From the model above, it can be concluded that noise has a coefficient value of 3.651. This means that every 1 point increase in noise will increase the pulse rate by 3.651. In addition, information is obtained that the sig. value is 0.002, this value is <0.05, meaning that noise has a significant effect on the pulse rate.

The basis for decision making in this stage is if the Walld Significance value. < 0.05 then H0 is rejected. The following are the results of a partial test of the effect of noise on blood pressure presented in the table below.

**Table. 6**

Differences In Blood Pressure and Pulse Rate Before And After Entering The Room Dynotest

Variables	Regression Coefficient	Significance
Noise	4.094	0.002
Constant	-6,397	0.004
Noise	3.296	0.003
Constant	-4,800	0.006

Based on table 6, it can be concluded that noise has a coefficient value of 4.094. This means that every 1 point increase in noise will increase the blood pressure value by 4.094. In addition, information was obtained that the sig. value is 0.002, this value is < 0.05, meaning that noise has a significant effect on blood pressure.

From the model above, it can be concluded that noise has a coefficient value of 3,296. This means that for every 1 point increase in noise, the pulse rate value will increase by 3,296. In addition, information is obtained that the sig. value is 0.003, this value is <0.05, meaning that noise has a significant effect on the pulse rate.

The following are the results of the analysis of the influence of workforce characteristics based on age, length of service, smoking habits and use of ear protection with increased blood pressure and pulse rate in the workshop area:

**Table. 7**

The Influence of Individual Characteristics Including Age, Length of Work, Smoking Habits, and Use of Ear Protectives on Blood Pressure in The Workshop Area

Variables	Regression Coefficient	Significance
Age	23,431	0.999
Length of working	-0.637	0.403
Smoking Habit	3.384	0.011
Ear Protection Devices	2,556	0.040
Constant	-54,746	0.999

Based on table 7, factors that trigger increased blood pressure such as smoking habits and the use of ear protection devices are obtained. Both factors have been proven to cause increased blood pressure in workers.

The following are the results of individual characteristics including age, length of service, smoking habits and use of ear protection against pulse which are presented in the table below:

**Table. 8**

The Effect of Individual Characteristics Including Age, Working Period, Smoking Habits, and Use of Ear Protection Devices on Pulse Rate in The Workshop Area

Variables	Regression Coefficient	Significance
Age	-0.218	0.958
Length of working	-0.859	0.320
Smoking Habit	4,061	0.010
Ear Protection Devices	2,782	0.037
Constant	-9.189	0.293

Based on table 8, factors that trigger an increase in heart rate are smoking habits and the use of ear protection. Both factors have been shown to cause an increase in heart rate in workers.

The following are the results of the analysis of the influence of workforce characteristics based on age, length of service, smoking habits and use of ear protection with increased blood pressure and pulse rate in the dynotest room.

**Table. 9**

The Influence of Individual Characteristics Including Age, Length of Work, Smoking Habits, and Use of Ear Protectives on Pulse Rate in The Dynotest Room

Variables	Regression Coefficient	Significance
Age	3,677	0.125
Length of working	1,667	0.159
Smoking Habit	4.902	0.048
Ear Protection Devices	0.041	0.980
Constant	-18,576	0.045

Based on table 9, it is found that the factors that trigger an increase in blood pressure are smoking habits and the use of ear protection. The smoking habit has been proven to cause an increase in blood pressure in workers.

The following are the results of individual characteristics including age, length of service, smoking habits and use of ear protection against pulse which are presented in the table below:

**Table. 10**

The Influence of Individual Characteristics Including Age, Length Of Work, Smoking Habits, And Use of Ear Protectives on Pulse Rate in The Dynotest Room

Variables	Regression Coefficient	Significance
Age	0.152	0.941
Length of working	0.751	0.546
Smoking Habit	3.479	0.034
Ear Protection Devices	3.148	0.048
Constant	-12,375	0.076



Based on table 10, factors that trigger an increase in heart rate are smoking habits and the use of ear protection. Both factors have been shown to cause an increase in heart rate in workers.

## Discussion

Based on the results of noise intensity measurements, an average result of 83.5 dBA was obtained. The area closest to the workshop obtained an average result of 82.5 dBA. The central area of the workshop obtained an average of 83 dBA. The farthest area from the workshop obtained an average result of 85 dBA. Meanwhile, for the dynotest room, an average of 117.8 dBA was obtained. From the results of noise intensity measurements, it can be concluded that the dynotest room exceeds the NAB for industrial work environment noise of 85 dBA according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018.

The results of the logistic regression test showed a p-value (sig) for the increase in blood pressure and pulse rate of 0.001 and 0.002 respectively (p-value (sig) <0.05) which means that there is an effect of noise on blood pressure and pulse rate. This is influenced by the stress experienced by workers due to noise, which causes an increase in blood pressure and pulse rate. This study is in line with research conducted [8] shows that there is an effect of noise on increasing blood pressure and pulse rate. According to research conducted by Amalia Rahmah *et al* [9] Noise exposure can affect increased pressure. High blood pressure causes workers to experience stress which can increase blood pressure. According to research conducted by Maulina *et al* [10] said that workers who experience noise during the day will have disturbed sleep at night and trigger stress.

The results of the logistic regression test showed a p-value (sig) for the increase in blood pressure and pulse rate of 0.002 and 0.003 respectively (p-value (sig) <0.05) meaning that there is an effect of noise on blood pressure and pulse rate. This is influenced by the stress experienced by workers due to high noise exposure, which causes an increase in blood pressure and pulse rate. According to research conducted by Iwan suryadi & khiki purnawati kasim [11] stated that there is a significant influence between noise and blood pressure. From the research Lendo *et al* [1] Noise factors trigger discomfort or stress, which can increase blood pressure and heart rate. According to other research conducted by Umaidah *et al* [3] Noise triggers an increase in stress hormones, which causes blood vessels to constrict and causes workers' blood pressure and heart rate to rise.

The results of the logistic regression test showed p-value (sig) for the increase in blood pressure and pulse rate of 0.999 and 0.958 respectively (p-value (sig) <0.05) which means there is no influence between age and the increase in blood pressure and pulse rate. The increase in blood pressure and pulse rate is influenced by several factors such as unhealthy lifestyles, including workers who have stress habits and stay up late. In line with research conducted by Khairani & Achmadi [8] showed that there was no significant relationship between age and increased blood pressure and pulse rate. In line with research conducted Wulan *et al* [12] shows that there are several factors that trigger increased blood pressure, such as smoking, stress and the habit of staying up late every night.

The results of the logistic regression test showed that the p-value (sig) for the increase in blood pressure and pulse rate were 0.403 and 0.859 respectively (p-value (sig) <0.05) which means that there is no influence between the length of service and the increase in blood pressure and pulse rate, this is because the length of service at PT. X is dominated by  $\leq 1$  year. The longer the length of service, the higher a person experiences an increase in blood pressure and pulse rate. in line with research Khairani & Achmadi [8] stated that there was no significant relationship between work period and increased blood pressure and pulse rate. According to research conducted by Nahda *et al* [13] The results showed that there was no influence between working years and the increase in blood pressure ( $p > \alpha = 0.005$ ), so there was no significant relationship between working years and blood pressure.

The results of the logistic regression test showed a p-value (sig) for the increase in blood pressure and pulse rate of 0.011 and 0.010 respectively (p-value (sig) <0.05) which means that there is an effect of smoking habits on the increase in blood pressure and pulse rate. Cigarette smoke contains nicotine which triggers adrenaline to be released so that the heart works harder. This study is in line with research conducted by Amalia Rahmah *et al* [9] shows that workers who have a smoking habit have higher blood pressure and pulse rates. According to research conducted Vandini *et al* [14] said smoking is an external factor that causes an increase in heart rate in humans, there is stimulation of the cooreceptors in the arteries and aorta boies which causes an increase in heart rate frequency. According to Romadhon & Kurniati [15] Smoking can increase systolic and diastolic blood pressure.

The results of the logistic regression test showed a p-value (sig) for the increase in blood pressure and pulse rate of 0.040 and 0.037 respectively (p-value (sig) < 0.05) which means that there is an effect of the use of ear

protection on the increase in blood pressure and pulse rate. In line with the research conducted Sofia *et al* [16] There is a relationship between the use of ear protection devices and increased blood pressure and heart rate. According to Setyani *et al* [17] Exposure to loud noise can damage the inner ear. Using ear plugs can reduce stress so that it does not cause an increase in blood pressure [18].

The results of the logistic regression test showed that the p-value (sig) for the increase in blood pressure and pulse rate were 0.126 and 0.152 respectively (p-value (sig) <0.05) which means that there is no influence between age and the increase in blood pressure and pulse rate. This is due to poor sleep patterns and workload. In line with research Audina *et al* [19] shows poor sleep patterns can increase blood pressure. According to Sibti Umar *et al* [20] The results showed that 33 people (73.8%) did not experience an increase in blood pressure, this was due to the unequal workload. High noise causes sleep disturbances [21].

The results of the logistic regression test showed that the p-value (sig) for the increase in blood pressure and pulse rate were 0.159 and 0.546 respectively (p-value (sig) <0.05) which means that there is no influence between work period and the increase in blood pressure and pulse rate. In line with research conducted by Nurjanah *et al* [22] said that the increase in blood pressure and pulse continuously for a long period of time can make the body adapt. There is no relationship between work period and increase in blood pressure, this is because there is an increase in blood pressure in employees with a work period of less than 5 years [4]. Not in line with research Hamdie *et al* [23] stated that there is a significant relationship between work period and increases in blood pressure and pulse rate.

The results of the logistic regression test showed a p-value (sig) for the increase in blood pressure and pulse rate of 0.048 and 0.034 respectively (p-value (sig) <0.05) which means that there is an effect of smoking habits on the increase in blood pressure and pulse rate. In line with research conducted by Toat & Daeli [24] Smoking can be a major factor in causing increased blood pressure and heart rate.

According to research conducted by Nurjanah *et al* [22] said that increased blood pressure and pulse rate occurred after the first puff. According to research conducted by Kurnia & Malinti [25] shows blood pressure and pulse rate are determined by the number of cigarettes smoked each day. Nicotine causes an increase in blood pressure and pulse rate. Smoking causes an increase in blood pressure and pulse rate, this is due to the addition of oxygen to the heart muscle. [26]. Smoking behavior causes changes in systolic and diastolic blood pressure [19].

The results of the logistic regression test showed that the p-value (sig) for the increase in blood pressure and pulse rate were 0.980 and 0.048 respectively (p-value (sig) <0.05), which means that there is no influence between the use of ear protection and the increase in blood pressure. Sumardiyono *et al* [27] states that ear protection can reduce noise. Lamawuran & Singga [28] states that noise can increase the pulse rate of peripheral blood vessel construction in the hands and feet and cause paleness and sensory disturbances. A faster pulse rate can be identified as someone experiencing workload, mental burden, fatigue and stress. According to Vandini *et al* [14] stated that there is a relationship between the use of ear protectors and increased blood pressure and heart rate, the use of ear protectors including ear muffs and ear plugs can protect the entire ear so as to minimize physiological disorders such as increased blood pressure and heart rate. Ear protectors can reduce noise up to 30 dBA.

## Conclusions

Based on the results of the study, it was found that noise in the workshop area and dynotest room had significant intensity, which directly affected the increase in blood pressure and pulse rate of workers. Prolonged exposure to noise contributes to physiological responses in the form of increased blood pressure and pulse rate, which indicates a risk to the cardiovascular health of workers. Therefore, noise in the work environment should be considered a risk factor that requires special attention. For further research, it is expected to expand the scope of the study by considering other variables such as lifestyle and sleep habits, which may affect cardiovascular health.

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## Informed consent statement

Informed consent was obtained from all subjects involved in the study.

## Conflicts of Interest

The authors declare no conflict of interest.



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