

THE EFFECT OF NOISE EXPOSURE ON BLOOD PRESSURE AND PULSE RATE ELEVATION AMONG WORKERS

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ABSTRACT

The Effect of Noise Exposure on Blood Pressure and Pulse Rate Elevation Among Workers. The noise intensity in the workshop area, specifically in the dynotest room at PT. X, records an average of 103 dB(A). This noise originates from assembly, maintenance, and equipment testing activities. The high noise levels and sustained intensity can significantly increase blood pressure and pulse rates in workers who do not use hearing protection devices (HPDs) while working. This study aims to evaluate the impact of noise on the blood pressure and pulse rates of workers in the workshop area, particularly in the dynotest room at PT. X. The research, which employed an observational approach with a cross-sectional study design, was conducted from December to May 2024, involving 40 workers exposed to noise in the dynotest room at PT. X. Data collected included noise measurements, blood pressure, and pulse rates, which were then analyzed using logistic regression tests. The results showed that the average noise level in the dynotest room was 83.5 dBA, while the peak noise level reached 117.8 dBA. Statistical analysis indicated a significant value ($p = 0.001$) for the relationship between noise exposure and the blood pressure and pulse rates of workers at PT. X, suggesting a significant increase in these parameters due to noise exposure. Recommendations were made for the company to monitor the health of workers to identify potential health issues arising from noise exposure.

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INTRODUCTION

Industrial growth in Indonesia continues to increase in line with its commitment to sustainable development. However, this progress also brings adverse effects to the work environment, one of which is elevated noise levels. According to data from the World Health Organization (WHO) ^[1], approximately 360 million people—or 3.6% of the global population—suffer from hearing impairment. Indonesia ranks fourth in Asia with a prevalence rate of 16.8%. WHO predicts this figure will rise to 630 million cases by 2023. In East Java Province, hearing loss among individuals over the age of five was recorded at 2.9% and continues to show an annual increase ^[2].

Noise does not only affect hearing but also induces psychological and physiological disturbances such as stress, headaches, reduced concentration, elevated blood pressure, and altered heart rate. High-intensity noise stimulates the release of stress hormones such as adrenaline, noradrenaline, and cortisol, which directly impact the cardiovascular system. Various studies have indicated that noise exposure exceeding threshold levels can lead to

increased blood pressure and heart rate among workers. For instance, a study on furniture workers in Touliang Oki Village revealed a noise level of 86.6 dB with a significant correlation to blood pressure and heart rate [3]. Similar results were found in studies at CV Rinjani Perkasa printing house and PT Rajawali Perkasa Furniture, where noise exposure above 90 dB(A) contributed to elevated systolic and diastolic blood pressure [4,5].

Observations at PT. X—a company engaged in the assembly and maintenance of heavy machinery—showed that workers were exposed to high noise levels, particularly in the workshop area (96.9 dB(A)) and the dynotest room (103 dB(A)). Several workers reported symptoms such as dizziness, nausea, and reduced concentration. Interviews indicated that 75% of 12 employees experienced these symptoms, and a case of noise-induced hearing loss was recorded in 2017. Low compliance with the use of hearing protection devices (HPDs), smoking habits, and inadequate ventilation were contributing factors. According to Indriyanti (2020), workers exposed to noise levels above 85 dB(A) are at risk of elevated blood pressure, especially when factors such as age, work duration, and smoking habits are involved.

Based on these conditions, this study aims to analyze the relationship between noise levels in the workshop and dynotest room at PT. X and the increase in workers' blood pressure and heart rate.

MATERIALS AND RESEARCH METHODS

This study employed an analytical observational design with a cross-sectional approach, aimed at measuring the relationship between noise levels and workers' blood pressure and heart rate at a single point in time. Data collection was conducted through direct observation and structured interviews. Logistic regression analysis was used to evaluate the influence between independent and dependent variables.

Noise Level Measurement

Noise intensity was measured using a Sound Level Meter in accordance with the Indonesian National Standard (SNI) 7231:2009 on Workplace Noise Measurement. The procedure included adjusting microphone sensitivity based on the characteristics of the noise source and avoiding sound reflections. The microphone was positioned at a 70°–80° angle to the noise source in an upright orientation. Measurements were conducted for five minutes during active work conditions, and the Leq (Equivalent Continuous Sound Level) was recorded as the sound pressure level. If the device lacked automatic Leq functionality, calculations were performed manually.

Blood Pressure Measurement

Blood pressure was measured using a digital sphygmomanometer following the operational standard outlined in Indonesian Ministry of Health Regulation No. 11 of 2017 on Patient Safety. Subjects were seated in a relaxed position with the arm placed on a flat surface at heart level. The cuff was placed on the upper right arm, and measurements were taken automatically by pressing the device's control button. Results were recorded after the reading was complete.

Pulse Rate Measurement

Pulse rate was measured according to the 2014 Standard Nursing Procedures and the Clinical Practice Medical Equipment Handbook. The radial artery was palpated using the index and middle fingers, and the number of beats was counted for 30 seconds and multiplied by two. In cases of irregular rhythm, the count was taken over a full minute.

RESEARCH RESULTS AND DISCUSSION

Noise Level Measurement

Table 1. Noise Intensity Measurement in the Workshop Area

No	Work Sector	Noise Measurement	Percentage (%)
1.	Area terdekat	82,5 dBA	53 %
2.	Area tengah	83 dBA	33 %
3.	Area terjauh	85 dBA	14 %

Measurement of Noise Intensity was conducted in two work areas: the workshop and the dynotest room. In the workshop area, noise levels varied between 82.5 dBA and 85 dBA. The lowest noise level was recorded in the sector closest to the office at 82.5 dBA, while the highest noise level, 85 dBA, was found in the farthest area. A total of 26 workers (86%) in the central and nearest sectors were exposed to noise levels below the threshold limit value (TLV), whereas 4 workers (14%) in the farthest sector were exposed to noise at exactly 85 dBA, which meets the TLV.

Table 2. Noise Intensity Measurements in the Dynotest Room

No	Work Sector	Measurement of Noise Levels	Percentage (%)
1.	Dynotest Room	117,8 dBA	100 %

The noise intensity in the dynotest room was measured at 117.8 dBA. All 10 workers (100%) were exposed to noise levels exceeding the threshold limit value. The noise originated from testing of the C9 engineering equipment.

Measurement of Blood Pressure and Pulse Rate

Table 3. Measurement of blood pressure and pulse rate conducted in the workshop area.

Blood Pressure	Frequency	Percentage
Elevated	16	53 %
Decreased	14	47 %
Total	30	100 %
Pulse Rate	Frequency	Percentage
Elevated	16	53 %
Decreased	14	47 %
Total	30	100 %

Blood pressure and pulse rate measurements were conducted before and after the workers performed activities in each work area. In the workshop area, 16 workers (53%) experienced an increase in blood pressure and pulse rate after exposure to noise, while 14 workers (47%) experienced a decrease. In addition, 4 workers were found to have a history of hypertension.

Table 4. Blood Pressure and Pulse Rate Measurement in the Dynotest Room

Blood Pressure	Tekanan Darah	Frekuensi	Persentase
Elevated	Naik	6	60 %
Decreased	Turun	4	40 %
Total	Total	10	100 %
Pulse Rate	Denyut Nadi	Frekuensi	Persentase
Elevated	Naik	6	60 %
Decreased	Turun	4	40 %
Total	Total	10	100 %

Blood pressure measurements were taken both before and after the workers performed their tasks. The results indicated an increase in both blood pressure and pulse rate. Based on the table, it was found that 6 workers (60%) in the dynotest room experienced elevated blood pressure and pulse rate following noise exposure, and 4 workers were known to have a history of hypertension.

Identification of Individual Characteristics in the Workshop Area

The individual characteristics of workers in the workshop area showed that the majority of respondents were aged between 20 and 60 years (93%), and most had a work duration of less than or equal to one year (43%). A total of 40% of respondents were classified as light smokers, and 63% were reported to rarely use hearing protection devices (HPDs) during work.

Identification of Individual Characteristics in the Dynotest Room

In the dynotest room, all respondents were also aged between 20 and 60 years, with half of them having worked for less than one year. As many as 90% of respondents were moderate smokers, and all (100%) rarely used HPDs while working. These conditions indicate additional risk factors that may exacerbate the impact of noise exposure on workers' health, particularly regarding blood pressure and pulse rate.

Noise Measurement

The noise intensity measurements yielded an average reading of 83.5 dBA. The average noise level recorded near the workshop was 82.5 dBA, while the central area of the workshop registered an average of 83 dBA. The farthest area from the workshop showed an average noise level of 85 dBA. Meanwhile, the dynotest room recorded an average noise level of 117.8 dBA. Based on the Indonesian Ministry of Manpower Regulation Number 5 of 2018, the dynotest room exceeds the occupational noise exposure threshold limit value (TLV) of 85 dBA for industrial work environments.

The Effect of Noise on Increased Blood Pressure and Heart Rate in Workshop and Dynotest Areas

Logistic regression analysis revealed significant p-values for increased heart rate and blood pressure at 0.002 and 0.001, respectively ($p < 0.05$). This confirms that noise exposure has a significant effect on both variables among workers in the workshop and dynotest areas. The primary contributing factor is stress induced by workplace noise, which can cause elevated heart rate and blood pressure in exposed individuals. This finding is consistent with study ^[5], which showed that noise significantly contributes to increased blood pressure and heart rate. Study ^[6] also found that blood pressure responses to noise exposure can be highly sensitive, especially for workers with prolonged exposure. Saiful ^[7] highlighted that noise-induced sleep disturbances during the day may elevate stress levels at night, potentially worsening workers' health conditions.

The logistic regression test indicated p-values of 0.002 and 0.003 for blood pressure and heart rate increases, respectively ($p < 0.05$), indicating a significant influence of noise on these parameters. This effect is driven by stress caused by high noise exposure leading to elevated blood pressure and heart rate. According to Iwan Suryadi et al. (2023), there is a significant influence of noise on blood pressure. Lendo et al. (2022) stated that noise triggers discomfort or stress, thereby increasing blood pressure and heart rate. Umaidah et al. (2023) found that noise induces stress hormone release, causing vasoconstriction and resulting in elevated blood pressure and heart rate.

The Influence of Individual Characteristics Including Age, Length of Service, Smoking Habits, and Use of Hearing Protection Devices on Increased Blood Pressure and Heart Rate in the Workshop Area

Age

No correlation was found between age and increased blood pressure or heart rate, as shown by logistic regression p-values of 0.999 for blood pressure and 0.958 for heart rate ($p > 0.05$). Various factors, including unhealthy lifestyles such as stress and late-night sleep patterns,

contribute to elevated blood pressure and heart rate. This aligns with study [5], which showed no significant relationship between age and increases in blood pressure and heart rate. Study [9] also noted factors like smoking, stress, and frequent late nights as contributors to increased blood pressure.

Length of Service

Logistic regression p-values for length of service were 0.403 (blood pressure) and 0.859 (heart rate), indicating no significant effect on increased blood pressure and heart rate. This is likely because most employees at PT. X have worked for ≤ 1 year. Generally, longer service duration correlates with higher increases in blood pressure and heart rate. Study [5] also reported no significant relationship between length of service and increased blood pressure and heart rate. Similarly, study [10] found no significant effect of length of service on blood pressure ($p > 0.005$).

Smoking Habits

Logistic regression results showed p-values of 0.011 (blood pressure) and 0.010 (heart rate), indicating smoking habits significantly influence increases in blood pressure and heart rate. Cigarette smoke contains nicotine which triggers adrenaline release, causing the heart to work harder. This finding aligns with study [11] showing that smokers have higher blood pressure and heart rates. Study [12] identified smoking as an external factor increasing heart rate by stimulating chemoreceptors in the arteries and aortic bodies. Study [13] also confirmed smoking increases both systolic and diastolic blood pressure.

Use of Hearing Protection Devices

Logistic regression indicated p-values of 0.040 (blood pressure) and 0.037 (heart rate), suggesting a significant influence of hearing protection device use on blood pressure and heart rate. This aligns with study [14], which found a relationship between hearing protection use and cardiovascular parameters. Study [15] noted that exposure to loud noise can damage the inner ear, whereas earplug use can reduce stress and thus prevent blood pressure elevation [16].

The Influence of Individual Characteristics on Blood Pressure and Heart Rate Increases in the Dynotest Room

Age

Logistic regression p-values of 0.126 (blood pressure) and 0.152 (heart rate) indicate no significant effect of age on these parameters, potentially due to poor sleep patterns and workload differences. Study [17] showed poor rest patterns can elevate blood pressure. Sibti Umar found 73.8% of subjects had no increase in blood pressure, likely due to varying workloads. High noise levels cause sleep disturbances [18].

Length of Service

No significant association was found between length of service and increased blood pressure or heart rate ($p = 0.159$ and 0.546). Study [19] suggests long-term exposure can lead to physiological adaptation. Study [20] reported increased blood pressure in employees with less than 5 years' service. However, study [21] found significant correlations between length of service and increased blood pressure and heart rate.

Smoking Habits

P-values of 0.048 (blood pressure) and 0.034 (heart rate) indicate smoking significantly affects these parameters. Study [22] identified smoking as a primary cause of increased blood pressure and heart rate. Study [23] reported increases occurring after the first cigarette puff. Study [24] found blood pressure and heart rate correlate with the number of cigarettes smoked

daily. Nicotine causes vasoconstriction leading to increased blood pressure and heart rate [25, 26]. Smoking alters systolic and diastolic blood pressure [17].

Use of Hearing Protection Devices

Logistic regression results showed p-values of 0.980 (blood pressure) and 0.048 (heart rate), indicating no significant effect on blood pressure but a borderline effect on heart rate. Studies [27] and [28] report hearing protection devices reduce noise exposure and noise can increase heart rate through vascular constriction.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that noise intensity in the workshop and dynotest room at PT. X exceeds the regulatory threshold, particularly in the dynotest room with 117.8 dBA. Logistic regression analysis confirmed a significant effect of noise exposure on increased blood pressure and heart rate in workers at both sites. Additionally, individual characteristics such as smoking habits and use of hearing protection devices significantly influence these cardiovascular parameters, while age and length of service do not show meaningful associations.

These findings underscore the detrimental impact of high noise exposure, especially without adequate protection and combined with behavioral risk factors like smoking, on workers' cardiovascular health. It is recommended that PT. X management strengthen policies mandating the use of hearing protection devices in high-noise areas. Furthermore, education and monitoring regarding smoking habits at the workplace should be intensified. Preventive measures, including establishing sound-insulated work zones and raising awareness about regular health check-ups, are strategic steps to mitigate noise-related cardiovascular risks. Future research may consider additional variables such as work-related stress and daily exposure duration to further elucidate the causal relationship between noise and worker health.

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