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Relationship of Noise Level to Increased Blood Pressure in Workers at PT X 2025

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ABSTRACT

Increased blood pressure is caused by various risk factors, such as noise. Noise is a physical occupational hazard that acts as a stressor, disrupting hearing, sleep, communication, and daily activities, thereby potentially increasing sympathetic nervous system activity. This study aimed to investigate the relationship between noise levels and the increase in blood pressure before and after work at PT. Shinko Plantech, a construction and manufacturing company specializing in pipe and forged steel production. This study used cross sectional study. Subjects were workers of PT. Shinko Plantech, selected by stratified random sampling according to inclusion and exclusion criteria. Data were analyzed with chi-square test, using univariate and bivariate methods, through SPSS. This study showed 63.3% of workers were exposed to noise levels ≥ 85 dB, and 66% experienced an increased blood pressure before and after work. Based on analysis, there was a significant association between noise intensity and increased blood pressure (p = 0.048). Other factors, such as age, length of employment, working hours, smoking habits, use of APD (earplug), and body mass index (BMI) had no relationship to increased blood pressure before and after work. Noise intensity ≥ 85 dB and increased blood pressure was significantly associated.

Keywords : *Noise intensity, increased blood pressure, industry, manufacture, repeated impulsive noise*

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INTRODUCTION

Increased blood pressure is the main trigger for cardiovascular disease mortality, which is caused by various risk factors, such noise exposure as occupational hazard.[1–3] Based on World Health Organization, 1.28 millions of people aged 30-79 years old suffer from hypertension, which two-thirds of them were from low- and middle- income countries.[4] According to Survei Kesehatan Indonesia 2023, hypertension is based on diagnosis by doctor and measurement result shows ≥ 140 mmHg for systolic pressure and/or ≥ 90 mmHg for diastolic pressure.[5,6] The prevalence on hypertension in Indonesia aged ≥ 18 years old, 8.6% based on doctor's diagnosis and 30.8% based on measurement result.[5,6] While hypertension prevalence in Banten aged ≥ 18 years old shows 10.2% based on doctor's diagnosis and 28.5% based on measurement.[5,6]

According to Occupational Safety and Health Administration (OSHA), 25% of workers were exposed to noise exposure.[7] Most of the workers who exposed to noise were those who works in mining, oil, and gas extraction (61%), followed by construction industry (51%), and manufacturing (46%).[7] An industry in Denmark presented 52% of workers in construction, 51% of workers in metal production manufacture, and about 50% of manufacture wood product were exposed to noise >85 dB.[8] Likewise, China revealed the most workers that exposed to ≥ 85 dB were in manufacture non-metalic mineral product (32.08%), while the least of them were in chemical product manufacture (7.59%).[9]

Noise exposure would affect on hearing impairment, sleep, communication, and other life activity.[10–12] Moreover, noise exposure could increase blood pressure and heart rate.[10–12] Blood pressure increment have impact on complications, such as aneurism, heart failure, and renal disease.[4,5] Those conditions will reduce one's quality of life, disrupt mobility, daily activities, and could lead to premature death.[13–16] Moreover, productivity will not be as efficient as healthy people.[17,18]

Several researches showed an association between noise intensity and increased blood pressure, while some of them did not validate that association. One of the research which confirmed an association between those two variables was Andjani, *et al* who conducted a study on cable factory workers in West Java and found that workers exposed to noise level ≥ 85 dB had 2.02 times higher risk on developing increased blood pressure compared to those who got exposed <85 dB.[19] On the other hand, Tessier, *et al*. did not find and association between noise intesity to increased blood pressure.[20]

Based on the problems description, this research was interested in studying th relationship between noise intensity and increased blood pressure among construction factory workers. There has been no research found in Banten Province on construction factories producing pipes and forged steel. This study aimed to provide knowledge and prevention for workers so that their quality of life and productivity would be efficient.

METHODS

This study used a cross sectional analytical observational study. The population was workers from PT. X and used stratified random sampling. Workers were randomized by numbers in each division of workers in PT. X using Toolpack Sampling in Microsoft Excel. Sample was calculated by proportion comparison test and obtained sample of 120 workers. Those respondents needed to fulfill informed consent that was given before any of measurement performed.

Noise measurements that we used was from Sound Level Meter application by National Institute of Occupational Safety and Health (NIOSH). This application has its own method measurement, such as 25-30 cm from receiver with 30-45 degree to noise exposure and estimated time was 15 minutes in unconstant noise sources.[21] PT. X has repeated impulsive noise in workshop werea because of their equipments and machines were only used when they were working.

Respondent's blood pressure was measured by sphygmomanometer of Omron HEM-7124. This sphygmomanometer is new, so it doesn't need any more calibration. The measurement was obtained before and after working. Each of respondent should get 5 minutes rest before measurement, talk was prohibited during measurement, hands supported and parallel to heart level, and cuff was placed directly on their skin.[22] Workers also need to get their weight and height measurement for another analysis. After that, all datas were collected by interviewing based on questionnaires.

This study used univariate analysis for respondents characteristic and bivariate analysis to show association between each variable, such as noise intensity, age, length of employment, working hours, smoking habit, BMI, and used of earplug. Bivariate analyses used chi-squaere test. This study has passed ethical review issued by Komite Etik Penelitian Kesehatan Universitas Sultan Ageng Tirtayasa number 24/UN43.20/KEPK/2025.

RESULTS

There were 120 respondents in this study that 54.2% of them were in ≥ 40 years old, while 45.8% were in their < 40 years old. Most of them have been in PT. X for ≥ 4 years (70.8%). A total of 71 respondents had smoking habit (59.2%). Of 60 respondents worked for 8 hours straight or less (50%). More than half of the respondents, such as 73 workers have BMI that categorized as overweight to obese (60.8%), meanwhile 47 of them were categorized as underwight to normal (39.2%). 76 of the respondents also got noise exposure for ≥ 85 dB (63.3%) shown in Table 1.

Table 1 Respondent's Characteristics Distribution

Characteristic	Frequency	
	n	%
Age		
1. ≥ 40 years	65	54.2
2. <40 years	55	45.8
Length of Employment		
1. ≥ 4 years	85	70.8
2. < 4 years	35	29.2
Smoking Habit		
1. Yes	71	59.2
2. No	49	40.8
Working Hours		
1. > 8 hours	60	50
2. ≤ 8 hours	60	50
BMI		
1. Overweight/obese (23,0 - >30,0 kg/m^2)	73	60.8
2. Underweight/Normal (<18.5 – 22.9 kg/m^2)	47	39.2
Noise Intensity		
1. ≥ 85 dB	76	63.3
2. < 85 dB	44	36.7

Source: Hafidza Sabrin, 2025

Moreover, the used of earplug in 76 respondents exposed by ≥ 85 dB were obtained by giving questionnaires. Thirty four of them admitted they didn't use earplug (44.7%) shown in Table 2.

Table 2 Used of Earplug Distribution

Characteristic	Frequency	
	n	%
Used of Earplug		
1. No	34	44.7
2. Yes	42	55.3

Source: Hafidza Sabrin, 2025

Table 3 shows 66 out of 120 workers had blood pressure increment before and after working (55%), while 54 others were not categorized as having blood pressure increment (45%). Blood pressure that categorized as an elevation before and after work, if systolic pressure increases ≥ 6 mmHg and/or diastolic pressure increases ≥ 4 mmHg.

Table 3 Frequency of Increased Blood Pressure

Characteristic	Frequency	
	N	%
Increased Blood Pressure		
1. Yes	66	55
2. No	54	45

Source: Hafidza Sabrin, 2025

Increased blood pressure has several risk factor. Respondent's characteristics were analyzed by bivariate analysis to know significancy relation on increased blood pressure. Table 4 showed association between seven variables and increased blood pressure. This study showed there was relationship between noise intensity and increased blood pressure (p-value=0.048). Noise intensity ≥ 85 dB could increased blood pressure 1.5 times higher than noise with <85 dB intensity (PR 1.5, 95% CI 1.0-4.5). On the other hand, other variables had no relationship to increased blood pressure, such as age (p = 0.65, PR 1.08, CI 95% 0.576-2.439), length of employment (p = 0.19, PR 1.29 CI 95% 0.576-2.439), smoking habit (p = 0.98, PR 0.99 CI 95% 0.478-2.064), working hours (p = 0.71, PR 1.07 CI 95% 0.557-2.350), dan BMI (p = 0.23, PR 0.82 CI 95% 0.303 – 1.345).

Table 4 Bivariate Analysis

Variable	Increased Blood Pressure				Total	*P value*	PR (95% CI)
	Yes		No				
	n	%	n	%	n		
Noise Intensity							
≥ 85 dB	47	61.8	29	38.2	76	0.048	1.5 (1.0-4.5)
< 85 dB	19	43.2	25	56.8	44		
Age							
≥ 40 years	37	56.9	28	43.1	65	0.65	1.08 (0.576-2.439)
<40 years	29	52.7	26	47.3	55		
Length of Employment							
≥ 4 years	50	58.8	35	41.2	85	0.19	1.29 (0.768–3.749)
< 4 years	16	45.7	19	54.3	35		

Smoking Habit							
Yes	39	54.9	32	45.1	71	0.98	0.99 (0.478-2.064)
No	27	55.1	22	44.9	49		
Working Hours							
> 8 hours	34	56.7	26	43.3	60	0.71	1.07 (0.557-2.350)
≤ 8 hours	32	53.3	28	46.7	60		
BMI							
Overweight/obese (23.0 – >30.0 kg/m^2)	37	50.7	36	49.3	73	0.23	0.82 (0.303-1.345)
Underweight/Normal (<18.5 – 22.9 kg/m^2)	29	61.7	18	38.3	47		

Source: Hafidza Sabrin, 2025

In addition, there was another variable that played a role in increasing blood pressure, namely the use of earplugs. Table 5 showed the relationship between used of earplug and increased blood pressure. But, there was no significancy between these two variables (p = 0.34, PR 0.83, 95% CI 0.249-1.609).

Table 5 Relation on Used of Earplugs and Increased Blood Pressure

Variable	**Increased Blood Pressure**				**Total**	***P value***	**PR (95% CI)**
	Yes		**No**				
	n	**%**	**n**	**%**	**n**		
Used of Earplug							
No	19	55.9	15	44.1	34	0.336	0.83 (0.249-1.609)
Yes	28	66.7	14	33.3	42		

Source: Hafidza Sabrin, 2025

DISCUSSION

Blood pressure is influenced by various factors that can contribute to its elevation include both modifiable and non-modifiable elements.[23] Non-modifiable risk factors comprise sex, age, and genetic predisposition or family history.[23–26] Conversely, modifiable risk factors include smoking, low-fiber diet, dyslipidemia, excessive sodium intake, physical inactivity, obesity or *overweight*, stress, and excessive alcohol consumption.[23–25,27–29]

Noise exposure is one of stressor that could elevate blood pressure.[30,31] This statement was confirmed by several studies. In this study, there was a relationship between noise intensity of ≥ 85 dB

and increased blood pressure (p = 0.048). As stated in noise concept of Babisch, there were two mechanisms of noise exposure, namely direct and indiret.[32–35] Direct mechanism could occur when noise intensity reaches >100 dB, therefore workers could suffer from hearing impaiment or noise-induced hearing loss (NIHL).[32–35] Meanwhile indirect mechanism could affect other systems by chronically moderate noise intensity exposure.[32–35] Communcation and sleeping disruption, even interrupt daily activities were caused by those noise exposure, and could lead to cortisol and other stress hormones activation to start cerebral or vascular inflammation, and produces oxidative stress.[33–35] Besides, sympathetic nerve could activate and lead to increased blood pressure and heart rate.[32–34] When these mechanism works in long term, diseases such as diabetes, stroke, myocardial infarction, and other kinds would decrease one's quality of life.[33,35]

Wulandari, *et al* showed that ≥ 85 dB could elevate blood pressure before and after work significantly (p = 0.041, CI 1.058 – 3.178).[30] Noise exposure with more than 85 dB could increase blood pressure before and after work 1.833 times higher than noise intensity lower than 85 dB.[30] Another research also confirmed relationship between those two variables, such Indriyanti, *et al*. obtained p-value 0.001 and even did multivariat analysis with 19.8 times higher than <85 dB noise exposure.[31] This study also showed same statement of significancy between ≥ 85 dB noise exposure could increase blood pressure, and 1.5 times higher than <85 dB noise exposure.

Another risk factor to increased blood pressure is age.[36] As the age become older, our body start giving some changes, such stiffnes and smaller diameter in artery.[36,37] Those condition would affect blood pressure to elevate.[36,37] Wulandari, *et al* obtained that aging was significantly affect increased blood pressure (p = 0.024).[30] Cayir, *et al* showed the same statement that age >40 years could elevate blood pressure 4 times higher than <40 years old.[38] On the other hand, this study didn't show the same result. There has no significant relation between age ≥ 40 years old to increased blood pressure (p = 0.065, PR 1.08, CI 0.576 – 2.439). Such statement also found in Indriyanti, *et al*. that age of ≥ 40 years old was unrelated to increased blood pressure (p = 0384).[31] Disconnection of these two variables were due to some possibilities, healthy diet in study's respondents, normal BMI, and no smoking habit.[39]

Length of employment is also one of blood pressure increment risk factors.[30] The longer length of employment, the more frequently the workers will be exposed to noise.[30,40] This could be shown in study by Wulandari, *et al*. that ≥ 4 years of employment was significant to increased blood pressure (p = 0.013).[30] Zhou, *et al*. revealed in line result, of ≥ 4 years of employment had a significant relation to increased blood pressure.[41] But another study from Indriyanti, *et al.* couldn't get the same result, that ≥ 10 years of employment was unrelated to increased blood pressure.[31] In conclusion, this study showed no significant relation between ≥ 4 years of employment and increased blood pressure (p = 0.19). This result occurred due to ≥ 4 years of employment to be the cut off hasn't enough to show any significancy to blood pressure increment. Beside that, population of this study was workers who only exposed to repeated impulsive noise exposure from their tools and machines while they were actively working.

Based on duration and noise intensity, worker who exposed to ≥ 85 dB has maximal 8 hours/day to spend on the field.[42] The duration per day will be reduced as the noise intensity increases.[42] Stress hormone, such cortisol would elevate as noise intensity gets high.[10,33,43] Cortisol activates sympathetic nerve system, oxidative stress that could increase blood pressure.[33,35,43] Another significant result between > 8 hours working duration and increased blood pressure was found in study by Wulandari, *et al*. (p = 0.020) and Sumardiyono, *et al.* (p = <0.001).[30,44] While those studies found significant relation on those variables, but Indriyanti, *et al* had no signficant result (p = 0.659).[31] So as this study that could not show significancy of > 8 hours of working and increased blood pressure. This could be caused by break time that occur oftenly. While workers were in a break, their machines and equipments wouldn't produce noice so no noise exposure would be found.

There were some chemical content in smoke, such nicotine and carbon dioxide that could promote free radicals so they could disrupt endothel and induced chronic inflammation.[45,46] Smoking could stimulate sympathetic nerve system, hence it will increase blood pressure and heart rate.[47,48] Indriyanti, *et al*. agreed that there was an association between smoking habit and increased blood pressure (p = 0.017).[31] In contrast, study by Wulandari, *et al*. obtained other result that there was no significancy between smoking habit and blood pressure increment.[30] This study also got no significancy result on smoking habit and increased blood pressure. It was due to bias in respondent's response of smoking habit question, or type of smoke that they used and other population used. Furthermore, weight also play role on increasing blood pressure.[49] One study showed that smoking cessation could elevate blood pressure, with another playing factor, which was weight gain ≥ 3 kg.[49]

Even though this study didn't find any association between used of earplugs and increased blood pressure (p = 0.336), but earplugs could reduce noise intensity 15-30 dB.[50] Indriyanti, *et al* also found the same result that there wasn't significancy on used of earplugs to elevate blood pressure.[31] This could due to workers' compliance on used of earplugs. As what this study observe, workers' in this population didn't put their earplugs according to operational standards. Yet, Wulandari, *et al*. obtained significancy on the result of association between used of earplugs and increased blood pressure, even found that earplugs was the most playing factor on increasing blood pressure (p = 0.001).[30] Noise reduction rate as much as 15-30 dB could lower risk of increased blood pressure and effect on cortisol levels.[51]

The last factor of variables that this study analyze was body mass index (BMI). Overnutrition, such overweight and obese could increase blood pressure by some interaction of renal, metabolic, and neuroendocrine.[52] They have longer blood vessels so it will increase resistancy that could lead to increased blood pressure.[25,52] Other than that, sympathetic nerve system will be stimulated due to pressure of fat to renal in order to activate renin-angiotensin-aldosterone system.[25,52] Study by Indriyanti, *et al*. obtained result that matched those mechanisms, such there was an association between BMI and increased blood pressure (p = 0.006).[31] Moreoever, Zhou, *et al* also found that BMI and

increased blood pressure has significant relation.[3] In contrast, Muhyidin, *et al*. there was no relation on BMI to systolic pressure (0.073) and diastolic pressure (0.08).[40] This study also found the same result as Muhyidin, *et al*. that there was no significant association on BMI to increased blood pressure. This could be caused by difference physical activity and work stress on each population of the studies. Categorization of BMI in this study also different from Indriyanti, *et al*. In this study, BMI was categorized in underweight to normal (<18.5 – 22.9 kg/m^2) and overweight to obese (23.0 – >30.0 kg/m^2), while Indriyanti, *et al* just categorized them into normal and obese.

CONCLUSION

This study found repeated-impulsive noise from machines and equipments that workers only used when they were working. There was more than half of the respondents (63.3%) exposed by noise intensity, such ≥ 85 dB. 66 out of 120 respondents (55%) had increased blood pressure before and after work with, their systolic increased ≥ 6 mmHg and/or diastolic increased ≥ 4 mmHg. These two variables of study, such noise intensity and increased blood pressure were analyzed and obtained a significant associaton. While other factors, such age, length of employment, working hours, smoking habit, earplugs use, and BMI had no relationship on increased blood pressure.

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