

# The Effect of Industrial Noise Exposure on Hypertension Incidence Among Factory Workers in Surabaya

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## Abstrak

Di Surabaya, sebagai salah satu pusat industri di Indonesia, banyak pekerja pabrik yang terpapar tingkat kebisingan tinggi setiap hari. Namun, data spesifik mengenai hubungan antara paparan kebisingan industri dan kejadian hipertensi pada pekerja pabrik di Surabaya masih terbatas. Studi ini bertujuan untuk menilai hubungan antara paparan kebisingan industri dan hipertensi pada pekerja pabrik di Surabaya. Data yang dikumpulkan dianalisis menggunakan uji statistik yang sesuai, seperti uji Chi-Square dan korelasi Spearman. Analisis korelasi Spearman menunjukkan bahwa paparan kebisingan industri berkontribusi pada peningkatan kejadian hipertensi sebesar 62% pada pekerja pabrik di Surabaya, dengan wanita terkena dampak lebih besar dibanding pria. Tingkat kebisingan yang lebih tinggi berkorelasi dengan risiko lebih besar untuk mengembangkan hipertensi. Kebisingan dari mesin pabrik juga meningkatkan risiko hipertensi secara lebih signifikan pada pekerja wanita dan karyawan berusia di atas 40 tahun, tanpa memandang jenis kelamin.

**Kata Kunci:** Paparan suara industri; Hipertensi; Pekerja Pabrik

## Abstract

*In Surabaya, as one of Indonesia's industrial centers, many factory workers are exposed to high noise levels daily. However, specific data on the relationship between industrial noise exposure and hypertension incidence among factory workers in Surabaya is still limited. This study aims to assess the association between industrial noise exposure and hypertension among factory workers in Surabaya. The collected data were analyzed using appropriate statistical tests, such as the Chi-Square test and Spearman correlation. The Spearman correlation analysis indicates that industrial noise exposure contributes to a 62% increase in the incidence of hypertension among factory workers in Surabaya, particularly affecting women at a higher rate than men. Higher noise levels correlate with a greater risk of developing hypertension. Noise from factory machinery also increases hypertension risks more significantly among female workers and employees over 40 years old, regardless of gender.*

**Keywords;** Industrial noise exposure; Hypertension; Factory workers

## INTRODUCTION

Hypertension, or high blood pressure, is a medical condition often referred to as the "silent killer" because it often shows no symptoms but can increase the risk of heart disease and stroke. Workplace noise exposure has been identified as a significant risk factor for increased blood pressure in workers (Sofia, 2024). Previous studies have shown that noise exposure exceeding established thresholds can lead to increased systolic and diastolic blood pressure, as well as

worsen cardiovascular conditions in workers (Arisdianto et al., 2025).

In Surabaya, as one of Indonesia's industrial centers, many factory workers are exposed to high noise levels daily. However, specific data on the relationship between industrial noise exposure and hypertension incidence among factory workers in Surabaya is still limited. This is important to study to provide a clearer picture of the impact of noise exposure on workers' health in the region. Occupational noise exposure can activate the body's stress response, leading to the release of stress hormones such as adrenaline and noradrenaline (Bolm et al., 2020).

This hormonal surge can cause vasoconstriction, increased heart rate, and elevated blood pressure (Wu et al., 2022). Over time, chronic exposure to such stressors can lead to sustained high blood pressure, increasing the risk of cardiovascular diseases. Exposure to factory machine noise can increase the risk of hypertension among workers (Zhang et al., 2021). High industrial noise, such as that produced by factory machines, has been shown to significantly correlate with elevated systolic and diastolic blood pressure in workers. Noise exposure exceeding established threshold limits can lead to increased systolic and diastolic blood pressure, worsening workers' cardiovascular health conditions (Zhang et al., 2022).

Workers exposed to noise have an average systolic blood pressure of 123.18 mmHg and diastolic blood pressure of 77.86 mmHg, higher than those not exposed. The prevalence of hypertension increases from 6% to 21% as the degree of hearing impairment and duration of noise exposure increase (Zhou et al., 2019). A study in the textile industry in Semarang found that noise exposure above 85 dBA is significantly associated with increased systolic and diastolic blood pressure among workers (Arumdani et al., 2022). In this study, it was found that exposure to noise in the refining section of PT. X is significantly associated with the incidence of hypertension. Statistical analysis yielded a p-value of 0.029 (OR 4.857; 95% CI 1.318 – 17.896), indicating that workers exposed to noise have nearly five times the risk of developing hypertension compared to those not exposed (Khairani & Achmadi, 2020).

The novelty of this study lies in investigating the noise exposure experienced by factory workers in Surabaya and whether there is a correlation with hypertension. This study aims to assess the association between industrial noise exposure and hypertension among factory workers in Surabaya. The findings are expected to contribute to the development of effective strategies to mitigate noise exposure and promote cardiovascular health in the workplace.

## METHODS

This study used an observational analytical approach with a cross-sectional design to analyze the relationship between noise exposure from factory machines and the incidence of hypertension in factory workers in Surabaya. The population of this study was all workers in the factory machine production section in Surabaya. A sample of 100 was taken. Independent variables: Noise exposure from factory machines, measured using a sound level meter and categorized based on the established noise threshold value. Dependent variables: The incidence of hypertension, measured based on the results of systolic and diastolic blood pressure measurements using a sphygmomanometer and classified according to applicable guidelines. Data collection using questionnaires, measuring blood pressure and noise measurements using sound level. The collected data were analyzed using appropriate statistical tests, such as the Chi-Square test and Spearman correlation.

## RESULTS AND DISCUSSIONS

The results As of 2025, approximately 30% of the adult global population is estimated to have hypertension, with two-thirds residing in developing countries, including Indonesia. Hypertension is a leading risk factor for non-communicable diseases such as stroke and coronary heart disease. In Indonesia, the prevalence of hypertension among adults is estimated at 31.7% . Hypertension often goes undetected due to its asymptomatic nature. Data from the Ministry of Health indicate that a significant portion of individuals with hypertension are unaware of their condition and do not receive appropriate treatment .

**Tabel 1. Subject characteristics (n=100)**

<b>Variabel</b>	<b>n</b>	<b>%</b>
Gender		
Woman	50	50,0
Man	50	50,0
Age		
20 – 39 years	47	47,0
40 – 60 years	53	53,0
Noise Level		
> TLV85dBA	56	56,0
<TLV85dBA	44	44,0

In Table 1, the study participants consisted of 50 men and 50 women working in factories in the Surabaya area. The age distribution was as follows: 53% were between 40 and 60 years old, and 47% were between 20 and 39 years old. Regarding noise exposure, 56% of participants were exposed to noise levels above 85 dBA, while 44% experienced noise levels below 85 dBA.

**Table 2. The relationship between Industrial Noise Exposure on Hypertension Incidence Among Factory Workers in Surabaya**

Variable	Increased Blood Pressure				Total		Sig. (2-tailed)
	High		Normal		n	%	
	n	%	n	%			
<b>Gender</b>							
Woman	40	40,0	10	10,0	50	100,0	
Man	23	23,0	27	27,0	50	100,0	
<b>Age</b>							
20-39 years	17	17,0	30	30,0	47	100,0	
40-60 years	33	33,0	16	20,0	53	100,0	
<b>Noise Level</b>							
> TLV85dBA	40	40,0	16	16,0	56	100,0	0,000 Significant
<TLV85dBA	13	13,0	31	31,0	44	100,0	
<b>Spearman Corelation</b>							
Correlation coefficient	0,621						
Criteria	Strong						

In Table 2, the data indicates that women are more likely to experience hypertension due to industrial noise exposure, with a prevalence rate of 40%. Regarding age, individuals aged 40–60 years are the most affected, accounting for 33% of cases. In terms of noise exposure levels, those exposed to noise levels exceeding the Threshold Limit Value (TLV) of 85 dBA exhibit a higher incidence of hypertension, with 40% of cases observed in this group. The Spearman correlation analysis indicates that industrial noise exposure contributes to a 62% increase in the incidence of hypertension among factory workers in Surabaya, particularly affecting women at a higher rate than men.

Chronic noise exposure can increase sympathetic nervous system activity, triggering the release of stress hormones such as adrenaline and noradrenaline. These hormones cause blood vessel constriction (vasoconstriction), increased heart rate, and eventually high blood pressure (Meng

et al., 2020). Studies show that noise exposure is associated with increased levels of blood pressure-related hormones, such as epinephrine, norepinephrine, and cortisol, in workers exposed to noise (Babasich et al., 2012).

Noise exposure can also trigger oxidative stress and inflammation, which damage blood vessel endothelial function and increase the risk of hypertension (Yang et al., 2018). The release of stress hormones can activate inflammatory and oxidative stress pathways by activating enzymes like NADPH oxidase, which damage endothelial and neuronal function (Stokholm et al., 2013). Noise exposure can increase the release of corticotropin hormones by the endocrine system, which in turn raises cortisol levels (Brook et al., 2009). Increased cortisol levels can amplify the effects of other stress hormones, such as adrenaline and noradrenaline, contributing to elevated blood pressure.

Adrenaline (epinephrine) and noradrenaline (norepinephrine) are hormones and neurotransmitters that play important roles in the body's stress response, including increasing blood pressure through vasoconstriction mechanisms (Brahem et al., 2019). Both adrenaline and noradrenaline work by binding to alpha-1 adrenergic receptors found on the smooth muscle of blood vessels. Activation of these receptors causes an increase in intracellular calcium ion ( $Ca^{2+}$ ) concentration in smooth muscle cells, which then activates the enzyme myosin light-chain kinase (Deng et al., 2001). This enzyme facilitates smooth muscle contraction, resulting in blood vessel narrowing (vasoconstriction) and increased systemic peripheral resistance, which in turn raises blood pressure.

Noradrenaline has a higher affinity for alpha-1 receptors compared to adrenaline, making its vasoconstrictive effects more dominant. As the primary neurotransmitter in the sympathetic nervous system, noradrenaline is released by sympathetic nerve endings and directly affects blood vessels, significantly increasing blood pressure (Hahad et al., 2023). Adrenaline, released from the adrenal medulla during the "fight-or-flight" response, also binds to alpha-1 receptors on blood vessels, causing vasoconstriction (Coney & Marshall, 2007). However, adrenaline can also bind to beta-2 adrenergic receptors on certain blood vessel smooth muscles, such as those in skeletal muscles and the liver, causing vasodilation. This vasodilatory effect is usually more dominant at physiological doses of adrenaline, but at high pharmacological doses, the vasoconstrictive effect through alpha-1 receptors can override the vasodilation, increasing blood pressure (Khosravipour et al., 2020).

The increase in blood pressure due to vasoconstriction caused by adrenaline and noradrenaline is part of the body's mechanism to prepare for stressful or dangerous situations (Skogstad et al., 2016). However, chronic exposure to stress or noise can lead to increased production of these

two hormones, contributing to the development of hypertension, including in cases of industrial noise exposure.

### **Industrial Noise Exposure on Hypertension Incidence Among Factory Workers in Surabaya**

Female factory workers exposed to noise have a higher risk of hypertension compared to men due to biological differences and physiological responses to stress. Chronic noise exposure increases sympathetic nervous system activity, triggering the release of stress hormones such as adrenaline and noradrenaline (Zhang et al., 2024). These hormones cause blood vessel constriction (vasoconstriction), increased heart rate, and ultimately high blood pressure. In women, this response can be stronger due to hormonal and metabolic differences compared to men (Lee et al., 2023).

A large study in China found that female factory workers exposed to noise have a higher risk of hypertension than men (Zhang et al., 2024). Factors such as age, duration of exposure, and use of hearing protection devices also influence this risk. Female factory workers are more vulnerable to hypertension caused by noise exposure due to differences in physiological responses and additional risk factors (Zeeb et al., 2017). It is important for companies to raise awareness and provide hearing protection devices as well as health programs to reduce this risk. Factory workers aged 40 and above are more susceptible to hypertension because of the combination of physiological factors, lifestyle, and work environment that interact with each other (Chen et al., 2021).

As age increases, the elasticity of blood vessel walls decreases due to collagen buildup and reduced production of nitric oxide. This causes blood vessels to become stiffer, increasing resistance to blood flow, and requiring higher pressure from the heart to pump blood throughout the body (Andini & Siregar, 2024). This process, known as arteriosclerosis, becomes significant after age 40 and contributes to increased systolic blood pressure. At 40 years and older, changes in metabolism can affect diet and physical activity patterns (Miao et al., 2023). Habits such as consuming foods high in salt and fat and low in fiber, along with lack of physical activity, can increase the risk of obesity, which in turn raises blood pressure. Furthermore, decreased physical activity can reduce heart and blood vessel capacity, increasing the risk of hypertension.

Factory workers aged 40 and above are more prone to hypertension due to a combination of natural physiological decline, accumulation of work stress, lifestyle changes, and workplace environmental exposure. Regarding noise exposure, the TLV (Threshold Limit Value) of 85

dBA means that noise exposure at a level of 85 decibels A-weighted (dBA) during an 8-hour workday is considered a safe limit to prevent permanent hearing damage. Noise exposure above this level increases the risk of hearing loss, especially with prolonged exposure exceeding 85 dBA (Salazar, 2023). If factory machine noise exceeds 85 dBA, the consequences can be significant.

Exposure to factory machine noise exceeding 85 dBA can cause various negative health effects for workers. High-intensity noise can cause permanent hearing damage known as Noise-Induced Hearing Loss (NIHL), due to damage to hair cells in the inner ear (Zhou et al., 2022). In addition, excessive noise can increase the production of stress hormones such as adrenaline and cortisol, leading to increased blood pressure and heart rate, potentially causing hypertension. Noise exposure can also trigger psychological disorders such as stress, anxiety, and sleep disturbances, which in turn can reduce concentration and work productivity. Moreover, high noise levels can interfere with communication among workers, increase the risk of workplace accidents, and decrease overall work quality. Therefore, it is important for companies to control noise levels in the workplace and provide appropriate personal protective equipment to safeguard workers' health.

This research aligns with studies by Bolm et al. (2020), Chen et al. (2017), and Nurfayanti et al. (2020), which show a relationship between industrial noise exposure and increased risk of hypertension. This emphasizes the importance of noise control in the workplace to protect workers' health. Prevention can be carried out by adopting a healthy lifestyle, such as consuming nutritious food, exercising regularly, managing stress, and using personal protective equipment to reduce noise exposure. Factory workers are more vulnerable to hypertension due to noise exposure because of a combination of environmental factors (high noise levels), physiological factors (activation of the sympathetic nervous system), and behavioral factors (lack of use of PPE). Preventive efforts such as the use of ear protectors, noise level control, and regular health check-ups are very important to reduce the risk of hypertension among factory workers

## **CONCLUSIONS**

Industrial noise exposure is significantly associated with an increased risk of hypertension among workers. Higher noise levels correlate with a greater risk of developing hypertension. Noise from factory machinery also increases hypertension risks more significantly among female workers and employees over 40 years old, regardless of gender. Therefore, it is crucial

for companies to implement effective noise control measures to protect workers' health.

## REFERENSI

- Andini, F.A.D. & Siregar, A.Y.M., 2024. Work hours and the risk of hypertension: the case of Indonesia. *BMC Public Health*, 24, p.2480. <https://doi.org/10.1186/s12889-024-20003-z>
- Arisdianto, A., Siauta, V.A. & Suriawanto, N., 2025. Pengaruh Intensitas Kebisingan terhadap Perubahan Tekanan Darah Pada Pekerja Bagian Produksi PT Sahabat Teknik Steel Construction di Sigi Biromaru. *Jurnal Pendidikan Tambusai*, 9(1), pp.7785–7789. Available at: <http://jptam.org/index.php/jptam/article/view/25759>
- Arumdani, I.S., Setiani, O., Joko, T., Raharjo, M. & Adi, S., 2022. Relationship of Noise Levels with Hypertension in Textile Workers in Semarang City. *Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan*, 19(3), pp.638-650.
- Babisch, W. et al., 2012. Exposure modifiers of the relationships of transportation noise with high blood pressure and noise annoyance. *The Journal of the Acoustical Society of America*, 132(6), pp.3788-3808. <https://doi.org/10.1121/1.4764881>
- Brahem, A., Riahi, S., Chouchane, A. et al., 2019. Impact of occupational noise in the development of arterial hypertension: A survey carried out in a company of electricity production. *Annals of Cardiology and Angiology*, 68(3), pp.168-174. <https://doi.org/10.1016/j.ancard.2018.10.008>
- Bolm-Audorff, U. et al., 2020. Occupational Noise and Hypertension Risk: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 17(17), p.6281. <https://doi.org/10.3390/ijerph17176281>
- Brook, R.D. et al., 2009. Insights into the mechanisms and mediators of the effects of air pollution exposure on blood pressure and vascular function in healthy humans. *Hypertension*, 54(5), pp.659-667. <https://doi.org/10.1161/HYPERTENSIONAHA.109.130237>
- Chen, F. et al., 2021. Impact of exposure to noise on the risk of hypertension: A systematic review and meta-analysis of cohort studies. *Environmental Research*, 195, p.110813. <https://doi.org/10.1016/j.envres.2021.110813>
- Chen, S. et al., 2017. Noise exposure in occupational setting associated with elevated blood pressure in China. *BMC Public Health*, 17(1), p.107. <https://doi.org/10.1186/s12889-017-4050-0>
- Coney, A.M. & Marshall, J.M., 2007. Contribution of alpha2-adrenoceptors and Y1



- neuropeptide Y receptors to the blunting of sympathetic vasoconstriction induced by systemic hypoxia in the rat. *The Journal of Physiology*, 582(Pt 3), pp.1349-1359. <https://doi.org/10.1113/jphysiol.2007.132563>
- Deng, J.T. et al., 2001. Ca<sup>2+</sup>-independent smooth muscle contraction. a novel function for integrin-linked kinase. *The Journal of Biological Chemistry*, 276(19), pp.16365-16373. <https://doi.org/10.1074/jbc.M011634200>
- Hahad, O. et al., 2023. Noise and Air Pollution as Risk Factors for Hypertension: Part II- Pathophysiologic Insight. *Hypertension*, 80(7), pp.1384-1392. <https://doi.org/10.1161/HYPERTENSIONAHA.123.20617>
- Khairani, S. & Achmadi, U.F., 2020. Analisis Hubungan Tingkat Kebisingan dengan Kejadian Hipertensi pada Pekerja Bagian Refining di PT X Tahun 2019. *Jurnal Nasional Kesehatan Lingkungan Global*, 1(3), pp.374-383. <https://doi.org/10.7454/jnklg.v1i3.1016>
- Khosravipour, M. et al., 2020. The effects of exposure to different noise frequency patterns on blood pressure components and hypertension. *International Archives of Occupational and Environmental Health*, 93(8), pp.975-982. <https://doi.org/10.1007/s00420-020-01545-2>
- Lee, J. et al., 2023. A Cross-Sectional Study of Occupational Noise Exposure and Hypertension in Malaysia. *Annals of Occupational and Environmental Medicine*, 35(1), p.e28. <https://doi.org/10.35371/aoem.2023.35.e28>
- Meng, L. et al., 2022. Chronic Noise Exposure and Risk of Dementia: A Systematic Review and Dose-Response Meta-Analysis. *Frontiers in Public Health*, 10, p.832881. <https://doi.org/10.3389/fpubh.2022.832881>
- Miao, L. et al., 2023. Hearing loss and hypertension among noise-exposed workers: a pilot study based on baseline data. *International Journal of Environmental Health Research*, 33(8), pp.783-795. <https://doi.org/10.1080/09603123.2022.2050681>
- Salazar, M.R., 2023. Hypertension, a linchpin between environmental noise exposure and the development of cardiovascular disease?. *Journal of Clinical Hypertension*, 25(2), pp.165-167. <https://doi.org/10.1111/jch.14618>
- Sofia, S., 2024. Relationship between respondent characteristics and noise intensity with increased blood pressure in production unit workers PT Japfa Comfeed Indonesia, Tbk. Plant Margomulyo. *KESMAS UWIGAMA: Jurnal Kesehatan Masyarakat*, 10(1). <https://doi.org/10.24903/kujkm.v10i1.2604>
- Skogstad, M. et al., 2016. Systematic review of the cardiovascular effects of occupational noise.

- Occupational Medicine, 66(1), pp.10-16. <https://doi.org/10.1093/occmed/kqv148>
- Stokholm, Z.A. et al., 2013. Occupational noise exposure and the risk of hypertension. Occupational and Environmental Medicine, 70(9), pp.646-651. <https://doi.org/10.1136/oemed-2012-101206>
- Wu, X. et al., 2022. The Impact of Occupational Noise on Hypertension Risk: A Case-Control Study in Automobile Factory Personnel. Frontiers in Cardiovascular Medicine, 9, p.803695. <https://doi.org/10.3389/fcvm.2022.803695>
- Yang, Y. et al., 2018. Relationship between occupational noise exposure and the risk factors of cardiovascular disease in China: A meta-analysis. Medicine, 97(30), p.e11720. <https://doi.org/10.1097/MD.00000000000011720>
- Zeeb, H. et al., 2017. Traffic noise and hypertension - results from a large case-control study. Environmental Research, 157, pp.110-117. <https://doi.org/10.1016/j.envres.2017.05.019>
- Zhang, D. et al., 2024. The influence of occupational noise exposure on blood pressure and hearing loss among female workers of childbearing age. BMC Public Health, 24(1), p.1489. <https://doi.org/10.1186/s12889-024-19004-9>
- Zhang, K. et al., 2021. Occupational noise exposure and the prevalence of dyslipidemia in a cross-sectional study. BMC Public Health, 21(1), p.1258. <https://doi.org/10.1186/s12889-021-11274-x>
- Zhang, L. et al., 2022. Relationship between occupational noise exposure and hypertension: Cross-sectional evidence from real-world. Frontiers in Public Health, 10, p.1037246. <https://doi.org/10.3389/fpubh.2022.1037246>
- Zhou, B. et al., 2022. Relationship Between Occupational Noise and Hypertension in Modern Enterprise Workers: A Case-Control Study. International Journal of Public Health, 67, p.1604997. <https://doi.org/10.3389/ijph.2022.1604997>
- Zhou, F. et al., 2019. Relationship between occupational noise exposure and hypertension: A cross-sectional study in steel factories. American Journal of Industrial Medicine, 62(11), pp.961-968. <https://doi.org/10.1002/ajim.23034>