Journal of Vocational Health Studies

https://e-journal.unair.ac.id/JVHS

DIFFERENCES IN WORKERS' BLOOD PRESSURE DUE TO NOISE IN THE MANUFACTURING INDUSTRY IN EAST JAVA, INDONESIA

PERBEDAAN TEKANAN DARAH PEKERJA AKIBAT KEBISINGAN PADA INDUSTRI MANUFAKTUR DI JAWA TIMUR, INDONESIA

Virrarny Eka Novyra , Ratih Damayanti *, Ratnaningtyas Wahyu Kusuma Wardani, Indah Lutfiya

Department of Health, Faculty of Vocational Studies, Universitas Airlangga, Surabaya, Indonesia

Original Research Article
Penelitian

A B S T R A C T

Background: *Continuous noise exposure can cause an increase in blood pressure and work-related stress in the rotary production area of PT APB Manufacturing Industry in East Java Province, Indonesia.* ***Purpose:*** *This research aims to analyze the effect of noise intensity on blood pressure before and after work among employees in the rotary production area of the manufacturing industry in East Java Province, Indonesia.* ***Method:*** *This research employed an analytic observational study with a cross-sectional design. The sample, obtained through cluster random sampling, consisted of 49 people. Data were collected by measuring noise intensity and monitoring blood pressure before and after work. A Paired Sample T-test was conducted to assess differences in workers' blood pressure before and after exposure to noise.* ***Result:*** *Significant differences were observed in both systolic (p-value = 0.000) and diastolic (p-value = 0.010) blood pressure before and after work.* ***Conclusion:*** *Increased blood pressure appears to be linked to noise levels in the workplace exceeding the threshold value. Consequently, there is a need for control efforts to overcome this issue.*

A R T I C L E I N F O

Received 21 September 2023
Revised 22 September 2023
Accepted 08 July 2024
Available Online 21March 2025

Correspondence:
Ratih Damayanti

E-mail :
ratih.damayanti@vokasi.unair.ac.id

Keywords:
Blood pressure, Manufacturing industry, Noise

A B S T R A K

Latar belakang: Paparan kebisingan yang terus menerus dapat menyebabkan peningkatan tekanan darah dan stres kerja pada area produksi rotari industri manufaktur PT APB di Provinsi Jawa Timur, Indonesia. **Tujuan:** Penelitian ini bertujuan untuk menganalisis pengaruh intensitas kebisingan terhadap tekanan darah sebelum dan sesudah bekerja pada pekerja di area produksi rotari industri manufaktur PT APB di Provinsi Jawa Timur, Indonesia. **Metode:** Penelitian ini merupakan penelitian observasional analitik dengan desain *cross-sectional*. Sampel yang digunakan teknik cluster *random* sampling diperoleh sebanyak 49 orang. Data diperoleh dengan mengukur intensitas kebisingan dan memeriksa tekanan darah sebelum dan sesudah bekerja. *Paired Sample T-test* dilakukan untuk mengetahui apakah terdapat perbedaan tekanan darah pekerja sebelum dan sesudah terpapar kebisingan. **Hasil:** Terdapat perbedaan tekanan darah sebelum dan sesudah bekerja. Terdapat perbedaan tekanan darah sistolik sebelum dan sesudah bekerja (*p-value* = 0.000) serta terdapat perbedaan tekanan diastolik sebelum dan sesudah bekerja (*p-value* = 0.010). **Kesimpulan:** Peningkatan tekanan darah dapat disebabkan oleh kebisingan di lingkungan kerja yang melebihi nilai ambang batas sehingga perlu adanya upaya pengendalian untuk mengatasi permasalahan tersebut

Kata kunci:
Tekanan darah, Industri manufaktur, Kebisingan

Journal of Vocational Health Studies p-ISSN: 2580–7161; e-ISSN: 2580–717x
DOI: 10.20473/jvhs.V8.I3.2025.177-182

INTRODUCTION

Processes in the manufacturing industry have generated 70% of noise exposure as an unwanted by product (Ismaila and Odusote, 2014). Factory workers are the first to face intense noise exposure and are at risk of its adverse effects. The duration of noise exposure for more than three years in workers is significantly associated with the occurrence of hearing loss with an odds ratio of 12.8 (Kamarudin *et al*., 2022). Another study on workers in China revealed a significant correlation between noise levels exceeding 80 dBA and the incidence of hypertension (Zhou *et al*., 2022).

Noise can serve as a typical stressor, leading to hyperactivity in the sympathetic autonomic nervous system and activation of the hypothalamic-pituitary-adrenal axis, both in the short and long term after exposure (Poulsen *et al*., 2018). The impact of noise on workers' hearing encompasses both auditory and non-auditory disturbances. Auditory disorders include balance disorders, hearing loss, and permanent hearing impairment, while non-auditory disorders comprise elevated blood pressure, electrocardiographic abnormalities, psychological disorders, impaired work focus, diminished alertness, negative emotions, work inefficiency, disruption in body physiology, and behavioral disorders (Kompala *et al*., 2013; Mukhlish *et al*., 2018; Zhou *et al*., 2022).

There is a positive correlation between noise intensity and the incidence of hypertension among the workforce. This correlation arises from exposure to a noisy environment exceeding NAB > 85 dBA for 8 hours without the use of *Ear Protection Equipment* (EPE) (Hamdie *et al*., 2020). In addition, there is a significant relationship between noise levels and work stress. As noise intensity increases, the level of work stress experienced by workers also rises. Conversely, when workers are exposed to low noise intensity, the experienced work stress is reduced (Candraditya, 2016).

Based on preliminary observations conducted at the PT APB manufacturing industry in East Java Province, Indonesia, noise was identified emanating from the rotary production process. Upon entering the rotary production area for the first time, noticeable noise coming from the spun pile manufacturing machines was observed, causing disturbance to hearing and resulting in ringing in the ears. The test results obtained in the rotary production area recorded a noise level of 92.7 dBA, surpassing the NAB threshold of 85 dBA as per Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment. Unfortunately, the test result report document cannot be displayed due to confidentiality concerns for the company. In response to the issue, PT APB has carried out control measures by providing EPE, such as ear plugs to workers. However, based on interviews with several risk control workers regarding noise intensity exceeding the *Threshold Value* (TLV) even with the use of EPE, the effectiveness of the control measures appears suboptimal. Furthermore, interviews with several workers in the rotary production area revealed instances where employees frequently complained of headaches and occasional ringing in their ears.

The intensity of this noise can lead to an increase in blood pressure. Therefore, it is important to conduct further discussion regarding the effect of noise intensity on blood pressure, considering the level of work stress among workers in the rotary production area of the manufacturing industry at PT APB in East Java Province, Indonesia. The aim of this research is to analyze the effect of noise intensity on blood pressure before and after work among workers in the rotary production area of the manufacturing industry in East Java Province, Indonesia.

MATERIAL AND METHOD

This research was an analytic observational type that looks for relationships between variables, namely by conducting an analysis of the data collected. This research has been ethically tested and received an ethical certificate from the Ethics Commission of the Faculty of Nursing, Universitas Airlangga No: 2804-KEPK/2023. Based on the implementation time approach, this research was a cross-sectional design. The population of this research was all workers in the manufacturing industry rotating production area in PT APB in East Java Province, Indonesia. The research was conducted during July 2022.

PT APB is a company engaged in making precast concrete. Spun piles or piles are one type of product produced by PT APB. Spun piles or piles are round and hollow in the middle. The spun pile production period started in August 2021 and finished in September 2022 with a production target of 70 rods per day. Spun pile production at PT APB was carried out in the rotary production area which is divided into eight areas, namely *Heading Cutting Caging* (HCC), assembling setting, pouring, stressing, spinning, steaming, demolding, and finishing. This rotary production area is divided into two shifts with a total of 55 workers on the morning shift and 40 workers on the night shift. The working duration at PT APB is eight hours from Monday to Friday with a one-hour break starting at 08.00 – 17.00 WIB. Noise intensity measurements at PT APB are carried out every 6 months, precisely in June and December. The population of workers in this research amounted to 55 workers in the morning shift. This was because there were more morning shift workers than night shift workers. The sample size obtained from the calculation of the sample size was 49 people.

Noise measurement

The tool used in this research to measure the equivalent noise intensity (Leq) is a *Sound Level Meter* (SLM). This sound level meter is calibrated following the coupler method sound level meter calibration guide (Endi *et al*., 2020), involving the following steps: 1) Turn on the SLM unit under test and set it to the *LA Fast* (LAF) reading, then insert the SLM unit under test microphone into the acoustic calibrator hole. 2) Turn on the acoustic calibrator, then read the designation on SLM unit under test. 3) Record the SLM unit under test reading on the worksheet. 4) Adjust the SLM unit under testreading with the SPL acoustic calibrator value stated on the calibration certificate. 5) Record the adjusted SLM unit under testreading on the worksheet.

The steps for measuring noise intensity using a sound level meter are as follows: 1) Measure *Sound Pressure Level* (SPL) every 15 seconds for 25 minutes every hour. 2) Consequently, the number of measurements for 25 minutes equals 100 times. 3) Next, create a tabulation and arrange the data in descending order from the highest SPL to the lowest. 4) Calculate using the Leq formula to derive the one-hour Leq. The recording is performed using a noise intensity observation sheet. The noise intensity measurement was carried out following the SNI 7231 : 2009 method, outlining noise intensity measurement methods in the workplace.

Blood pressure measurement

Blood pressure measurement was conducted using a digital tensimeter, before the morning work shift, workers underwent their blood pressure measurement. Then, workers engaged in their regular tasks for approximately eight hours, after which blood pressure was measured again. The following are the steps outlining the blood pressure measurement procedure: 1) Allow the patient to rest for five minutes, 2) The measurement position can be achieved by sitting back, with arms supported at heart level, 3) Place the cuff, covering 2/3 of the arm's length, set it 2 - 3 fingers above the cubital fossa, 4) Perform blood pressure measurements, 5) Take measurement at least two times, if the results differ by >5 mmHg, repeat the measurements until close results are obtained. A *Paired Sample T-test* was conducted to determine whether there is a difference in workers' blood pressure before and after exposure to noise.

RESULT

The rotary production area at PT APB is divided into eight subareas, namely heading-cutting-caging, assembling-settings, pouring, stressing, spinning, steaming, demolding, and finishing. The following are the results of measurements in the PT APB production area can be seen in Table 1.

Table 1. Noise measurement results at PT APB, East Java Province, Indonesia, 2022

Sub area	Noise intensity
Heading, cutting, caging	>NAB
Assembling, setting	<NAB
Pouring	>NAB
Stressing	>NAB
Spinning	>NAB
Steaming	<NAB
Demoulding	>NAB
Finishing	>NAB

Note: <NAB (< 85 dbA) and >NAB (> 85 dbA)

The results of noise measurements in the rotary production area showed that the majority of workers worked with noise exposure of more than 85 dbA, namely 77.6% can be seen in Table 2. The remaining 22.4% of workers were exposed to noise less than the threshold value.

Table 2. Frequency distribution of workers exposed to noise at PT APB, East Java Province, Indonesia, 2022

Noise intensity (dBA)	Total (n)	Percentage (%)
≤ Threshold value (85 dB)	11	22.4
> Threshold value (85 dB)	38	77.6
Total	**49**	**100.0**

After work, both systolic and diastolic blood pressure in workers increased compared to the measurements taken before work. Table 3 shows the increase in blood pressure among workers. The majority of workers in the rotary production area experienced a 77.6% increase in systolic blood pressure and a 75.5% increase in diastolic blood pressure.

There was a significant increase in systolic blood pressure (*p-value* = 0.000) and diastolic blood pressure (*p-value* = 0.010). The average systolic pressure of workers before work ranged from 112.18 ± 11.36. Meanwhile, the average diastolic pressure of workers before work ranged from 75.71 ± 10.35. The results of this research show that the average blood pressure of workers before work falls within the normal category. However, the results of blood measurements after work showed an increase in both systolic blood pressure and diastolic blood pressure can be seen in Table 4. There was a significant difference between the blood pressure before and after in workers exposed to noise at PT APB, East Java Province, Indonesia.

Table 3. Frequency distribution of increased systolic and diastolic blood pressure among workers at PT APB, East Java Province, Indonesia, 2022

Blood pressure	Increased blood pressure				Total	
	Yes		No			
	n	%	n	%	N	%
Systolic	38	77.6	11	22.4	49	100
Diastolic	37	75.5	12	24.5	49	100

Table 4. Results of the *Paired Sample T*-test for systolic and diastolic blood pressure among workers before and after work at PT APB, East Java Province, Indonesia, 2022

Blood pressure	Before (mmHg)	After (mmHg)	Sig
	Mean ± SD	Mean ± SD	
Systolic	112.18 ± 11.36	122.55 ± 15.85	0.000
Diastolic	75.71 ± 10.35	84.94 ± 14.40	0.010

DISCUSSION

Noise is a term that describes an unpleasant sound. In this context, it refers to sound capable of causing both permanent and temporary damage to the inner ear (Jaafar *et al*., 2017). The distribution of workers exposed to noise is illustrated in Table 1. The noise intensity originates from industrial machines in the production area that operate continuously. High noise levels are also frequently observed in machine holding furnaces that operate continuously, measuring around 96.46 dBA in other studies (Rasdi *et al*., 2019). In addition, noise sources can arise from the process such as using an impact gun to remove mold bolts and grinding machines are another notable source of noise. The grinding process can lead to hearing problems and potential hearing loss (Akande, 2001; Mamat and Naim, 2020).

According to Minister of Manpower Regulation Number 5 of 2018 concerning Work Environment Safety and Health, exposure to noise exceeding 85 dBA without a hearing protection device should not last for more than eight hours (Minister of Manpower, 2018). Based on the conducted research, the average worker still works for eight hours with a rest period of one hour before continuing their work. Consequently, the noise present in these locations is detrimental to hearing and poses a risk of *Noise-Induced Hearing Loss* (NIHL) if appropriate control measures are not implemented.

Blood pressure is the force exerted on the inside of the blood vessels when the heart pumps blood around the body. It also represents the force generated by the blood against each unit area of the vessel (Hall, 2016). A cross-sectional survey conducted at a geothermal power plant showed that subjects exposed to noise for eight hours with a noise dose of exceeding 80 dBA had higher blood pressure levels, not only in systolic but also in diastolic, compared to subjects with a noise dose of 80 dBA or less (Muhyidin and Nasri, 2021).

Based on Table 3, a significant difference is evident between systolic and diastolic blood pressure before and during work in the rotary production area. This indicates an effect of noise on variations in blood pressure before and after work, processes inducing both auditory and non-auditory effects. A study in the manufacturing industry showed that workers' exposure to noise dramatically increased systolic blood pressure, but there was no significant increase in diastolic pressure (Ismaila and Odusote, 2014).

Research on workers in the automotive parts industry showed changes in heart rate, systolic blood pressure, and diastolic blood pressure in both case and control groups. Despite the observed changes in heart rate, systolic blood pressure, and diastolic blood pressure, they remained within normal limits (Kalantary *et al*., 2015). However, several studies have identified differences between noise exposure and increased blood pressure and heart rate in workers, with all participants showing systolic and diastolic levels within normal limits (Zamanian *et al*., 2013). These results are in line with studies comparing blood pressure before and after work in areas with noise intensity above TLVs, which demonstrated differences in blood pressure before and after work (Albustomi, 2017). The results of this research are also consistent with research conducted on workers in the hull construction workshop at PT Dok and Perkapalan Surabaya, indicating an association between noise intensity and changes in the workforce's blood pressure. The intensity of noise can induce emotional tension, leading to an increase in blood pressure and even the occurrence of hypertension. Elevated emotional tension results in increased production of the hormone cortisol by the *Hpothalamus Pituitary Adrenal* (HPA) axis, causing a rise in blood pressure (Rizkiawati, 2018). The use of hearing protection devices can assist in safeguarding workers from the adverse effects of exposure to high levels of noise (Kalantary *et al*., 2015).

In the United States, reduced hearing function due to noise or NIHL accounts for approximately 11% of all occupational diseases. Beyond impacting hearing, noise is also associated with an increased risk of cardiovascular disease, including myocardial infarction, stroke, and hypertension (Indriyanti *et al*., 2019). Hypertension is estimated to cause 7.5 million deaths worldwide, representing around 12.8% and is a major risk factor for coronary and ischemic heart disease, as well as hemorrhagic stroke (Non-communicable Disease Branch, 2023). Known as the silent killer, hypertension is a blood vessel disease that often remains asymptomatic until it progresses into a more serious condition. Hypertension is responsible for the deaths of 9.4 million people each year. The pathophysiology of noise-induced hypertension is theorized to elaborate dysfunctional stress mechanisms. The auditory system, which is also associated with the sympathetic nervous system and the neuroendocrine system, reacts to sound stimuli through reflexes, as evidenced by cardiovascular effects such as changes in catecholamines, epinephrine and non-epinephrine, and corticosteroid levels. Very loud and repeated noise exposure can be pathogenic, leading to a continuous up-regulation of vascular autoregulation leading to hypertension (Indriyanti *et al*., 2019) However, other studies have shown that there is no relationship between noise level and blood pressure in workers who work in the textile industry, but it is significantly related to heart rate (Chahyadhi *et al*., 2022).

Noise exposure can activate the sympathetic nervous system and induce hormonal changes in the HPA axis. The noise stimulus causes an increase in blood pressure by elevating total peripheral resistance and cardiac output. Repeated exposure can expedite the development of structural changes in peripheral blood vessels, leading to persistent increases in blood pressure and the onset of hypertension (Arumdani *et al*., 2022).

In a study of noise-exposed individuals in Chinese steel construction, equipment manufacturing, household appliance manufacturing, and cigarette production/packaging industries, subjects exposed to noise exhibited significantly higher levels of systolic blood pressure and diastolic blood pressure compared to control subjects. A significant correlation was found between noise exposure and blood pressure. After adjusting for age, sex, and smoking, subjects with noise exposure had a risk of hypertension with an *Odds Ratio* (OR) of 1.941, compared to the control group (Chen *et al*., 2017).

Based on interview results, workers in the rotary production area admitted that they often complained of headaches. To date, in the manufacturing industry in East Java Province-Indonesia, socialization and blood pressure checks have never been carried out. The increase in blood pressure during work that is felt by workers should be given more attention by companies through initial, periodic, and special health checks in order to decrease the incidence of work-related diseases and or diseases due to work relationships caused by a less than ideal work environment. Provision of special health checks for workers who are at risk of exposure to noise should be made. Furthermore, during the safety morning talk, health, safety, and environment officers can bring material related to the risks of increased blood pressure for the body and deliver a program of regular blood pressure checks once a month. This is done in order to add to the knowledge of workers regarding the dangers of increasing blood pressure so that workers can anticipate and be more aware of maintaining health. Besides that, measurement of noise frequency is also very important to do to relate it to the frequency of hearing loss in workers.

CONCLUSION

There was a significant difference in blood pressure between before and after working in the rotary production unit at PT APB, East Java Province. Recommendations that can be given to the company are that machines or work tools with high noise intensity be given periodic maintenance and care once a week as needed, provision of *Ear Protection Equipment* (EPE) that are evenly distributed while working, providing material related to the risk of work stress and increased blood pressure during safety morning talk activities and it is advisable for the company to carry out special medical examinations to monitor the health condition of workers.

Recommendations for other researchers are other factors due to noise such as noise induced hearing loss due to noise at PT APB. In addition, recommendations that can be given to workers are that they must wear the EPE that have been provided, and relax during working hours when the body feels tense as an effort to prevent work stress. Simple relaxation involves taking a deep breath, then exhaling until there is no more air left in the lungs and taking time for time management, relaxation and exercise.

ACKNOWLEDGMENTS

We express our gratitude to all individuals who contributed and participated in this research. Our heartfelt thanks go to the workers at PT APB who served as respondents in this re-search. We also extend our appreciation to PT APB for granting permission for the research process. The authors state that there is no conflict of interest with any parties involved in this research.

REFERENCE

Akande, T., 2001. Awareness of Commercial Grinding Machine Operators in Ilorin to Noise Induced Hearing Loss. Fooyin Journal of Health Sciences Vol. 8(1), Pp. 28-31.

Albustomi, Y., W, D.A., 2017. Perbedaan Tekanan Darah Sistole dan Diastole Sebelum dan Setelah Kerja pada Pekerja yang Terpapar Bising di PT X. Journal of Public Health Research and Community Health Development Vol. 1(1), Pp. 22-29.

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 Vol. 19(3), Pp. 638-650.

Candraditya, R., 2016. Hubungan Tingkat Kebisingan dengan Stress Kerja pada Pekerja di PT Vale Indonesia (Skripsi). Universitas Airlangga.

Chahyadhi, B., Widjanarti, M.P., Ada', Y.R., Suratna, F.S.N., Wijayanti, R., 2022. Noise Intensity, Blood Pressure, and Pulse Rate in Textile Industry Workers. Placentum: Jurnal Ilmiah Kesehatan dan Aplikasinya Vol.10(1), Pp. 73-80.

Chen, S., Ni, Y., Zhang, L., Kong, L., Lu, L., Yang, Z., Yang, L., Zhang, X., Zhu, Y., 2017. Noise Exposure in Occupational Setting Associated with Elevated Blood Pressure in China. BMC Public Health Vol. 17(1), Pp. 107.

Endi, D.R.T., Dwisetyo, B., Palup, M.R., Prasasti, N.R., Putri, C.C., Utomo, F.B., 2020. Panduan Kalibrasi Sound Level Meter Metode Coupler, SNSU PK.A-01:2020. Badan Standardisasi Nasional.

Hall, J.E., 2016. Guyton and Hall: Textbook of Medical Physiology Thirteenth Edition. 13. Elsevier, Philadelphia, PA.

Hamdie, S.A., Fauzan, A., Chandra, 2020. Hubungan Intensitas Kebisingan dan Lama Kerja dengan Kejadian Hipertensi pada Tenaga Kerja di PT. Kondang Buana Asri Tahun 2020, Pp. 1-7.

Indriyanti, L.H., Wangi, P.K., Simanjuntak, K., 2019. Hubungan Paparan Kebisingan terhadap Peningkatan Tekanan Darah pada Pekerja. Jurnal Kedokteran dan Kesehatan Vol. 15, Pp. 36.

Ismaila, O., Odusote, A., 2014. Noise Exposure as A Factor in The Increase of Blood Pressure of Workers in A Sack Manufacturing Industry. Beni-Suef University Journal of Basic and Applied Science, Pp. 1-6

Jaafar, N.I., Md Daud, M.K., Mohammad, I., Abd Rahman, N., 2017. Noise-Induced Hearing Loss in Grass-Trimming Workers. Egypt. Egyptian Journal of Ear, Nose, Throat and Allied Sciences Vol. 18, Pp. 227–229.

Kalantary, S., Dehghani, A., Yekaninejad, M.S., Omidi, L., Rahimzadeh, M., 2015. The Effects of Occupational Noise on Blood Pressure and Heart Rate of Workers in An Automotive Parts Industry. ARYA Atheroscler. Vol. 11(4), Pp. 215-219.

Kamarudin, N., Robinson, F., Saupin, S., Mohammad, A.H., Domingo, O., Hafizah, N., Salan, H., 2022. Hearing Loss Among Vector Control Unit Workers In Bornean Malaysia : A Cross-Sectional Risk Factors Study. Malaysian Journal of Public Health Medicine. Vol. 22, Pp. 61-67.

Kompala, T., Shenoi, S.V., Friedland, G., 2013. Transmission of Tuberculosis in Resource-Limited Settings. Curr. HIV/AIDS Rep. Vol. 10(3), Pp. 264-272.

Mamat, S.N.S., Naim, F., 2020. Noise Exposure and Perceived Hearing Symptoms of Metal Fabrication Workers in Heating, Ventilating and Air Conditioning Manufacturing Industry. Malaysian Journal of Medicine and Health Sciences. Vol. 16 (Supl:1), Pp. 135-143.

Minister of Manpower, R.I., 2018. Minister of Manpower Regulation number 5 of 2018 con-cerning Work Environment Safety and Health, Peraturan Menteri Ketenagakerjaan Republik Indonesia No 5 Tahun 2018.

Muhyidin, M., Nasri, S.M., 2021. Analysis of Occupational Noise in Association with Blood Pressure among Workers at Geothermal Power Plant. Jurnal Presipitasi : Media Komunikasi dan Pengembangan Teknik Lingkungan. Vol. 18(3), Pp. 504-511.

Mukhlish, W.I.N., Sudarmanto, Y., Hasan, M., 2018. Pengaruh Kebisingan terhadap Tekanan Darah dan Nadi pada Pekerja Pabrik Kayu PT. Muroco Jember. Jurnal Kesehatan Lingkungan Indonesia Vol. 17(2), Pp. 112-118.

Non-communicable Disease Branch, 2023. Non-Communicable Diseases Watch.

Poulsen, A.H., Raaschou-Nielsen, O., Peña, A., Hahmann, A.N., Nordsborg, R.B., Ketzel, M., Brandt, J., Sørensen, M., 2018. Short-Term Nighttime Wind Turbine Noise and Cardiovascular Events: A Nationwide Case-Crossover Study from Denmark. Environment International Vol. 114, Pp. 160-166.

Rasdi, I., Zin, N., Norkhadijah, S., 2019. Factors of Job Satisfaction among Workers Exposed to Occupational Noise. Malays. Malaysian Journal of Medicine and Health Sciences Vol. 15(SP4), Pp. 2636-9346.

Rizkiawati, N.L., 2018. Hubungan Beban Kerja dan Intensitas Kebisingan terhadap Tekanan Darah pada Pekerja Bagian Hull Construction di PT Dok dan Perkapalan Surabaya (Skripsi). Universitas Airlangga.

Zamanian, Z., Rostami, R., Hasanzadeh, J., Hashemi, H., 2013. Investigation of The Effect of Occupational Noise Exposure on Blood Pressure and Heart Rate of Steel Industry Workers. Journal of Environmental and Public Health Vol. 19. Pp. 256060.

Zhou, B., Lan, Y., Bi, Y., Li, C., Zhang, X., Wu, X., 2022. Relationship Between Occupational Noise and Hypertension in Modern Enterprise Workers: A Case-Control Study. International Journal of Public Health Vol. 67, Pp. 1604997.