**META-ANALYSIS**                                        **Open Access**

# A SYSTEMATIC LITERATURE REVIEW WITH META-ANALYSIS ON RISK FACTORS FOR HYPERTENSION

**Oryza Filial Zulkarnain[1], Yura Witsqa Firmansyah[2]\*, Muhammad Fadli Ramadhansyah[3], Ayu Widyawati[4], Ike Rachmawati[4], Muslyana Muslyana[4], Ramadani Sukaningtyas[4], Rafika Rafika[5], Afdal Hardiyanto[6], Hanung Nurany[7], Anshah Silmi Afifah[8], Aziz Yulianto Pratama[9]**

[1]Departement of Environmental Health, Faculty of Public Health, Universitas Airlangga, Surabaya 60115, Indonesia
[2]Department of Health Information Management, Faculty of Health Science, Universitas Nasional Karangturi, Semarang, 50227, Indonesia
[3]Master of Environmental Health, Faculty of Public Health, Diponegoro University, Semarang, 50275, Indonesia
[4]Tarakan Class II Port Health Office, Tarakan, 77111, Indonesia
[5]Master of Health Promotion, Faculty of Public Health, Universitas Diponegoro, Semarang, 50275, Indonesia
[6]Padang Class II Port Health Office, Padang, 25586, Indonesia
[7]Tangerang City Health Office, Tangerang, 15111, Indonesia
[8]Department of Furniture Production Engineering, Politeknik Industri Furnitur dan Pengolahan Kayu, Kendal Regency, 51371, Indonesia
[9]Master of Electrical Engineering, Faculty of Engineering, Universitas Diponegoro, Semarang, 50275, Indonesia

*Corresponding Author:*
\*) firmansyahyura@gmail.com

**Abstract**

***Introduction:*** *Hypertension is a manifestation of hemodynamic imbalances resulting in various cardiovascular complications and others in the body systems. The prevalence of hypertension in Indonesian adults aged 18 years was 34.1%, and it increased by 8.3%. Globally, it accounts for about 60% of deaths. This study aimed to analyze risk factors for hypertension in industrial workers.* ***Methods:*** *This study used a meta-analysis, a statistical method that combines previous studies to find an effect size value or summary on JASP software. Data in this study came from database online and were sorted according to the inclusion-exclusion criteria following PRISMA. In the final step, 14 research articles were collected.* ***Results and Discussion:*** *Noise intensity had a 1.974 times greater risk on the prevalence of hypertension in industrial workers; work period had 2.316 times greater risk; duration of exposure gave a 1.716 times greater risk; and smoking had a 1.896 times greater risk.* ***Conclusion:*** *The highest risks for the incidence of hypertension in industrial workers come from period of work, noise intensity, and smoking habits; while, the lowest is in the length of exposure.*

## INTRODUCTION

Hypertension has caused a total of 9.4 million according to the World Health Organization's report (1). The prevalence of hypertension in Indonesia is higher than that in Singapore, Thailand, and Malaysia at 27.3%, 22% and 20%, respectively (2). Hypertension is a manifestation of hemodynamic imbalances resulting in various cardiovascular complications and others in the body system (3). The 2018 Basic Health Research shows that the prevalence of hypertension in Indonesian adults aged 18 years was 34.1% (4). Compared to the 2015 Basic Health Research, this number increased more by 8.3%. Hypertension not only has devastating impacts on Indonesia, but also contributes to about 60% of deaths worldwide (5).

In the Industrialization Era, humans will interface the application of advanced technology and increasingly complex and modern materials and equipment. Noise is

a pollutant resulted from the use of human technology (6). It is an unwanted sound that has an exceeding predetermined threshold value, which is 85 dB(A). It may cause not only hearing loss but also mental, emotional and blood circulation disorders (7).

Many companies have oriented to production activities more than human resource management. The use of large machines in production activities sometimes causes quite large and disturbing sound effects (8). Noise and hypertension are occupational hazards as big health problems in the world (9). Research conducted in Rio de Janeiro (Brazil) used a cross-sectional design to study the relationship between exposure to noise at work and hypertension. It shows that exposure to noise is independently associated with hypertension (10).

Hypertension may be caused by multifactors, including genetic, racial, socio-cultural, lifestyle, and work environment factors, one of which is noise (11). Besides hypertension, noise causes other health problems for workers such as hearing loss, ischemic heart disease, diabetes, sleep disturbances, and work performance (22). Noise intensity, noise frequency, and duration of exposure to noise in the workplace are factors that determine the severity level of health problems (13). The association between noise and health problems, therefore, is influenced by these three factors (14). While factors that influence the incidence of hypertension include age, race, environmental factors, psychological stress, obesity, lack of exercise, smoking, and alcohol consumption (15).

Looking into this issue, this current study aimed to analyze whether risk factors i.e., noise intensity, working period, length of exposure, and smoking habits, are associated with hypertension. The factor identification was conducted using a hearing sensitivity test to industrial workers (15).

## METHODS

This study is a systematic meta-analysis literature review. Meta-analysis is a statistical method that combines several (two or more) previous studies with the same hypothesis to generate quantitative data. It is a technique of summarizing previous quantitative research to determine an effect size value (16). Research articles collected addressed four risk factors i.e., noise intensity, length of work, length of exposure, and smoking on the incidence of hypertension in industrial workers. The articles were retrieved from journals, articles, and scientific proceedings.

This study used secondary data from several electronic databases i.e., Google Scholar, Pubmed,

PLOS ONE, Research Gate, and Science Direct within 2016 to 2021 of publication year. Some keywords used include "noise intensity hypertension", "industrial worker hypertension factor", "hypertension causative factor", "influence on blood pressure", "noise intensity", "noise intensity blood pressure", "noise intensity hypertension", "noise exposure" and "occupational noise exposure". International and national research articles that have topics relevant to the research objectives are the current population, and only articles that examine the risk factors for hypertension above in industrial workers are included as samples.

A meta-analysis method is more objective compared to other research methods to estimate effect size values and their significance. However, the current research findings are not conclusive yet because the articles included have different qualities and pose publication bias, limitation in data collection as well as different characteristics of research subjects. Therefore, meta-analysis research should apply multiple selections of articles.

### Literature Search

The keywords used for literature search were formulated using the PICOS method (17). The sampled articles should have abstracts and full texts.

### Data Collection Method

This study screened research articles that fit inclusion and exclusion criteria. The studied articles may be journal articles and theses in Indonesian and English and may involve noise intensity, working period, length of exposure, and smoking habits that may contribute to the incidence of hypertension. After searching articles published from 2016 to 2021 on Google Scholar, Pubmed, PLOS ONE, Research Gate, and ScienceDirect databases, their abstracts and fulltexts were screened. If articles have no abstracts and fultexts, they will be excluded. Next was re-screening whether the articles used cross-sectional research designs. If they do not meet this final criteria, they will be excluded.

### Data Type

Selected research articles as secondary data have to discuss pre-determined risk factors for hypertension in industrial workers.

### Data Analysis Techniques

For a meta-analysis, data abstraction, data analysis, publication bias test, and sensitivity test were performed. Data collection or abstraction, information was obtained from each research article, and obtained

data i.e., year of publication, location, design, exposure, and outcome of each study were converted into a 2 x 2 table. They were then stored in Comma Separated Values (CSV) format for a classical meta-analysis with a fixed effect model or random effect model. They were proceeded on JASP Version 0.9.2 to generate results presented in a forest plot graph to describe a combined effect size value of each variable. This research bias was identified using a funnel plot and followed by the Egger's Test. Sensitivity test was performed to prove whether the meta-analysis results were relatively stable to changes. It compared the results obtained from the fixed effect model with those from the random/restricted effect model.

The collected articles were then extracted and synthesized to obtain data. The wanted data were compiled and analyzed to produce a problem-solving material for the meta-analysis test. Literature search followed PRISMA steps.

Fifteen research articles were obtained and analyzed to find the pooled odds ratio estimates using the Mentel-Haenszel method in the fixed effect analysis model and the DerSimonian-Laind method in the random-effect model. If homogenous variation seems showing a heterogeneity p-value greater than 0.05 between variables, the analysis model used is the fixed effect model. Meanwhile, if the variation between variables is heterogeneous with a p-value of less than 0.05, the random-effects analysis model is used.
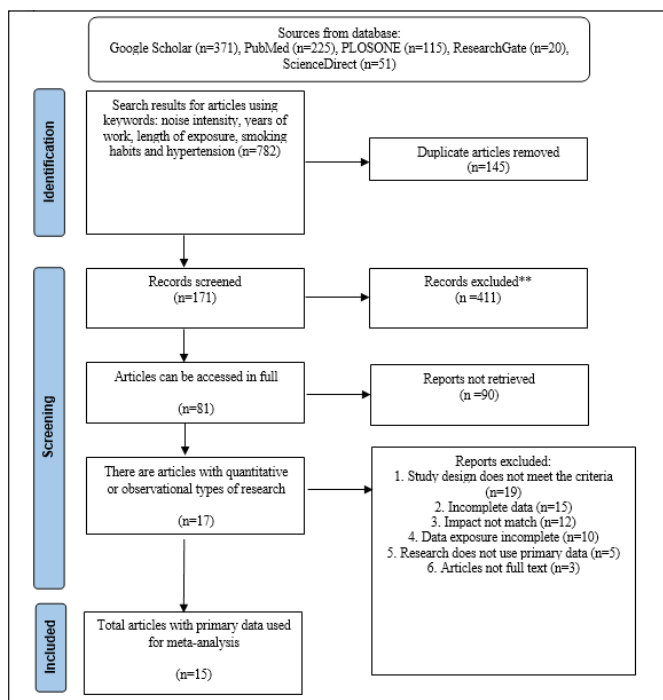


**Figure 1. Prisma Flowchart (The Prisma Statement) Risk Factor Analysis of Noise Intensity, Working Period, Length of Exposure and Smoking Habits on The Incidence of Hypertension in Industrial Workers**

The meta-analysis calculates the Prevalence Ratio (PR) value in some steps. First, if the estimated PR value of PR is > 1 and the range of confidence intervals does not exceed 1, a certain variable is considered a risk factor. Coversely, a variable is considered a protective factor. If the estimated value of PR equals to 1 and the range of confidence intervals does not exceed 1, such independent vairbales included have no relationship with the incidence of hypertension in industrial workers.

## RESULTS

### Noise Intensity as A Risk Factor for Hypertension in Industrial Workers

After the final screening, 10 selected articles published in 2016 to 2020 addressed noisy intensity. A more complete description is presented in Figure 2.

The Fixed Effect (FE) Model value represents the estimated Prevalence Ratio (PR) value at a 95% CI of 0.68 with a range value of 0.50 – 0.87. The results of the forest plot in Figure 2 show that the value of pooled PR ($e^{0.68}$) is 1.974. It indicates noise intensity has a 1.974 times greater risk of causing hypertension in industrial workers (18).
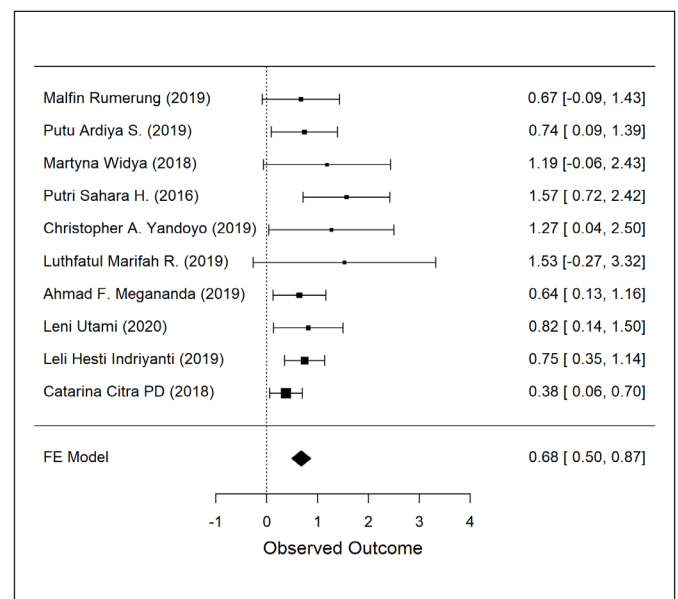


**Figure 2. Forest Plot of The Noise Intensity Risk Factor for The Incidence of Hypertension in Industrial Workers (18,33,34,19,7,20,8,21,22,25)**

Based on Table 1, the p-value in the heterogeneity test is greater than 0.05 (p = 0.333). Since the variables are homogenous, the fixed effect model is used for analysis. Furthermore, a publication bias on noisy intensity variable is identified using a funnel plot, presented in Figure 3. After measuring the distribution of plots either in a symmetrical or asymmetrical arrangement, we figured out that the funnel plots are asymmetric, and thus a regression test, Egger test is used.
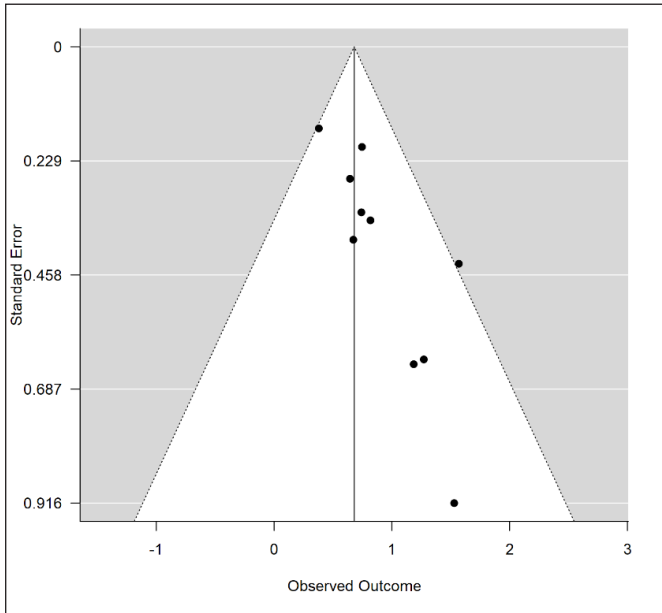
**Figure 3. Funnel Plot of Noise Intensity Risk Factors for Hypertension Incidence in Industrial Workers**

**Table 1. Heterogeneity Test of Noise Intensity Meta-Analysis of Hypertension Incidence in Industrial Workers (Fixed and Random Effects)**

|  | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 51.74 | 1 | < .001 |
| Test of Residual Heterogeneity | 10.21 | 9 | 0.333 |

*Note. p -values are approximate.*

Table 2 shows the p-value from the Egger's test is less than 0.05, and the articles have a publication bias on noise intensity variable. The meta-analysis results showed that noise intensity variable had a 1.974 times greater risk of contributing to hypertension in industrial workers. This study is in line with Elfiza's research that the hypertension risk ratio in increasing noise per 10 dB(A) was 1.13 (95% CI: 0.99 to 1.28) with moderate heterogeneity (p = 0.003, I2 = 72.1%). It means that noise exposure can be a risk factor for hypertension. Another study also supports these findings that exposure to long-term noise at work may lead to increase hypertension in industrial workers in the long term (p < 0.01) (19).

**Table 2. Egger's Test Table of Noise Intensity Risk Factors for Hypertension Incidence in Industrial Workers**

|  | z | p |
|---|---|---|
| sei | 2.5502 | 0.011 |

**Sensitivity Test on Noise Intensity as A Risk Factor for Hypertension in Industrial Workers**

The sensitivity test was used to identify data heterogeneity, interpret the effects of research quality and prove whether meta-analysis results are relatively stable (20). This test compares the pooled prevalence ratio in the fixed-effect model and the random effect model. It was performed according to a minimum number of studies processed for meta-analysis (21).

**Table 3. Comparative Sensitivity Test Pooled Prevalence Ratio Fixed Model and Random Model**

| Research Variable | N | Heterogenity (p-value) | Fixed effect Models | | Random Effect Model | |
|---|---|---|---|---|---|---|
|  |  |  | PR | 95% CI | PR | 95% CI |
| Risk Factors for Long Exposure to Hypertension Incidence in Industrial Workers | 4 | 0.518 | 1.716 | 0.23 – 0.85 | 1.716 | 0.23 – 0.85 |
| Work Period Risk Factors Against the Incidence of Hypertension in Industrial Workers | 5 | < .001 | 1.271 | 0.03 – 0.45 | 2.316 | -0.10 – 1.79 |
| Risk Factors of Smoking Habits on the Incidence of Hypertension in Industrial Workers | 7 | 0.646 | 1.896 | 0.37 – 0.92 | 1.896 | 0.37 – 0.92 |
| Noise Intensity Risk Factors for Hypertension Incidence in Industrial Workers | 10 | 0.333 | 1.974 | 0.50 – 0.87 | 2.096 | 0.51 – 0.96 |

Table 3 shows independent variables vary between studies, the pooled PR value increases from the fixed-effect model to the random effect model, and the Confident Interval (CI) rises too. The length of exposure and smoking habit have pooled PR values that are not much different from one model to another at the CI (22). While there are variations between studies in terms of noise intensity and working period as pooled PR values increase from one model to another at 95% Confident Interval (23).

**Work Period as A Risk Factor for Hypertension**

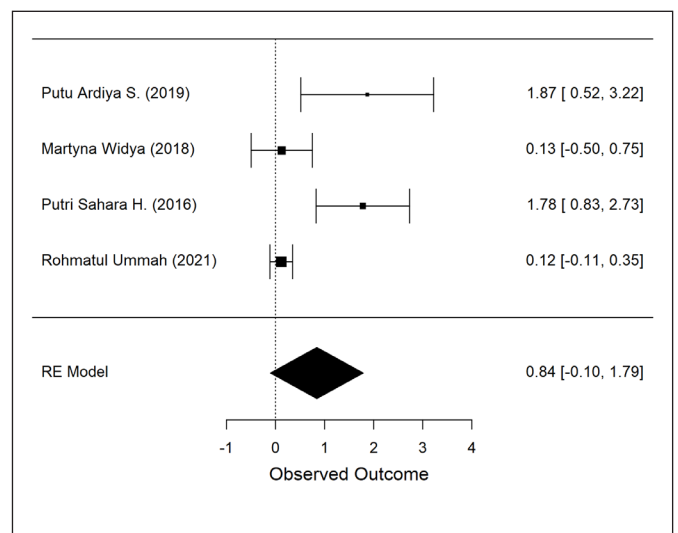Four articles screened discuss work period variable. Their results are described in Figure 4,



**Figure 4. Forest Plot of Work Period Risk Factors for Hypertension Incidence (33,34,19,35)**

**Table 4. Table of Heterogeneity Test Meta-Analysis of Working Period on Hypertension Incidence (Fixed and Random Effects)**
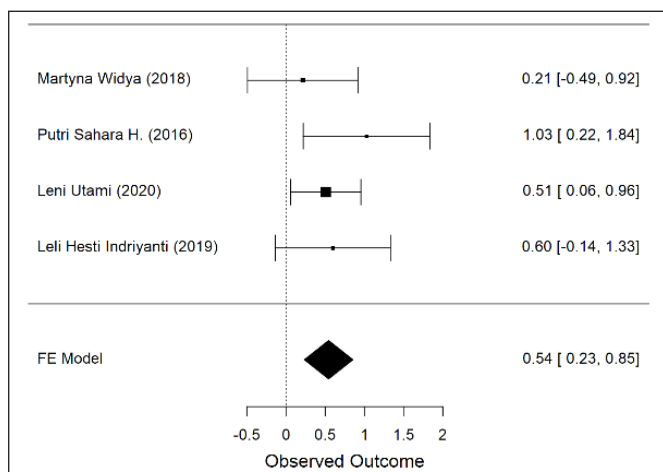
|  | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 3.052 | 1 | 0.081 |
| Test of Residual Heterogeneity | 16.812 | 3 | < .001 |

*Note.   P -values are approximate.*

The Random Effect (RE) Model showed the estimated Prevalence Ratio (PR) with 95% CI is 0.84. The forest plot shows the value of pooled PR (e0.84) is 2.316 (95% CI -0.10 – 1.79). It means work period has a 2.316 times greater risk of contributing to hypertension in industrial workers. According to the heterogeneity test on work period variable, its p-value is smaller than α. Since the variation between studies is heterogeneous, the random-effect model is used for analysis. Industrial workers who have worked for more than five years have a 2.316 times greater risk of experiencing hypertension than those who have worked under five years. A previous study also mentions that years of service and the incidence of hypertension in industrial workers are significantly related and obtain a p-value of 0.013

**Duration of Exposure to Noise as A Risk Factor for Hypertension**

Four articles published in 2016-2020 examined duration of exposure to noise. The FE Model value has a PR estimate with a 95% CI value of 0.54. The forest plot has a pooled PR value ($e^{0.54}$) of 1.716. It indicates that duration of exposure to noise gives 1.716 times greater risk for hypertension to workers. The FE model has a 95% confidence level and an interval range of 0.23 – 0.85. Furthermore, Table 5 explains heterogeneity on this variable that has a p-value greater than α (p = 0.518). This means that the variation between studies is homogeneous, and thus the fixed-effect model is used. Based on the meta-analysis, length of exposure above 8 hours per day poses 1.716 times greater risk than that less than 8 hours per day.



**Figure 5. Forest Plot of Risk Factors for Duration Exposure to Hypertension Incidence (34,19,21,22)**
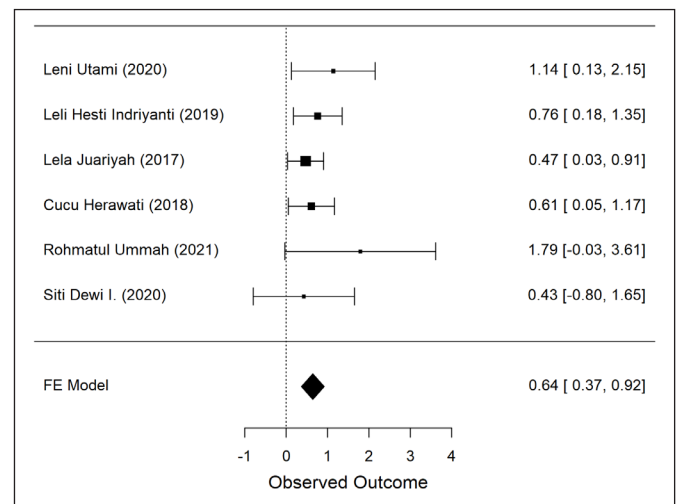
**Table 5. Heterogeneity Meta-Analysis of Duration Exposure to Hypertension Incidence (Fixed and Random Effects)**

|  | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 11.800 | 1 | < .001 |
| Test of Residual Heterogeneity | 2.270 | 3 | 0.518 |

*Note.   P -values are approximate*

**Smoking Habit as A Risk Factor for Hypertension**

Six research articles in this review discuss about smoking habit as a risk factor for hypertension. They were pubslihed around 2017-2021. The FE Model demonstrates an estimated PR value of 0.64 with an 95% CI range of 0.37 - 0.92 and the value of pooled PR ($e^{0.64}$) of 1.896. It indicates smoking has 1.896 times greater risk of hypertension. According to Table 6, the heterogeneity test shows a p-value is greater than α (p = 0.646). In other words, the fixed-effect model is used to study the previous studies which are homogenously varied (24).



**Figure 6. Forest Plot of Smoking Habits Risk Factors on Hypertension Incidence (21,22,36,37,35,6)**

**Table 6. Heterogeneity Test Meta-Analysis of Smoking Habits on The Incidence of Hypertension (Fixed and Random Effects)**

|  | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 21.281 | 1 | < .001 |
| Test of Residual Heterogeneity | 3.354 | 5 | 0.646 |

*Note.   p -values are approximate.*

**Table 7. Meta Analysis Results of Noise Intensity, Working Period, Length of Exposure, and Smoking Habits on Hypertension Incidence in Industrial Workers**

| Research Variable | N | Fixed/Random effect Models | |
|---|---|---|---|
|  |  | PR | 95% CI |
| Years of Service | 4 | 2.316 | -0.10 – 1.79 |
| Noise Intensity | 10 | 1.974 | 0.50 – 0.87 |
| Smoking Habits | 6 | 1.896 | 0.37 – 0.92 |
| Exposure Time | 4 | 1.716 | 0.23 – 0.85 |

## DISCUSSION

### Noise Intensity as A Risk Factor for Hypertension in Industrial Workers

Noise intensity has a significant correlation with the incidence of hypertension. To avoid the risk, workers have to use personal protective equipment (PPE) such as earplugs and/or earmuffs at noise sources. Additionally, company management have to maintain equipment/ machinery/heavy equipment routinely to prevent exposure to high sound that exceeds the threshold value.

The period of service is for how long an officer works in a place. The period of service is directly proportional to exposure to dangers in the workplace. Workers who have been more than 5 years in the workplace will be more exposed to risk factors for hypertension, one of which is noise due to machine production activities. To reduce the incidence of hypertension, a company has to conduct a job rotation. Rotation may be useful to find out the potential of each employee, invest new knowledge in employees, and minimize the existing level of attrition..

Long-term repeated noise will result in a lasting increase in blood pressure. Continuous increase in blood pressure without prevention and control will cause hypertension. High noise in the workplace (industry) can be overcome if officers more comply with wearing ear protection equipment such as ear muffs or ear plugs during work. With proper use of PPE, officers will not experience noise hyperstimulus. Ear plugs reduce noise by ± 30 dBA, while earmuffs reduce higher noise between 40 -50 dBA. Using the equipment, the noise level received by ground handling officers can be reduced to create a safer work environment (25).

### Sensitivity Test on Noise Intensity as A Risk Factor for Hypertension in Industrial Workers

Good ear protection devices such as earplugs only hold certain frequencies, while the frequency of speech is not disturbed (25). Ear plugs can reduce noise intensity by 25 dB(A) to 30 dB(A). While the earmuffs can be used for high noise intensity (> 95 dB) by protecting the entire ear with an adjustable size to various ears. Monitoring is important to conduct to indicate if infection occurs in the ear while it is in use (26).

### Work Period as A Risk Factor for Hypertension

Work period is closely related to noise exposure as well. The longer a worker works, the longer he/she is exposed to noise. Excessive exposure to noise for a long period will lead to emotional instability, which may trigger stress. As a result, blood vessels may be narrow due to stress, spurring the heart to pump blood harder and then leading to hypertension (27).

### Duration of Exposure to Noise as A Risk Factor for Hypertension

A study conducted to an overhead flight in France explains exposure to noise that exceeds a certain period possibly causes hypo reaction and hyper-reaction, which can indicate a regulation abnormality in the HPA axis [28]. In addition, research conducted to Quebec workers in Canada states that acute and chronic stress, due to the length of exposure, can release cytokines, not only as markers but also as inflammatory mediators, leading to vascular endothelial dysfunction and atherosclerosis. To the end of the process, blood pressure chronically increases and thus causes hypertension (28).

The length of exposure has a significant relationship with the incidence of hypertension. Previous research mentions that workers who are exposed to noise for more 8 hours per day can develop fatigue, increase stress hormones, and narrow blood vessels which eventually raise blood pressure rapidly (29).

### Smoking Habit as A Risk Factor for Hypertension

In addition, smoking habit has a 1.994 times greater risk of hypertension compared to non-smoking (30). Smoking habits is related to hypertension (p = 0.017). Similar results are explained in an annual nationwide household survey in England (30) and a study on health primary care in West Cikarang (31).

Cigarettes contain dangerous chemicals such as nicotine that activate free radicals. According to the latest study in America, vasomotor disfunction induced by nitric oxide, inflammation, and modification of lipid components, causes atherosclerosis which may change blood pressure (22). Research conducted to spaceflight workers in America declares that smoking can increase 20-25% peripheral leukocyte levels and increase the activation of inflammatory mediators such as interleukin-6 (IL-6), C-reactive protein, and tumor necrosis factor α (TNF α) (31). The increase in proinflammatory cytokines causes raises leukocyte-endothelial interactions as the initial process of atherosclerosis.

Cigarette smoke contains about 0.5% to 3% nicotine. When it is inhaled, nicotine levels in the blood will range from 40-50 mg/ml. It can irritate the heart, make the heart rhythm irregular, speed up blood flow, damage the inner lining of blood vessels and cause blood clots. Nicotine in tobacco may increase blood pressure as well after the first puff (32).

With a strong correlation between smoking habit and the incidence of hypertension (32), companies or industries need to provide a special smoking room to avoid smokes circulated outside to non-smoking workers (33). Workers with smoking habits should be

given education about the dangers of smoking and the importance of healthy lifestyle to prevent hypertension (34−35). Among the risk factors identified, this current study concludes period of service has the highest contribution to hypertension, followed by length of exposure to noise (36−37).

## ACKNOWLEDGMENTS

## CONCLUSION

Risk factors for hypertension include noise intensity, work period, duration of exposure, and smoking. The meta-analysis results show that noise intensity has 1.974 times greater risk; work period has 2.316 times greater risk; duration of exposure to noise gives 1.716 times greater risk; and smoking posits 1.896 times greater risk of hypertension in industrial workers. Controlling the risks can be done by reducing noise intensity, using PPE, conducting work rotation and working hours, and providing education about dangers of smoking and healthy lifestyles.

## REFERENCES

1. World Health Organization. World Health Day 2013: Measure Your Blood Pressure, Reduce Your Risk. Geneva: World Health Organization; 2013. https://apps.who.int/mediacentre/news/releases/2013/world_health_day_20130403/en/index.html

2. Oparil S, Acelajado MC, Bakris GL, Berlowitz DR, Cifková R, Dominiczak AF, et al. Hypertension. *Nat Rev Dis Primers*. 2018;4(18014):1–48. https://doi.org/10.1038%2Fnrdp.2018.14

3. Agustina R, Raharjo BB. Faktor Risiko Yang Berhubungan Dengan Kejadian Hipertensi Usia Produktif (25-54 Tahun). *Unnes J Public Heal*. 2015;4(4):146–158. https://doi.org/10.15294/ujph.v4i4.9690

4. Ministry of Health Republic of Indonesia. Indonesian Health Profile 2018. Jakarta: Ministry of Health of Republic Indonesia; 2019. 1−556 p. https://pusdatin.kemkes.go.id/resources/download/pusdatin/profil-kesehatan-indonesia/PROFIL_KESEHATAN_2018_1.pdf

5. Ministry of Health Republic of Indonesia. Main Results of Basic Health Research 2018. Jakarta: Health Research and Development Agency; 2018. 1−220 p. https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf

6. Ismayatun SD. Hubungan Kebiasaan Merokok dan Beban Kerja Fisik dengan Hipertensi pada Pekerja Laki-Laki di Area Produksi PT Putra Bungsu Tegal. *Medical Technology and Public Health Journal*. 2020;4(1):101−107. https://doi.org/10.33086/mtphj.v4i1.692

7. Yandoyo CA, Merijanti. Hubungan Antara Intensitas Kebisingan dan Tekanan Darah Pada Pekerja PT. X. *Jurnal Biomedika dan Kesehatan*. 2019;2(1):10−14. http://dx.doi.org/10.18051/JBiomedKes.2019.v2.10-14

8. Megananda, AF, Suwandi T. The Influence of Noise Intensity and Age to the Employees' Blood Pressure at Heavy-Duty Shop and EHS Department. *The Indonesian Journal of Occupational Safety and Health*. 2019;8(2):168−177. https://doi.org/10.20473/ijosh.v8i2.2019.168-177

9. Tumane RG, Thakkar L, Pingle SK, Jain RK, Jawade AA, Raje D V. Expression of Serum Proteins in Noise induced Hearing Loss Workers of Mining Based Industry. *Journal of Proteomics*. 2021;240(104185):1−10. https://doi.org/10.1016/j.jprot.2021.104185

10. Setyabudi S, Setiani O, Nur E. Hubungan Kadar Pb dalam Darah dengan Kejadian Hipertensi pada Pekerja Peleburan Timah Hitam di Perkampungan Industri Kecil (PIK) Kebasen Kabupaten Tegal. *Jurnal Kesehatan Lingkungan Indonesia*. 2016;13(1):14–19. https://doi.org/10.14710/jkli.13.1.14%20-%2019

11. Nserat S, Al-Musa A, Khader YS, Abu Slaih A, Iblan I. Blood Pressure of Jornaian Workers Chronically Exposed to Noise in Industrial Plants. *The International Journal of Occupational and Environmental Medicine*. 2017;8(4):217–223. https://doi.org/10.15171/ijoem.2017.1134

12. Addina S, Keman S. Relationship of Traffic Noise with High Blood Pressure to Pedicab Drivers Around Purabaya Bus Station Surabaya. *Jurnal Kesehatan Lingkungan*. 2016;8(1):69–80. https://doi.org/10.20473/jkl.v8i1.2015.69-80

13. Li X, Dong Q, Wang B, Song H, Wang S, Zhu B. The Influence of Occupational Noise Exposure on Cardiovascular and Hearing Conditions among Industrial Workers. *Scientific Reports*. 2019;9(11524):1–7. https://doi.org/10.1038/s41598-019-47901-2

14. Siswati S, Adriyani R. Hubungan Pajanan Kebisingan Dengan Tekanan Darah dan Denyut Nadi pada Pekerja Industri Kemasan Semen. *Jurnal Kesehatan Lingkungan Indonesia*. 2017;16(1):29−36. https://doi.org/10.14710/jkli.16.1.29-36

15. Sumardiyono S, Hartono H, Probandari A, Setyono P. The Association between Risk Factors and Blood Pressure in the Textile Industry Workers. *Global Medical & Health Communication*. 2017;5(3):228−235. https://doi.org/10.29313/gmhc.v5i3.2650

16. Egger M, Smith GD, Phillips AN. Meta-analysis: Principles and procedures. *BMJ*. 1997;315(7121):1533–1537. https://doi.org/10.1136/bmj.315.7121.1533

17. Methley AM, Campbell S, Chew-Graham C, McNally R, Cheraghi-Sohi S. PICO, PICOS and SPIDER: A Comparison Study of Specificity and Sensitivity in Three Search Tools for Qualitative Systematic Reviews. *BMC Health Services Research*. 2014;14(579):1−10. https://doi.org/10.1186/s12913-014-0579-0

18. Rumerung M, Maddusa SS, Sondakh RC. Hubungan antara Intensitas Kebisingan dengan

Tekanan Darah dan Denyut Nadi pada Pekerja Industri Mebel Di Desa Leilem. *J Kesmas*. 2019;8(6):583–591. https://ejournal.unsrat.ac.id/index.php/kesmas/article/view/26211

19. Sahara P. Faktor-Faktor yang Berhubungan dengan Tekanan Darah Pekerja di PLTD/G. *J Endur I*. 2016;1(3):100-106. http://ejournal.lldikti10.id/index.php/endurance/article/download/487/438

20. Rahmawati LM, Hariyono W. Hubungan Intensitas Kebisingan dengan Tekanan Darah pada Karyawan PT. Mataram Tunggal Garment Kabupaten Sleman. Skripsi. Yogyakarta: Universitas Ahmad Dahlan; 2019

21. Utami L, Novrikasari, Idris H. Hubungan Faktor Risiko Dengan Peningkatan Tekanan Darah pada Pekerja. *Public Heal Saf Int J*. 2020;1(1):29-37. https://mand-ycmm.org/index.php/phasij/article/view/26/21

22. Indriyanti LH, Wangi PK, Simanjuntak K. Hubungan Paparan Kebisingan terhadap Peningkatan Tekanan Darah Pada Pekerja. *J Kedokt dan Kesehat*. 2019;15(1):36-45. https://jurnal.umj.ac.id/index.php/JKK/article/view/3627

23. Teixeira LR, Pega F, Dzhambov AM, Bortkiewicz A, da Silva DTC, de Andrade CAF, et al. The Effect of Occupational Exposure to Noise on Ischaemic Heart Disease, Stroke and Hypertension: A Systematic Review and Meta-Analysis from the WHO/ILO Joint Estimates of the Work-Related Burden of Disease and Injury. *Environ Int*. 2021;154(106387):1-34. https://doi.org/10.1016/j.envint.2021.106387

24. Kokubo Y, Padmanabhan S. Necessity of Preventing Cardiovascular Disease by Smoke-Free Policies. *Journal of the American Heart Association*. 2018;7(23):1–3. https://doi.org/10.1161/JAHA.118.011120

25. Dewi CCP, Setiani O, Raharjo M. Hubungan Tingkat Kebisingan dengan Tekanan Darah pada Pekerja Ground Handling di Bandar Udara Internasional Adisutjipto Yogyakarta. *J Kesehat Masy*. 2018;6(4):419-427. https://ejournal3.undip.ac.id/index.php/jkm/article/view/21450

26. Souza, Périssé, Moura. Noise Exposure and Hypertension : Investigation of a Silent Relationship. *BMC Public Health*. 2015;15(328):1-9. https://doi.org/10.1186/s12889-015-1671-z

27. Kuang D, Yu YY, Tu C. Bilateral High-Frequency Hearing Loss is Associated with Elevated Blood Pressure and Increased Hypertension Risk in Occupational Noise Exposed Workers. *PLoS One*. 2019;14(9):1–11. https://doi.org/10.1371/journal.pone.0222135

28. Chen S, Ni Y, Zhang L, Kong L, Lu L, Yang Z, et al. Noise Exposure in Occupational Setting Associated with Elevated Blood Pressure in China. *BMC Public Health*. 2017;17(107):1–7. http://dx.doi.org/10.1186/s12889-017-4050-0

29. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease. *Journal of the American College of Cardiology*. 2004;43(10):1731−1737. https://doi.org/10.1016/j.jacc.2003.12.047

30. Lusno MFD, Haksama S, Wulandari A, Sriram S. Association between Smoking and Hypertension as a Disease Burden in Sidoarjo : A Case-Control Study. *Int J Appl Biol*. 2020;4(2):9–16. https://journal.unhas.ac.id/index.php/ijoab/article/view/10951

31. Smith JK. IL-6 and the Dysregulation of Immune, Bone, Muscle, and Metabolic Homeostasis During Spaceflight. *NPJ Microgravity*. 2018;4(24):1-8. https://www.nature.com/articles/s41526-018-0057-9

32. Ahmed SJ, Siddique MA, Barua A, Saikia H. Risk Factors of Diabetes Mellitus amongst The Executives of An Industrial Area of North East India: A Community Based Cross Sectional Study. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2017;11(1):S87–S90. https://doi.org/10.1016/j.dsx.2016.12.012

33. Suginama PA, Duana IMK. Hipertensi Pada Pekerja yang Terpapar Kebisingan di PT Indonesia Power (UBP) Bali Tahun 2015. *J Public Heal Udayana Univ*. 2019;6(1):40–46. https://ojs.unud.ac.id/index.php/ach/article/view/59828

34. Widya M, Setiani O, Dangiran HL. Hubungan Intensitas Kebisingan dengan Tekanan Darah Pekerja Tambang Pasir PT. X Rowosari, Semarang. *J Kesehat Masy*. 2018;6(6):225-234. https://ejournal3.undip.ac.id/index.php/jkm/article/view/22180/20394

35. Ummah R, Winarko, Rusmiati. Perbedaan Tekanan Darah Sebelum dan Sesudah Terpapar Kebisingan di Area Fabrikasi Baja Gresik Tahun 2020. *GEMA Kesehat Lingkung*. 2021;19(2):143-151. https://doi.org/10.36568/kesling.v19i2.1533

36. Juariah L, Mauliku NE, Saepudin W. Faktor-Faktor yang Mempengaruhi Status Tekanan Darah pada Pekerja di Job Pertamina Talisman Jambi Merang Tahun 2017. *Pinlitamas I*. 2018;1(1):305–315. http://repository2.stikesayani.ac.id/index.php/pinlitamas1/article/download/391/348/

37. Herawati C, Yuslichah A. Analisis Faktor Risiko Kejadian Hipertensi Pada Pekerja Pelabuhan. *J Kesehat Cirebon*. 2018;9(2):84-88. https://jurnal.stikescirebon.ac.id/index.php/kesehatan/article/view/82