

Review Article

Systematic Review: Noise Exposure Risks and Factors Associated with Hypertension Incidence in Workers

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Abstract

Noise is associated with hypertension. Exposure to noise that exceeds quality standards can cause an increase in workers' blood pressure. This study was conducted to examine the risk of noise exposure and the factors associated with the incidence of hypertension in workers through a systematic review method. Article searches were conducted through the journal sites Google Scholar, Garuda Portal, Science Direct, Proquest, JSTOR, Scopus, Semantic Scholar, and PubMed. The selection of articles was carried out with the following criteria: the dependent and independent variables were the incidence of hypertension in workers and exposure to noise, open access full text, the articles selected were articles with a publication date of not more than 10 years (2012-2021), and articles in English. Indonesian and English. Based on 724 relevant articles, 9 main articles met the criteria and were discussed further in this study. 9 main articles showed statistical test results p-value <0.05 which means there is a significant relationship between noise exposure and the incidence of hypertension in workers. Other factors, namely age of workers, length of work, gender, use of ear protective equipment, BMI, and family history of hypertension all have a significant relationship with the incidence of hypertension.

Keywords: Noise exposure; hypertension; blood pressure; worker

1. Introduction

The global economy is influenced by the existence of a workplace which also affects the availability of employment opportunities. In this modern era, the workplace has developed by implementing industry 4.0, which refers to increased automation, machine to machine, and human to machine communication (Jeshika, 2019). More interaction between machines and workers can undoubtedly increase work efficiency, but sophisticated machines can hurt workers' health. One of the impacts or hazards caused is the noise generated by production machines (Dewi et al., 2021).

Noise can be defined as any unwanted sound that can cause hearing loss (Menteri Tenaga Kerja Dan Transmigrasi Republik Indonesia, 2011). The Threshold Value for the noise level contained in the Decree of the Minister of Manpower of the Republic of Indonesia number 5 of 2018 is 85 dBA for 8 hours of exposure in one day or 40 hours in one week (Menteri Ketenagakerjaan Republik Indonesia, 2018). Meanwhile, WHO sets the maximum threshold value for noise in industrial areas at 70 dBA (WHO, 1999).

In addition to causing a significant impact on hearing loss, noise is also associated with cardiovascular disease, one of which is hypertension. Noise exposure can increase blood pressure and

pulse rate. Workers exposed to noise for five years and experiencing a continuous increase in blood pressure can cause hypertension (Mukhlis et al., 2018). Several factors in the work environment can cause an increase in blood pressure in workers. In addition to lighting and heat stress, noise is a work environment factor that can affect increasing blood pressure. Exposure to noise that exceeds quality standards can cause emotional disturbances and affect physiology (heart rate) and increase a person's blood pressure. (Afifah et al., 2016).

Based on a comprehensive global analysis conducted by WHO and Imperial College London, people with hypertension have increased from 650 million to 1.28 billion people in the last 30 years. Based on 2019 data, around 1.13 billion people worldwide experience hypertension, most experienced in developing countries with low incomes (Nonasri, 2020). Several studies have proven a relationship between noise exposure and the incidence of hypertension in workers, one of which in industry X, as many as 67.9% of workers exposed to high noise 85dB between (85 - 100.1 dB). Workers who suffer from hypertension are primarily found in locations exposed to high noise. From the results of statistical tests, it was found that there was a significant relationship between noise intensity and the incidence of hypertension ($p=0.007$) (Andjani and Mediana, 2021).

Hypertension can develop as a result of either high or low blood pressure. Hypertension is sometimes only discovered when difficulties in target organs such as the kidneys, brain, heart, and eyes occur. Hypertension is also linked to a higher risk of stroke. Other cardiovascular diseases that can arise due to complications of hypertension include the risk of myocardial infarction, kidney failure, dementia and atrial fibrillation. Therefore, it is necessary to do early detection to prevent hypertension in workers and reduce the risk of cardiovascular complications to death (Anshari, 2020). This review is essential because it has not been widely reviewed, and the results can be used as a reference for stakeholders to pay more attention to the health and welfare of their workers. Detection of hypertension can be done earlier to extend workers' working periods and productivity. This study was conducted to examine the risk of noise exposure and the factors associated with the incidence of hypertension in workers, based on articles that have been published in national and international journals.

2. Methods

This research was conducted through a systematic review method of various articles. A systematic review is used to help convey information more structured and comprehensively with inclusive results and make accurate conclusions. There is a specific time vulnerability in the article used so that it can be found novelty faster for research results. Based on 724 relevant articles, 9 main articles met the criteria and are discussed further in this article. The articles that have been obtained will then be collected, tabulated, compared, then summarized, and concluded.

Meanwhile, keywords are used for English-language journals: "Noise Exposure with Hypertension in workers" and "Noise with hypertension". Indonesian-language articles are obtained from accredited journal sites (Google Scholar and Garuda Portal). International journals are obtained from databases: Science Direct, Proquest, JSTOR, Scopus, Semantic Scholar, and PubMed.

The selection of articles begins with reading the abstract, which obtained 724 articles. Then, after reviewing the complete article's contents and evaluating many inclusion criteria, the re-election was carried out. Reading journals, books, and other sources about noise and the occurrence of hypertension in workers helped to determine the inclusion criteria. Inclusion criteria consist of : (1) the dependent variable in the research article was the incidence of hypertension in workers, (2) the independent variable in the research article was noise exposure, (3) open access full text, (4) the articles selected are articles with a publication date of no more than the last ten years (2012-2021), and (5) articles in Indonesian and English. Exclusion criteria, the article is a review article and not a research article. After conducting a full-text review, nine articles met the criteria. The flow chart for sorting articles can be seen in Figure 1. The next step is to analyze to assess the relevance of the literature found. The articles that have been collected will be analyzed through several stages. The first article will

be collected, then tabulated, compared to the findings, summarized, and concluded. The analysis is done by comparing the same study results across many variables. The data/information obtained from the article will be recapitulated and displayed in the form of a synthesis matrix table. The analysis is presented in the form of a narrative.

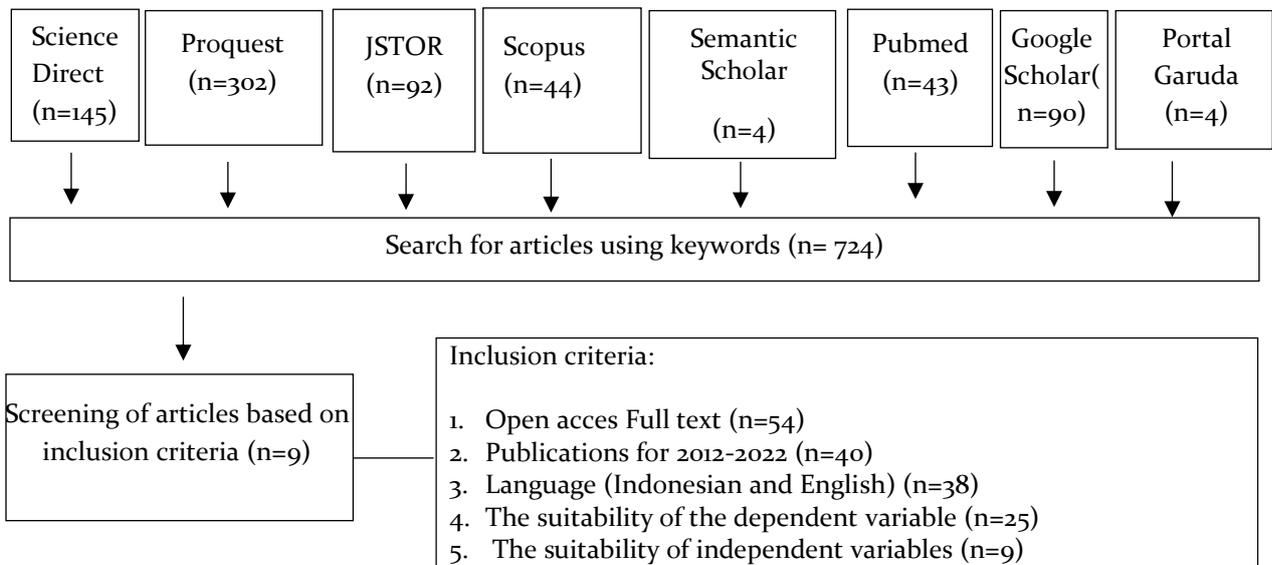


Figure 1. Article selection flowchart

3. Result and Discussion

The research locations of all the articles studied are in the Asian region. Three studies are in China, and the rest are in Indonesia. The majority of the research locations of the articles studied are developing countries. The type of research in the article being studied is analytic observational. There are 6 articles with a cross-sectional design, 1 article with a case-control design, and 1 article cohort. Based on a review of 9 selected articles, the number of samples in the study varied from 37 to 1,874.

All research subjects are more than 20 years old, and all research subjects are workers in industries, factories, airports and ports. Measuring instruments or instruments used in research related to noise exposure with the incidence of hypertension are sound level meters to measure noise intensity, sphygmomanometer to measure blood pressure, microtoise to measure height, and scales to measure weight. All studies also used an instrument in the form of a research questionnaire to determine individual characteristics related to the incidence of hypertension in workers.

All publications reported that noise exposure was significantly connected to the occurrence of hypertension in employees, as evidenced by the results of statistical tests in each study, which revealed that the p-value was less than 0.05, or the OR value, and the lower and higher bounds. The 95 percent confidence interval (CI) value was greater than 1. Noise exposure has been identified as a major risk factor for hypertension. Worker age, length of employment, gender, use of hearing protection, body mass index, and family history were also found to have a significant link with the occurrence of hypertension.

Table 1. Article finding

Research Title & Location	Author & Year Published	Method	Population	Result
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Research Title & Location	Author & Year Published	Method	Population	Result
1). Relationship between Noise Exposure and Hypertension in Cable Industry Employees (West Java) (Andjani and Mediana, 2021)	Nabilla, 2021	Observational analytics, Cross-sectional. Interviews with questionnaires and measurements using a sound level meter, sphygmomanometer, microtoise, and weight scales.	The workers at the cable factory in West Java are 78 male respondents aged 22-53 years.	67.9% of workers were exposed to high noise ≥ 85 dB between (85 - 100.1 dB). Workers who suffer from hypertension are primarily found in locations exposed to high noise. From the results of statistical tests, it was found that there was a significant relationship between noise intensity and the incidence of hypertension ($p = 0.007$). Workers with age ≥ 40 years (54.3%). Suffering from hypertension stages 1 and 2. From the results of statistical tests, there is a significant relationship between age and hypertension ($p = 0.019$). Measurement of noise intensity reached 88.2 dB. The results of statistical tests showed a moderate relationship between noise intensity > 85 dB and the incidence of hypertension (p -value = $0.002 < = 0.05$ $r = 0.407$) There is a relationship between length of service or tenure (> 3 years) with the incidence of hypertension (p -value = $0.014 < = 0.05$ $r = 0.323$).
2). The Relationship of Noise Intensity and Length of Work with Incidence of Hypertension in The Manpower of The Production Division of PT. Japfa Comfeed Indonesia Tbk (South Kalimantan) (Setiawan et al., 2018)	Andry, 2017	Analytical surveys. Cross-sectional. Interviews with questionnaires and measurements using a sound level meter, sphygmomanometer, microtoise, and weight scales.	There are 57 respondents in the production division.	
3). Effect of Aircraft Noise Exposure on Hypertension Incidence Rates in Adi Sumarmo Boyolali Airport Employees (Central Java) (Prasetya et al., 2016)	Novandi, 2016	Analytical Observation. Cross-sectional.	Adi Sumarmo Boyolali airport employees numbered 91 respondents	There are 9 employees (20.93%) who suffer from hypertension when they are exposed to low noise (85 dB). Of employees who are exposed to high noise (≥ 85 dB), there are 22 employees (51.16%) who suffer from hypertension. The statistical tests showed a p -value of 0.004, so that $p < 0.05$, there was a significant relationship between noise intensity and the incidence of hypertension.
4).Hypertension in Workers Exposed to Noise at PT. Indonesia Power Ubp Bali 2015 (Bali) (Suginama and Duana, 2019)	Putu, 2015	Crosssectional. Interviews with questionnaires and measurements using a sound level meter and sphygmomanometer.	There are 79 respondents at PT Indonesia Power UBP Bali.	The results of statistical tests showed that there was a significant relationship between noise exposure ≥ 85 dB(A) ($p=0.000$), age ≥ 40 years ($p=0.028$), respondents who did not comply with the use of ear protective equipment ($p=0.000$), and years of service. 5 years ($p=0.004$).

Research Title & Location	Author & Year Published	Method	Population	Result
5). Noise Exposure and Hypertension Among Port Workers (North Kalimantan) (Harianto and Pratomo, 2013)	Eddy, 2013	Crosssectional.	There are 361 respondents at Tarakan Class II Port.	<p>The statistical tests showed a significant relationship between noise exposure and the incidence of hypertension, p value = 0.03 POR = 0.52 (95% CI = 0.29 - 0.95).</p> <p>The statistical tests showed a significant relationship between age > 42 years and the incidence of hypertension, p value = 0.000 with POR = 5.89 (95% CI = 1.89 - 18.33).</p> <p>The statistical tests showed a significant relationship between BMI and the incidence of hypertension. The results of statistical tests on obese BMI obtained p-value = 0.26, POR value = 3.53 (95% CI = 0.71 - 4.46). The statistical tests on obesity BMI obtained a p-value = 0.11 and a POR value of 5.66.</p> <p>The results of statistical tests showed that there was a significant relationship between family history and hypertension (p-value = 0.03).</p>
6). Airport Noise Level Event With Hypertension In The Cargo International Airport Workers Adisucipto Yogyakarta (Jawa Tengah) (Indra and Tedy Candra Lesmana, 2013)	I Made, 2013	<p>Analytical observation. Cross-sectional.</p> <p>Interviews with questionnaires and measurements used a sound level meter, a mercury sphygmomanometer, and a stethoscope.</p>	There are 37 respondents at Adisucipto Airport Yogyakarta.	<p>The average noise level is 90.8 dB and exceeds the threshold value of ≥ 85 dB.</p> <p>The statistical tests showed a significant relationship between the noise level and the incidence of hypertension, the p-value = 0.000.</p>
7). A cross-sectional study on the effects of occupational noise exposure on hypertension or cardiovascular among workers from an automobile manufacturing company in Chongqing, China (China)	Shuai, 2013	<p>Cohort Study.</p> <p>Interviews with questionnaires and measurements using a sound level meter and a mercury sphygmomanometer.</p>	Worker The car manufacturing industry in Chongqing, China, totalled 728 respondents.	<p>The noise intensity in the car manufacturing industry was measured to reach 75.0 - 88.2 dB (mean = 78.6).</p> <p>Workers are grouped into noise-exposed and not exposed to noise. As many as (21.49%) of workers experienced hypertension in the noise-exposed group with a statistical test value ($p < 0.01$).</p> <p>With a statistical test value of ($p 0.01$), the percentage of female workers with hypertension has a significant link with the incidence of hypertension when compared to male workers.</p> <p>The statistical analyses revealed a link</p>

Research Title & Location	Author & Year Published	Method	Population	Result
(Wang et al., 2013)				between 10-20 years of work experience and the occurrence of hypertension. 0.000 was the P-value.
8). Relationship between occupational noise exposure and hypertension: A cross-sectional study in steel factories (China)	Fan Zhou, 2019	Cross-sectional. Interviews with questionnaires and measurements using a sound level meter and a mercury sphygmomanometer.	Workers at steel factory in Guangzhou, China, a total of 1874 respondents.	77.81% or as many as 1213 workers are exposed to workplace noise. The prevalence of hypertension in workers exposed to work noise is 11.98%. The statistical studies revealed a link between noise exposure and the occurrence of hypertension in the workplace. The significance level was 0.034.
(Zhou et al., 2019)				The prevalence of hypertension in workers exposed to noise was higher than in the unexposed group (adjusted OR: 1.88, 95% CI: 1.45-2.44). The length of labor has a substantial link with the occurrence of hypertension, according to statistical testing. 0.001 was the P-value.
9). Prevalence of hypertension and noise-induced hearing loss in Chinese coal miners (China)	Jing Liu, 2016	Case Contol. Interviews with questionnaires and measurements using a sound level meter and a mercury sphygmomanometer.	There are 738 respondents at Datun Coal Power Company China.	The noise intensity measured in the work area reaches 60 to 110 dB. The prevalence of hypertension was 29.2%, significantly higher in workers exposed to noise (≥ 85 dB) compared to the control group (< 85 dB), with a statistical test value ($P=0.012$).
(Liu et al., 2016)				The statistical tests showed a significant relationship between older age and the incidence of hypertension, p-value = 0.001. (OR =1.112 95% CI = 1.055-1.171). The statistical tests showed a significant relationship between gender and the incidence of hypertension, p value = 0.001. (OR = 0.367 95% CI = 0.228-0.591).

Table 2. Matric Synthesis of Results

The Results of The Study Related Noise with The Incidence of Hypertension			
1.	Noise Exposure	The findings revealed a link between noise levels and the occurrence of hypertension. Workers who work in noisy environments (over 85 dBA) are more likely to develop hypertension.	Source 1,2,3 4,5,6 ,7,8, 9
2.	Age of Workers	Existing research indicates a link between age and the occurrence of hypertension. Hypertension is more common among workers as they get older.	Source 1,4,5,9
3.	Length of Work	The current research results indicate a relationship between the length of service and the incidence of hypertension. The prevalence of hypertension in workers increases according to the length of service.	Source 2,4,7,8

The Results of The Study Related Noise with The Incidence of Hypertension

4.	Use of Ear Protective Equipment	The current research results show that non-compliance in-ear protection has a significant relationship with the incidence of hypertension in workers.	Source 4
5.	Body Mass Index (BMI)	The current research results show that body mass index has a significant relationship with the incidence of hypertension in workers. An increase followed the increase in BMI in the prevalence of workers with hypertension.	Source 5
6.	Family History with Hypertension	The current research results show that a family history of hypertension has a significant relationship with the incidence of hypertension in workers.	Source 5
7.	Gender	The current research results indicate that gender has a significant relationship with the incidence of hypertension in workers.	Source 7,9

3.1 Noise Exposure

When working, of course, there is an unavoidable interaction between workers with machines and heavy equipment and with reasonably high noise intensity. Noise exposure can increase blood pressure, and it can be proven by measuring blood pressure after noise exposure. The article mentions an increase in the average pressure after work or after noise exposure based on the article reviewed. A total of 2 articles grouped workers to be exposed to noise and not exposed to noise. The number of workers who experience the incidence of hypertension is more prevalent in the group exposed to noise. Workers in Indonesia risk noise exposure of more than 85 dB by 30-50%. Workplaces with noise exposure of more than 85 dB have a risk of hypertension in workers (Sulistiyono et al., 2022). Noise is a risk factor for hypertension that can be changed or reduced by intervention. Intervention actions can come from internal or external. Internal actions include adopting a healthier lifestyle, such as eating healthy and nutritious foods, limiting salt intake, stopping smoking, and abstaining from alcohol consumption. External actions taken by treating the noise source include reducing the intensity of the noise source, choosing a machine with a softer sound, modifying the technology for the noise source, changing the type of engine propulsion, installing equipment that blocks the distribution of sound, and using a vibration attenuator for the sound source plate with sound. Smoother and engine maintenance by repairing, replacing or lubricating loose engine components (Sumantri, 2015).

3.2 Age of Workers

Based on 9 articles that have been reviewed, 4 articles state that there is a relationship between the age of workers and the incidence of hypertension in workers. Age factor is very influential on the incidence of hypertension because, with increasing age, the risk of hypertension will be more likely to occur. As a person ages, a person blood pressure will increase. This can be caused by several factors, such as natural changes in the heart and blood vessels. These changes occur naturally during the ageing process. Workers over the age of 40 dominated the publications reviewed in this study. At that age, hypertension is more common because of natural changes in the body that affect the elasticity of blood vessels and a decrease in body resistance as people get older (Maulidina et al., 2019).

3.3 Length of Work

A more extended working period can make workers more exposed to hazards posed by the work environment, including noise. Thus, long working hours will affect and accumulate on the worker's body (Luthfiyah and Widajati, 2019). The longer the workforce is in a noisy area, the exceeds the Threshold Value in one day, and the longer you will be exposed to noise and hazard hazards that can have a negative impact on health. From 9 articles reviewed, 4 articles stated that the length of work that varied from 3 years to 20 years had a relationship and was associated with the incidence of hypertension in workers. The incidence of hypertension is more common in workers with a more extended working period.

3.4 Use of Ear Protective Equipment

In the study conducted (suwaji, 2013), there was a difference in blood pressure after work in workers who used earplugs and did not use earplugs. From the results of statistical tests obtained, systolic blood pressure values p -value = 0.003 and diastolic blood pressure p -value = 0.007. Based on the research above, earplugs are significantly associated with increased blood pressure. Researchers concluded that the diastolic pressure after working on the earplug was lower at 1.67mmHg than the diastolic pressure after not wearing an earplug. (Susanti and Suwaji, 2013). In this study, there was 1 corresponding article. The statistical tests show that respondents who were not obedient in using ear protection equipment got a value (p -value = 0.000). Earplugs and earmuffs are ear protection devices used to protect a person from noise hazards with great intensity. Earplugs can reduce noise by 8-30 dB and are usually used for protection up to 100 dB. The lack of discipline of workers in using ear protection equipment can be caused by discomfort in the use of Ear Protective Equipment or feeling disturbed in communicating between workers. Therefore, monitoring can be applied in strict use and mandatory regulations using ear protection equipment. (Indriyanti et al., 2019).

3.5 Body Mass Index (BMI)

Body Mass Index (BMI) measurement is a simple method to monitor the nutritional status of adults. The BMI value is calculated using measurements and the formula: weight (kg) divided by the result of the square of height (m) (Luthfiah and Widajati, 2019). In this study, 1 article stated that workers with overweight BMI had a significant association with the incidence of hypertension. The statistical tests obtained a p = 0.11 and a POR value of 5.66. It can be concluded that workers with an overweight BMI are at 5.66 times greater risk of suffering from hypertension than workers with a normal BMI. The results of the study (Kusumaningtiar 2017) showed that a person's blood pressure is influenced by their nutritional state. If the weight increases above the ideal body weight, then the risk of hypertension also increases. Weight loss trials showed an average change in systolic blood pressure and diastolic blood pressure of about 5.2 mmHg in hypertensive patients and 2.5 mmHg in people with normal blood pressure. It can be established that for every kilogram of weight lost, the predicted blood pressure drops by 1 mmHg. (Kusumaningtiar et al., 2017). Obesity or being overweight has a risk of developing hypertension. Obesity occurs due to the lack of attention of workers to nutritional intake. Too often, eating foods with high salt content also impacts the risk of hypertension(Sulistiyono et al., 2022).

3.6 Family History with Hypertension

Based on the article review, there is 1 article with statistical test results showing a significant relationship between family history and hypertension (p -value = 0.03). In a study conducted (angesti, 2018), the results of logistic regression analysis showed that a family history of hypertension was the dominant factor for hypertension with an OR value of 3.884, which means that respondents who have a family history of hypertension have a 3.9 times greater chance of experiencing hypertension than respondents who do not have a history of hypertension. Hypertension. Research in India revealed a close relationship between a family history of hypertension and the incidence. In this case, the family history of hypertension is more emphasized through parenting in the family, decreased diet, and parental income levels. (Angesti et al., 2018). Usually, one family lives in the same environment, having similar habits and environmental risk factors, such as daily lifestyle and food consumed. These same factors can then increase the risk of hypertension in family members (Heryant and Pulungan, 2019).

3.7 Gender

This study discovered a statistically significant association between the occurrence of hypertension in female workers and male workers, with a statistical test value (p 0.01). Another study found that 15 percent of male respondents had hypertension, whereas female respondents had greater

hypertension than men, with 27 percent having hypertension (45 percent). A p-value of 0.035 was found in statistical tests. It can be concluded that there is a significant link between gender and hypertension occurrence. Women will experience an increased risk of hypertension after 45 years because they will experience menopause. Women who have gone through menopause have low levels of estrogen. While this estrogen functions to increase levels of High-Density Lipoprotein (HDL), which plays a significant role in maintaining healthy blood vessels. In menopausal women, decreased a decrease will also follow estrogen levels in HDL levels if it is not balanced with a good and healthy lifestyle (Falah, 2019). A man is more likely to have a lifestyle that can trigger an increase in blood pressure compared to women. However, when women enter menopause, the prevalence of hypertension in women will increase because the production of the hormone estrogen decreases, so blood pressure increases (Kusumaningtiar et al., 2017).

4. Conclusion

Noise is associated with cardiovascular disease, one of which is hypertension. Exposure to noise that exceeds quality standards can cause emotional disturbances and affect physiology (heart rate), increasing workers' blood pressure. The statistical test results produced a p-value of 0.05 between noise exposure and the occurrence of hypertension based on an evaluation of 9 papers. There is a substantial link between noise exposure and the occurrence of hypertension in workers in all of the studies. Age of workers, length of work, gender, use of ear protection equipment, BMI, and family history are all factors that have a substantial impact on the occurrence of hypertension. Further control is needed and regular monitoring and evaluation in the use of ear protection equipment to reduce noise exposure to prevent the occurrence of hypertension in workers. Every worker can also do prevention of hypertension by changing a healthier lifestyle.

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