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Regional Case Study

Relationship of Noise Levels with Hypertension in Textile Workers in Semarang City

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Abstract

Noise is associated with a risk factor for several cardiovascular diseases, one of which is hypertension. Hypertension is estimated to cause 7.5 million deaths, or about 12.8% worldwide. The textile industry is exposed to high noise intensity because it constantly uses machines. The results of a preliminary study of noise measurement showed that the average at 6 points reached 90 dBA. The Threshold Value for the noise level contained in permitted government regulation is ≤ 85 dBA for duration of exposure of 8 hours. The measurement results exceed the threshold value. This study was analytical observational research with a Cross-sectional study design. The sample in this study was 74 workers textile industry in Semarang city. The average noise intensity measurement in the entire machine area of spinning unit 5 of the Semarang City Textile Industry is 87.49 dBA. Based on statistical test analysis, the results of noise levels (p-value = 0.037), working period (p-value = 0.015), and continuity of use of ear protection equipment (p-value = 0.048) and duration of exposure per day (p-value 0.510) were obtained. There is a significant relationship between noise level, working period, and continuity of Ear Protection Equipment use with the incidence of hypertension.

Keywords: Blood pressure; hypertension; industry; noise; textile workers; threshold value

1. Introduction

In this increasingly advanced and sophisticated era, the Indonesian industrial world has developed by applying industry 4.0, which refers to improved automation, machine-to-machine, and human-to-machine communication(Jeshika, 2019). The use of more modern machines is aimed at increasing the pace of the production process more optimally so that it can produce products with larger quantities and be supported by good quality, along with the development of technology and modernization of the machines used for the production process. Compared to the resulting positive impact, these developments cause negative effects due to the interaction between machines and workers. However, in the process there are still many industries that use humans as the main workforce in large numbers, which is called labor intensive. The textile industry is included in the labor-intensive industry with a total workforce of 593,899 people (40.78%) (Winardi et al., 2019; Direktorat Publikasi, 1991).

The number of machines in Spinning Unit 5 includes: 2 blowing machines, 32 carding machines, 8 draw frames, 12 flyer machines, 80 ring spinning machines, and 12 winding machines. The large number of machines in the room increases the density of the machine and can produce sounds with varying noise levels. The density of the engine affects the noise, the higher the density of the engine, the higher the noise generated (Manongko et al., 2021; Dindin Syafrudin, 2019).

The workplace can affect workers' health because there are many risk factors that, if ignored, will be fatal. One of the impacts and dangers caused is the noise from advanced production machines (Dewi et al., 2021). Textiles are an industry that focuses on processing fibres into yarns or from raw materials into semi-finished materials and then into various types of clothing. The textile industry has exposure to high noise intensity because the production process starting from the spinning process into yarn, sizing, twisting, weaving, to dyeing finishing (Elnathan, 2014) uses a machine that turns on and can cause noise in the workplace, where a high source of noise, one of which comes from a spinning unit in which there are several machines including machines blowing, carding, flyer, ring spinning, winding and labour are exposed for 8 hours of work per day (Sumardiyono et al., 2019).

Based on the Regulation of the Minister of Manpower and Transmigration Number Per.13 / Men / X / 2011 of 2011 concerning the Threshold Value of Physical Factors and Chemical Factors in the Workplace, noise can come from production process tools that are at work and noise can be interpreted as all unwanted sounds that can cause hearing loss (Menteri Tenaga Kerja Dan Transmigrasi Republik Indonesia, 2011). The government has set a maximum limit or Threshold Value for the noise level contained in the Regulation of the Minister of Manpower of the Republic of Indonesia number 5 of 2018, threshold value allowed noise is ≤ 85 dBA for the duration of exposure for 8 hours in one day or 40 hours within one week (Menteri Ketenagakerjaan Republik Indonesia, 2018).

Noise is associated with and is a risk factor for several cardiovascular diseases, including stroke, myocardial infarction and hypertension (Indriyanti et al., 2019). Noise exposure can increase blood pressure and pulse rate. Sympathetic nerves that receive stimulation in the form of noise will affect the veins and arterioles, causing vasoconstriction. Vasoconstriction that occurs in arterioles will lead to an increase in blood pressure. In the veins, vasoconstriction will cause the contents of stroke volume and cardiac output to increase—increased cardiac output, resulting in increased blood pressure. Workers are exposed to noise over five years and experience a continuous increase in blood pressure can cause hypertension (Mukhlish et al., 2018).

Hypertension, commonly called high blood pressure, can be interpreted as an increase in systolic blood pressure of more than 140 mmHg and diastolic blood pressure of more than 90 mmHg at two measurements with an interval of 5 minutes in a state of sufficient rest/calm. An increased blood pressure that lasts for a long time and continuously can trigger kidney failure, stroke and coronary heart disease if not given treatment early on(Data and Information Center of the Ministry of Health of the Republic of Indonesia, 2014). Hypertension is estimated to cause 7.5 million deaths, or about 12.8% worldwide. Hypertension is a major risk factor for coronary heart disease and ischemic and hemorrhagic stroke. Globally, the overall prevalence of hypertension in a person aged 25 years and over is 40%(World Health Organizations, 2021). There have been previous studies that have linked noise to the incidence of hypertension. In the research (Andry, 2018) conducted on the workers of PT. Pt. Japfa Comfeed Indonesia Tbk. Obtained the result that there is a meaningful relationship between noise intensity and hypertension with a p-value = 0.002 and a p-value of 0.407, which means a moderate correlation between variables (Setiawan et al., 2018).

The industry for this research is one of the industries engaged in the textile sector located in the city of Semarang with a land area of 182700 m2, producing Spun Yarn type textile yarn from the primary material of various types of polyester, composition, and yarn numbers. A preliminary noise measurement study in May 2022 showed that the average result at 6 points reached 90 dBA. This indicates an increase from 2021 of 89.5 dBA, and the measurement results also indicate that the noise intensity exceeds the threshold value set by the government, which is 85 dBA.

While the results of blood pressure measurements in 10 workers, 5 workers (50%) had abnormal systolic and diastolic blood pressure with an average systolic blood pressure of 140 mmHg and diastolic blood pressure of 91 mmHg, based on the exposure above, the noise measurement results exceeded the threshold value. The results of measuring systolic and diastolic blood pressure from 5 workers were abnormal. For this reason, it is necessary to research to examine whether there is a relationship between noise levels and the incidence of hypertension in Semarang textile industry workers. The purpose of this

research is to knows the relationship between noise level, working period, length of noise exposure per day, and continuity of use of ear protection equipment with the incidence of hypertension in workers of Spinning Unit 5 Textile Industry in Semarang city.

2. Methods

The type and design of this study is analytical observational research, which is a study that aims to prove the relationship between free variables in the form of exposure and bound variables in the form of effects. This study used a cross-sectional design for the research time, where all subjects and variables were only observed once at a predetermined time (Irmawartini and Nurhaedah, 2017). The samples in this study were 74 workers in spinning unit 5 of the Textile Industry in Semarang city spread across blowing, carding, drawing, flyer, ring spinning, and winding machines. Data collection in this study was taken through measurements and interviews, the primary data measured included data on noise levels and blood pressure in workers. Noise measurement tools in the form of sound level meters in the work environment of the textile industry in Semarang City and blood pressure measurements using digital tension. Interview data were obtained by filling out questionnaires to get data related to hypertension in workers. The independent variables in this study were noise level, working period, length of exposure per day, and continuity of use of ear protection equipment. The dependent variable in this study is the incidence of hypertension in workers in the textile industry in Semarang City. This study used univariate, bivariate, and multivariate data analysis with Chi-Square and Fisher's Exact Test tests.

3. Result and Discussion

The results of measurements, observations, and interviews found the Frequency Distribution of Worker Characteristics including noise level, working period, duration of Exposure (per day), Continuity of Use of ear protection equipment, Incidence of Hypertension in Spinning Unit 5 of the Semarang City Textile Industry. The results found that there are 58 workers (78.4 %) exposed to noise exceeding the threshold value, for more details the results are described in Table 1.

Table 1. Frequency distribution of characteristics of spinning unit workers 5 textile industry Semarang City

No.	Variable	Category	Frequency	%
1.	Noise Level	Exceeding threshold value (> 85 dBA)	58	78.4
		Not exceeding threshold value (≤ 85 dBA)	16	21.6
2.	Working Period	≥ 5 Years	61	82.4
		< 5 Years	13	17.6
3.	Duration of Exposure (per day)	> 8 Hours	11	14.8
		≤ 8 hours	63	85.2
4.	Continuity of Use of ear protection equipment	Yes	25	33.8
		Not	49	66.2
5.	Incidence of Hypertension	Hypertension	31	41.9
		No Hypertension	43	58.1

Based on table 1, it can be seen that the number of workers with a working period of ≥ 5 years is more than workers with a working period of < 5 years. Namely, there are 61 workers (82.4%) who are in the ≥ 5 years' work period group, and the remaining 13 workers (17.6%) are in the < 5-year group. A worker who had an exposure duration of >8 hours less than workers who had a ≤ exposure length of 8

hours, namely there were 11 workers (14.8%) who were in the long exposure group > 8 hours and the remaining 63 workers (85.2%) who were in the long exposure group ≤ 8 hours. There are more workers who do not use ear protection equipment continuously than workers who use ear protection equipment continuously, namely there are 49 workers (66.2%) who are in the group who do not use ear protection equipment continuously and the remaining 25 workers (33.8%) who are in the group who use ear protection equipment continuously.

Table 2. Noise level frequency distribution in the machine area of spinning unit 5 textile industry Semarang city

No.	Engine Area	Number of Workers	Percentage (%)	Noise Level (dBA)
1	Blowing	6	8.10	85.36
2	Carding	16	21.62	84.64
3	Drawing	4	5.40	86.59
4	Flyer	6	8.10	88.87
5	Ring Spinning	26	35.13	90.87
6	Winding	16	21.65	88.63
	Total	74	100	524.96
	Average			85.36

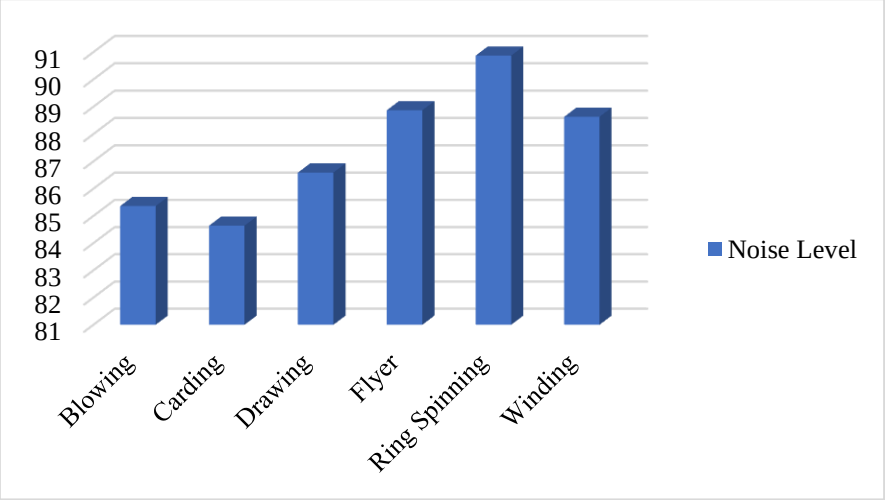

Figure 1. Chart of noise level frequency distribution in the machine area of spinning unit 5 textile industry Semarang city

This study was conducted at 6 starting points with 4 repetitions, bringing the total measurement points to 24 points. Noise level assessment is carried out 4 times at different times (at 09.00 WIB, 11.00 WIB, 13.00 WIB, and 15.00 WIB). Each point is then averaged to obtain the average noise level value at each measurement point. Measurements are carried out using a sound level meter (SLM) tool from the first point to the last point. The results of noise measurements in the entire machine area of spinning unit 5 of the Semarang City Textile Industry amounted to 87.49 dBA. The measurement shows the results above the threshold value of the Regulation of the Minister of Manpower of the Republic of Indonesia number 5 of 2018, which is 85 dBA for 8 working hours.

The measurement results showed a blowing machine of 85.36 dBA, carding of 84.64 dBA, drawing of 86.59 dBA, flyer of 88.87 dBA, ring spinning of 90.87 dBA, and winding of 88.63 dBA. The highest noise level is in the ring-spinning machine, which is 90.87 dBA, and the lowest is in the Carding machine 84.64 dBA. Based on Table 2 and figure 1, workers are spread out in several areas to operate the production machine. The highest number of workers was in the Ring Spinning machine, with 26

workers (35.13%), and the least number of workers was in the Drawing machine as many as 6 workers (5.40%).

Table 3. Noise level frequency distribution in workers of spinning unit 5 textile industry Semarang City

Noise Level	Frequency	Percentage (%)
Exceeding Threshold Value (> 85 dBA)	58	78.4
Not exceeding Threshold Value (≤ 85 dBA)	16	21.6
Total	**74**	**100**

Based on table 3, the number of workers exposed to noise exceeds the Threshold Value in the Regulation of the Minister of Manpower of the Republic of Indonesia number 5 of 2018, which is 85 dBA. A total of 58 workers or 78.4% of the total number of workers were in the work area which exceeded the threshold value of the workers, while as many as 16 workers or 21.6% of the total number of workers were in the work area that did not exceed the noise Threshold value.

Table 4. Results of systolic and diastolic blood pressure examinations on workers in spinning unit 5 textile industry in Semarang city.

	Blood Pressure Test Results					
	Systolic Blood Pressure			**Diastolic Blood Pressure**		
	Check 1	Check 2	Check 3	Check 1	Check 2	Check 3
Sum	9847	9834	9771	6318	6282	6170
Average	133.06	132.89	132.04	85.37	84.89	83.37
Minimum	88	97	102	63	59	60
Maximum	157	165	175	115	113	114

Based on table 4, it can be seen that the systolic and diastolic blood pressure tests of 74 workers. The average systolic blood pressure at examination 1 was 133.06 mmHg with a minimum value of 88 mmHg and a maximum value of 157 mmHg. The average systolic blood pressure on examination 2 was 132.89 mmHg with a minimum value of 97 mmHg and a maximum value of 165 mmHg. The average systolic blood pressure at examination 3 was 132.04 mmHg with a minimum value of 102 mmHg and a maximum value of 175 mmHg. While the average diastolic blood pressure on examination 1 is 85.37 mmHg with a minimum value of 63 mmHg and a maximum value of 115 mmHg. The average diastolic blood pressure at examination 2 was 84.89 mmHg with a minimum value of 59 mmHg and a maximum value of 113 mmHg. The average diastolic blood pressure at examination 3 was 83.37 mmHg with a minimum value of 60 mmHg and a maximum value of 114 mmHg.

Table 5. Frequency distribution of hypertension in workers of spinning unit 5 textile industry Semarang city

Blood Pressure Measurement	Frequency	Percentage (%)
Hypertension	31	41.9
No Hypertension	43	58.1
Total	74	100

To determine the incidence of hypertension in workers, a blood pressure examination is carried out using a Sphygmomanometer. The results of the blood pressure examination were carried out 3 times on 74 workers, and the results showed that the average systolic blood pressure was 132.66 mmHg with a minimum value of 88 mmHg and a maximum value of 175 mmHg. While the average diastolic blood pressure at 84.54 mmHg with a minimum value of 59 mmHg and a maximum value of 115 mmHg. Based on table 5, workers who did not experience hypertension were 43 workers or 58.1% of the total number of workers, while workers who experienced hypertension 31 workers (41.9%). The clinic doctor carries blood pressure measurements 3 times for each worker. Measurement hours are selected outside of working hours or when workers are resting so as not to interfere with production activities. Blood

pressure measurements are taken in the morning before work, during the day during rest hours, and in the afternoon just before the time to go home.

Table 6 Recapitulation of statistical analysis results

No.	Variables	Nilai P-Value	RP (95% CI)	Information
1.	Noise Level	0.016	RP = 4.000 CI = 1.067 – 14.999	There's a Relationship
2.	Working Period	0.015	RP = 6.393 CI = 0.956 – 42.758	There's a Relationship
3.	Duration of Exposure	0.510	RP = 1.375 CI = 0.740 – 2.554	No relationship
4.	Continuity of Use of Ear Protection Equipment	0.048	RP = 2.126 CI = 1.005 – 4.498	There's a Relationship

Table 6 shows the results of bivariate analysis, there are three free variables associated with bound variables. These variables are noise level (P-value = 0.016), working period (P-value = 0.015) and continuity of use of Ear Protection Equipment (P-value = 0.048). At the same time, duration of exposure per day (P-value = 0.510), have no relationship with the incidence of Hypertension in workers of the Spinning unit 5 Textile Industry in Semarang City.

Table 7. Recapitulation of multivariate analysis results

No	Variable	B	P-Value	OR	95 % CI
1.	Noise Level	3.757	0.001	42.821	(4.995-367.121)
2.	Working Period	2.516	0.030	12.379	(1.269-120.768)
	Constant	-6.222	0,000	0.002	

After univariate and bivariate tests were carried out to determine the risk factors that most influenced the incidence of hypertension in workers of Spinning Unit 5 of the Semarang City Textile Industry, then a multivariate test was carried out using a binary logistic regression test. Based on the results of the multivariate analysis, two variables were obtained that were most influential with the incidence of hypertension in workers of Spinning Unit 5 of the Semarang City Textile Industry, with a value of P-Value = 0.001 for noise level and P-Value = 0.030 for the working period.

The probability of a spinning unit worker of 5 experiencing the incidence of hypertension in workers can be calculated using the following formula :

$$P = \frac{1}{1+e^{-(\alpha+\beta 1x1+\beta 2x2+\cdots+\beta pxp)}}$$

$$P = \frac{1}{1+2.718^{-(-6.222+3.757+2.516)}}$$

$$P = \frac{1}{1+2.718^{-(-6.222+3.757+2.516)}}$$

$$P = \frac{1}{1.95}$$

$$P = 0.513$$

Thus, it can be concluded that workers of Spinning Unit 5 of the Semarang City Textile Industry who work with noise exposure exceeding the threshold value and have a working period of more than five years have a probability of experiencing hypertension by 51.3%. After several multivariate modelling was carried out, until it was eliminated one by one, the final model of multivariate analysis was obtained where the primary variable, namely the noise level, had an Odds Ratio (OR) value of 42.8, meaning that workers exposed to noise above the Threshold Value (>85dB) would be at risk of experiencing a hypertension event of 42 times higher than workers exposed to noise with values below the Threshold Value.

3.1 Relationship of Noise Levels with the Incidence of Hypertension

The results of the bivariate analysis with the chi-square test showed a p-value of 0.016 ($p < 0.05$), then Ho was rejected, and Ha was accepted, which means that there is a significant relationship between noise level and the incidence of hypertension in workers of spinning unit 5 textile industry in Semarang City. Such results prove that workers who are exposed to continuous noise over a long period can cause physiological changes in the body and cause hypertension. The highest noise exposure to the worker's body was measured at 91.68 dBA. This figure exceeds the threshold value set by the

government for 8 hours of work per day. Exposure above 85 dBA that occurs continuously and has accumulated during the service period leads to an increase in the automatic regulation of systemic blood pressure, which is continuous and pathogenic, so it is at high risk of causing hypertension(Shrestha and Shiqi, 2017).. Workplace noise levels between 68-102 dBA were associated with an increased risk of hypertension by 8.3% (OR: 1.083, 95% CI: 1.058 –1.109) (Wu et al., 2022).

A high noise level is a form of pressure the body feels through the auditory system. Noise exposure activates the sympathetic nervous system and in the body induces hormonal changes in the hypothalamic-pituitary-adrenal (HPA) axis. Stimulation of noise through sympathetic nerve mechanisms causes a rise in blood pressure through an increase in total peripheral resistance and cardiac output. Repeated exposure can accelerate the development of changes in the vascular structure of peripheral vessels, resulting in a persistent rise in blood pressure up to the level of hypertension.

This research is in line with the study conducted by Zhou in China in 2019, out of 1,874 workers, as many as 1,213 steel industry workers exposed to noise experienced hypertension. The prevalence of hypertension in workers exposed to occupational noise is 11.98%. Statistical tests showed a significant relationship between noise exposure and the incidence of hypertension in workers, with a p-value of 0.034. The prevalence of hypertension in workers exposed to noise was higher compared to the unexposed group of Wu et al. (2022). The results of another study conducted by Apsari in 2022 with a sample of 75 workers in the textile industry showed that there was a relationship between noise intensity (P-value = 0.018) with the incidence of hypertension, the highest noise intensity measured was 90.6 dBA (Apsari, 2022). The research has similarities with this study because there are similarities in textiles, the exact source of noise and production process, namely yarn spinning, and the same source of noise from production machines.

The Semarang City Textile Industry has worked to reduce and control the effects of high noise by providing ear protection equipment in the form of ear plugs to workers. However, these control efforts are not accompanied by supervision from the management. As a result of the observations that have been made, many workers do not use earplugs when working on the grounds of discomfort and are used to not using them. The control is considered less effective and efficient because, until now, the noise level in Spinning Unit 5 is still exceeding the threshod value. After all, it only relies on the discipline of workers in using Ear Protection Equipment.

3.2 The Relationship between Working Period and hypertension

The results of the bivariate analysis with the chi-square test showed a p-value of 0.015 ($p < 0.05$), then Ho was rejected, and Ha was accepted so that statistically, there was a significant relationship between the length of work and the incidence of hypertension in workers of spinning unit 5 textile industry in Semarang City. The length of service can be interpreted as the length of time a person works somewhere (Eko Kurniawan and Sulianto, 2019). The length of service is vulnerable time people have worked at work within (years), calculated from the time off work until the study lasted (Lantong et al., 2017).

This research is in line with research conducted by Saryawati at PT Bitratex, a textile industry where the working population exposed to noise has similarities, namely in winding machines, ring frames, carding, and blowing. Statistical analysis showed a significant relationship between the length of service and the incidence of hypertension (P-value < 0.05). The respondents in this study were 46 people, there were 22 people (47.8%) with a working period of > 10 years, while there were 24 people (52.2%). Working period < 10 years (Saryawati, 2008).

Research conducted by Shuai in 2013 in China showed results that were in line with this study, statistical test results showed that the length of work of 5 – 10 years had a significant relationship with the incidence of hypertension, with a p-value value of 0.000. The respondents in the study were workers in the car manufacturing industry, as many as 728 respondents. Workers are grouped into exposed to noise and not exposed to noise as many as (21.49%) of workers experienced the incidence of hypertension in the noise exposure group with a statistical test value ($p < 0.01$) (Wang et al., 2013). Another study by Putu in 2015 on workers at PT Indonesia Power UBP Bali with a total of 79 respondents also showed a significant relationship between noise exposure ≥ 85 dBA and a working period of ≥5 years ($p = 0.004$) (Suginama and Duana, 2019).

The length of work can affect productivity and work results positively and negatively. The positive impact is that the longer the working period will make the workforce more experienced and reliable in carrying out their work. The negative effect of a working period can produce bad influences if, with the length of work, labour suffers losses due to work processes and environments, such as health

problems or occupational diseases (Maulina and Syafitri, 2019). The longer people work, the more risk of developing occupational diseases, working for a long duration of up to years can affect workers' health because of the frequency of noise exposure that occurs continuously (Khumaidah, 2009). Workers with more or over 5 years of service will tend to be more at risk of an increase in blood pressure compared to workers who have a working period under 5 years (Maulina et al., 2022).

3.3 The Relationship Between Duration of Exposure to Noise and The Incidence of Hypertension

The length of exposure is the length of time a person is exposed to a harmful substance in a day, the longer the time of exposure to food the level of risk of experiencing health problems will be greater. The length of exposure in this study is interpreted as the length of time a person works in one day. The duration and frequency of exposure can affect the health effects caused. The longer the worker's working hours in a meal a day, the longer the exposure to noise received by the worker's body, and the greater the risk of developing health problems. Continuous exposure will accumulate so that a response from the body appears in the form of an increase in blood pressure to cause hypertension (Rumerung et al., 2019; Salami, 2015).

Research Yang et al. (2018) conducted in 2018 showed that exposure to high levels of noise with a continuous duration of exposure can significantly increase the risk of hypertension and cause cardiovascular disease. Long-term noise exposure can increase the secretion of adrenal glands in the body, which leads to an increase in blood pressure. Cumulative noise exposure is a significant predictor of diastolic blood pressure, it suggests that noise exposure has a direct or indirect impact on changes in blood pressure (Yang et al., 2018).

The results of the bivariate analysis with the fisher exact test showed a p-value of 0.510 ($p > 0.05$), so Ho was accepted, and Ha was rejected so that statistically, there was no significant relationship between the length of noise exposure per day and the incidence of hypertension in workers of spinning unit 5 textile industry in Semarang City. The Prevalence Ratio (RP) value is 1.375 (RP > 1) with 95% CI (0.740 – 2.554). This study is in line with a study husna conducted in 2014, which was conducted on 52 women living around the railway track. The results of statistical tests showed no relationship between the length of exposure per day and the incidence of hypertension ($p = 0.727$ and OR = 1.538) in women living around the Semarang City railway track (Husna, 2014).

This study is in line with research conducted by Vina in 2014 on 100 public transport drivers, showing that as many as 55 respondents (55%) worked more than 8 hours. Based on statistical tests, it showed that no significant relationship was obtained between the length of exposure per day and the incidence of hypertension ($p = 0.807$) (Anggraeni, 2012). From the observations and interviews, the number of workers was more than 63 (85.2%) worked less than 8 hours per day. This is suspected to be the cause of the absence of a relationship between the length of exposure and the incidence of hypertension in workers of Spinning Unit 5 of the Textile Industry of Semarang City because working hours have met the requirements set by the government, where according to PP No.35/2021 and Law No.13/2013 a good working time is no more than 7 hours a day for 6 working days and no more than 8 hours in a day for 5 working days (Presiden Republik Indonesia, 2021; Presiden Republik Indonesia, 2013).

The results of this study are not in line with theory because although workers have the same hours between one worker and another, the exposure that enters the worker's body is different according to the area where you work, which has different noise levels and depends on the use of personal protective equipment. Although it is dominated by workers who work less than the same 8 hours per day, there are still 11 workers who work more than 8 hours per day, with the reason that is waiting for the next shift worker so that shift changes are always made late.

3.4 Relationship of Continuity of Ear Protection Equipment Use with The Incidence of Hypertension

The results of the bivariate analysis with the chi-square test showed a p-value of 0.048 ($p < 0.05$), and then Ho was rejected. Ha was accepted so that statistically, there was a significant relationship between the continuity of Ear Protection Equipment use and the incidence of hypertension in workers of spinning unit 5 of the Semarang City Textile Industry. This research is in line with the study conducted by Suginama in 2015 in line with this research, where out of 79 workers at PT. Suginama. Indonesia Power UBP Bali, 61 respondents, were obedient in wearing ear protection equipment, and 18 respondents were not compliant in wearing ear protection equipment. The incidence

of hypertension was higher in respondents who did not comply with the use of ear protective equipment with a value of p = 0.000, which means that there is a meaningful relationship between the adherence to the use of ear protective equipment and the incidence of hypertension in workers (Suginama and Duana, 2019).

The study was conducted by Yu-Ting Lin in 2020 with 2459 respondents. The use of ear protection equipment is grouped into always wear (100%), sometimes (50%), and never (0%). The ear protection equipment used is earplugs and earmuffs. The results showed that workers exposed to noise between 82 and 124 dBA had an increased risk of hypertension. The results of the analysis showed the use of ear protection equipment could reduce substantially the level of noise exposure and prevent workers from the risk of hypertension (Lin et al., 2020).

Another study by Ernita in 2022 on Terasi home industry workers showed a value (P-value of 0.000 < 0.05), which means that there is a significant difference between workers' blood pressure before and after wearing ear protective equipment. The use of ear protection equipment can provide stability to workers' blood pressure from exposure to noise (Sari et al., 2022). The average noise level in the Sragen furniture industry was 96.17 dBA. The average blood pressure in workers wearing earplugs is 90.67 mmHg, while in workers who do not wear earplugs, it is 103.6 mmHg. Based on statistical tests, there was a significant difference (p = 0.000) in blood pressure between furniture workers exposed to noise wearing and not wearing ear plug (Kurniawati, 2012). From the study, it can be concluded that ear protective equipment has proven effective in preventing the rise in blood pressure.

Ear protective equipment is an ear plug or earplug device to reduce and protect against exposure to noise entering the ear. The use of ear protection equipment is mandatory for workers exposed to noise with an intensity of > 85 dBA for 8 hours per day or 40 hours per week (Septiana and Widowati, 2017). There are two types of ear protection equipment that can be used, and the first is ear plugs that can protect the entire ear and reduce exposure to noise up to 25-30 dBA, while the ear is external earmuffs that can reduce noise frequency by 100-8000 Hz and can reduce noise intensity by about 30-40 dBA (Tarwaka, 2008; Anizar, 2009). Using ear protection equipment, the noise received by the worker's ear becomes below the threshold value (85 dBA) and can be reduced to 25-40 dBA.

4. Conclusions

The results of measuring the noise level at 6 points are an 85.36 dBA blowing machine, an 84.64 dBA carding machine, an 86.59 dBA drawing machine, an 88.87 dBA flyer, a 90.87 dBA ring spinning machine, an 88.63 dBA winding machine. The average noise intensity measurement in the entire machine area of spinning unit 5 of the Semarang City Textile Industry is 87.49 dBA. There is a significant relationship between noise level (p-value = 0.037), working period (p-value = 0.015), and continuity of use of Ear Protection Equipment (p-value = 0.048) with the incidence of hypertension (p-value < 0.05). There was no relationship between the length of exposure per day (p-value 0.510) and the incidence of hypertension (p-value > 0.05). The results of the multivariate analysis show the value of P-Value = 0.001 for the noise level and P-Value = 0.030 for the working period. Based on multivariate analysis, the two variables that most influence the incidence of hypertension in workers of Spinning Unit 5 of the Semarang City Textile Industry are noise level and working period. To reduce the risk of hypertension in workers, advice for the Semarang City Textile Industry can carry out strict monitoring or supervision of workers in using Ear Protective Equipment. Meanwhile, workers are expected to increase further awareness and compliance in using Ear Protective Equipment when working for 8 hours/day or while in the work area.

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