The Influence of Noise Intensity and Age to the Employees' Blood Pressure at Heavy-Duty Shop and EHS Department

Pengaruh Intensitas Kebisingan dan Usia terhadap Tekanan Darah pada Pekerja Heavy Duty Shop dan EHS Departemen

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ABSTRACT

Introduction: Noise is an unwanted sound heard by the hearers, which can trigger health problems if it continues to be exposed to a certain intensity. One of the health problems that can arise due to noise is the blood pressure increase. This study aims to analyze the influence of noise intensity and age to the blood pressure increase. **Methods:** This study was an observational study completed with cross-sectional design and analytics. The independent variables in this study were the noise intensity and age, while the dependent variable was the blood pressure. The sample collection of this study applied the total sampling method with 46 employees as respondents, i.e., 29 employees of the heavy-duty shop and 17 employees of the EHS Department in PT. Vale Indonesia. The data analysis was conducted by using the logistic regression statistical test with α-value of 0.05. **Results:** The noise intensity affected the increase of both systolic blood pressure (significance/p-value=0.00) and diastolic blood pressure (significance/p-value=0.01) with an odds ratio of the increase of systolic blood pressure (Exp (B) =9.75) and the increase of diastolic blood pressure (Exp (B)=5.76). Furthermore, the variable of age does not influence the increase of both systolic (significance/p-value=0.57) and diastolic (significance/p-value=0.41) blood pressures. **Conclusion:** The rise of the blood pressure of the employees is affected by the noise intensity factor in the workplace.

Keywords: *noise intensity, age, blood pressure*

ABSTRAK

Pendahuluan: *Kebisingan merupakan bunyi yang tidak dikehendaki oleh seseorang yang mendengarkannya. Kebisingan dapat mengakibatkan gangguan kesehatan jika terpapar terus menerus dengan intensitas tertentu. Gangguan kesehatan yang dapat muncul akibat kebisingan salah satunya adalah meningkatnya tekanan darah. Tujuan dari penelitian ini adalah untuk menganalisis pengaruh intensitas kebisingan dan usia terhadap peningkatan tekanan darah.* ***Metode:*** *Penelitian ini termasuk penelitian observasional dan dilaksanakan dengan rancangan cross sectional serta analitik. Variabel independen dalam penelitian ini adalah intensitas kebisingan dan usia sementara variabel dependen adalah peningkatan tekanan darah. Pengambilan sampel dalam penelitian ini menggunakan total sampling dengan jumlah responden sebanyak 46 pekerja, 29 pekerja bekerja di bagian heavy duty shop sementara 17 merupakan pekerja di bagian EHS Departemen PT. Vale Indonesia. Analisis data dilakukan menggunakan uji statistik regresi logistik dengan nilai α=0,05.* ***Hasil:*** *Penelitian ini menunjukkan bahwa intensitas kebisingan berpengaruh pada peningkatan tekanan darah sitole (sig/ P value=0,00) maupun peningkatan tekanan darah diastole (sig/ P value=0,01) dengan nilai odds rasio untuk peningkatan tekanan darah sistole (Exp (B)=9,75) dan untuk peningkatan tekanan darah diastole (Exp (B)=5,76). untuk variabel usia tidak mempengaruhi peningkatan tekanan darah sistole (sig/ P value=0,57) maupun diastole (sig/P value=0,41).* ***Simpulan:*** *Peningkatan tekanan darah pekerja dipengaruhi oleh faktor intensitas kebisingan tempat kerja.*

Kata kunci*: intensitas kebisingan, usia, tekanan darah*

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INTRODUCTION

The on going industrialization is one phase to increase the productivity and efficiency of a production process. Industrialization is followed by the implementation of sophisticated technologies and the use of more complex and complicated materials and equipment. The implementation of sophisticated technologies, as well as the use of more complex and complicated materials and equipment, are believed to be a lot more effective to increase the productivity and efficiency of a production process since it improves the speed, precision, and accuracy. The technology application generates good quality and the same products in every production. The industrialization process causes positive implications to the increase of productivity and efficiency of the ongoing production process. High productivity will raise the company's financial profitability. Other than that, the company image will be known better if the productivity target can be achieved or surpassed. However, the operation of sophisticated technologies and the use of more complex and complicated materials and equipment are more likely to initiate potential hazards in the workplace. The potential hazards that are likely to occur in a workplace include physical, chemical, biological, ergonomic, and psychological hazards. A physical hazard is a hazard that often arises in every industrial process. One of the examples of physical hazard is noise.

Suma'mur (2013) defines noise as the sound that is heard as a stimulus to the listening nerve cells inside the ears by longitudinal waves that is caused by the vibration from sound sources or sound. These waves propagate through the air or other conductive media, and when the sound is unwanted since it is disturbing or undesired by the person listening to it, that sound is called noise. Thus, noise can be declared as an unwanted sound.

The threshold value of noise in a workplace is regulated in the (Minister of Manpower and Transmigration of the Republic of Indonesia, 2011). The allowed threshold value is 85 dBA for the 8-hour duration a day or 40-hour duration a week.

Suma'mur (2013) has grouped noise into several types, namely: (1) steady state, wideband noise, for instance, the noise from machines, fans, and incandescent kitchen; (2) steady state, narrow band noise, such as the noise from circular saw and gas valve; (3) intermittent noise, for instance the noise from airplane traffic at the airport; and (4) impact or impulsive noise, such as the noise from hammer blow, gun or cannon shots, and explosions. Another kind of noise is the recurring impulsive noise; for instance, the noise from forging machines in a company or forging building piles.

According to Suma'mur (2013), the noise exceeding the established threshold value can cause health problems in the form of auditory disorders and non-auditory disorders. The auditory disorder is one kind of health problems that result in disruption or reduction of the hearing ability. These health problems include temporary deaf, permanent deaf, and acoustic trauma. Meanwhile, the non-auditory disorder is a kind of health problems occurring in other limbs beside the hearing organs. The symptoms of non-auditory disorders include physiological changes, psychological influence, annoyance, communication disturbance, and working performance disturbance.

The physiological disorders that can occur due to exceeded threshold value noise are the increase of blood pressure (± mmHg), the increase of pulse, basal metabolism, sleep disorders, constrictions of small blood vessels, especially in the feet and hands, pale and sensory disorders, impaired reflexes, hearing thresholds, and sleep pattern disorders.

Blood pressure is a state where there is a pressure caused by the blood in the arteries when the heart pumps the blood to the whole body both when the heart contracts (systole) and when the heart relaxes (diastole). Blood pressure can also be interpreted as a force produced by the blood on each unit area of blood vessels walls. The blood pressure increase can happen due to three mechanisms of the human body. The first mechanism is when the heart pumps the blood faster than its usual speed. The second mechanism is when the blood volume in the human body increases. The last mechanism is the lack of elasticity of human's blood vessels.

Noise influences the blood pressure increase of the employees. According to the research conducted on the employees of a rubber factory in Iran who were exposed to the noise exceeding the threshold value, the noise intensity was found to influence the increase the employees' blood pressure. In addition, the research conducted on 30 employees of PT PLN, Barito Sector in Banjarmasin discovered that there was a significant statistical difference between the increase of blood pressure of the employees working in a place with the noise intensity that exceeded the threshold value. Thirteen employees (86.67%) in the maintenance section, exposed to the noise intensity that exceeded the threshold value, suffered from the blood pressure increase with an average rate of 3.58 mmHg. In addition, the research conducted on the pilots of Indonesian Air Force exposed to the noise intensity from 90 to 95 dBA suggested that inside the airplane, the risk of blood pressure increase was 2.7 times higher than the risk of the pilots exposed to the noise with the intensity of 70-80 dBA.

The blood pressure increase of the employees is not only influenced by noise exposure with the intensity exceeding the threshold value. Additionally, there are several internal factors from the workers that can also influence the blood pressure, such as age, sex, race, lifestyle, nutrition, and hereditary.

The research conducted by Sinaga (2013) revealed that the increase in blood pressure is more likely to occur to employees with the ages of 40-45 years old due to the high risks of suffering from high blood pressure. In that age group, employees risk approximately 3.36 times higher than those with the ages of 25-39 years old.

According to the 2013 monitoring data of industrial hygiene of PT Vale Indonesia, it was noticed that the noise intensity in the heavy-duty shop reached that noise value of approximately 90.40 dBA. The value already exceeded the threshold value set by the Government of the Republic of Indonesia through (Minister of Manpower and Transmigration of the Republic of Indonesia, 2011). Thus, it is necessary to re-measure the noise intensity in the heavy-duty shop to figure out the current noise average value. Furthermore, the EHS Department was chosen as the comparison providing its noise value below the threshold value. In addition, the employee characteristics of both in the heavy-duty shop and the EHS Department in PT Vale Indonesia require identification. The blood pressure measurement needs to be performed before and after work to obtain blood pressure differences. Moreover, it is crucial to distinguish the influence of the noise to the blood pressure increase as well as the influence of age to the blood pressure increase. From several aspects that have been previously elaborated, the author then entitled this study as "The Influence of Noise Intensity and Age to the Employees' Blood Pressure at Heavy-Duty Shop and EHS Department."

METHODS

The method applied in this study was the observational method since the data collection was completed without giving any treatment to the respondents nor the study variables. Based on the period, this study is a cross-sectional study by measuring the exposures (noise intensity and age) and its impacts (blood pressure increase) in a certain period of time. Observed from the data analysis, this study was categorized as an analytical study since it analyzed the influences of two independent variables to one dependent variable.

The study was performed in the heavy-duty shop and the EHS Department, which were two sections in PT Vale Indonesia, Sorowako, Nuha, South Sulawesi. This study began with the planning stage conducted in November 2015. Then, it continued with data management and data analysis. The last step was conducted in June 2016. The study population included all employees in the heavy-duty shop and the EHS Department in PT Vale Indonesia, with several inclusion criteria. The study inclusion criteria were male employees, not smoking 15 minutes before the blood pressure measurement, not drinking caffeine, and not suffering from hypertension. The population gathered with those criteria reached 46 employees, i.e., 29 employees from the heavy-duty shop and 17 employees from the EHS Department. The sample collection in this study was taken by implementing the total sampling method, which was expected to describe the employees' actual conditions working both in the heavy-duty shop and in the EHS Department in PT Vale Indonesia.

The study variables were noise intensity, age, and the increase in systolic blood pressure and diastolic blood pressure. The data was collected by using primary and secondary data. The primary data collection was completed by providing questionnaires to identify each individual characteristics, namely age, and the use of sound level meter (SLM) to measure the noise intensity in each section. The measurements of the noise intensity was performed twice, i.e., in the morning and the afternoon to avoid the measurement error. Additionally, the sphygmomanometer was also used to measure the employees' blood pressure before and after work to measure the blood pressure differences. The differences in the blood pressure, before and after work, were the increase rates in the employees' blood pressures.

The data presentation was conducted in univariate and bivariate analysis. The univariate analysis described the distribution of minimum, maximum, and mean values of the observed variables. On the other hand, the bivariate analysis was presented by using cross tabulation between the dependent variable and the independent variables before being analyzed by implementing simple logistic regression method with α-value of 0.05.

RESULTS

The noise measurement was done in the heavy-duty shop and the EHS Department in PT Vale Indonesia, Sorowako. The measurement was completed by using Pulsar model 46 Sound Level Meter. The Sound Level Meter used had been calibrated with Pulsar calibrator model 106 with the intensity of 94 dBA. The measurement was done twice. The first measurement was performed at 8.00-10.00 a.m. to identify the noise occurring in the morning, while the second measurement was carried out at 12.00 a.m.-2.00 p.m. In the heavy-duty shop, the measurements were done in 17 locations that had been previously determined, whereas the measurements in the EHS Department were completed in 16 locations. The intensity rates occurring in the morning and the afternoon were then obtained by calculating the average level of several locations.

Table 1. Noise Intensity in the Heavy-Duty Shop

Measurement Time	Noise Intensity
Morning (08.00 a.m.-10.00 a.m.)	99.91 dBA
Afternoon (12.00 a.m.-2.00 p.m.)	95.86 dBA
Total	97.89 dBA

From Table 1, it can be perceived that the first measurements of the noise intensity in the heavy-duty shop were performed in 17 locations and achieved the value of 99.91 dBA. The second measurements completed in the same 17 locations reached a lower value of 95.86 dBA, resulting in the mean noise intensity in the heavy-duty shop, reaching 97.89 dBA.

Table 2. Noise Intensity in the EHS Department

Measurement Time	Noise Intensity
Morning (8.00 a.m.-10.00 a.m.)	67.50 dBA
Afternoon (12.00 a.m.-2.00 p.m.)	61.93 dBA
Total	64.72 dBA

From Table 2, it can be identified that in the EHS Department, the first measurement performed in the morning in 16 locations obtained the noise intensity of 67.50 dBA. The second measurement of noise intensity done in the afternoon in the same locations acquired the level of 61.93 dBA. Thus, the mean noise intensity in the EHS Department was 64.72 dBA.

The measurement of the blood pressure was performed to the employees of the heavy-duty shop and of the EHS Department in PT Vale Indonesia. The measurement was done by using OMRON sphygmomanometer HEM-7203 model, which had been calibrated before use. The blood pressure measurement was performed twice. The first measurement was done in the morning at approximately 7.30 a.m. before the employees started their works. The second measurement was done in the afternoon at 2.30 p.m when the employees finished their works and were ready to go home. The measurement was completed by measuring the blood pressure in the employees' arms by examining the systolic and diastolic blood pressures.

Table 3 showed the results of the blood pressure measurement on the employees of the heavy-duty shop and the EHS Department performed before and after work on two blood pressures in the human body, namely systolic and diastolic blood pressures. The results indicated that the employees' systolic blood pressure before work ranging from the lowest state, amounting to 96.00 mmHg, until the highest stage, reaching 152.00 mmHg with the mean systolic blood pressure of 124.91 mmHg. On the other hand, the measurement of the employees' systolic blood pressure after work ranged from 104.00 mmHg until 182.00 mmHg, with an average rate of 131.02 mmHg. Furthermore, the measurement of the employees' diastolic blood pressure before work ranged from 54.00 mmHg to 106.00 mmHg, with the average blood pressure of 75.48 mmHg. In addition, the measurement results of the employees' diastolic blood pressure after work varied from 52 mmHg to 111 mmHg with the mean pressure rate of 77.80 mmHg.

Table 3. The Distribution of the Employees' Blood Pressures

Blood Pressure	Minimum	Maximum	Average
Systolic Blood Pressure Before Working	96.00 mmHg	152.00 mmHg	124.91 mmHg
Systolic Blood Pressure After Working	104.00 mmHg	182.00 mmHg	131.02 mmHg
Diastolic Blood Pressure Before Working	54.00 mmHg	106.00 mmHg	75.48 mmHg
Diastolic Blood Pressure After Working	52.00 mmHg	111.00 mmHg	77.80 mmHg

The increase rate of systolic blood pressure was divided into two categories. The first category is non-increasing systolic blood pressure, in which the systolic blood pressure measured after work resulted less than or equal to 0 after being subtracted by the systolic blood pressure measured after work. However, if the result was more than 0, it belonged to the category of rising systolic blood pressure. Similar to the systolic blood pressure, the increase of the diastolic blood pressure was also divided into two categories. The first category was non-increasing diastolic blood pressure, where the diastolic blood pressure measured after work resulted less than or equal to 0 after being subtracted by the diastolic blood pressure measured after work. In addition, if the result was more than 0, it belonged to the category of increasing diastole blood pressure.

The noise intensity was categorized into two classifications. The first classification was noise intensity less than or equal to the threshold value, in this case, less than or equal to 85 dBA when measured. On the other hand, the second classification was when the noise intensity in the workplace exceeded 85 dBA, which was classified as more than the threshold value.

The age groups in this study were categorized merely to be more easily presented. In bivariate data analysis, the data ratio scale was implemented. To categorize the age variable, the age itself was divided into four categories with a range of 10 years in each category. The first category consisted of the employees with the age of 21-30 years old; the second category consisted of the employees with the ages of 31-40 years old; the third category consisted of the employees with the ages of 41-50 years old; and the last category consisted of the employees with the ages of more than 50 years old.

Table 4 presented the univariate analysis of every observed variable. The table showed that the number of employees who experienced the increase of both systolic and diastolic blood pressures was greater than the number of those whose blood pressures did not increase. It was discovered that the workplace with the noise intensity of more than the threshold value had a lot more employees than the workplace which noise intensity was less than or equal to the threshold value. In addition, the age group with the most number of the respondents was the group of the employees with the age ranging from 31-40 years old, followed by the group of the employees with the age of 21-30 years old and 41-50 years old. The least number of employees was found in the age group of more than 50 years old. Additionally, it was noted that the youngest age was 21 years old, while the oldest age was 52 years old, with the average age of the employees of 35 years old.

The bivariate analysis was presented in the form of cross-tabulation between the independent variables (noise intensity and age) and the dependent variable (the increase of systolic and diastolic blood pressures). Furthermore, to discover the amount of the influence between two variables, the statistic test by implementing the logistic regression test method with SPSS 21 application and α=0.05 was performed. After that, the influence of noise intensity and age to the increase of both systolic and diastolic blood pressures was analyzed.

Table 4. The Distribution of the Employees' Blood Pressure, Noise Intensity, and the Employees' Ages

Risk Factor	Category	Sum (%) Total=46
Systolic Blood Pressure	Non-rising	12 (26.09%)
	Rising	34 (73.91%)
Diastolic Blood Pressure	Non-rising	18 (39.13%)
	Rising	28 (60.87%)
Noise Intensity	< Threshold Value	17 (36.95%)
	> Threshold Value	29 (64.05%)
Age	21-30	12 (26.09%)
	31-40	23 (50.00%)
	41-50	10 (21.74%)
	>50	1 (2.17%)

Table 5. The Distribution of Noise Intensity and the Employees' Age to the Increase of Systolic Blood Pressure

Risk Factor Category	Systolic Blood Pressure		Sig /p-Value	Exp (B)
	Non-increasing (%)	Increasing (%)		
Noise < Threshold Value	9 (19.57)	8 (17.39)	0.00	9.75
Noise > Threshold Value	3 (6.52)	26 (56.52)		
Age of 21-30 years old	3 (6.52)	9 (19.57)	0.57	1.03
Age of 31-40 years old	9 (19.57)	14 (30.43)		
Age of 41-50 years old	0 (0)	10 (21.74)		
Ages of > 50 years old	0 (0)	1 (2.17)		

Table 5 indicated the value of cross-tabulation, significance/ p-value and Exp (B) between the independent variables (noise intensity and age) and the dependent variable (the increase of systolic blood pressures). The results obtained from the cross tabulation between the noise intensity and the increase of systolic blood pressure showed that the employees with systolic blood pressure increase were those who worked in a workplace with the noise intensity exceeding the threshold value. On the other hand, the employees whose systolic blood pressure did not increase were most likely found in the workplace with the noise intensity below the threshold value. The significance/p-value increased between the noise intensity and the increase of systolic blood pressure resulted in the number of 0.00, which meant that the noise intensity variable influenced the increase of the employees' systolic blood pressure. The influence of the noise intensity to the increase of the employees' systolic blood pressure can be noticed from the Exp(B) value, which showed the number of 9.75. The Exp(B) value indicated that the employees working in a workplace with the noise intensity that exceeded the threshold value were more likely to risk 9.75 times more from the increase of systolic blood pressure than those who worked in a workplace with the noise intensity below the threshold value.

The results of the cross-tabulation between the age and the increase of the employees' systolic blood pressure disclosed that the employees aging from 31-40 years old suffered from the increase of systolic blood pressure more than the employees in the age group of 31-40 years old whose systolic blood pressure did not increase. The significance/p-value between the age and the increase of systolic blood pressure showed the number of 0.57. The value meant that the age did not influence the increase of systolic blood pressure. Therefore, the Exp(B) value could not be read. Thus, the significance/p-value did not have any influence.

Table 6 presented the result of the cross-tabulation, Significance/p-value, and Exp(B) between the independent variables (noise intensity and age) and the increase of diastolic blood pressure. The results of the cross-tabulation between the noise intensity and the increase of diastolic blood pressure revealed that the highest occurrence of the increase of diastolic blood pressure occurred to the employees working in the workplace with the noise intensity that exceeded the threshold value. Meanwhile, the employees discovered not to suffer from the increase of the diastolic blood pressure were those who worked in the workplace with the noise intensity lower than or equal to the threshold value. The significance/p-value between the noise intensity and the increase of diastolic blood pressure showed the number of 0.01, which meant that the noise intensity was indeed influential to the increase of the employees' diastolic blood pressure. The amount of the influence of the noise intensity to the increase of diastolic blood pressure can be perceived from the Exp(B) value on the influence of the noise intensity to the increase of diastolic blood pressure, reaching 5.76. The value indicated that the risk of the increase of diastolic blood pressure of the employees working in the workplace with the noise intensity that exceeded the threshold value was 5.76 times greater than the risk of the employees working in the workplace whose noise intensity was below the threshold value.

Table 6. The Distribution of Noise Intensity and the Employees' Ages to the Increase of Diastolic Blood Pressure

Risk Factor Category	Diastolic Blood Pressure		Sig/p-Value	Exp (B)
	Non-increasing (%)	Increasing (%)		
Noise < Threshold Value	11 (23.91)	6 (13.04)	0.01	5.76
Noise > Threshold Value	7 (15.22)	22 (47.83)		
Ages of 21-30 years old	5 (10.87)	7 (15.22)	0.41	1.04
Ages of 31-40 years old	10 (21.74)	13 (28.26)		
Ages of 41-50 years old	3 (6.52)	7 (15.22)		
Ages of > 50 years old	0 (0)	1 (2.17)		

The results of the cross-tabulation between the age and the increase of diastolic blood pressure indicated that the increase of diastolic blood pressure was more likely to be suffered by the employees in the age group of 31-40 years old. On the other hand, the employees who did not suffer from the increase of diastolic blood pressure were found in the age group of 31-40 years old. Additionally, the significance/p-value between the noise intensity and the increase of diastolic blood pressure indicated the number of 0.41, which can be interpreted that the age variable did not have any influence to the increase of diastolic blood pressure. Other than that, the significance/p-value, which revealed that there was no influence found, resulted in unreadable Exp(B) value.

DISCUSSION

According to the study that has been conducted, the noise intensity in the heavy-duty shop resulted in the value of 97.89 dBA. The standard of threshold value determined in Indonesia, as established in the Minister of Manpower and Transmigration (2011) on the Threshold Value of Physical and Chemical Factors in Workplaces, declares that the allowed noise threshold value is 85 dBA for the 8-hour duration per day or 40-hour duration per week. If compared to the regulation, the noise intensity in the heavy-duty shop section, reaching 97.85 dBA, was greater than the standard threshold value of 85 dBA. Thus, it can be implied that the noise intensity in the heavy-duty shop section exceeded the established threshold value as determined by The Ministry of Labour and Transmigration.

Referring to Mukono (2011), one of the noise sources is the industrial process. The industrial process here includes the machines and every equipment used in the workplace. In fact, this is similar to the condition of the heavy-duty shop section of PT Vale Indonesia, in which the industrial processes include welding, cutting, hitting, lifting, grinding, and gouging. The noise in the heavy-duty shop can be categorized to the continuous noise since there is a continuous working process for almost 8 hours a day, starting from 7.00 a.m. to 3.00 p.m. with a 45-minute break.

The noise intensity in the EHS Department revealed the figure of 64.72 dBA. If compared to the standard threshold value, set in Indonesia as established in the aforementioned Ministry Regulation, was below the established threshold value of 85 dBA. Thus, it can be presumed that the noise intensity in the EHS Department was below the threshold value established by The Ministry of Labour and Transmigration.

According to the Ministry of Health Republic of Indonesia (1978), it was declared that the maximum noise level recommended for every company is 50 dBA, with the allowed maximum noise of 60 dBA. If compared, the noise intensity in the EHS Department of 64.72 dBA still exceeds the allowed maximum threshold value. The noise in the EHS Department came from the activities of the employees when talking to the co-workers or from the telephones, as well as from the air conditioners, which were the internal noise sources. Other than that, the EHS Department got the noise from the plant process and utilities, such as the cooling tower. The noisy atmosphere in the workplace influenced the employees's productivity. The employees exposed to the noise would likely find difficulties to concentrate and finish all the works. On the other hand, the employees' productivity could be optimized if the noise was decreased to the threshold value of 50 dBA, as established by The Regulation of the Ministry of Health.

The measurement of systolic blood pressure completed before the working hour obtained the figures of 96.00 mmHg as the lowest result and 152.00 mmHg as the highest result, with the average systolic blood pressure measured before the working hour reaching 124.91 mmHg. According to the National Institutes of Health and National Heart, Lung (2004), the mean rate of the employees' systolic blood pressure before work, be it in the heavy-duty shop or the EHS Department, belongs to the prehypertension category. On the other hand, the systolic blood pressure measured after work showed the minimum result of 104.00 mmHg and the maximum result of 182.00 mmHg with an average rate of 131.02 mmHg. According to the National Institutes of Health and National Heart, Lung (2004), the average value of systolic blood pressures measured before work of the employees of both the heavy-duty shop and the EHS Department belongs to the prehypertension category.

The measurement of diastolic blood pressure completed before work obtained the results of 54.00 mmHg as the lowest pressure and 106.00 mmHg as the highest pressure with an average of 75.48 mmHg. Referring to the National Institutes of Health and National Heart, Lung (2004) the employees' diastole blood pressure, both in the heavy duty shop and in the EHS Department, belonged to the normal category. The measurement of diastole blood pressure performed after work revealed the results of 52.00 mmHg as the lowest pressure and 111.00 mmHg as the highest pressure with the average pressure of 77.78 mmHg. Referring to the National Institutes of Health and National Heart, Lung (2004), the average diastole blood pressure after work of the employees in the heavy-duty shop section and EHS Department belonged to the normal category.

From the conducted statistical test, it was discovered that the noise intensity was influential to the increase of systolic blood pressure with significance/p-value of 0.00 and Exp(B) value of 9.75. This phenomenon means that the risk of the employees working in the workplace with the noise intensity exceeding the threshold value to experience the increase of systolic blood pressure was 9.75 times greater than the employees who worked in the workplace whose noise intensity was less than or equal to the threshold value. Interestingly, these results are in accordance with the result of the study conducted by Hartati, Qomariah and Birowo (2013), which investigated the influence of the noise intensity and body mass index to the increase of systolic blood pressure of the employees of PT PLN (*Persero*) in Asam-Asam sector and showed that the influence of the noise intensity to the increase of systolic blood pressure with significance/p-value of 0.00. Another study by Babba (2007) also stated that the employees exposed to the noise intensity that exceeded the threshold value had 10.5 times greater risk of experiencing the increase of systolic blood pressure than those who were exposed to the noise intensity less than or equal to the threshold value had.

The statistic test carried out to identify the influence of the noise intensity to the increase of diastole blood pressure showed the significance/p-value of 0.01, which indicated that the noise intensity influenced the increase of diastole blood pressure. Moreover, the Exp(B) value of 5.76 specified that the employees exposed to the noise intensity that exceeded the threshold value experienced the increase of diastole blood pressure for 5.76 times greater than the employees who worked in the workplace with the noise intensity that was less than or equal to the threshold value. In fact, these results are similar to the results of the research authored by Hartati, Qomariah and Birowo (2013) who attempted to identify the influence of noise intensity and body mass index to the increase of systolic blood pressure of the employees of PT. PLN (*Persero*) in the Asam-Asam sector. It showed that the influence of the noise intensity to the increase of systolic blood pressure with significance/p-value of 0.02. Another research by Babba (2007) also mentioned that the employees exposed to the noise intensity that exceeded the threshold value had the risk of experiencing the increase of diastole blood pressure of 7.6 times greater than the employees exposed to the noise intensity less than or equal to the threshold value.

Similar research was also conducted by Syidiq (2013) concerning the influence of noise intensity to the increase of the employees' blood pressure. In the result section, Syidiq (2013) mentioned that there was influence caused by the noise intensity to the increase of blood pressure, be it systolic or diastolic, with the significance/p-value of 0.03. The noise intensity that exceeded the allowed threshold value of 85 dBA, as mentioned in the aforementioned Regulation of the Ministry of Labour and Transmigration, can trigger negative impacts on the employees' health. Noise can be perceived by the brain as a threat or stress that is related to the release of stress hormones, such as epinephrine (catecholamine hormone secreted by the initial part of the adrenal glands and a neurotransmitter released by certain neurons that work actively in the central nervous system), norepinephrine (one of the natural catecholamine), and cortisol (the main natural glucocorticoid synthesized in the fasciculate cortex adrenals zone, affecting the metabolism of glucose, protein, and fat, and has significant mineralocorticoid activities). Stress will affect the nervous system that later causes heart defects, resulting from the changes in blood pressure (Miswar, 2004).

The influence of age to the increase of systolic blood pressure displayed the significance/p-value of 0.57, which indicated that the age did not influence the increase of systolic blood pressure. The research results are in line with the research conducted by (Imas, 2015), which was performed to 53 furniture employees in Bukir Village, Gadingrejo Sub-district, Pasuruan. In the result section, the research revealed that there was no correlation between the age and the increase of systolic blood pressure with the significance/p-value of 0.71. On the other hand, the influence of age to the increase of diastolic blood pressure reached the significance/p-value of 0.41, which also indicated that there was no correlation between the age and the increase of diastolic blood pressure. In general, the research results are similar to the research by Imas (2015) which mentioned that the age did not have any influence to the increase of diastolic blood pressure, with the significance/p-value of 0.88.

Referring to Sinaga (2013), age is the factor that emerges from within. The older the employees get, the more prone they become to experience the increase of systolic and diastolic blood pressure. The blood pressure will increase easier to the employees with the ages of above 40 years old. When an employee is above 40 years old, the systolic blood pressure will increase due to the disruption of the blood vessels that experience blockages, the hardening of blood vessels walls, and the loss of its elasticity. According to the research conducted by Sinaga (2013), the employees within the ages of 40-45 years old will likely to experience blood pressure increase. In the age of 40-45 years old, the employees tend to have 3.36 times greater risk to experience the increase of blood pressure than the those in the ages of 25-39 years old. This study concluded that there was no correlation between the age and the increase of systolic and diastolic blood pressure. This is because the employees working in the heavy-duty shop section and EHS Department in PT Vale Indonesia had the average age of 35 years old so that the possibility to experience the increase of diastolic blood pressure is small, along with the normal condition of the employees' blood vessels that are not blocked and still elastic.

CONCLUSION

According to the study conducted to the employees of the heavy duty-shop section and EHS Department in PT Vale Indonesia Sorowako, it can be concluded that:

The noise intensity in the heavy-duty shop section showed the value of 97.85 dBA, which exceeded the threshold value established (Minister of Manpower and Transmigration of the Republic of Indonesia, 2011). On the other hand, the noise intensity in the EHS Department reached the value of 64.72 dBA, which was below the determined threshold value (85 dBA). The average systolic blood pressure of the employees perform before work revealed the rate of 124.91 mmHg and belonged to the prehypertension category. In addition, the systolic blood pressure measured after work showed the average rate of 131.02 mmHg and belonged to the prehypertension category as well. The average diastolic blood pressure before work displayed the number of 75.48 mmHg and belonged to the normal category, while the diastolic blood pressure after work obtained the average result of 77.78 mmHg, which also belonged to the normal category.

Referring to the carried out analysis, it was discovered that the noise intensity was influential to the increase of both systolic and diastolic blood pressure. The employees exposed to the noise exceeding the threshold value had a risk of 9.75 times greater to experience the increase of systolic blood pressure than the employees exposed to the noise below the threshold value. Furthermore, the employees exposed to the noise that exceeded the threshold value had a risk of 5.76 times greater to suffer from the increase of diastolic blood pressure than those who were exposed to the noise below the threshold value. Additionally, for the moment, there was no influence of the age to the increase of both systolic and diastolic blood pressures to the employees of the heavy-duty shop and the EHS Department in PT Vale Indonesia.

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