UNS UNIVERSITAS SEBELAS MARET
PLACENTUM
Laman resmi: http://jurnal.uns.ac.id/placentum
ISSN 2303-3746
e-ISSN 2620-9969
PLACENTUM Jurnal Ilmiah Kesehatan dan Aplikasinya

Noise Intensity, Blood Pressure, and Pulse Rate in Textile Industry Workers

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ABSTRACT

Background: Noise intensity that exceeds Threshold Limit Value (TLV) can give impacts on non-auditory on the workers in a factory, in the form of an increase in blood pressure and pulse rate. Currently, health problems due to noise have caused the company's total loss to reach 300 billion dollars due to absenteeism rate, decreased productivity, and treatment for occupational diseases. Research in Indonesia, especially the textile industry in the city of Surakarta, shows that noise from weaving machines with an intensity above 100 dBA affects blood pressure and pulse rate. This research was conducted at textile industry in Surakarta, one of the largest textile companies in Surakarta where the company has not been able to overcome the problem of noise intensity that exceeds the TLV which has the potential to cause blood pressure and pulse disturbances, and even decreased hearing function. This study aims to determine the relationship between noise intensity with blood pressure and pulse rate in textile industry workers.

Method: This research is a correlation study, which is connecting the measurement variables of noise intensity with blood pressure and pulse rate. The sample in this study were 30 female workers in the weaving division who met the inclusion and exclusion criteria. The instruments used in measuring noise were sound level meters and sphygmomanometers. Data analysis used the Pearson correlation test to determine the relationship between noise intensity with blood pressure and pulse rate disturbances.

Result: The study showed significant correlation between noise intensity and pulse rate with a *p* value of 0.029, but noise intensity with blood pressure disturbances does not correlate, with a *p* value of 0.443.

Conclusion: There is a relationship between noise intensity and pulse rate of the workers in a factory.

***Keywords*: Noise, Blood pressure, Pulse rate**

INTRODUCTION

The process of textile production cannot be separated from the potential dangers coming from the work environment. One of which is the noise from production machines, so efforts to prevent occupational diseases are needed to increase work productivity. In general, noise is defined as the intensity of sound whose presence is undesirable and can pose a health and safety risk to workers in various workplaces.[1]

The sound source will produce sound waves that reach the human eardrum and will generate vibrations in the eardrum membrane. The vibrations that occur will be transmitted to three bones; namely the hammer (*malleus*), anvil (*incus*), and stirrup (*stapes*) which are connected to each other in the middle ear, and then will move fluid in the snail-shaped auditory organ (*cochlea*) on the inside of the ear (*inner ear*).[2] Furthermore, this fluid movement will vibrate thousands of hair cells in the inner ear which then convert the vibrations it receives into impulses for the auditory nerve. These impulses will be sent to the brain by the nerve to be translated into the sound we hear.[3] Through the pituitary neuroendocrine adrenal system, there is secretion of corticosteroids, which are stress trigger and controller; and through the sympathetic-adrenal system, there is secretion of catecholamine, adrenaline, and noradrenaline. Different activities of the central nervous system initiate a number of symptoms of impaired physiological function in the form of increased blood pressure and disturbance of pulse rhythm.[4]

One of the impacts of noise is on the non-auditory of the workers. It is characterized by disturbances in blood pressure and pulse. Some studies in Indonesia, especially the textile industry in Surakarta, shows that noise from weaving machines with an intensity of 93-105 dBA affects blood pressure and pulse rate. One of the largest textile companies in Surakarta, has not been able to overcome the problem of noise intensity that exceeds the threshold value which has the potential to cause work stress. [5]

Industrial factories generating noise intensity that exceed 85 dB include textile factories (93 dB), furniture factories (93 dB), paper factories (92 dB) and wood processing factories (106 dB).[6] National Institute for Occupational Safety and Health (NIOSH) and Indonesia through Minister of Manpower's Regulation No. 5 of 2018 concerning Environmental Occupational Safety and Health stipulates the Threshold Limit Value (TLV) in the workplace is 85 dBA as the highest intensity and does not exceed 8 hours a day or 40 hours a week.

This research is focused on the effect of noise intensity exposure on non-hearing disorders, especially on the blood pressure and pulse rate of textile workers. In addition to its intensity, the duration of noise exposure also affects blood pressure. The results of research in the textile industry of PT. Panca Tunggal Jaya Semarang show that noise increases blood pressure ($p = 0.017$), where the risk of increased blood pressure is more commonly found in workers with more than 5 years of working period.[7]

RESEARCH METHODS

This research was conducted at textile industry in Surakarta. Population was taken from the Weaving division which has a total of one hundred workers. But, this study used a purposive sampling technique where there were inclusion and exclusion criteria including female gender, working period of more than five years, and willing to become respondents, so the number of samples obtained was thirty workers.

The research instruments were in the form of a questionnaire to interview about the characteristics of respondents, the sound level meter to measure noise intensity, and the digital

sphygmomanometer to measure blood pressure and pulse. Furthermore, the data analysis used was univariate and bivariate analysis using Pearson's correlation test. If the significance value of $p<0.05$, it means that there is a relationship between the independent variable and the dependent variable. Before conducting the data analysis test, the data normality test was carried out, if the p value > 0.05 then the research data was normally distributed. [8]

RESULTS

Table 1. Data Normality Test

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Noise	.150	30	0.085
Systolic Blood Pressure	.087	30	.200*
Diastolic Blood Pressure	.099	30	.200*
Pulse	.082	30	.200*

Based on the results of the normality test, the data for noise intensity variables, systolic and diastolic blood pressure and pulse are normal.

Table 2. Univariate analysis of the Noise Intensity, Systolic, Diastolic Blood Pressure and Pressure Pulse

No	Variable	Mean	Standard Deviation
1	Noise Intensity	100.3	4.364
2	Systolic Blood Pressure	141.7	16.629
3	Diastolic Blood Pressure	90.6	8.716
4	Pulse	94.7	10.838

The measurement of noise intensity was carried out in the weaving machine area, with fifty six machines in one room. According to the Minister of Manpower's Regulation no. 5 of 2018 concerning Occupational Health and Safety in the Work Environment, the noise threshold value for working hours of eight hours per day is 85 dBA. It shows that the average noise intensity exceeds the TLV so that it can cause hearing loss and other organs' problems such as constriction of blood vessels and heart organs. The results of the average systolic and diastolic blood pressure of the workers at textile industry in Surakarta show a tendency above normal blood pressure, so there is a tendency for the impact of high noise intensity to reach 100 dBA. Meanwhile, their average pulse rate is in normal condition, because the average is still in the range of 60 – 100 beats per minute.

Based on the results of the analysis at textile industry in Surakarta, it was found that there is no relationship between noise intensity and blood pressure, however, noise intensity and pulse rate has a significant relationship.

Table 3. Bivariate analysis of the Relationship between Noise Intensity, Blood Pressure, and Pulse Rate

No	Variable	P-value
1	Noise Intensity with Systolic Blood Pressure	0.443
2	Noise Intensity with Diastolic Blood Pressure	0.892
3	Noise Intensity with Pulse	0.029

DISCUSSION

The results of the research variables on table 2 show that the average blood pressure of both systolic and diastolic workers has a tendency to increase from the normal limit, although there is no correlation in bivariate analysis. It can be interpreted that noise that exceeds the safe threshold value can be a risk factor for

increasing systolic and diastolic blood pressure in textile workers of at textile industry in Surakarta. It should also be a concern from the company that if these risk factors are not controlled immediately, it will become a health problem for them.

The control of blood pressure depends on two main determinants, namely cardiac output and total peripheral resistance, mainly determined by the degree of arterial vasoconstriction. An increase in heart rate will give an effect on systolic blood pressure, while total peripheral resistance can affect diastolic blood pressure. Noise exposure will cause a response from the nervous system and hormone system that will trigger fast heart rate speed, which then has a direct effect on systolic blood pressure. However, it takes time to affect diastolic blood pressure.[9]

Noise is all unwanted sound and has an impact on hearing loss, which comes from the tools in the production process and/or work tools. It can harmfully affect the sense of hearing and has an impact on wider health problems both directly and indirectly. [10][11] Noise that exceeds the tolerable threshold value can cause various impacts on human health, including Temporary threshold shift (TTS) which is a temporary loss of hearing power in the human ear, and can be interpreted as a reduced ability to hear weak sounds that can be heard caused by sudden/ impulsive noise exposure which is also known as transient acoustic trauma.[12] In addition, it can cause physiological problems such as symptoms of an increase in pulse rate and blood pressure. It is also capable of causing nervous system disorders that result in feelings of nausea, shortness of breath, insomnia, blood pressure, and decreased quality of workers' life.[13][14] In several other studies, the intensity of noise can cause psychological disorders such as emotional disturbances, stress, feelings of worry, memory decline, insomnia, difficulty in solving problems, and lack of concentration.[15][16][17]

Based on the literature study that has been conducted, noise control in the workplace can be control in three ways, namely by engineering methods, administrative methods, and the use of personal protective equipment. Engineering control is the most effective noise control, which is intended to change the structure of the work object to prevent exposure to potential risks to workers. It can be done by providing noise reduction and installing sound barriers from natural or synthetic fibrous materials, active noise control and noise source enclosures.[18][19][20] Meanwhile, control of administrative methods is carried out by managing the system and working time. The aim of which is to reduce the amount and level of exposure and potential risks to the workers.[21] It can be in the form of rotation and, the arrangements of working time and rest periods.[22][23] The use of personal protective equipment is the last control method, which is easy to apply, but only for temporary control because of the inconvenience in wearing it during working hours.[24] It is the last option in a series of risk control systems in the workplace. Ear plugs and ear muffs are personal protective equipment that can be used to protect the human sense of hearing.[25] Ear plugs can be made of sponge, cotton, and wax that can only be used once, while those made of plastic and rubber can be used repeatedly.[26][27][28]

To reduce noise intensity, soundproofing materials which have a sound absorption function can be used, including: [29]

1) Material which is soft (porous), has small pores (invisible), can absorb high-frequency sounds with small/short wavelengths. The pores of the soft material are assumed to be cavities that can absorb small incoming sound waves, but are not effective at absorbing low-frequency waves.
2) Materials with large pores/ perforations, which can be soft/ hard materials with large holes (visible) that can absorb

sound with a frequency of 125-4000 Hz. They can be in the form of random perforated soft board or wooden board with round or checkered perforations.

3) Fibrous materials which can absorb sound in a wide frequency range. They can be mineral wool blanket. The thickness and density of this fibrous material varies depending on the frequency that will be used to absorb sound.
4) Fiber layer coated with porous panels, which is a fibrous material covered with porous panels to protect the fibers inside. The lining panels can be thick fabric, wood, or sheet metal. For thin coating panels, 15-20% porous holes are sufficient for good low-frequency sound absorption. [30]

The sound source will produce sound waves that can reach the human eardrum and generate vibrations in the eardrum membrane. The vibrations that occur will be transmitted to three bones, namely the hammer (*malleus*), anvil (*incus*), and stirrup (*stapes*) which are connected to each other in the middle ear, which then move fluid in the snail-shaped hearing organ (*cochlea*) on the inside of the ear (inner ear).[31] [32] Furthermore, this fluid movement will vibrate thousands of soft hair cells in the inside which will convert the vibrations it receives into impulses for the auditory nerve. The impulses are then sent to the brain to be translated into the sound we hear.[32] Through the pituitary neuroendocrine adrenal system, there is secretion of corticosteroids, which are stress triggers and controllers; and through the sympathetic-adrenal system there is the secretion of catecholamine, adrenaline, and noradrenaline. Different activities of the central nervous system initiate a number of symptoms of impaired physiologic function in the form of elevated blood pressure and impaired pulse rhythm.[34] [35]

CONCLUSION

Based on the results of this study, there is a correlation between noise intensity and pulse rate with a p value of 0.029, but noise intensity with blood pressure disturbances has no correlation, indicated by a p value of 0.443. So implementation engineering control of noise suppression effectively reduces physical fatigue on workers at textile industry.

ACKNOWLEDGMENT

We would like to thank all those who have helped to carry out this research, they are:

1. Institute for Research and Community Service (LPPM), Universitas Sebelas Maret
2. PT Iskandar Tekstil Surakarta
3. Occupational Safety and Health Study Program, Vocational School, Universitas Sebelas Maret

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