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Analysis of Noise Factors in Increasing Blood Pressure of Railway Employees in Semarang Poncol Train Station

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Abstract - Noise is one of the negative impacts of the rapid development of transportation facilities in Indonesia. One of the potential means of transportation is train. Noise can affect human health, among others, can cause hearing loss, communication disorders, psychological disorders, and increased blood pressure. The purpose of this study is to analyze the factors of noise associated with the increase in blood pressure of employees working in the Semarang Poncol Station. This research is an observational with cross sectional approach. Data were obtained from interviews and measurements of blood pressure, noise intensity and salivary pH. The population in this study are employees who live in the neighborhood of Semarang Poncol Station. The number of samples taken is 39 people. Data analysis using Chi Square with significant level α = 0,05. The results showed that the noise level at Semarang Poncol Station was85.97 dB (A). The blood pressure of respondents measured before and after work, experiencing systolic and diastolic blood pressure increase which were 53.85% and 51.28% respectively. The intensity of noise, duration of exposure to noise, and stress, was associated with increase in blood pressure. The increase in blood pressure in railway employees at Semarang Poncol station is caused by noise factor. It is recommended that in each employee's workspace soundproofing equipment is installed to reduce the noise level.

Keywords: noise, blood pressure, salivary pH, stress, railway employees

Introduction

The transportation facilities nowaday is one of the important aspects in an urban community, especially in big cities in Indonesia.[1] Along with the existence of mankind on this earth, activities and means of transportation are increasingly developed. Starting from the conventional transportation activities, they turn into using modern technology that develop by the era.[2] One of the positive effects of means of transport is that it is easier for people to reach distant areas in a relatively short time, while the negative impacts include the increasing pollution due to pollutants and increasing levels of noise due to sound from transportation means used by humans.[3]

Noise can be interpreted as an unwanted sound or voice. Continual exposure and occurrence to noise over a period of time can slowly impact human health. The relation between noise and the possibility of health problems is strongly influenced by several factors, namely the intensity and frequency of noise, and the length of time a person in near the source of the sound.[4] According to Sasongko et al. , the influence of noise on health, among others, causes damage to the senses of hearing, mental emotional disorders, the heart system and blood circulation. Mental emotional disorders in the form of disruption of life comfort, irritability and become more sensitive or irritable. This emotional instability can lead to stress.[5]

Stress can influence some functions of the body, including the nervous and hormonal systems that will affect the increase in blood pressure. If this happens for a long time, it will cause a permanent rise in blood pressure.

Blood pressure is a very important factor in the circulatory system. An increase or decrease in blood pressure will affect homeostatic in the body. There are two types of blood pressure abnormalities, namely hypertension or high blood pressure and hypotension or low blood pressure.[6,7] Hypertension is a serious public health problem, because if it is not controlled it will develop and can cause dangerous complications. The result can be fatal due to frequent complications, such as

stroke (brain bleeding), coronary heart disease and kidney failure.[8]

In Indonesia, the prevalence of hypertension had increased, the results of basic health research in 2013 (Riskesdas 2013) the prevalence of hypertension increased by 25.8% to 34.1% according to research in 2018.[9] Hypertension cases in Central Java in 2017 were 12.998%, increased to 15.14% in 2018. [10] Hypertension cases in Semarang in 2017 was 6.88% and decreased to 6.29% in 2018. However, we need to be aware of this disease, considering hypertension is a risk factor of degenerative diseases such as heart disease, stroke and other blood vessel diseases. Hypertension in Semarang is more prevalent in female population than in male.[11]

Semarang as an economic center in Central Java has a quite busy transportation activities. One type of transportation that is often used is the train. Semarang has two train stations, one of which is the Semarang Poncol Station which operates 24 hours. The traffic of trains in Semarang Poncol Station is a source of noise that must be managed. Therefore it is necessary to know the noise level because noise may have an impact on station users (employees, employees and prospective passengers) both physiologically and psychologically.

Research Methods

Research Types and Design

This research is an analytical research *(explanatory research)* which aims to explain the relation between the independent and the dependent variable. The research method used was a survey with a *cross sectional* approach.

Population and Sample

The population of this study was all employees in the Semarang Poncol Station who were directly related to noise exposure in the environment where they worked. The sample in this study is the total population chosen not based on probability (*non-probability* sampling) in *consecutive sampling.* The sampling technique based on the inclusion and exclusion criteria as follows:

a. Inclusion criteria in this study are:

1. Employees > 20 years old and male

2. Willing to be a respondent.

b. Exclusion Criteria:

1. Have a history of diseases that cause hypertension
2. Having a family member who has or is suffering from hypertension.

Data analysis

Analysis of the data used in this study was univariate and bivariate analysis with the *chi-square* test in the form of a 2x2 cross tabulation to find the prevalence ratio (RP).

Results and Discussion

Noise is as an unwanted sound or voice. If there is exposure to noise continuously and occur within a certain time can gradually lead to health damages for humans. Based on the research that has been conducted, the following results are obtained:

1. Noise Intensity

Table 1. Distribution of Respondents' Systolic Blood Pressure Increase Based on Workplace Noise Intensity

Noise Intensity	Systolic blood pressure				Total	
	Increase		Not Increase			
	F	%	f	%	f	%
High (>85dBA)	18	75.0	6	5.0	24	100.0
Low (≤85 dBA)	3	20.0	12	80.0	15	100.0

p value = 0.001; Ho denied; RP = 3.75 (Cl 95%, 1.328-10.59)

From Table 1, respondents who experienced an increase in systolic blood pressure were more likely to come from workplaces with high noise intensity, which was 75.0%. Respondent who had not experience an increase in systolic blood pressure and were at place with low noise intensity was 80.0%. Based on the Chi-Square test results, there was a relation between noise intensity and an increase in systolic blood pressure (p = 0.001). The RP value obtained at Cl 95% is 3.75, which means that respondents who are in the workplace with high noise intensity have a risk for an increase in systolic blood pressure 3.75 times than respondents who are in the workplace with low noise intensity (≤85 dB (A)).

Table 2. Distribution of Respondents' Diastolic Blood Pressure Increase Based on Workplace Noise Intensity

Noise Intensity	Diastolic Blood Pressure				Total	
	Increase		Not Increase			
	F	%	F	%	f	%
High (>85dBA)	19	79.2	5	20.8	24	100.0
Low (≤85 dBA)	1	6.7	14	93.3	15	100.0

p value =0.0001; Ho denied; RP=11.875 (Cl 95%, 1.768-79.761)

From Table 2, respondents who experienced an increase in diastolic blood pressure were more likely to come from workplaces with high noise intensity, which was 79.2% , while the number of respondents who had not experienced an increase in diastolic blood pressure and worked in a place with low noise intensity more than the respondents who work at place with high noise intensity, which is 93.3%. Based on the Chi-Square test results, there is a relation between noise intensity and the increase in diastolic blood pressure (p = 0.0001) with an RP value of 11.875 (Cl 95%), which means that respondents who were at work with high noise intensity have the risk for an increase in

diastolic blood pressure 11.875 times than respondents who were at work with low noise intensity (≤85 dB (A)).

Noise can affect the response of the hormonal and nervous system so that it can result in an increase in heart rate which will affect systolic and diastolic blood pressure. When exposed to noise, the body will try to deal with these stimuli, one of which is by increasing heart rate and blood pressure. Any changes in blood pressure will be detected by an auto-regulation system that will try to return to normal pressure. This will cause an increase in diastolic and systolic blood pressure.[12] Therefore, it is necessary to control the received noise intensity.

2. Exposure Duration to noise

Table 3. Distribution of Respondents' Systolic Blood Pressure Increase Based on Exposure Duration to Noise

Duration of exposure to noise	Systolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	F	%	f	%
>8 hours/day	11	78.6	3	21.4	14	100.0
≤8 hours/day	10	40.0	15	60.0	25	100.0

p value=0.020; Ho denied; RP=1.964 (Cl 95%; 1.130-3.413)

From Table 3, the respondents who experienced an increase in systolic blood pressure were more from the group of respondents who worked for more than 8 hours per day (78.6%), while the respondents who had not experienced an increase in systolic blood pressure were mostly respondents who worked ≤8 hours daily (60.0%).

Based on the test results of Chi-Square obtained, there is a relation between prolonged exposure to noise and the increase in systolic blood pressure (p = 0.020), with a value RP = 1.964 (Cl = 95%) which indicates that

respondents with longer exposure to noise > 8 hours / day have a risk for an increase in systolic blood pressure 1.964 times than respondents with long exposure to noise ≤ 8 hours / day.

Table 4. Distribution of Respondents' Diastolic Blood Pressure Increase by Duration of Exposure to Noise

Exposure Duration to Noise	Diastolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	F	%	f	%
>8 hours/day	12	85.7	2	14.3	14	100.0
≤8 hours/day	8	32.0	17	68.0	25	100.0

p value=0.001; Ho denied; RP=2.679 (Cl 95%, 1.455-4,930)

From Table 4, it is known that most respondents experienced an increase in diastolic blood pressure because they work for more than 8 hours per day (85.7%). In contrast, respondents whose diastolic blood pressure that did not increase were mostly respondents who worked ≤8 hours per day (68.0%).

The p value obtained from the Chi-Square test was 0.001 (p <0.05), so Ho was denied and Ha was accepted. From these values it can be concluded that there is a relation between the length of exposure to noise and the increase in diastolic blood pressure. RP = 2.679 (Cl = 95%) which indicates that respondents with long exposure to noise > 8 hours / day have a risk for an increase in diastolic blood pressure of 2.679 times than respondents with long exposure to noise ≤ 8 hours/day.

This is related to the duration a person exposed to noise in the workplace. Based on KEP/51/MEN/1999 concerning noise threshold at work, for the noise intensity of 85 dB (A), the allowed working hours are a maximum of 8 hours per day.

A similar study of exposure duration to noise was shown in the study of Yang et al (2006) which showed a relation between working hours and the case of hypertension. Research with *cr oss sectional* studies and based on this population shows that long working hours can affect the hypertension caused by work stress. This is also influenced by environmental factors at work, such as exposure to heat, noise, dust, or smoke, so that if the wrokers are exposed for a long time can lead to work stress, while stress is one of the risk factors for hypertension. The study produced an OR = 1.29 at 95% CI = 1.10-1.52 in people who worked ≥ 51 hours per week.[13]

3. Stress

Table 5. Distribution of Respondents' Systolic Blood Pressure Increase Based on Stress Level

Stress	Systolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	f	%	f	%
Yes	15	78.9	4	21.1	19	100.0
No	6	30.0	14	70.0	20	100.0

p value=0.002; Ho denied; RP=2.632 (Cl 95%, 1.296-5.345)

From Table 5, it is known that most of the respondents who experienced an increase in diastolic blood pressure and suffered stress at work are up to 78.9%, while respondents whose systolic blood pressure had not increased is largely the respondents who did not experience stress at work, that is 70.0%. In this study, stress can be figured out by measuring the acidity level (pH) of the respondents' saliva. The p value obtained from the *Chi-Square* test was 0.002 ($p < 0.05$) so that Ho was denied and Ha was accepted. This can be interpreted that there is a

relation between stress and the increase in systolic blood pressure. The value of RP = 2.632 (Cl = 95%) which shows that respondents who experienced stress have a risk for an increase in systolic blood pressure 2.632 times than respondents who had not experienced stress.

Table 6. Distribution of Respondents' Diastolic Blood Pressure Increase Based on Stress Level

Stress	Diastolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	F	%	f	%
Yes	14	73.7	5	26.3	19	100.0
No	6	30.0	14	70.0	20	100.0

P value= 0.0006; Ho denied; RP=2.456 (CI 95%, 1.194-5.053)

From Table 6, it shows that respondents who experienced an increase in diastolic blood pressure and stress at work are up to 73.7%. Whereas respondents whose diastolic blood pressure not increased were mostly respondents who had not experienced stress at work, that is 70.0%. Based on the Chi-Square test results, it is known that there is a relation between stress and the increase in diastolic blood pressure (p = 0.006), with a value of Rp = 2.456 (Cl = 95%) which shows that respondents who are stressed have a risk of increase in diastolic blood pressure 2.456 times than respondents who did not experience stress.

People who exposed to noise for a long time will more easily experience stress. A person's sensitivity to stress seems to influence the autonomic nervous mechanism which in a long time can consistently cause an increase in blood pressure and can stimulate excessive release of energy in the body's chemical fluids, glucose and fats in the blood. This condition is in fact similar to what was reported by

Kartari who conducted a survey in Jakarta with a prevalence of 14.2%. This high number is associated with living in a city full of tension (stress). Stress conditions can be figured out once by measuring the acidity of saliva.

Saliva is a liquid that contains electrolytes and proteins produced by the major salivary glands, namely parathyroid, submandibular and sublingual. When the body is in good health, the range of pH in the saliva is 7-7.4. Saliva water PH measurements are carried out using a PH meter or PH paper. If the pH of saliva increases or decreases, it will greatly affect your health. Stressful conditions can accelerate the ongoing process of metabolism in the body. The results of the body's metabolism are acidic. If the body is too acidic, the body will "borrow" calcium, sodium, potassium, and magnesium from the body's vital organs and bones to reduce the acidity of the body. This situation will make the body organs and bones become weak from time to time. This situation will affect the body systems such as cardiovascular disorders, weight gain, bladder and kidney disorders, decreased immunity, accelerate the occurrence of damage due to free radicals, structural system weakness, hip fractures and brittle bones, anxiety and lack of energy.[12]

4. Smoking History

Table 7. Distribution of Systolic Blood Pressure Increase Based on History of Smoking

Smoking History	Systolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	f	%	f	%
Not Smoking	2	12.5	14	87.5	16	100.0
Light Smoker	11	84.6	2	15.4	13	100.0
Medium Somker	7	77.8	2	22.0	9	100.0
Heavy Smoker	1	100.0	0	0.0	1	100.0

p value = 0.0001 Ho denied

From Table 7, it indicates that respondents who experienced an increase in systolic blood pressure who smoke heavily are 100.0%, far greater than the respondents who did not smoke of 12.5%. In contrast, respondents who had not experience an increase in systolic blood pressure did not come from the group of respondents who were heavy smokers (0.0%) and most of them come from the group of respondents who did not smoke (87.5%)

Kendall test results for smoking variable with an increase in systolic blood pressure showed the value of probability p = 0.000 at α = 0.05, so that Ho was denied and Ha was accepted. These results indicate there is a relation between smoking and the increase in systolic blood pressure.

Table 8. Distribution of Diastolic Blood Pressure Increase Based on Smoking History

Smoking History	Diastolic Blood Pressure				Total	
	Increase		Not Increase			
	f	%	f	%	f	%
Not Smoking	4	25.0	12	75.0	16	100.0
Light Smoker	10	76.9	3	23.1	13	100.0
Medium Somker	5	55.6	4	44.4	9	100.0
Heavy Smoker	1	100.0	0	0.0	1	100.0

p value = 0.019 Ho denied

From Table 8, it shows that respondents who experienced an increase in diastolic blood pressure who were heavy smokers are 100.0%, far greater than the respondents who did not smoke of 25.0%. On the other hand, respondents who did not experience an increase in diastolic blood pressure did not come from the group of respondents who were heavy smokers (0.0%) and most of them come from the group of respondents who did not smoke (75.0%)

Kendall test results for smoking variables with an increase in diastolic blood pressure showed a probability value of p = 0.019 at α = 0.05, so that Ho was denied and Ha was accepted. These results indicate there is a relation between smoking and the increase in diastolic blood pressure. These results are in accordance with studies that reported the increased blood pressure from 140 ± 7/99 ± 3 mmHg to 151 ± 5/108 ± 2 mmHg after smoking for 10 minutes.[13] Nicotine in cigarettes can affect a person's blood pressure, through the formation of atherosclerotic plaque, the direct effect of nicotine on the release of the hormones epinephrine and norepinephrine, or through the effect of CO in increasing red blood cells.[14] Even though most of them are not heavy smokers, light smokers can someday become heavy smokers if they experience

heavy pressure/stress. The high number of smokers shows the low understanding and awareness about the dangers of smoking to health, especially in the future for the respondents.

Conclusion

1. There is a relation between noise intensity and the increase in systolic and diastolic blood pressure in employees at the Semarang Poncol Station with a value of p = 0.001 and p = 0.0001.
2. There is a relation between exposure duration to noise and the increase in systolic and diastolic blood pressure in employees at the Semarang Poncol Station with p values of 0.02 and 0.001.
3. There is a relation between stress and the increase in systolic and diastolic blood pressure on employees at the stations of the Semarang Poncol with p = 0.002 and p = 0.006.
4. There is a relation between smoking history and the increase in systolic and diastolic blood pressure in employees at the Semarang Poncol Station with p = 0.0001 and p = 0.019 .

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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