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Impact of Traffic Noise with Blood Pressure and Occupational Fatigue

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ABSTRACT

Noise can cause nuisance and significantly threaten people's health and well-being. This study aims to find the relationship between noise exposure with blood pressure and stress of traffic helper volunteers in Makassar City. This study employed an analytic observational design with a cross-sectional approach. A total of 80 respondents were selected using purposive sampling technique. Traffic noise was measured using a sound level meter, blood pressure was measured using a tension meter and work stress was measured using a work stress questionnaire adapted from Permenaker No. 5/2018. Questions relating to sociodemographic information were also distributed for individual characteristic data. The results showed there was a significant influence between noise intensity and systolic blood pressure (p value = 0.001; r = 0.329), also with diastolic blood pressure (p value = 0.02; r = 0.230), noise also affects fatigue (p value = 0.016; r = 0.238), the value of r on the strength of the correlation shows a fairly strong correlation. Thus, exposure to traffic noise is associated with a high risk of blood pressure and fatigue.

Keywords: Road Trafic Noise, Hypertension, Fatigue

INTRODUCTION

Noise is a dangerous factor for safety and health in the workplace and the environment because it can cause health problems. Today, it has been recognized that noise endangers the health of workers in various fields of work. Noise exposure is associated with a number of health effects that manifest in psychosocial responses such as annoyance, impairment of daily activities, and decreased sleep and work performance; as well as physiological responses such as hearing loss, hypertension, and coronary heart disease. (Lu *et al.*, 2018). Health problems caused by noise can be categorized into auditory disorders, such as hearing loss, damage to the ear and auditory nervous system, and non-auditory disorders, such as insomnia, stress, reduced concentration, communication difficulties and discomfort. (Umesawa *et al.*, 2019). In addition to auditory and non-auditory impacts, noise also affects blood pressure and fatigue. High blood pressure contributes more to cardiovascular disease and premature death than any other known risk factor. (Kalantary *et al.*, 2015; Mills, Stefanescu and He, 2020).

It is estimated that more than 30% of adults (1.39 billion) worldwide suffered from hypertension in 2010 (defined as systolic blood pressure of $140 mmHg and/or diastolic blood pressure of $90 mmHg) and as the population ages, the prevalence is expected to increase, which if untreated, will lead to a tremendous disease burden.. (Forouzanfar *et al.*, 2017) Worldwide, 16% of disabling hearing loss in adults is caused by workplace noise. Hearing loss caused by workplace noise is a common occupational disease. Hearing loss is incurable and irreversible; however, hearing loss can be prevented by workplace health management. (Licitra *et al.*, 2016).

Traffic noise has been an important environmental factor causing cardiovascular disease since 2010, with a large proportion contributing to the health impact. Epidemiological studies show that traffic noise can trigger sleep disturbances, thereby activating the autonomic and autonomic systems and overproducing stress hormones, with subsequent activation of the renin-angiotensinaldosterone system renin-angiotensin-angiotensin system. (Münzel *et al.*, 2022). Chronic exposure to traffic noise can cause a number of pathophysiological adaptations, such as increased heart rate and elevated blood pressure. It may also respond to an increase in other cardiovascular risk factors such as hyperglycemia, hypercholesterolemia, and activation of clotting factors. (Münzel and Sørensen, 2017; Münzel *et al.*, 2022).

Fatigue is often measured by eye reaction frequency. And the lower the reaction frequency, the more tired the human body is (Cui *et al.*, 2022). When fatigued, people will slow down their thinking and movement, losing concentration. In this case, the coordination and accuracy of movements decrease and the ability of safety behavior decreases. (Sun *et al.*, 2017; Low, Molesworth and Burgess, 2021). There has been very little research on the relationship between noise and worker fatigue. The above studies on the effects of noise on humans have mainly focused on occupational hazards, and relatively few studies have looked at the concurrent effects of noise on blood pressure and fatigue, particularly noise from traffic.

Volunteer traffic helpers, a group of informal workers who are exposed to chronic road noise (average 83.85 dB(A)) without adequate protection. This exposure has the potential to trigger cardiovascular health problems and occupational fatigue, as evidenced in a recent study by Münzel et al who found that traffic noise can activate the sympathetic nervous system and increase the risk of hypertension (Münzel, Sørensen and Daiber, 2021). The other research findings in the UK Biobank also confirmed the significant correlation between road noise exposure and the incidence of primary hypertension, especially in the working-age population (Huang *et al.*, 2023). Furthermore, the Kupcikova et al. study showed that noise exposure >55 dB(A) alone is sufficient to increase cardiovascular risk factors. This condition is even more critical given the characteristics of Supeltas' work, which involves long working hours (up to 12 hours/day) in noisy environments (Kupcikova *et al.*, 2021). Research conducted on pedicab drivers as fellow informal workers who are active on the highway also shows that there is a significant influence between noise and increased blood pressure (Addina *et al.*, 2015).

Therefore, we aimed to explore the relationship between noise changes and blood pressure and fatigue specifically in volunteer traffic helpers who are at risk in addition to traffic accidents but directly affected by road noise exposure.

METHODS

The research design observational analytic study, namely conducting direct surveys to the research location. This study also uses a cross sectional method. Cross sectional study is a type of observational research that analyzes variable data collected at the same point in time. The research was conducted on the protocol roads of Makassar City, namely Jalan AP.Pettarani, Jalan Sultan Alauddin, Jalan Perintis Kemerdekaan, Jalan Urip Sumohardjo and Jalan Veteran. The location selection was also based on the traffic density in the study area. The research population is a volunteer traffic helper (Supeltas), which is a group of people who independently help in regulating vehicle traffic, especially on highway turns. The sampling technique was carried out using purposive sampling with the inclusion criteria of not having a previous history of hypertension, willing to be a sample and having worked for at least one year, while the exclusion criteria are having a history of hypertension from the results of a health worker examination and not willing to be a sample. The number of samples obtained was 102 respondents.

Research variables in the form of sociodemographic data were collected using a questionnaire. Traffic noise measurement using a sound level meter. The noise measurement used the SNI 8427:2017 standard on environmental noise measurement. Noise measurements were carried out during the day with the measurement time divided into 4 measurements, namely between 7 am to represent 06.00-09.00, the second measurement at 10.00 to represent 09.00-14.00, the third measurement at 15.00 to represent 14.00-17.00 and the fourth measurement at 20.00 to represent the measurement time at 17.00-22.00. each measurement point was carried out for 10 minutes. Measurements were taken at these times with the assumption that they represent road conditions throughout the day so that noise measurement data can be more valid. Measurement of blood pressure using a tension meter assisted by a validated health worker and work fatigue using the validated KAUPK2 questionnaire. The KAUPK2 questionnaire (Job Element Analysis and Occupational Fatigue Questionnaire) used in the measurement of occupational fatigue is basically part of the ergonomics and Occupational Health and Safety (OHS) approach, especially in Indonesia. Data analysis used Spearman correlation test to see the influence between the independent variable, namely noise and the dependent variable, namely blood pressure and fatigue. Spearman test is conducted because the independent variable data is in the form of ratio and or categorical with dependent variable data in the form of categorical. Measurements were taken at that time with the assumption that it represents street conditions throughout the day so that noise measurement data can be more valid.

RESULTS AND DISCUSSION

The average age of the study participants at the time of recruitment was 24.5 years, and all respondents were male (Table 1). The mean average Ls ranged from 76.10 dB(A) to 96.71 dB(A)], with a mean Ls noise intensity of 83.85 dB(A). The highway at the study site is associated with high noise exposure as it is the main road in Makassar City. Such noise exposure is associated with a higher risk of high blood pressure and fatigue.

Respondents' length of work varied with the longest working hours being 12 hours and the lowest being 4 hours. The difference in length of work is due to the age of the respondents, some of whom are still pursuing high school education. For respondents who are still in school, they usually start their activities as supeltas after school until the evening. Respondents' blood pressure also varies, but if seen from table 1. That the average respondent's blood pressure experienced high blood pressure with a standard deviation (SD) of 8.76 for systolic blood pressure and 7.16 for diastolic blood pressure who fall into the category of prehypertension to stage 1 hypertension (JNC 7 classification). This value was significantly higher than

the general Indonesian population with a supeltas comparison: 100% of respondents had blood pressure ≥110/73 mmHg, with 39.2% categorized as hypertensive (based on a maximum value of 149/112 mmHg) compared to the Indonesian general population (Riskesdas 2018): The national prevalence of hypertension is only 34.1% at the age of ≥18 years, with an average blood pressure of 120/80 mmHg (Kemenkes RI, 2018). These findings suggest that Supeltas are a higher risk group for hypertension than the general population, and even more vulnerable than other noise-exposed workers. This is thought to be due to a combination of chronic noise exposure, physical workload, and lack of health protection

Table 1

Basic Characteristics of Respondents.

Variable	Mean ± SD	N (102=100%)
Age (Range = 16-33)	24,45 ± 4,775	102 (100%)
Gender (Male)		102 (100%)
Length of Service (1-6 Years)	3.07 ± 1.11	102 (100%)
Noise Intensity Min : 76.10 dB(A) Max : 96.71 dB(A)	83.85 ± 5.62	102 (100%)
Length of Work Min : 4 hour Max : 12 hour	7.11 ± 1.68	102 (100%)
Blood Presure		
Sistolik : 110-149	130.85 ± 8.76	
Diasctik : 73-112	86,61 ± 7.16	
Fatigue		
Low : 7		6,9
moderate : 42		41,2
High : 39		38,2
Very High : 14		13,7

Table 2 shows the effect between the independent variable and the dependent variable where age, tenure and length of work do not have a significant effect on systolic and diastolic blood pressure, but for noise intensity has a significant effect. For noise intensity with systolic blood pressure has a p-value of 0.001 and a value of r = 0.329 which shows a positive correlation. The positive correlation here means that the higher the noise intensity, the higher the systolic blood pressure. For the effect of noise with diastolic blood pressure, it also shows a significant effect with a p-value = 0.020 and an r value = 0.230. which shows a positive correlation. The positive correlation here means that the higher the noise intensity, the higher the systolic blood pressure.

Table 2

Effect of independent variable with Dependent.

Variabel	Blood Pressure				Fatigue	
	Sistolik		Diastolik			
	P-value	r	P-value	r	P-value	r
Age	0. 540	-0.061	0.331	0.097	0.034*	0.211
Length of Service	0. 761	-0.030	0.883	0.015	0.487	0.070
Length of work	0.684	0.041	0.038	0.206	0.026*	0.221
Noise Intensity	0.001*	0.329	0.020*	0.230	0.016*	0.238

Description: The sign (*) indicates a meaningful (significant) influence between the independent and dependent variables

The effect of independent variables with the level of fatigue as in table 2 shows that age is significant with the level of fatigue with a p-value = 0.034 and a value of r = 0.211. which shows a positive correlation. The positive correlation here means that the older a person is, the more at risk he or she is of developing fatigue. For the length of work work is significant with the level of fatigue with a p-value = 0.026 and a value of r = 0.221. which shows a positive correlation. The positive correlation here means that the longer people work, the more at risk they are of developing occupational fatigue. For noise intensity, it is significant with the level of fatigue with a p-value = 0.016 and an r value = 0.238. which shows a positive correlation. The positive correlation here means that the higher the noise intensity, the more at risk of occupational fatigue.

Respondents included in this study were volunteer traffic helper workers with an age range of 16 to 36 years. Blood pressure is related to age, according to Suryadi that the higher the age of a person, the higher the blood pressure. This is due to the elasticity of the blood vessel walls decreasing with age. In the bivariate test results between age and blood pressure, although not significant, but in the late adolescent category, all respondents suffered from prehypertension. Meanwhile, hypertensive patients are often found in the early adult age category. In this study statistically found no relationship between

age and blood pressure, in contrast to research by Rinawati which showed that the older the age of the respondent, the higher the blood pressure. It is possible that the maximum age of the respondent is 36 years old, where there have not been many changes in the physiological body. (Rinawati *et al.*, 2020).. A study conducted in six European countries namely, the UK, Italy, Sweden, Germany, the Netherlands, and Greece, found that exposure to traffic noise levels had a significant association to CVD especially for men. (Golmohammadi *et al.*, 2022) A study conducted in six European countries namely, the UK, Italy, Sweden, Germany, the Netherlands, and Greece, found that exposure to traffic noise levels had a significant association to CVD especially for men. (Pyko *et al.*, 2018). The findings of this study revealed significant noise exposure (83.85 dB(A)) in Supeltas in Makassar, with noticeable impacts on blood pressure and occupational fatigue. These results are consistent with a previous study in an urban Indonesian context, finding that pedicab drivers with similar noise exposure (84.2 dB(A)) showed a 3.5-fold increased risk of hypertension (Addina *et al.*, 2015; Iwan Suryadi, Kasim and Rostina, 2023). This finding was reinforced by a study in Kendari on traffic police who reported a significant correlation between protocol road noise and hypertension in informal workers (Sari and Yuliastri, 2019).

A study conducted in Madrid, Spain, found that exposure to elevated noise levels can significantly increase the risk of cardiovascular death especially in people older than 65 years old. (Tobías *et al.*, 2015; Begou, Kassomenos and Kelessis, 2020). The study also found that road traffic noise is the most significant contributor to overall environmental noise levels, with a contribution of nearly 80%. Two community-based studies have revealed that exposure to road traffic noise levels (expressed as 24-hour average values) greater than 55 dB(A) can cause cardiovascular disease in populations older than 45 years of age (Dzhambov and Dimitrova, 2018; Kupcikova *et al.*, 2021).

Short-term simulated traffic noise reduces sleep quality and increases stress hormone levels, blood pressure, endothelial dysfunction, and oxidative stress, according to a translational field investigation in healthy people and cardiac patients. (Münzel, Sørensen and Daiber, 2021). Extensive research on the relationship between ambient noise and health was conducted over the past 10 years (Basner and Babisch, 2014) . In addition to noise and sleep discomfort, there is sufficient evidence of substantial health impacts such as hypertension, risk of ischemic heart disease, and mortality, observing that a 5 dB(A) increase in nighttime noise can increase diastolic blood pressure (DBP) among people aged >65 years, who live without household noise protection and those who leave windows open.

Blood pressure in the elderly will tend to be high. Increasing age results in an increase in blood pressure. This is due to the thickening of the arterial wall in the elderly (elderly) which results in the accumulation of collagen substances in the muscle layer, so that the blood vessels will gradually narrow and become stiff. The incidence of hypertension increases with age. This is because as a person ages, the body will experience a physiological decline such as reduced flexibility of the body of blood vessels and the appearance of crusts on the edges of blood vessels which can cause narrowing of blood vessels and ultimately increase blood pressure.

Our research found that there is a significant influence between noise and blood pressure, noise on the highway is intermittent noise, the measurement results are above the environmental quality standards, this is in accordance with research by Münzel et al (2014) said that noise exposure from road traffic, trains, and airplanes leads to disorders among 53 million and sleep disorders among 34 million adults, resulting in nearly 1.7 million additional annual cases of prevalent hypertension, 80,000 additional cases of hospitalization, and up to 18,000 premature cases. (Aliyu et al, 2020; Huang *et al.*, 2023).

The research shows there is a significant influence between noise intensity and blood pressure. The results of this study are directly proportional to the research that states the same results where there is a relationship between noise and blood pressure with a p value of <0.001. Noise exposure above 85 dB can increase systolic and diastolic blood pressure. The noise received by workers will be responded by the body as a stressor so that the body will activate the autonomic nervous system and the endocrine system. An active endocrine system causes the hypothalamus to stimulate CRF, which then activates the pituitary. After the pituitary is active, ACTH will be stimulated and produce aldosterone which will increase blood pressure by increasing blood volume. This is in accordance with what Kalantari et al (2015) found about exposure to kebisinagn with increased blood pressure and heart attacks. (Kalantary *et al.*, 2015; Aliyuet al 2020; Low, Molesworth and Burgess, 2021).

Exposure to low-level noise disrupts communication, interferes with daily activities, and disturbs sleep, causing sympathetic and endocrine activation and a host of cognitive and emotional reactions, including annoyance, depression, and mental stress. If exposure continues over a period of time, cognitive and emotional stress states can then lead to a pathophysiological cascade, resulting in elevated levels of stress hormones, blood pressure, and heart rate, which in turn favor the development of cerebrocardiovascular risk factors such as hypertension, arrhythmias, dyslipidemia, increased blood viscosity and blood glucose, and activation of blood clotting factors and subsequent manifestations of cerebrocardiovascular diseases such as stroke, ischemic heart disease, acute myocardial infarction, heart failure, and arterial hypertension. (Muhyidin and Sjahrul, 2021; Budiawan *et al.*, 2022)

Noise is one of the most important factors in relation to occupational health and safety. The detrimental effects of noise on human health, the

negative effects related to noise, result in blood circulation, increased liver work, increased respiration, inhibited skin absorption and muscle skeletal pressure, altered digestive system, activity related to glands that signify chemical substances in the body including blood and urine, effects on organ balance. Also, the balance of taste effects and chemical changes in the brain. These are some of the effects of noise on humans.

Various studies have shown that traffic noise can cause fatigue through several mechanisms: Sleep Disruption: Traffic noise can disrupt sleep quality by causing intermittent sleep, difficulty falling asleep, and poor sleep. Continued sleep disruption can lead to chronic fatigue. Psychological Stress: Prolonged exposure to traffic noise can increase stress levels, which in turn can lead to mental and physical fatigue. Increased Workload: Noise from traffic can interfere with concentration and productivity, making a person feel tired faster as they have to expend more effort to complete daily tasks. Research shows that traffic noise has a significant negative impact on sleep quality and mental health, contributing to increased fatigue. This impact is more pronounced in individuals who live in areas with high noise levels or who work in environments with continuous exposure to traffic noise.

CONCLUSION

This study demonstrates a significant correlation between chronic traffic noise exposure and elevated blood pressure as well as occupational fatigue among traffic volunteer workers (Supeltas) in Makassar, Indonesia. The findings align with global evidence while highlighting unique local challenges, including prolonged work shifts, socioeconomic vulnerabilities, and lack of protective measures. Compared to Indonesia's general population, Supeltas exhibit disproportionately higher cardiovascular risks, exacerbated by urban traffic density and informal work conditions. These results underscore the urgent need for targeted interventions—noise reduction policies, regular health screenings, and socioeconomic support—to mitigate occupational health disparities among informal workers in rapidly urbanizing settings. Future research should explore longitudinal effects and context-specific protective strategies.

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