A pilot study: the impact of continuous and intermittent noise on human blood pressure changes

N Khoirunnisa, A Nadiroh, D Arifianto and T Dhanardono

1Department of Engineering Physics, Institut Teknologi Sepuluh Nopember, Indonesia

*Email: najihah.nasa@yahoo.co.id

Abstract. Noise is one of factor that is often encountered as physical hazards in the workplace. Moreover, it can allow health problems in the circulatory system, especially blood pressure which is hypertension. Exposure of occupational noise in industries rise the heart rate, systolic, and diastolic blood pressure, but not generally in field studies what kind of noise characteristics that can increase the blood pressure changes. A pilot studies of the impact of continuous and intermittent noise on human blood pressure changes was conducted. The results show that variation of continuous and intermittent noise increase the blood pressure changes not significantly. Increased blood pressure changes by the intermittent noise is more give impact than continuous noise. Future research is needed adding more training time and prolong intermittent noise exposure.

1. Introduction
Noise is one of the physical factors that can give harmful effects in residential and industrial environment [1]. It is the major preventable cause of hearing loss. Noise-induced hearing loss can be caused by a one-time exposure to an intense impulse sound such as gunfire, or by steady state long-term exposure with sound pressure levels higher than LA 75–85 dB—e.g., in industrial settings. Moreover, the others impact of noise exposure are interference in conversation, annoyance, disturbs sleep and causes daytime sleepiness, affects patient outcomes and staff performance in hospitals, increases the occurrence of hypertension and cardiovascular disease, and impairs cognitive performance in school children [2] [3]. Noise exposure is also considered as the third cause of heart attack among the residents after smoking and air pollution [1].

The previous study was obtained the effect industrial noise to workers [4] [5]. The studies proved that occupational noise rise the heart rate, systolic, and diastolic blood pressure [4] also concluded that exposure to noise significantly increased systolic blood pressure but had no significant increase in the diastolic pressure of the workers [5]. The previous study also conducted to analyze the impact of noise exposure in climatic chamber [6]. Both systolic and diastolic blood pressures decreased in exposure to heat, while exposure to different levels of noise elevates systolic and diastolic blood pressures. This paper discusses the influence of continuous and intermittent noise on human systolic blood pressure changes in experimentally controlled conditions. Also, to know the noise characteristics that increase the blood pressure and differences impact between continuous and intermittent noise exposure.
2. Materials and Methods

2.1. Participants
A total of 12 students (6 female, 6 male) aged 20-25 years took part in the experiment. All participants reported normal hearing. The 2 (1 female, 1 male) of participants were chosen to be control objects. The control objects are the participants that is not given any treatment as a control variable.

2.2. Measurement
The tests were conducted in a semi-anechoic chamber with a length of 3.31 m, width of 2.74 m, and height of 2.37 m in which the background noise level was about 36.5 dB(A). The noise is generated from a SRS-X55 speaker. Sphygmomanometer OMRON HEM-7203 is used to measure the blood pressure.

2.2.1. Noise equipment. The noises designed to study the effect of noise variety to the blood pressure changes. Two types of noise exposed consist of continuous noise and intermittent noise. White noise and pink noise are used for continuous noise. Each noise was conditioned to adjust the ear response, in which the sound density forms a ramp curve for 20 ms as the active ear. Four types of sounds i.e. sound of airplanes, trains, ambulance sirens, and exploding bombs are used for intermittent noise.

2.2.2. Test conditions. The continuous noise was exposed for 10 minutes with three of sound pressure level that is 74 dB(A), 80 dB(A), and 86 dB(A) for three times for each exposure. The details of measurement procedure are shown in the steps below:

- Participants enter the test chamber and rest for 10 minutes
- The blood pressure of participants is measured to determine blood pressure before exposure to noises
- Noise at the 74 dB(A) sound pressure level was exposed to the participants for 10 minutes
- The blood pressure of participants is measured to determine blood pressure after exposure to noises
- Participants rest for 10 minutes
- The measurement procedure is also performed for the 80 dB(A) and 84 dB(A) sound pressure level

The measurement procedure for intermittent noise are shown in steps below:

- Participants enter the test chamber and rest for 10 minutes
- The blood pressure of participants is measured to determine blood pressure before exposure to noises
- Airplane sound was exposed to the participants for 1 minutes
- The blood pressure of participants is measured to determine blood pressure after exposure to noises
- Participants rest for 10 minutes
- The measurement procedure is also performed for trains, ambulance sirens, and exploding bomb sounds
3. Results

3.1. The Result of Blood Pressure Changes to Continuous Noise
The test of blood pressure changes to continuous noise has been evaluated to 2 kinds of noises, i.e. white noise and pink noise. It can be shown by the graphic of systole value (Fig 1).

![Figure 1](image1)

**Figure 1.** The result of average of blood pressure (systolic) [a] white noise [b] pink noise. [c] The result of blood pressure changes after exposure. The impact of white noise and pink noise exposure to the participants can be seen by the changes on figure 1c.

3.2. The Result of Blood Pressure Changes to Intermittent Noise
The test of blood pressure changes to intermittent noise has been evaluated for 4 types of sounds i.e. sound of airplanes, trains, ambulance sirens, and exploding bombs. The result of sound pressure level for each sound can be shown by the table 1 and the result of blood pressure changes after exposure can be shown by the figure 2.

| Sounds                  | Sound Pressure Level (dBA) |
|-------------------------|----------------------------|
|                         | Minimum | Maximum |
| Airplane                | 53.3    | 90.4    |
| Exploding Bomb          | 81.6    | 93.9    |
| Ambulance Siren         | 90.4    | 100.2   |
| Trains                  | 80.2    | 91.3    |

Table 1. The sound pressure level of intermittent noises
The Pilot test was conducted to evaluate and analyse the general response of participants after doing some testing as a feasibility test for this research. The 3 of participants (Number 6, 14, and 23) was tested in the experiment using 2 sources of noise i.e station and traffic noise.

**Figure 2.** The average of blood pressure test (systole).

**Figure 3.** The average of blood pressure test (systolic) [a] station noise [b] traffic noise.
Figure 4. Pilot test blood pressure changes on some participant (a) Number 6 (b) Number 14 (c) Number 23 (d) The result of blood pressure changes after exposure.

4. Discussion
The continuous noise increase blood pressure changes and cause hypertension. The sensation is sensed by auditory sensor and hippocampus. The noise is defined as distraction and cause hyper-activity for HBF. It stimulates production of stress hormone (epinephrine) and increase metabolism of glucose, protein, and neuron system. The metabolism changes cause heart beat changes then blood pressure changes [7].

4.1. Continuous Noise
The test was conducted to analyze the impact of noise to blood pressure changes. From the result, there is no positive value for blood pressure changes. The theory said that exposure noise causes the changes of blood pressure with positive value. It means blood pressure will increase after exposure by noises. These results therefore seem to contradict the theory. However, White noise and pink noise have a constant sound spectrum to frequency. Therefore, participants can relax after exposed by the noises. Beside that, noise dose of noise exposure that give to the participants is low.

The conclusion of the results of continuous noise test can be shown by figure 1c. The blood pressure changes decrease at 74 dB(A) sound pressure level. For 80 dB(A) sound pressure level, the
blood pressure increases after exposed by pink noise. And both of the noises increase after exposed at 86 dB(A) sound pressure level.

4.2. Intermittent Noise
The intermittent noise was conducted to prove that continuous noise gives less effect than intermittent noise. The result of blood pressure changes after exposed by intermittent noise can be shown by figure 2. All of the condition increases the blood pressure changes. The biggest change occurred on aircraft noise exposure with the value is 8 mmHg. It means its condition does not change the blood pressure changes significantly. The blood pressure changes significantly if it changes more than 10 mmHg [8].

The result of test using station and traffic noise can be shown by figure 3. Increased blood pressure generally occurs when exposed noise is station noise. However, the traffic noise does not impact blood pressure significantly. Traffic noise conditions are very common and experienced by humans. The noise exposes continuously and affects the background noise of the environment. Therefore, the noise is not defined as a threat by the body. It means the traffic noise does not increase blood pressure significantly.

5. Conclusion
The experiment of the impact of several noise variety to blood pressure changes has been conducted. The results show that variation of continuous and intermittent noise increase the blood pressure changes not significantly. Increased blood pressure changes by the intermittent noise is more give impact than continuous noise. In addition, future research should add more training time. To prolong intermittent noise exposure.

References
[1] A. T., "Noise Effect on Mental Health," Shahid Beheshti University of Medical Sciences, Tehran.
[2] M. Basner, W. Babisch, A. Davis, M. Brink, C. Clark, S. Janssen and S. Stansfeld, "Auditory and non-auditory effects of noise on health," National Center for Biotechnology Information, vol. 383, no. 9925, p. 1325–1332, 2013.
[3] P. Nasiri, M. M. Esmaeelpour, A. R. Foroushani, H. Ebrahimi and Y. Salimi, "Occupational noise exposure evaluation in drivers of bus transportation of Tehran City," Iranian Journal of Health & Environment, vol. 2, p. 124–131, 2009.
[4] S. Kalantary, A. Dehghani, M. S. Yekaninejad, L. Omid and M. Rahimzadeh, "The effects of occupational noise on blood pressure and heart rate of workers in an automotive parts industry," ARYA Atherosclerosis, vol. 11, no. 4, pp. 215-219, 2015.
[5] S. O. Ismaila and A. Oduose, "Noise exposure as a factor in the increase of blood pressure of workers in a sack manufacturing industry," Beni-Suef University Journal of Basic and Applied Sciences, vol. 3, no. 2, pp. 116-121, 2014.
[6] H. Deghnan, M. T. Bastami and B. Mahaki, "Evaluating combined effect of noise and heat on blood pressure changes among males in climatic chamber," Journal of Education and Health Promotion, vol. 6, no. 39, 2017.
[7] M. Monsefi, A. Bahoddini, S. Nazemi and G. A. Dehghani, "Effects of Noise Exposure on the Volume of Adrenal Gland and Serum Levels of Cortisol in Rat," JMS, vol. 31, no. 1, pp. 5-8, 2006.
[8] M. Ulyah, KDPK: Keterampilan Dasar Pabrik Klinik untuk Kebidanan, Health Book Publishing, 2008.

Acknowledgments
This study was done in the semi-anechoic chamber of Department of Engineering Physics, Institut Teknologi Sepuluh Nopember, Indonesia, as a part of requirements of the study, and the authors are grateful to all those who participated in the study and supported its procedure.