



THE TRADITIONAL HIGH-NOISE STONE CARVING INDUSTRY: HOW DOES IT AFFECT THE HEALTH QUALITY OF WORKERS?

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ABSTRACT

The purpose of this study is to identify and describe the health quality of stone carving workers exposed to noise by production machine. A total of 30 workers consisting of 29 men and 1 woman with an average age of 42.2 years, were selected using the saturation sampling method. The respondent had worked for approximately 14.4 years (8 hours/day), with 83.3% possessing elementary-junior high school education, and 56.7% had never worn personal protective equipment while working. Their health quality was measured using the physiological and psychological aspect, which includes blood pressure and hearing quality, as well as workers' comfort. The observation found an average noise level of 117.93 dB, 110dB, and 111.3dB from saw, grinding, and turning machine, respectively. This level is over from the Threshold Value set in the Minister of Manpower Decree, Republic of Indonesia Number 51/Men/1999 is 85 dB for a maximum work time of 8 hours/day. The average blood pressure (systole and diastole) of the respondents was 126.2 and 85.8, in the condition of prehypertension. The hearing quality of 43.3% of the respondents was in a moderate condition in both left and right ears, with an increased hearing threshold on average between 41-60 dB, which led to permanent deafness or Permanent Threshold Shift (PTS). Furthermore, 36.7% of respondents were quite disturbed by noise from the work environment, 50.1% had communication problems, 53% were often fatigue, and 46.7% had muscle tension for the past 4 years. Psychologically, noise in the work environment caused disturbance towards 36.7% of respondents. Therefore, it is concluded that the health quality of stone carving workers in Muntilan Subdistrict, Indonesia, is quite poor. Suggestions from this research are implementing a health literacy program accompanied by assistance and empowerment. As a result, the stone carving workers have a high awareness of access and apply various health information in their daily lives, especially when working.

Keywords: noise, hearing quality, stone carving workers.

1. INTRODUCTION

The Indonesian demographics has predicted that in 2030 the productive age population (15-64 years) is going to be greater than the non-productive age (<14 years and > 65 years). This indicates a significant amount of productive workers tend to optimize the nation's economy. Therefore, it is important to ensure they are in perfect health conditions. Occupational health efforts are aimed at protecting workers from health problems and the adverse effects caused by work, as stated in the Law of the Republic of Indonesia Number 36 of 2009. Therefore, occupational health and safety regulations need to be implemented to optimize productivity. When workers are well maintained, then the morbidity rate, absenteeism, disability, and work accidents are minimized, thereby producing healthy and productive employees.

One of the health problems experienced by workers is hearing loss due to noise associated with the working environment. Noise is a loud and unpleasant or unexpected sound [1], which endangers human health. Noise at work is sourced through production, and about 16% of workers across the globe suffer from hearing loss, with 23% and 10% in developing and developed countries, respectively [2], [3].

Rong, *et al.* [4] found noise levels in 18 small and medium industries in Malaysia between 71.4 dB to 94.2 dB, with an average of 8 hours/day. In addition, 26 of 34 workers were found to suffer from hearing loss, such as ringing ears (tinnitus). Rong [4] also suggested that

reducing noise is conducted through technical control by installing a silencer, isolating the source of noise, rotating workers, and using Personal Protective Equipment.

Elias, *et al.* [5] researched small corn milling industries in the Saalam and Morogoro region, Tanzania. Approximately 41 industries were found to possess noise levels of 89-103 dB (Saalam) and 92-103 dB (Morogoro), with an average of 8 hours/day. These were due to loose engine parts, improper systems, worn bearings, and unbalanced grinding hammers. A total of 20 respondents indicated ear irritation, 3 had headaches, 6 were stressed, and the rest were not affected. Furthermore, it was found that 38% of the respondents often had communication problems, 54% stated it rarely occurred, and 8% had no communication difficulties.

Thepaksorn, *et al.* [6] research on 4 sawmills of the Trang industry, Southern Thailand, found an average noise level of more than 85 dB. As a result, 22.8% of workers indicated "Noise-Induced Hearing Loss" due to the low compliance associated with the use of protective equipment. The results of this research are used as a guide for managers to design effective regulations and work safety training, especially for hearing protection. However, a comprehensive hearing loss prevention program, able to assess, control, protect, and audio metrically monitor workers' hearing efficiency, need to be developed. Furthermore, proper training, documentation, and effective program evaluation need to be carried out to reduce noise induce hearing loss.



In an observational research conducted in Magelang Regency, Indonesia, high noise was found in stone carving industrial centers, located in Salam, Muntilan, Mungkid, Shaman, Sawangan, and Secang Subdistricts. Out of these areas, Muntilan Subdistrict was found to contain the largest stone carving centers, with 151 industries, comprising of approximately 500 workers laborers. These industries are micro and small, which uses production machinery such as saws, grinders, and turning machine to produce stone carving products, for instance, kitchen utensils, lanterns, sinks, fountains, and tombstones. The production process creates significant noise and dust, which creates adverse health effects on workers and the surrounding environment (see Figure-1). The stone sawing machines showed a noise value of 115 dB, which exceeded the Threshold Value, set in the Regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia Number Per.13/Men/X/2011 in 2011 at 85 dB for 8 hours per day. The ILO has also recommended that the Threshold Noise Limit for 8 hours per day is 85 dB, with 110 dB set as a dangerous limit.



Figure-1. Activities on traditional stone carving industry: (a) carving, (b) grinding, (c) turning, and (d) sawing.

Despite the high noise experienced in the surrounding industrial environment, workers failed to wear Personal Protective Equipment, in the form of earmuffs or plugs, which are capable of reducing Noise Reduction Rating (NRR) to 50 dB (earplug) and 30 dB (ear muff) [6]. Instead, they formed the habit of clogging cotton to the ear, which was only able to reduce the noise level to 3 dB. Some workers stated that noise was common to the industrial environment, and they only possessed the skills to carve stones to fulfill family needs with the inability to acquire another job.

Constant high noise leads to various health problems and diseases. Chen, *et al* [7] stated that noise affects the increase in systolic and diastolic blood pressure and causes hypertension. High noise levels significantly affect cerebrovascular diseases, hypertension, and heart diseases [8], which tends to lead to hearing loss influenced

by age, eventually, exposure time, type, and smoking habits as experienced by employees in the iron industry [9].

Prior to this publication, there was no data on the health quality of workers in the stone carving industry. Therefore, this article presents an identification and description method of the health quality of stone carving workers in Muntilan Subdistrict, Indonesia. This is always expected to motivate workers to maintain healthy work ethics through safety behaviors.

2. METHODS

To analyze the health quality of respondents using a cross-sectional method. A total of 30 people consisting of 29 men and 1 woman with an average age of 42.2 years, were selected using the saturation sampling method. The respondent had worked for approximately 14.4 years (8 hours/day), with 83.3% possessing elementary-junior high school education, and 56.7% had never worn personal protective equipment while working. The sample was determined based on inclusion criteria, and willing of those above 20 years, with working time-frame of 8 hours/day, and in the stone carving industry environment. The characteristics of respondents obtained through observation and interviews include age, work time, length, education level, and the use of Personal Protective Equipment. Health quality was measured from physiological factors, including blood pressure and hearing quality, with psychological aspects consisting of respondents' comfort. The supporting data is the noise level from the work environment, derived from stone sawing machines, grinding machines, and turning machines.

The respondent's blood pressure was measured with a sphygmomanometer and a stethoscope during the afternoon break (12.00-13.00 pm) to obtain the actual value. Furthermore, the hearing quality is measured by audiometry series 2.0.1.3 to determine the type and degree of deafness in accordance with the International Standard Organization (ISO) [10]. The degree of hearing loss was measured by audiometry at a frequency of 4000 Hz, to determine the mild (25-40 dB), moderate (40-55 dB), and severe (55 dB) values. The work comfort of respondents towards noise was measured using a questionnaire developed by Rahmi [11] in accordance with response to noise, communication, physiological, and psychological disorders. The noise level was measured by a sound level meter carried out at 120 points with repetition in the morning, afternoon, and evening. Finally, the research data were analysed univariately to determine the health quality of respondents.

3. RESULTS AND DISCUSSIONS

3.1 Noise measurement results

The observation found that noise in the stone carving work environment was continuous with a narrow frequency spectrum from sawing machines, grinding machines, and turning machines. The noise levels of the three production machines, on average exceed the



threshold value set in the regulation of the Minister of Manpower and Transmigration Republic of Indonesia Number Per.13/Men/X/2011. The measurement results of

the noise levels from these machines are presented in Table-1.

Table-1. Noise level of the production machines.

No	Time	Average noise level (dB)		
		Sawing machine	Grinding machines	Turning machines
1	Morning	117,30	110,00	113,30
2	Afternoon	79,22	79,50	79,00
3	Evening	117,58	110,00	111,00
	Average	104,70	99,83	101,10

Noise levels exceeding the Threshold Value also occur in several stone industries, such as the gemstone in Taiwan. Huang, *et al.* research [12] showed that the noise level in 9 gemstone industries was more than 85 dB and 90 dB in some regions. In the mining industry in Ghana, machines make noise exceeding the threshold, from 85.5 dB to 102.7 dB [13]. The noise level of the stone industry in Hualien, Taiwan, also exceeds the Threshold Value of 87.7 dB [14]. When compared with those countries, the noise level in the stone carving industry in Magelang Regency is the highest, because the production machines are not equipped with dampers, are not isolated in special places, but are rather close to the workers.

According to Iskak and Shah's [15], the causes of high noise in production machines are vibration dampers, limited space, high motor rotation, and poor maintenance. Huang *etal*[12] stated that the high level of noise was due by the use of old production machines, while Cinar and Sensogut[16] found that high noise in the mining work environment and the stone-breaking industry in Turkey were from unmaintained machines, such as non-routine engine lubrication, worn machinery parts, and its poor, isolated production place.

3.2 Effects of noise on workers' blood pressure

The results of blood pressure measurements (systole and diastole) of respondents were at an average of 126.2 and 85.8. When compared with the standard [10], the average blood pressure of the respondents in the condition of prehypertension was 120-139 mmHg and 80-89 mmHg. Prehypertension is a clinical term used to describe patients with high blood pressure, though it considered being within normal limits. Prehypertension is not a category of disease category. However, individuals stand a high risk of getting hypertension with blood pressure between 130/80 mmHg-139/89 mmHg have the possibility to experience hypertension twice greater when compared to individuals with lower blood pressure [17]. Further, the analysis of 30 respondents, which consists of 12, 14, and 4 hypertension, prehypertension, and normal workers was done, respectively. There are several possibilities which cause this, such as noise, not wearing personal protective equipment, and smoking habit. This assumption is reinforced by the research conducted by

Kuang, *et al.*[18] in Chengdu, Sichuan Province, China, which stated that noise at work is positively related to blood pressure levels and the risk of hypertension. High noise shows a significant relationship with hypertension and hearing loss in those with more than 10 years working experience [19]. Nassiri, *et al.* [20] also found a statistically significant relationship between occupational noise exposure (≥ 100 dBA), hypertension, and work experience ≥ 4 years. Therefore, to study the relationship between noise and blood pressure, the length of work need to be considered

Smoking habits also affected the condition of individual hypertension. This is in line with Kim's research [21] on office workers in Seoul, South Korea, which stated that systolic and diastolic blood pressure was significantly highest in the smokers' group. Previous studies also showed that blood pressure in the smoker group was higher rather than in the group with non-smokers [22]. Mayne, *et al.*[23] found that respondents who work in places with no-smoking policies such as in restaurants and bars have lower systolic blood pressure compared to the place without a smoke-free policy.

3.3 Effect of noise on the hearing quality of workers

High noise from the work environment ultimately affects the hearing quality of workers on average of 43.3% on both left and right ears. It means the increase in the average hearing threshold of the respondents was between 41-60 dB with Deafness or Permanent Threshold Shift (PTS) based on ISO. PTS is permanent deafness due to longer noise and greater intensity that occurs at a sound frequency of 4000 Hz. Factors causing PTS are long working periods in noisy environments, its levels, and a person's sensitivity [24]. Workers that experience PTS do not complain initially, but when it is lowered to a frequency of 2000 Hz and 3000 Hz, complaints tend to arise. Furthermore, hearing loss at a frequency of 4000 Hz continues to grow and persist after 10 years, and then the progress becomes slow [24][25].

Further analysis showed that 16.7% and 13.3% of respondents have severe deafness with a hearing threshold between 61-90 dB and greater than 90 dB, respectively. Out of 5 people with severe deafness, there was a respondent with hearing loss before becoming a stone



carving worker. Therefore 4 from 30 people (13.3%) were affected.

3.4 Effect of noise on work comfort

The comfort of workers toward noise in the work environment is determined by their perceptions of communication problems, physiological and psychological disorders. The results showed 36.7%, 33%, and 29.6% of respondents were quite, very, and not disturbed by noise, respectively. Respondents that did not feel disturbed by hearing loss were accustomed to noise for a long time with a high level [26].

Noise in the work environment also causes communication problems. Rantala, *et al*[27] stated that teachers that work in high-noise environments speak louder to communicate well with students. The results of this research showed that 50.1% of respondents had communication problems, and they had to shout when communicating with fellow workers. Very high noise levels tend to interfere with the way people speak during daily activities at work, school, and home [28].

The respondent's physiological disorders, such as increased blood pressure and decreased hearing quality, made 53% tired more quickly, and 46.7% often had muscle tension. These disorders have been complained by respondents for the last 4 years. In comparison, noise in a patient's operating room increases nurses' feelings as indicated by heavy workloads and high levels of fatigue. This affects the safety and security of nurses and patients [29]. Ravindra, *et al*[30] found 40% of respondents have headaches and 29% sleep problems. Other physiological disorders are tinnitus and hearing fatigue [31], along with increasing noise level (> 85 dBA). Tinnitus was experienced more in individuals exposed to high levels of noise [32]. The prevalence of tinnitus slowly increases according to hearing damage and is influenced by age and time of noise exposure [33].

Psychological disorders also arise due to noise, on 36.7% of the respondents. Research by Beutel, *et al.*, [34] in settlements around the Frankfurt airport, Germany concluded that noise from the airport caused increased depression and anxiety in the surrounding community, with 50% of the community feeling upset. High noise levels from airports also lead to hearing loss, increased blood pressure, headaches, sleep problems, and symptoms of anxiety in workers [35].

The impact of noise in the stone carving industries of Muntilan Subdistrict, Indonesia, towards workers is quite diverse both physiologically and psychologically. Therefore, solutions are needed to prevent the noise that affects workers or the surrounding community. Therefore, health literacy programs need to be implemented, considering the fact that 83.3% of respondents have low education. Therefore, workers do not understand properly understand the matters relating to occupational health and safety at work. Health literacy is a person's ability to understand health information [36]. Health literacy is needed for someone to manage health properly, in the form of skills in obtaining, processing, and acting based on accurate information

developed through formal and informal education [37], [20]. However, knowledge of health is not enough to make someone aware of ways to manage their health properly. Assistance and empowerment are also needed to be conducted, therefore, a person becomes more confident when conducting activities related to health information [38]. Implementation of health literacy to adults encourages them always to control their lives, reduce health care costs, and improve physical and psychosocial welfare [20].

4. CONCLUSIONS

The quality of workers' health is influenced by internal and external factors from the environment, such as noise. This research proves that the health quality of stone carving workers in Muntilan Subdistrict, Indonesia, is quite poor because the average worker tends to experience permanent deafness or threshold shift (PTS). The average blood pressure condition in prehypertension workers has a high risk of getting hypertension and experiencing work discomforts, including noise, communication problems, physiological and psychological disorders. The health quality of stone carving workers needs to be handled immediately because most respondents are often tired and have muscle tension, leading to low productivity. This research suggests implementing a health literacy program to build their awareness in accessing and applying various health information in their daily lives, especially at work. Due to the low level of formal education of some stone carving workers, it is necessary to provide assistance and empowerment efforts to obtain optimal results.

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