The effect of increasing physical workload and environmental noise exposure on physiological stress among textile industry workers in the CARE covid-19

Haris Setyawan[1*], Hanifa M Denny[2], Nurjazuli[3] and Endah Kumala Dewi[4]

[1]Doctoral Student in Public Health, Faculty of Public Health, Diponegoro University, Semarang Indonesia
[2]Department of Occupational Safety and Health, Faculty of Public Health, Diponegoro University, Semarang Indonesia
[3]Department of Environmental Health, Faculty of Public Health, Diponegoro University, Semarang Indonesia
[4]Faculty of Psychology, Diponegoro University, Semarang Indonesia
[*]Corresponding author: haris.setyawank3@staff.uns.ac.id

Abstract. In June-September 2021, Surakarta experienced a long dry season as a result of global climate change, creating high temperatures that interfere with working comfort. In the textile industry, these conditions can make the workplace hotter than usual. In addition, the presence of very high noise and increased physical workload can trigger physiological stress events for weaving workers. The Community Activities Restrictions Enforcement (CARE) throughout Indonesia, restriction of people's movement to daily work, especially for unvaccinated workers. This condition has an impact on the activities of the textile industry sector, restrictions on the number of workers, trigger a shortage of manpower, forcing available workers to carry out more overtime to get the company's production targets. The increase in overtime causes workers to experience an increase in physical workload than usual. This study is to investigate the direct impact of this phenomenon and corrective action analysis can be carried out. This cross-sectional study included 47 workers of the weaving section in IT Co. Ltd Surakarta, Indonesia using a sound level meter and fitness tracker to measured physical workload, environmental noise, and physiological stress. This study showed physical workload (p=0.005, r=0.745) and environmental noise exposure (p=0.021, r=0,886) has a significant correlation toward physiological stress. Noise and workload control by using a hierarchy of control are urgently needed to reduce the incidence of physiological stress in the workplace.

Keywords: environmental noise, physical workload, hot temperature, physiological stress, CARE covid-19

1. Introduction

Climate change and the covid-19 pandemic have changed the pattern of industrial work, which has both positive and negative impacts, especially on the textile industry throughout Indonesia. [1] In Surakarta, climate change has made the temperature in the workplace hotter [2], especially in June-September 2021, reaching 40 degrees Celsius [3]. The increase in temperature in the workplace can increase the physical workload to the workers, it can cause various health problems [4], one that is often complained about in the textile industry is stress [5]. This also happened in the weaving section IT Co., Ltd.

Surakarta, added with the high level of noise, increases the risk of occurrence of stress in the workplace [6].

During the COVID-19 pandemic, the Indonesian government issued a CARE policy to control the spread of the coronavirus. The purpose of Community Activities Restrictions Enforcement (CARE) is to restrict people's movement to daily activities, especially for unvaccinated citizens [7]. This condition has an impact on the activities of the industry sector, restrictions on the number of workers, trigger a shortage of manpower, forcing available workers to carry out more overtime to get the company's production targets [8]. The increase in overtime causes workers to experience an increase in physical workload than usual [9].

In 2017, the prevalence of stress in various countries reached 10.7% of the total population [10]. In Asia, work is the main cause of stress, especially in Indonesia reached 73% of the number of workers [11]. The number of risks of workers exposed to stress in Indonesia must be a concern for research and control. IT Co. Ltd is one of the largest textile factories in Surakarta, which is experiencing production disruptions due to the effects of climate change and the covid-19 pandemic, both from an increase in the physical workload on workers (increase in temperature, humidity, over time, production targets) and the effect from the high level of noise exposure (up to 104 dB), which this unfavorable condition can be suspected of many complaints in physiological stress that experiencing weaving workers. The purpose of this study is to determine the direct effect of physical workload and environmental noise exposure on physiological stress in weaving workers. Hopefully, this study can be a reference for researchers, companies, and the government to take advanced control to reduce the incidence of physiological stress in textile industry workers.

2. Subject and methods

This study employed observational analytic with a cross-sectional approach. This research was conducted in the weaving section, especially to determine the direct effect of physical workload and environmental noise exposure on physiological stress in weaving workers in IT Co. Ltd., Surakarta Indonesia. 47 weaving operators were selected being respondents with the inclusion and exclusion criteria. Ethics approvals for this study were obtained from The Research Ethics Committee, Faculty of Health, Universitas Jendral Soedirman.

The independent variable in this study was physical workload and environmental noise, while the dependent variable was physiological stress. To measure environmental noise, a sound level meter EXTECH 10059792 was used. To assess the level of physical workload and physiological stress, the fitness tracker Mi Band 5 was used. The measurement of physical workload based on the criteria of pulse per minute (light, medium, heavy, very heavy, more than very heavy) while the assessment of physiological stress using heart rate variability, with scale categories ranging from mild, moderate, high, and very high. Bivariate analysis in this study using Gamma and Spearman's rho correlation test to analyze the correlation physiological stress, environmental noise with physiological stress using SPSS 17 application program.

3. Results and discussion

This research was conducted in weaving section IT Co. Ltd., Surakarta, Indonesia with total sample 47 female operators. The univariate analysis can be seen in table 1, while the results of the bivariate analysis between the independent and dependent variables can be seen in table 2.

Based on table 1, most of weaving workers get a light workload (78.7%) with environmental noise exposure in weaving section dominated in range 101-105 dB (34%). More than half of weaving workers experience physiological stress in the high category (55.3%).

Table 1. Univariate analysis of physical workload, environmental noise exposure and physiological stress in weaving section IT Co. Ltd., Surakarta, Indonesia

Variables	Frequency (people)	Percentage (%)
Physical workload		
Light (75-100 pulses/minute)	37	78.7
Medium (>100-125 pulses/minute)	10	21.3
Total		
Environmental Noise		
86-90 dB	1	2.1
91-95 dB	2	4.3
96-100 dB	7	14.9
101-105 dB	16	34.0
106-110 dB	14	29.8
111-115 dB	7	14.9
Total	47	100
Physiological Stress		
Moderate (Stress meter score >25-50)	10	21.3
High (Stress meter score >50-75)	26	55.3
Very High (Stress meter score >75)	11	23.4
Total	47	100

Table 2. Bivariate analysis of physiological stress using Gamma and Spearman's rho correlation test

Variables	P Value	Correlation coefficient (r)
Physical workload	0.005	0.745
Environmental noise	0.021	0.886

The results Gamma correlation test showed significant correlation between physical workload and physiological stress (p-value = 0.005), with strong and positive correlation (r=0.745). The same result is also shown in Spearman's rho correlation test, showed significant correlation between environmental noise and physiological stress (p-value = 0.021), with very strong and positive correlation (r=0.886).

The physical workload is dominated by the light category (78.7%), only 21.3% of the weaving workers respondents experience a moderate physical workload. The physical workload can be from the interaction between the demands of tasks, the environment, skills, behavior, and perceptions of workers [12]. The physical workload in workplaces comes from the daily activities of the weaving operator, interaction between workers, mastery of skills in completing tasks, and abilities for operating the weaving machine in a standing position for 8 hours per day, additional workloads (temperature, heat, and humidity) [13]. The operation of the weaving machine includes the work of installing and removing yarn during the weaving process of the machine [14].

Bivariate analysis showed a significant correlation between physical workload and physiological stress (p-value = 0.005, r=0.745). A high physical workload level will make the time employees spend working longer, and reduce time to relax, as a result, employees feel pressured and bored [15]. The pressure gets higher when employees are required to complete work in a short time or do work that has high risk. A heavy workload will turn into stress when employees are required to work in a field of work that they do not understand or are different from their experience and competence [16].

Excessive physical workload, which can be sourced from the workload or environmental factors, can be carried out by various methods. Engineering control can be implemented by

expanding natural ventilation in the weaving area, can improve air quality and comfort, and the high level of temperature can be decreased [17]. Administrative control can be applied by setting working shift not to exceed the provisions, [18] and the company can coordinate with the local government to speed up weaving workers to get vaccines so that the number of workers can be following shift arrangements and is not constrained by work restrictions during the Covid-19 pandemic.

Environmental noise in the weaving section dominated above 101 dB, far exceeding the threshold value required in Indonesia (85 dB). The negative impact of the high level of noise on stress has been proven through many studies in many countries. Study in Serbia, high-intensity noise not only causes stress to workers but also increase the level of aggressiveness at work [19]. A high level of occupational noise also had a negative effect on hypertension and hearing loss of Chinese coal miners, with the highest noise exposure reaching 108 dB [20].

Spearman's rho test showed a significant correlation between environmental noise and physiological stress (p-value = 0.021, r=0.886). These results indicate that the higher the exposure to environmental noise, the higher the incidence of stress on weaving workers, with a very strong correlation. The physiological stress that occurs in textile workers, can disrupt workers and companies in the long term if improvements are not made, such as impaired concentration, emotional disturbances, decreased job satisfaction, less in performance and productivity, and trigger physiological disorders, such as cardiovascular disease, heart disease, cancer, respiratory and muscle disorders [21],[22].

Risk control in the workplace is a very important priority in preventing occupational diseases and accidents [23]. Noise control should be a concern to reduce the effects of noise exposure on health [24]. Engineering control, administration, and the use of PPE can be used as an alternative solution in reducing the effects of noise exposure received by weaving workers. Engineering control is carried out by providing sound absorbers in the weaving room to reduce echoes and sound intensity [25]. Arrangement of work shift patterns and regular work rotation can be used as an alternative in administrative control through reducing the number of hours of noise exposure to prevent physiological stress to workers [26]. The last option, controlling with workers using ear protection (earplugs) can reduce noise exposure received by workers by up to 15 dB, but can interfere with comfort at work [27].

4. Conclusion

The higher the value of physical workload and environmental noise in the textile industry, the higher the risk of physiological stress experienced by workers with a very strong correlation strength. Based on the results of investigations and field observations at the company, the increase of physical workload was caused by the increase in air temperature (up to 40^0C) as a result of global climate change especially in long dry season in Surakarta. The increase of physical workload also caused by addition of working hours due to the implementation of CARE Covid-19 in IT Co., Ltd. This condition increases the amount of exposure to noise intensity received by workers, which is greater than the usual exposure received per day. Considering the high impact of increasing physical workload and noise exposure on weaving workers, the company can immediately take several control alternatives to reduce the impact of these physiological stress problems to a safer level.

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