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Relationship Between Heat Stress and Job Fatigue with Stress Levels in Employees at CV. Fatra Karya Logam

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ABSTRACT

Background: According to the Institution of Social Security Employment, based on data for 2020, there was an increase in cases of work accidents, with 177,000 cases recorded. One of the common problems for employees in the industrial environment is heat exposure. Heat stress is one of the working conditions of physical factors in the work environment, which is an additional burden for employees. **Objective:** To determine the relationship between heat stress, job fatigue, and stress levels in employees at CV. Fatra Karya Logam**. Methods:** This is a quantitative research method with a cross-sectional design**.** The population and sample in this study were employees in the production section of CV. Fatra Karya Logam, as many as 30 people. **Results:** The results of measuring heat stress with medium workloads in the production section of CV. Fatra Karya Logam exceed NAV (> 28.0ºC), it is known that the average Wet Bulb Globe Temperature (WBGT) in CV. Fatra Karya Logam is 31.4°C, and statistical tests show that there is a relationship between heat stress and stress levels for employees at CV. Fatra Karya Logam with a value of $p = 0.000$, and there is a significant relationship between job fatigue and stress levels for employees at CV. Fatra Karya Logam with p value = 0.006. Conclusion: Therefore, to manage the impacts properly and avoid health issues or worse outcomes while working, we must understand what triggers job tiredness and work stress. **Recommendation**: by identifying causes of fatigue and work stress, employees can handle the effects properly to prevent health problems and worse consequences during work.

Keywords: Heat Stress; Job Fatigue; Stress Level

INTRODUCTION

Indonesia is a developing country heading toward the era of free trade and industrialization. In the industrial sector, technological advances are needed to improve human welfare by applying sophisticated technology and using complex and diverse equipment and materials. However, this is sometimes not accompanied by the readiness of its human resources. The limited ability of human resources can be a determining factor in the occurrence of work hazards, work accidents, and occupational diseases, resulting in reduced work productivity (Ratih, 2012).

According to the Institution of Social Security Employment Data, in 2019, there were 114,000 work accident cases; in 2020, there was an increase in the January to October 2020 range. The Institution of Social Security Employment recorded 177,000 work accident cases. The Ministry of Manpower and Transmigration also mentioned that in Indonesia, every day on average, 414 work accidents occur, 27.8% due to high fatigue, and approximately 9.5%, or 39 people, have disabilities. Fundamental steps or actions are needed so that human resources, in this case employees, prevent and control the impacts that may arise from the production process and create a healthy, safe, comfortable, and productive work environment.

One of the conditions in the working environment that can cause health problems for employees is heat exposure or exposure to extreme heat. Exposure to extreme heat has become a common problem in the industrial environment

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and can result in various health problems that can potentially cause work accidents that pose a safety hazard and can reduce work productivity (Sari, 2017; Sholihah *et al*., 2019). The many potential hazards of heat stress in the work environment need attention and control to maintain occupational safety and health conditions.

For this reason, the government has made the Law on Occupational Safety and Health concerning threshold values, where this law becomes the standard for factor exposure that is acceptable for daily employees not to exceed 8 hours per day or 40 hours per week, so as not to result in health problems or disease. Permenaker No. 5 of 2018 work activities in industries that can cause a hot climate are 31.0°C for light workloads, 28.0°C for moderate workloads, and 25.9°C for heavy workloads for 8 hours a day with one hour of rest time. This affects blood pressure and pulse frequency, fatigue, decreased work performance, reduced agility, prolongs reaction time, prolongs decision making, interferes with sensory and motor nerve conditions, is not easily stimulated, and causes abnormalities due to hot temperatures such as heat cramps, heat exhaustion, heat stroke, and miliaria (Khan, 2019).

Job fatigue will reduce performance and increase the level of work errors. Increased work errors will provide opportunities for work accidents in the industry (Nurmianto, 2004). In completing work, employees will not be separated from stress because stress problems cannot be separated from the world of work (Ratih, 2012). As the demands of work increase, the possibility of employees experiencing work stress increases due to pressure from various parties.

Furthermore, based on previous research conducted by Maulana (2018) at PT. Perkebunan Nusantara II Kwala Madu Sugar Factory, it was found that the heat stress measurement results obtained an average heat stress of 31.3°C. There is a relationship between heat stress and job fatigue at PT. Perkebunan Nusantara II Kwala Madu Sugar Factory (p=0.040). Based on previous research conducted by Ramadhani (2016), it was found that the results of statistical tests showed p of 0.415 (p >0.05). This means that there is no significant relationship between job fatigue and work stress for nurses in the inpatient ward of RSUD Dr. Pirngadi Medan. Based on previous research conducted by Ratih (2012) on the workforce of the weaving section of PT. Iskandar Indah Printing Textile Surakarta, the results showed a positive relationship between job fatigue and work stress among the employees of the weaving section of PT. Iskandar Indah Printing Textile Surakarta with p=0.008. CV. Fatra Karya Logam is one of the many smelting companies that process aluminum B3 waste into aluminum ingots (bars). This aluminum production begins with sorting the trash and then cleaning and drying it. The trash is then liquefied at high temperatures, and casting is carried out to print molten aluminum into aluminum ingots.

In the initial survey of 15 respondents at CV. Fatra Karya Logam using interview, observation, and measurement methods, the researchers found that the heat stress in the production room was 34.4°C using a Heat Index Meter type 8778 and saw an uncomfortable working environment where the roof was made of zinc, making the environment feel hotter. The results of the heat stress measurement were compared with Permenaker No. 5 of 2018 regarding climate standards in Indonesia; the result is that the temperature in the room exceeds the predetermined threshold value, coupled with complaints from employees that lead to symptoms of work stress due to fatigue and heat stress from the work environment. It is the background for researchers to conduct research titled "Relationship Between Heat Stress and Job Fatigue with Stress Levels in Employees at CV. Fatra Karya Logam".

METHODOLOGY

This study uses analytic observational research to find the relationship between risk factors and effect variables, whose analysis determines whether there is a relationship between these variables (Notoatmodjo, 2010). The population and samples in this study were taken from all production employees at CV. Fatra Karya Logam, including as many as 30 people. The determination of the samples in this study was carried out with the non-probability sampling technique, in which all members of the population are used as samples (Sugiyono, 2019). Data collection instruments are tools that will be used by researchers to collect data (Notoatmodjo, 2012). The instrument is used to obtain information about the variables studied. In this study, the data collection instrument used is heat pressure measurement by direct measurement using a Heat Index Meter (Type 8778). Assessment of job fatigue using the Subjective Self Rating Test Questionnaire (SSRT from IFRC) and for work stress using the Workplace Stress Scale Questionnaire (Executive Stress Coach New York). The data analysis used in this research is univariate and bivariate. The analysis used data processing software for Windows, version SPSS 25.00.

Ethical Consideration

This study was approved by the CV Fatra Karya Logam on 21st January 2022 with reference number 23/CV/Fatra Karya Logam/I/2022.

RESULTS

A. Univariate Analysis

The frequency distribution of respondents heat stress, job fatigue, and stress level can be seen in the following table.

1) Heat Stress at Work

Table 1: Heat Stress Measurement Result

No	Measure-ment time	Point A	Point B	Point C	Average
1	15.00	28.2	28.2	28.2	28.2
2	15.30	28.5	28.4	28.1	28.3
3	16.00	31.9	31.9	30.1	31.3
4	16.30	32.4	31.9	31.9	32.1
5	17.00	32.8	32.2	32.1	32.4
6	17.30	33.7	33.5	33.1	33.4
7	18.00	34.2	34.2	33.9	34.1
8	18.30	34.2	34.1	33.7	33.9
9	19.00	33.4	32.9	32.8	33.0
10	19.30	32.9	32.1	31.9	32.3
11	20.00	32.2	32.1	31.8	32.0
12	20.30	33.4	33.1	32.9	31.1
13	21.00	34.0	33.9	33.8	33.9
14	21.30	33.8	33.7	33.5	33.7
15	22.00	32.9	32.1	31.9	32.4
16	22.30	31.9	31.8	31.6	31.8
17	23.00	30.9	30.6	30.6	30.7
18	23.30	31.9	31.7	30.3	31.3
19	00.00	32.3	32.1	31.8	32.1
20	05.30	29.5	27.8	27.7	28.3
21	06.00	28.4	27.9	27.9	28.1
22	06.30	28.2	28.0	27.9	28.1
23	07.00	28.0	28.0	28.0	28.0
Average		31.72	31.37	31.25	31.45

The results of measuring workload through the pulse method were carried out simultaneously by other researchers against 30 respondents at CV. Fatra Karya Logam obtained an average pulse rate of ±120.55 beats per minute. So it can be concluded that the average workload of employees is moderate, namely between 100 and 125 beats per minute. Therefore, heat stress in the production area of CV. Fatra Karya Logam is categorized into two groups: exposed to heat stress (>28°C) and not exposed to heat stress (≤ 28°C) based on Permenaker No. 5 of 2018. The results of heat pressure measurements at CV. Metal Works Fatra were carried out at three measurement points: point A in the firing area, point B in the casting area, and point C in the printing area, which were carried out over time. Based on table 1, it is known that the average ISBB in CV. Fatra Karya Logam is 31.4°C with a minimum temperature of 27.7°C and a maximum temperature of 34.2°C. The highest temperatures were at points A and B. Namely the burning area and casting area, at 18.00 WIB and the lowest temperature was at point C, namely the printing area, at 05.30 WIB.

Table 2: Heat Stress Frequency

No	Heat stress	Frequency	%
1	Not exposed	6	20
2	Exposed	24	80
	Total	30	100

Based on table 2, it is known that the majority of employees in CV. Fatra Karya Logam are exposed to heat stress; the proportion of employees who are exposed is higher (80%) than the proportion of employees who are not exposed (20%).

2) Job Fatigue

Table 3: Job Fatigue

No	Job fatigue	Frequency	%
1	Moderate	7	23.3
2	Heavy	23	76.7
	Total	30	100

Based on the results of measurements using a questionnaire-subjective self-rating test (SSRT from IFRC) conducted at CV. Fatra Karya Metal production division, 23 people (76.7%) experience heavy job fatigue, and a small portion experience moderate job fatigue (7 people, 23.3%).

3) Stress Level

Table 4: Stress Level Frequency

No	Stress Level	Frequency	%
1	Mild	5	16.7
2	Moderate	25	83.3
	Total	30	100

Table 4, the result of work stress on employees at CV. Fatra Karya Logam in the production department, was measured using the Workplace Stress Scale (Executive Stress Coach New York) questionnaire. The results of the work stress measurement carried out on 30 employees were that 25 employees (83.3%) experienced moderate levels of work stress, and a small portion of 5 employees (23.3%) experienced a mild level of work stress.

A. Bivariate Analysis

1) Relationship Between Heat Stress and Stress Level

Table 5: Relationship Between Heat Stress and Stress Level

Heat stress	Stress level				Total		Sig. *(p)*
	Mild		Moderate				
	N	%	N	%	N	%	
Not exposed	5	16.7	1	3.3	6	20.0	0.000
Exposed	0	0.0	24	80.0	24	80.0	
Total	5	16.7	25	83.3	30	100.0	

Based on the results of the cross-tabulation in Table 5, it was found that most of the employees exposed to heat stress experienced moderate stress levels (80.0%). While almost none of the employees exposed to heat experienced average stress levels (3.3%), a small proportion experienced mild stress levels (16.7). Based on the results of Fisher's exact test between heat stress and stress levels, the value of $p = 0.000$, where $p < 0.05$, means that there is a significant relationship between heat stress and stress levels in employees at CV. Fatra Karya Logam.

2) The Relationship Between Job Fatigue and Stress Levels

Table 6: Relationship Between Job Fatigue and Stress Level

Job fatigue	Stress level				Total		Sig. (*p*)
	Mild		Moderate				
	N	%	N	%	N	%	
Moderate	4	13.3	3	10.0	7	23.3	0.006
High	1	3.3	22	73.3	23	76.7	
Total	5	16.7	25	83.3	30	100.0	

Based on table 6, the results of cross-tabulation between job fatigue and the level of stress on employees revealed that employees who experience heavy job fatigue experience moderate levels of stress (73.3%), and almost none experience mild levels of stress (3.3%). Meanwhile, for employees who experienced moderate job fatigue, a small proportion experienced moderate stress (10.0%), and a small number experienced mild stress (13.3%). Based on the results of Fisher's exact test between job fatigue and stress levels in employees, the value of $p = 0.006$ where $p < 0.05$ means that there is a relationship between job fatigue and work stress levels in employees at CV. Fatra Karya Logam.

DISCUSSION

Heat stress combines air temperature, air humidity, movement speed, and radiation temperature (Fajriah, 2018). The heat pressure in this study is the temperature in the production section of CV. Fatra Karya Logam. Work environment factors are one of the factors causing fatigue in employees. One of the environmental factors in the workplace is heat stress. If employees are exposed to heat, the body's organs will work harder to remove excess heat from the body, so the physical burden received by employees will be more significant, and employees will experience faster fatigue (Marif, 2013).

Based on the results of heat stress measurements in the production department of CV. Fatra Karya Logam, it was noted that the average ISBB is 31.4°C with a minimum temperature of 27.7°C and a maximum temperature of 34.2°C. To determine the threshold value (NAV) in CV. Fatra Karya Logam, we must first know the workload of employees at CV. Fatra Karya Logam. The workload category can be seen from the number of pulses per worker per minute. From secondary data obtained by researchers, it can be seen that the average pulse rate of employees in CV. Fatra Karya Logam is as much as ±120.55 beats/minute. With this pulse, the workload category is included in the moderate workload category. Furthermore, the workload category is compared with Permenaker No. 5 of 2018 with working time settings of 75% work and 25% moderate workload. The results show that 24 employees were exposed to heat stress (80.0%), and 6 employees were not exposed to heat stress (20.0%).

Measurement results using the Subjective Self Rating Test questionnaire (SSRT from IFRC) conducted at CV. It is known that 23 employees (76.7%) experienced heavy job fatigue in the production section of Fatra Karya Logam. The tendency for high levels of job fatigue is caused by heat stress when employees work beyond the permissible threshold value. Also, employees do not use personal protective equipment due to discomfort when working, so they are directly exposed to heat from the furnace. According to Juliana, Camelia, & Rahmiwati (2018), work fatigue will decrease one's performance and endurance at work. The weakening of the energy needed to carry out an activity will decrease the immune system. Factors causing fatigue in the industry may vary and are influenced by workload, work environment, work shifts, physical problems, and health conditions. Individual factors such as age, health status, nutritional status, diet, gender, and psychological disorders can also be affected (Arnani, 2019; Nada, 2022; Dotulong, 2022). Several things can be done to control the work environment. Such as reducing the workload factor, reducing the radian heat load, using artificial ventilation, limiting heat exposure time, and adjusting the work-rest time appropriately based on workload and wet bulb temperature index value. Work stress is a form of psychological response from the body to pressures; work demands that exceed the capabilities possessed. Both physical or environmental demands and social

situations that interfere with the implementation of tasks, which arise from interactions between individuals and their work, can cause work stress. The work stress measurement carried out on 30 employees found that 25 (83.3%) experienced moderate levels of work stress (Djafri, Chongsuvivatwong, & Geater, 2015). There is a significant relationship between heat stress and stress levels; most experienced employees experienced an average stress level (80%) and a small proportion experienced mild stress levels (16.7%). The correlation can be seen from the positive value of the relation coefficient (r) $r = 0.894$, meaning a significant relationship where the higher the heat stress, the higher the work stress level, and vice versa, the lower the heat stress, the lower the work stress level. According to Minister of Manpower Regulation No. 5 (2018), the heat pressure standard is 28°C, with a working time setting of 75% working and 25% resting. While the results of this study show most of the employees experience high fatigue.

There is a significant relationship between job fatigue and stress levels, the correlation can be seen from the positive value of the relation coefficient *(r)* $r = 0.599$, meaning a significant relationship where the higher the job fatigue, the higher the work stress level, and vice versa, the lower the job fatigue, the lower the work stress level. This is according to Sunyoto (2012), opinion that fatigue can cause stress because the ability to work decreases. A decreased ability to work causes decreased performance and unwittingly causes stress. Furthermore, the results of this study are also in line with the results of previous studies, such as the results of research by Ratih (2012) which show a positive relationship between job fatigue and stress levels in the weaving section of PT. Iskandar Indah Printing Textile Surakarta with $p = 0.008$. Another study was conducted by Windyananti (2010), on the relationship between job fatigue and work stress on employees at Wreksa Rahayu plywood processing, Boyolali. The intensity is significant, with the results of $r = + 0.626$, $p = 0.000$ which means that there is also a significant relationship between the intensity of job fatigue and work stress. In another study, which was subsequently carried out by Rinawati & Astuti (2017), the Relationship Between Heat Stress and Fatigue and Blood Pressure in Copper Wirun Craftsmen was significant, with a p-value = 0.008.

This study suggests significant health impacts on workers from heat stress exposure in the workplace, showed that heat stress and highlights the need for revision of work practices, increased protective measures, and possible development of work safety standards for heat exposure. The workers in adverse conditions must stay hydrated, scheduling sufficient rest periods and letting workers to self-pace. Continuous health education program for outdoor workers regarding prevention of heat stress is essential (Mohammad, Shafik, & Mahmoud, 2023).

CONCLUSION

Based on the results, there is a significant relationship between heat stress and stress levels in employees at CV. Fatra Karya Logam $p = 0.000$; and there is a relationship between job fatigue and work stress levels $p = 0.006$. Therefore, we must know what causes job fatigue and work stress so we can handle the effects properly to prevent health problems and worse consequences while working.

Conflict of Interest

The authors declare that they have no conflict of interest.

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