Subjective Work Fatigue Due to Hot Work Climate (A Study on Indoor Production Workers of Ud King Rack Surabaya Indonesia)

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Abstract

One of physical factors contributing to the increasing number of work accidents and deaths is the hot working climate. One of the effects of hot working climate is work fatigue. The purpose of this study is to analyze the strength and direction of the relationship between the hot work climate and work fatigue in indoor production workers. This is an observational descriptive study using a cross sectional design. The sample was 33 workers. This study collected data of workers weight, workers height, pulse rate, Wet Bulb Globe Temperature, reaction timer and Subjective Self Rating Test. Data was analyzed using univariate and bivariate analysis.

The result showed that only working area of Oven 1 and Oven 2 that have the hot work climate exceeding the threshold limit value. All of 6 workers in those areas reported to experience subjective work fatigue. This study found that hot work climate and work fatigue has fairly strong and unidimensional relationship.

Keywords*: hot work climate, work fatigue, subjective*

Introduction

Hot work climate is one of the physical factors that are the cause of work-related illnesses, workplace accidents, and even death of workers. Work climate potentially causes health problems such as Prickly Heat, heat exhaustion, an increase of body temperature, heat stroke, heat cramps, increasing pulse rate, and dehydration[1].. Those health problems are because the body is not able to adapt to the work environment.

The hot working climate in Indonesia is regulated by the Threshold Limit Value (TLV) in the Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health, detailed at the Appendix point 1.

The work climate that exceeds the TLV will potentially disrupt workers health and comfort, and even can lead to death. An evidence of such cases was shown from the case found by NIOSH in 1992 to 2006. During those years, it found 423 workers death due to excessive exposure to the hot environment[2]. In addition, according to USA Bureau of Labor Statistics Report of 2015, there were 37 deaths and 2830 occupational injuries and diseases caused by exposure to hot environments [3].

One of the health problems that can occur is work fatigue. This is supported by the theory of "The Bucket Model" which explains that one of fatigue causes is climate[4]. According to Grandjean, in Setyawati's book (2010), fatigue cannot be clearly explained or defined, but it can only be felt, however Grandjean (1995) defined fatigue as the feeling of tired and decreasing alertness. Therefore, this study focuses on the state of feeling tired. Feeling of fatigue is a subjective symptom in the form of

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uncomfortable and unpleasant feelings experienced by workers at work and after work[5].

Other than by climate, work fatigue are also caused by mental workload and physical workload, length of work, noise, ergonomics, emotional and organizational demands and personal factor[4].

There are researches that support the theory that subjective work fatigue is associated with a hot work climate. Research by Yuli Suryaningtyas and Noeroel Widajati (2017) on Work Climate and Nutritional Status with Work Fatigue on Workers in Ballast Tanks at Ship Repair Section PT. X Surabaya found that there is a moderate relationship with a positive direction between work climate and fatigue. The measurement of fatigue of their research was carried out using a subjective method, namely the KAUPK2 questionnaire. In this study, it found that the WBGT index in Ballast Tanks exceeded the TLV of the permissible work climate. It also found that most of workers felt very tired[7].

Based on the background above, it was encouraging to conduct a scientific study and research on the relationship of hot work climate and subjective work fatigue in Indoor Production workers UD King Rack Surabaya Indonesia.

Material and Method

This study is an observational study as the researchers did not provide special treatment and intervention to workers. The research was carried out with a cross sectional method, namely a one-time approach, where identification of causes and effects was carried out at the same time. This study was descriptive research in accordance with the nature of the problem and analysis of the data. This study used total population sample. Therefore, subjects of this research were all workers (33 workers) who worked in the indoor production section of UD King Rack Surabaya.

This study aimed to determine the strength and direction of the relationship of hot work climate and subjective work fatigue. The independent variable in this study is the hot work climate and the dependent variable is subjective work fatigue. To determine the relationship strength relationship between the two variables, the theory of Sarwono (2006) was used. It categorized the strength into six categories based on the analysis results[8] :

1. 0 = no correlation
2. 0-0,25 = weak
3. 0,25- 0,5 = moderate
4. 0,5-0,75 = strong
5. 0,75-0,99 = very strong
6. 1 = perfect.

The direction was concluded by the positive and negative sign of the correlation coefficient.

RESULT

A. Characteristics of Indoor Production Section Workers of UD King Rack Surabaya Indonesia

Table 1. Characteristic distribution of Indoor Production Section Workers of UD King Rack Surabaya Indonesia 2019

individual characteristics	Category	Total	Percentage (%)
Gender	Male	33	100
Age	20-30 years	28	84,8
	31-40 years	2	6,1
	> 40 years	3	9,1
Years of service	<5 years	16	48,5
	5-10 years	13	39,4
	>10 years	4	12,1
Smoking habit	Yes	28	84,8
	No	5	15,2
Body Mass Index (BMI)	Thin	9	27,3
	Normal	21	63,6
	Excess weight	2	6,1
	Obesity	1	3,0

Table 1 shows that most of workers in the Indoor Production section 2019 are male aged 20 – 30 years. Most of them work for less than 5 years. They have smoking habit and their Body Mass Index (BMI) is normal.

B. Result of Hot Work Climate in the Indoor Production Section Workers of UD King Rack Surabaya Indonesia

The measurement of hot work climate was carried out in all indoor areas of UD King Rack Surabaya. The measurement was carried out using a tool called Heat Stress Apparatus from Quest Type Temp 36.

Table 2. Result of Hot Work Climate Measurement in Indoor Production Section of UD King Rack Surabaya Indonesia

Location	Sb	Sk	Sg	WBGT	RH
	(°C)	(°C)	(°C)	(°C)	(%)
oven 1	27,1	33,1	37	30,2	59,3
oven 2	27,4	33,8	37,4	30,7	58
Electric welding area	27,1	35,3	37	30,1	57,6
GTAW area	27,3	35,1	37,2	30,3	55,3
Air flow speed :		0,1 - 1 (m/dt)			

Table 2 shows that the highest WBGT index was in the oven 2 area of 30.7ºC and the lowest was in the friction welding area of 28.8ºC.

C. Measurement Results of Workload for Indoor Production Workers UD King Rack Surabaya Indonesia

To assess whether work climate meet the TLV is not only from the WBGT index in each area, but also from the workload and working time arrangements for every hour. Heavy workload will affect to the declining resilience of the worker's body in facing the hot work environment. Therefore, if the workload is heavy, it is necessary to have a comfortable work climate for workers. The workload measurement used in this study was a 10-pulse method workload measurement. The measurement of pulse rate included the Resting Pulse Rate (RPR) and Working Pulse Rate (WPR).

Table 3. Workload Measurement Result of Workers in Indoor Production Section of UD King Rack Surabaya Indonesia

Work area	**Workload**					
	Light		**Medium**		**Heavy**	
	N	**%**	**n**	**%**	**n**	**%**
oven 1	0	0	0	0	3	100
oven 2	0	0	0	0	3	100
Electric welding area	3	100	0	0	0	0
GTAW area	12	100	0	0	0	0
friction welding area	12	100	0	0	0	0
Total	27	81,81	0	0	6	18,2

Table 3 shows that 6 workers (18.2%) in the Indoor Production Area of UD King Rack Surabaya have very heavy workload with a pulse rate of 125-150 per minute from 10 pulse rate measurements. Most of the workers (81.81%) experienced light workload with a pulse rate of 75-100 per minute.

D. Determination of Suitability of Hot Work Climate in Indoor Production UD King Rack Surabaya Indonesia 2019 with Threshold Limit Value

Based on the measurement of work climate (WBGT), workload and working time arrangements, it can be concluded that hot work climate in each area is in accordance with or did not exceed the Threshold Limit Value determined by the Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health at the Work Environment. The following table shows the suitability of hot work climate in Indoor Production of Surabaya Indonesia UD King Rack in 2019 with Threshold Limit Value of the above regulation:

Table 4. The Suitability of Hot Work Climate in Indoor Production UD King Rack Surabaya Indonesia 2019 with the TLV

No	Work area	WBGT(°C)	Workload	Work time/ hours	Keterangan
1	oven 1	30,2	Heavy	75-100%	Not Suitable
2	oven 2	30,7	Heavy	75-100%	Not Suitable
3	Electric welding area	30,1	Light	75-100%	Suitable
4	GTAW area	30,3	Light	75-100%	Suitable
5	friction welding area	28,8	Light	75-100%	Suitable

Table 4 shows that there were 2 areas that have a work climate that is not in accordance with the Threshold Limit Value in terms of the WBGT index, workload and working time arrangements for each hour. The two areas were oven area 1 with WBGT of 30.2ºC and oven area 2 with WBGT of 30.7ºC.

E. Result of Subjective Work Fatigue Measurement

In this study, work fatigue data was obtained from a subjective method measurements in the form of Subjective Self Rating Test questionnaire, consisting of 30 questions. The fatigue category is divided into 4 categories: not tired, mild fatigue, moderate fatigue, and severe fatigue. The following table shows the results of the work fatigue measurements:

Table 5. Result of Subjective Work Fatigue Measurement of Indoor Production Workers UD King Rack Surabaya Indonesia 2019

Work area	Subjective Work Fatigue							
	Not tired		Light		Medium		Heavy	
	n	%	n	%	n	%	n	%
oven 1	0	0	0	0	3	100	0	0
oven 2	0	0	0	0	3	100	0	0
Electric welding area	0	0	2	66,7	1	33,3	0	0
GTAW area	0	0	6	50	6	50	0	0
friction welding area	0	0	6	50	6	50	0	0
Total	0	0	14	42,4	19	57,6	0	0

Table 5 shows subjective work fatigue in 5 work areas. It shows that the majority of workers (57.6% or 19 workers) of UD King Rack Surabaya's Indoor Production workers experience moderate fatigue.

F. Analysis Results of the Relationship between Hot Work Climate and Subjective Work Fatigue in Indoor Production Workers UD. Surabaya Indonesia King Rack 2019

The following table shows the results of the analysis of the relationship between hot work climate and subjective work fatigue:

Table 6. Analysis Results of the Relationship between Hot Work Climate and Subjective Work Fatigue in Indoor Production Workers UD. Surabaya Indonesia King Rack 2019

Hot work climate	Subjective Work Fatigue							
	Not tired		Light		Medium		Heavy	
	n	%	n	%	n	%	n	%
Suitable	0	0	14	51,9	13	48,1	0	0
Not suitable	0	0	0	0	6	100	0	0

Table 6 shows that workers who are exposed to hot work climate exceeding the TLV experienced moderate fatigue. The fatigue was 2.07 times greater than the moderate fatigue experienced by workers with a hot work climate within the TLV. The result of data analysis shows that there was moderate relationship between hot work climate and subjective work fatigue in the indoor area of UD King Rack Surabaya Indonesia. The correlation was positive and can be seen from the correlation coefficient of 0.375.

Discussion

Based on the analysis results, there were only 2 areas that have hot work climate index exceeding the Threshold Limit Value. It was area of oven 1 and oven 2. The relationship between hot work climate and subjective fatigue is quite strong. It was shown by the fact that workers of area oven 1 and oven 2 reported complaints both physically and motivationally, especially those who often experienced dizziness and dehydration. The complaint was caused by very high temperatures released by the oven with a temperature of 75ºC to 90ºC.

Direct exposure to the heat from the oven adds the heat burden felt by workers. Workers were often seen to stop working in order to drink and take a break while waiting for oven to process which takes 5 minutes. This indicates that the occurrence of worker fatigue. As the consequences, the fatigue can decrease worker work speed, make them to be more prone to errors and less productive, which lead to the increasing risk of negative safety or incidents. In fact, one study estimates work fatigue contributes to 13% of workplace injuries[9]. During the interview, complaints to be most of workers reported were dizziness and thirst. Dizziness and dehydration are among the physical symptoms of fatigue[10].

Subjective work fatigue indicates that there is no worker experiencing severe fatigue. This is because workers have acclimatized to the existing temperature. They feel accustomed and report small number of complaints of continuous fatigue symptoms. This is in line with their working period in the oven area. Most of them have been working for more than 1 month while the acclimatization process only needs 5-7 days for workers to adapt the hot work climate with the longest of 12-14 days[1].

The relationship between hot work climate and subjective fatigue has a positive direction. This means that if the hot work climate increases, subjective work fatigue also increases.

This result is in line with research from Ridha Ramayanti (2018) entitled "Analysis of the Relationship between Nutritional Status and Work Climate with Fatigue in Catering in Surabaya Food Wisdom". Ramayanti found that there is a moderate positive relationship between the work climate and work fatigue. The hot work climate at Catering Surabaya's Food exceeded the TLV. Their workers experienced severe, moderate, and mild fatigue. Ramayanti (2018) also used the same subjective method, the Subjective Self Rating Test questionnaire from Japan's Industrial Fatigue Research Committee (IFRC) [11].

Conclusion

1. Workers in the Indoor Production Section of the UD King Rack Surabaya are all male. Most workers are 20-30 years old, with work periods of less than 5 years, have smoking habits, and have a normal MBI.

2. The highest WBGT index value is in the oven 2 area of 30.7ºC and the lowest is in the friction welding area of 28.8ºC. Hot work climate that is not in accordance with the Threshold Limir Value set by PERMENAKER No. 5 of 2018 is in the oven area 1 with WBGT of 30.2ºC and oven area 2 with WBGT of 30.7ºC. All workers in the areas where the hot work climate exceeded the TLV reported to have heavy workloads and to set the working time 75% -100% for every hour.

3. The result of subjective work fatigue indicates that all workers (100%) in the area exceeded the TLV of work climate reported moderate fatigue.

4. There is a positive moderate relationship between the hot work climate and subjective work fatigue

Recommendation

1. Control of heat sources or oven by isolation or limiting heat source exposure to other areas.

2. To manage the hot work climate with the addition supply of air conditioning devices such as fans

3. To provide quite cool rooms for body cooling equipped with drinking water supply for workers of oven 1 and 2.

4. To educate worker on the importance of

drinking 150-200 cc of water or equivalent to a glass of water for every 15 minutes -20 minutes.

5. To set working time 25% - 50% for oven 1 workers every hour, equivalent to 15 to 30 minutes working for every hour, and 20% - 25% for oven 2 workers, equivalent to a maximum of 15 minutes working time for every hour.

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