

Working Climate, Physical, Workload and Its Relation to Heat Strain on Construction Workers at Airport Development Project

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WORKING CLIMATE, PHYSICAL WORKLOAD AND ITS RELATION TO HEAT STRAIN ON CONSTRUCTION WORKERS AT AIRPORT DEVELOPMENT PROJECT

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ABSTRACT

The construction sector has absorbed much of the productive workforce in Indonesia. Construction workers become one of the groups vulnerable to heat stress because they have to work in open areas so they will get exposed to the solar radiation. Moreover, they will have highly physical activity. Extremely hot temperatures will cause a sense of fatigue, drowsiness, decreased work performance, and increased the likelihood of work errors. The heat of the environment also has a physiological impact of increased pulse rate and body temperature. This study aimed to analyze the relationship between work climate and physical workload with heat strain. This research is an observational analytic study with cross-sectional study design. The research sample is taken from 57 respondents, consisting of construction workers in iron fabrication, formwork, daily workers of HSE (Health, Safety and Environment), and housekeeping. The sample was chosen using proportionate random sampling. The statistical analysis used was chi-square test. The 89.5% of construction workers worked in a working environment with heat stress that exceeds the threshold value with the average results of measurement of outdoor WBGT (Wet-Bulb Globe Temperature) 31.11°C. All respondents experienced heat strain with the index level of moderate up to very high. The statistical analysis resulted significance value of each variable that is work climate (p -value < 0.05) and physical workload (p -value < 0.05). This research concludes that there is a significant correlation between work climate and physical workload on heat strain occurrences in construction workers.

Keywords: Work climate, Physical workload, Physiological strain index, Heat strain, Construction workers

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1. INTRODUCTION

The construction sector ranks the third after the manufacturing and trading sectors as a contributing source of economic growth in Indonesia by 2016. (Indonesian Ministry of Public Works and Housing 2017) [1] About 6.74% of the total productive workforce is absorbed by the construction sector with 142.852 construction companies in Indonesia operating in 2016. (Indonesian Statistics Center 2017) [2]

The work environment for that sector can be divided into two components namely physical and behavioral components. (Stallworth, J. & Kleiner, B 1996) [3] There are two types of physical environments that are directly related to the workers and to the intermediary environment such as noise, vibration, mechanical, color, air circulation, lighting, humidity, temperature, and others. (Norianggono Y. C. P et al. 2014) [4] In addition to that, supportive work environments provide conditions that enable health workers to perform effectively, making best use of their knowledge, skills and competences and the available resources in order to provide high-quality health services. (Leshabari M et al. 2008) [5]

There have been more than 4,100 deaths in India and Pakistan in 2015 due to the heat wave. (World Meteorological Organization 2016) [6] The heat-related disease is also experienced by thousands of workers in the United States each year, if not handled immediately, heat exhaustion can continue to be a heat stroke, which has killed more than 30 workers since 2003. (Occupational Safety and Health Administrator 2013) [7] In the construction sector there have been 17 deaths by 2015 based on the data from Construction Research and Training (CPWR). (National Safety Council) [8]

Serious health risks related to excessive physical workload and heat stress have been identified within the frame of the sudden unexplained death syndrome. (Gogh, K.T 1990) [9] Despite the fact about this, it is still consistently denied; in many South-East Asian countries physical workload and heat stress are risk factors for occupational diseases. (Yoopat, P. et al. 1999) [10]

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Construction workers become one of the vulnerable groups to heat stress because they usually have to work in open areas exposed to solar radiation. The temperature in the construction area allows being hotter than the air temperature, it is reported that the temperature in the construction area can reach 45°C when air temperature is only 32°C. (Yi W. and Chan A. P. C 2017) [11]

Extreme hot temperatures will cause a sense of fatigue, drowsiness, decreased work performance, and increased the likelihood of work errors. The heat of the environment also has a physiological impact of increased pulse rate and body temperature. (Harrianto R 2010) [12] Heat Strain is a human physiological response to heat stress, in which the body seeks to increase the release of heat from the body to the environment in order to keep the body temperature stable. (Jacklitsch B et al. 2016) [13]

Package IV Airport Development Project is an airport construction and development project supporting facilities located in coastal areas. From the measurement results at sites in the airport development project, it can be concluded that the WBGT in the work area of Package IV Airport Development Project has exceeded the threshold value according to the

Indonesia Minister of Labour Regulation No. 5 year 2018 which has been adjusted to the workload of each worker. The physical workload of construction workers based on the level of calorie needed is in the category of light to very heavy. In addition, many subjective complaints due to the heat stress most felt by workers are lack of concentration, sweat, thirst, and rarely urination. The purpose of this study is to analyze the correlation between work climate and physical workload with heat strain event.

2. MATERIAL AND METHOD

This type of research was an analytic observational with cross-sectional study design. The research was carried out at Package IV Airport Development Project on June 2018. The research population was construction project workers in four parts of work i.e. iron fabrication, formwork, daily workers of HSE (Health Safety Environment), and housekeeping. 57 samples were chosen using proportionate random sampling. The work climate is measured using area heat stress monitor and the workload is assessed on a calorie level basis, and heat strain is assessed using the Physiological strain index (PSI) from the results of pulse measurement and core body temperature measurement. Statistical analysis was performed using chi square test.

3. RESULTS AND DISCUSSION

The results showed that 51 respondents (89.5%) worked in a working climate that was not allowed under Indonesia Ministerial Regulation No. 5 year 2018. The highest outdoor WBGT measurement result was 32.33o C, the lowest outdoor WBGT was 29.17oC with average measurement results in all points of 31.11o C. The most workloads are light workload of 45.6% or 26 respondents. The lightest workload is the caloric requirement of 111.3 kcal/hour, the heaviest workload is with the caloric needs of 629.1 kcal/hour, and the average workload of all respondents is 245.6 kcal/hour.

Table 1 Frequency Distribution of Independent and Dependent Variables on Construction Workers in Airport Development Project

Variables	n	%
Work Climate		
Not allowed	51	89.5
Allowed	6	20.5
Physical Workload		
Very heavy	2	3.5
Heavy	8	14.0
Medium	21	36.8
Light	26	45.6
Heat Strain		
Very High	5	8.8
High	47	82.5
Moderate	5	8.8
Low	0	0.0
No	0	0.0

All study respondents experienced heat strain but with different PSI, the majority had a high index of 82.5%. The normality test data showed the result that the data is abnormally distributed (sig <0.05) so that the correlation test used was chi square test. The chi square test results are shown in Table 2.

Table 2 P-Value of Independent Variable Relation with Heat Strain on Construction Workers

Independent Variable	p-value
Working Climate	0.0001
Physical Workload	0.0001

3.1. Correlation between Work Climate and Heat Strain

The proportion of heat strain events with very high index entirely experienced by workers in the area that are not allowed in the work climate (WBGT > NAB), is about 5 respondents (9.8%). The result of correlation test using chi square test shows there is correlation between work climate and heat strain occurrence with p-value 0.0001.

The result is in line with a research in 2014 on cracker factory workers that was conducted in East Ciputat Sub district. It shows that there is a relationship between heat stress or WBGT measurement results and heat strain. (Fadhilah R 2014) [14] However, the results do not match with the research in 2013 at PT.IGLAS (Persero) which concludes that there is no correlation between the work climate and subjective complaints due to the heat stress felt by forming, melting, and sorting workers. (Istiqomah F. H. & Nawawinentu E. D 2013) [15] A case studies undertaken in 2016 in Iran on various types of heat-exposed worker have concluded that WBGT measurements have a significant relationship with physiological parameters such as heart rate, core body temperature, and blood pressure. (Golbabaei F et al. 2016) [16]

The theory states that extreme heat environment temperature will cause tiredness, drowsiness, decreased work performance, and increase the possibility of work errors. The heat of the environment also has a physiological impact of increased pulse rate and body temperature. In hot working climate conditions; thermoregulation depends on the release of body heat to the environment. The discharge of sweat will cool the skin by evaporation. Sweating is a major heat loss mechanism while working in a very hot environment. In addition, increased blood flow to the surface of the skin while working in a hot working climate can cause significant heat loss. (Bates G. P & Schneider J. 2008) [17]

3.2. Correlation between Physical Workload and Heat Strain

The proportion of heat strain events with very high index is experienced by workers who have a heavy work load as many as 4 respondents (50%). The result of correlation test using chi square test shows that there is correlation between physical work load and Heat Strain occurrence with p-value of 0.0001.

The result of the research is match with previous research on workers in PT Aneka Boga Makmur, it is concluded that there is a relation between work load and heat strain which in this research, it uses indicator of body temperature, pulse, and blood pressure of respondent. (Adiningsih R 2013) [18] The results of this study are not match with the previous research conducted on oil production workers of PT Pertamina (Persero) in 2012. The results of the research on lubricant production workers concluded that there is no relationship between the workload and the subjective complaint rate of heat strain. (Puspita A. H. 2012) [19]

In theory when physical activity increases then the heat of metabolism in the body will also increase so that the excessive heat in the human body must be released into the surrounding air because the body has limited ability to store the heat. (Soeripto M 2008) [20] The heavier the workload the greater the metabolism burden and more body heat that must be released so that the stress on the environmental temperature will be higher. Based on univariate analysis, this research shows that light work load dominates 26 (45,6%) but there are still many respondents who experience heat strain with high index.

On the workers who do not have experience of heat strain complaints, they still create productivity instead, but there are still needs of a favorable balance between physical workload, additional burden resulting from work environment and work capacity, as such the physical workload is not the only factor affecting the heat strain event. (Istiqomah F. H. & Nawawinentu E. D. 2013) [15]

Physiological strain happens due to both heavy dynamic muscular work and high heat stress. It can be reduced by using more technical aids, improving the thermal environment, and introducing efficient work-rest regimens. (Yoopat P et al. 2002) [21]

4. CONCLUSION

The occurrence of heat strain was experienced by all respondents. The heat strain event is dominated by the high index while the workload is dominated by workers with light work load. This study concludes that the work climate and physical workload are significantly related to heat strain on construction workers in airport development project.

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