Conference Paper

Health Effect Symptoms Due to Heat Stress Among Gong Factory Workers in Bogor, Indonesia

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Abstract

Heat stress is the combination of environmental heat, metabolic heat due to activity and clotting factor that increases body temperature, pulse rate, and sweating. A hot environment can cause heat stress and health problems, such as heat-related diseases. Dehydration is one of the heat-related diseases that can cause an accident in a work environment. Employees of a gong factory in Bogor are at risk of suffering heat stress. This study, performed in June 2016, aimed to describe health complaints caused by heat stress. The method used was a cross-sectional descriptive study of 18 employees. The study found the wet-bulb globe temperature (WBGT) index in the production area at 31.1°C, which exceeded the threshold value, causing the employees to suffer from heat stress. Complaints from employees included excessive perspiration, thirst, fatigue, discomfort while working, hot skin, and skin redness. Suggestions were made to help the factory provide a work environment that would minimize health complaints and the risk of heat-related illnesses.

Keywords: Health Complaint, Heat Stress

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1. INTRODUCTION

Law No. 13 of 2013 employment (UU RI No 13) states that all workers have the right to protection of health and safety. There are a variety of potential hazards and risks in a workplace that may cause health problems. The hazard potentials come from work environment factors (physical, chemical, biological), somatic disorders, ergonomics, worker behavior, and organization and work culture [4]. One of the physical factors that potentially interferes with worker productivity and may cause health problems is work climate (heat) in the workplace.

Workers in hot environments will feel uncomfortable and can experience health problems or even death. Heat stress occurs when workers perform physical activity continuously in a hot environment [9].

Informal industrial sectors, such as the manufacturing of gamelan gongs, are small industries that can provide jobs. Based on preliminary observations in March 2016, workers in the gong-manufacturing industry work six days a week from 8:00 am to 4:00 pm and make gongs every day. In general, the temperature in the room where materials are mixed and forged can be categorized as hot. Work takes place in a dark room filled with charcoal dust from the fuel, and the heat required to melt the ingredients is around 500°C (Kristanto n.d). During the process of forging, workers must swing the gong hammer repeatedly. There is no ventilation inside the room, so it is very hot. The temperature and strenuous work causes health complaints due to thermal stress. Workers experience excessive sweating, which can cause dehydration, in turn reducing concentration and causing accidents. This study aimed to collect descriptions of workers' thermal stress-related health complaints in a gong factory in Bogor in 2016.

2. METHODS

2.1. Subjects

The subjects of this study were 18 workers in a gong factory in Bogor. The subjects were evaluated based on factors that caused heat stress—namely environmental factors, occupational factors, and clothing. The dependent variable in this study was the number of health concerns related to heat exposure in a gong factory. This study was conducted at the gong manufacturing plant in Bogor for three months, from March to June 2016.

2.2. Measurement

To measure the working environment temperature, a 3M^{TM} QUESTemp°^{TM} 34 Thermal Environment Monitor was used (wet-bulb temperature, dry-bulb temperature, globe temperature, relative humidity (RH), and absolute humidity). Air velocity was measured using a digital vane anemometer. The workload of each worker was calculated using the assessment table for workload based on caloric requirements according to SNI 7269:2009. Information about work patterns and clothing was collected through observation. Details about age, body mass index, status of acclimatization, hydration status, and health status were obtained through a questionnaire.

3. RESULTS

3.1. Work Environment

Table 1 shows environmental measurements at work sites (production site and wood site).

3.2. Calculation of the Workload

Calculation of the workload was derived from direct observations in the field and interviews with workers about their everyday activities. Calorie estimates were then grouped into workload categories based on recommendations of the Regulation of the Minister of Manpower and Transmigration No. 13 of 2011 [2]. A light workload is categorized as ≤ 200 kcal/h, a medium workload is200 kcal/hr < workload ≤ 350 kcal/h, and a heavy work load is 350 kcal/hr < workload ≤ 550 kcal/h. The distribution of the workload based on location of work is seen in Table 2.

Table 1: Results of Working Environment Measurements.

Location	Air Velocity (m/s)	Wet Bulb (°C)	Dry Bulb (°C)	Globe (°C)	WBGT indoor (°C)	WBGT outdoor (°C)	RH (%)	HI*(°C)
Wood Site	0.3	25.7	30.8	30.6	27.1	27.1	70	36
Production Site	0.1	28.5	36	38.8	31.5	31.2	59	48
		28.5	35.9	37.2	31.2	31.1	59	47
		28.1	36	37.4	30.7	30.8	54	45
		28.7	35.3	36.2	31	30.9	59	46
Average in Production Site		28.45	35.8	37.4	31.1	31	57.75	46.5
*Heat Index								

Table 2: Distribution of Work Load Based on Job Location.

Location	Work Load		Total
	Light Work Load	Medium Work Load	
Production site	1	10	11
	9.10%	90.90%	100.00%
Wood Site	7	0	7
	100.00%	0.00%	100.00%
Total	8	10	18

3.3. Work and Rest Patterns Workers

The subjects worked eight-hour shifts, from 8:00 am to 4:00 pm with a one-hour break from 12:00 noon until 1:00 pm. Workers performed the same job in accordance with their duties for ±7 hours. Workers employed in the production room were exposed to heat during work, while workers in the timber space were not exposed to heat. Patterns of workers was included in 75% -100% patterns that was based on the recommendations of the Regulation of the Minister of Manpower and Transmigration No. 13 of 2011 [2].

3.4. Workers' Clothing as a Factor

Workers wore short sleeve shirts and shorts. Based on the American Conference of Governmental Industrial Hygienists' 2014 Threshold Limit Values [11], the type of clothing had an adjustment weight of zero for the WBGT index [11].

3.5. Overview of Heat Stress

The overview of heat stress on workers was determined by comparing the measured indoor WBGT index, the workload based on the energy level expenditure and caloric needs according to SNI 7269:2009, and patterns of work with established standards. The standard used was the Regulation of the Minister of Manpower and Transmigration No. 13 of 2011 [2]. The heat stress incidence calculation seen in Table 3 is the result of the distribution of heat in the production and timber sites.

Table 3: Overview of Heat Stress in Production and Timber Spaces.

Location	Work Load	Work Pattern	Amount of worker	Index WBGT indoor (°C)	NAB* (°C)	Heat Stress
Production site	Light	75%-100%	1	31.1	31	Yes
	Medium	75%-100%	10		28	Yes
Wood Site	Light	75%-100%	7	27.1	31	No
	Medium	75%-100%	0		28	No
*Threshold Value *(Nilai Ambang Batas)*						

In the production room, all workers (100%) experienced heat stress due to threshold values of exposure that exceeded indoor WBGT index recommendations. In the timber room, none (0%) of the workers suffered from heat stress.

3.6. Overview of Health Complaints

The frequency distribution of workers' health complaints is seen in Table 4.

Table 4: Frequency and Percentage Distribution of Workers' Health Complaints.

Complaint	Frequency and Percentage (%) Complaint									
	Always		Often		Rarely		Ever		Never	
	n	%	n	%	n	%	n	%	n	%
Sweating	11	61.1	0	0	0	0	3	16.7	4	22.2
Thirsty	11	61.1	0	0	0	0	3	16.7	4	22.2
Limp	0	0	3	16.7	5	27.8	2	11.1	8	44.4
Tired	2	11.1	9	50.0	0	0	1	5.6	6	33.3
Rapid heart rate	1	5.6	0	0	6	33.3	0	0	11	61.1
Uncomfortable	3	16.7	11	61.1	2	11.1	2	11.1	0	0
Restless	0	0	0	0	5	27.8	3	16.7	10	55.6
Skin feels hot	0	0	2	11.1	9	50.0	2	11.1	5	27.8
Skin redness/stinging	0	0	3	16.7	9	50.0	0	0	6	33.3
Skin is dry and pale	0	0	0	0	5	27.8	6	33.3	7	38.9
Skin is moist/prickly heat	0	0	0	0	8	44.4	3	16.7	7	38.9
Decreased urination	0	0	3	16.7	4	22.2	0	0	11	61.1
Cramps/spasms (stomach)	0	0	2	11.1	0	0	1	5.6	15	83.3
Cramps/spasms (arms)	0	0	0	0	3	16.7	2	11.1	13	72.2
Cramps / spasms (legs)	0	0	1	5.6	4	22.2	1	5.6	12	66.7
Dizziness/lightheadedness	0	0	2	11.1	5	27.8	1	5.6	10	55.6
Nausea and/or vomiting	0	0	0	0	5	27.8	2	11.1	11	61.1
Lack of concentration	0	0	4	22.2	3	16.7	0	0	11	61.1
Feeling faint	0	0	0	0	2	11.1	0	0	16	88.9
Loss of balance	1	5.6	0	0	2	11.1	0	0	15	83.3

4. DISCUSSION

The WBGT index value in the production room was high atis 31.1°C because of the furnace as a heat source to forge the gongs. Air velocity measurements in the room were quite low (0 m/s - 0.1 m/s). According to The National Institute for Occupational Safety and Health [6], this measurement is categorized as no air movement. The production room is not equipped with adequate ventilation. Relative humidity in the production

room reached 57.75% with a heat index of 46.7°C. The heat index value is a combination of temperature and humidity. A high heat index would result in lower heat transfer from the body to the environment through evaporation.

Workers employed in the production room (11) all experienced heat stress with both mild and moderate workloads. In the timber space, there were seven workers, all with a light workload, and there was no heat source. None of the workers employed in the timber space suffered from heat stress.

Workers had complaints due to exposure to heat with different frequencies. Workers in the production site felt significant signs and symptoms of heat exhaustion, based on frequency and percentages. Heat stress can cause discomfort in the workplace and influence safety. This is in line with the statement in the Occupational Health and Safety (OHS) Body of Knowledge [1], that high temperatures in summer resulted in increased accident and injury rates among mine workers. Accidents can be caused by fatigue due to dehydration as shown in Meivita's 2008 study stating that heat stress of more than 30°C increased the risk of chronic fatigue 40.28 times (Meivita n.d.)

Worker characteristics measured were age, body mass index, status of acclimatization, hydration status, and health status. Workers aged ≥ 40 years were more at risk of complaints due to heat exposure than younger workers. No significant difference was noted in health problems among IMT workers due to body type of thin, normal, and obese. This result was influenced by an uneven distribution of IMT workers with different body types, thus affecting the distribution of types of workers who suffered health complaints. Workers who did not acclimate described many complaints, as there was no adaptation to the heat, and there was a higher risk of suffering health problems due to heat stress. There were workers with good hydration status, attained by consuming ≥ 8 glasses of water daily, but many still perceived grievances. Based on the results of the questionnaire, the types of beverages consumed by workers other than plain water were tea, coffee, and soda. Many workers consumed beverages containing caffeine, which can cause dehydration [8], and may be one cause for many complaints. All workers (100%) were categorized in a healthy condition. Workers living in unsanitary conditions would have a lower ability to cope with heat stress.

5. CONCLUSION

It is necessary to control the environment in the gong-making factory—especially in the production room with the heat source—so perceived health complaints of the workers can be minimized.

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