The Relationship between Heat Stress and Dehydration in the Continous Casting Machine Section of Pt X

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Abstract

One of the hazards in the CCM (Continuous Casting Machine) section of PT X is the heat stress. The heat stress is predominantly caused by hot metal liquids processed before being compacted into billets. Heat Stress causes workers sweating a lot and leads to dehydration. The purpose of this study is to find the correlation between heat stress and dehydration in CCM (Continuous Casting Machine) section of PT X. It is an observational study and a cross sectional study due to time examined. The tools to measure heat stress is Heat Stress Apparatus Quest Temp 36 and measurement of work dehydration is by observing the color of the respondent's urine compared to the urine color table. This study has a sample of 30 workers exposed to the hot work climate in CCM (Continuous Casting Machine) section of PT X. The data analysis techniques used are univariate and bivariate analysis techniques. The results show that the highest working climate in the place is 42.3 ^{o}C and of the 30 respondents studied, there are 28 respondents who are dehydrated, ranging from mild to severe. By using the chi-square test statistical calculations to see the correlation, p is 0.045 where p <α, means there is correlation between the work climate and work dehydration. Suggestions that can be given to companies to overcome heat stress problems are by adding fan blowers in the workplace and providing electrolyte salts added to the workers' drinks.

Keywords: *Heat Stress, Relationship, Dehydration, Continous Casting Machine, PT X*

Introduction

Every company has hazards in their workplaces. One of the factors of hazard in the workplace of a company is the work climate. If work climate exceeds the allowable Threshold Limit Value (TLV) that can affect workers, workers can experience a work-related illness caused by the work climate. If the worker suffers from a disease due to the work climate, it will have an impact of decreasing productivity in the company.

Heat Stress is a combination and attachment of work temperature, air humidity, wind speed, and radiation temperature in the workplace. Work climate that is uncomfortable and discordance with the standards of workers and provisions will lessen workers' capacity resulting a decline in efficiency and productivity of work[(1)]. According to the Minister of Manpower and Transmigration Regulation, the work climate is the result of a combination of temperature, humidity, movement speed of air and radiant heat due to the level of heat dissipation from the workforce as a result of work[(2)].

The temperature in the workplace can be influenced by machinery and work environment factors. As long as the worker's body is active, the body will naturally adjust the temperature received through the process of heat loss. The comfortable temperature for Indonesians at work is between 24-26 ^{o}C. When workers are exposed to hot temperature, it will reduce agility, prolong reaction time and slow down decision-making time, disrupt the accuracy of the brain's work, interfere motor sensory nerve coordination, and provoke emotion. The high-risk working environment, especially the hot work climate, can endanger the safety and health of the workers, so it is necessary to make work time adjustments and safeguards to overcome the hazards at work that might happen[(3)]. When the heat in the workplace exceeds the limit and disturbs the comfort of workers, it can cause

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heat stress to these workers.

Heat stress is a limit of the body's ability as a result of receiving heat exposure from the combined contributions while doing a job and the factors that exist in the environment (such as air temperature, humidity, air movement, and heat transfer radiation) and clothing used when working. Mild or moderate heat stress conditions can cause uncomfortable condition for workers, and disturb the performance and safety, although this does not cause harm to workers' health[4].

Dehydration is a health disorder caused by lack of fluids, especially Na salt. The effect of exposure to hot temperature and accompanied by excessive sweating will result in the loss of sodium salt. After a few weeks of experiencing this condition, it will cause muscle spasms. If someone loses fluid <1.5%, the symptoms still do not appear, but fatigue will appear earlier with dry mouth. In such condition, workers only need to be given rest time in a cooler place and given sweat relieving powder[5].

In a study conducted by Nindi Puspita in 2014, the result of the effect calculation of hot work climate on dehydration by SPSS Mann Whitney test showed that the p value was 0.023 or $p \leq 0.05$. This value indicates that there is a significant influence between the work climate and dehydration[6].

PT. X is a production site whose scope of business is in the field of hot roll steel plate. In the production process, it has exposure to hot temperatures affecting the company's workers. The example of impacts that can be caused by hot temperature exposure to workers is dehydration. Therefore, researcher will analyze the correlation between heat stress and dehydration

Material and Method

Based on the type of research and the method of data collection, this research is an observational study with cross sectional study. The sample in this study are 30 workers who work in the CCM (Continuous Casting Machine) section of PT X and exposed to hot work climate in their workplace. This research was conducted in one of the Surabaya regional companies, East Java, which is engaged in the production of hot rolled steel, in this case called PT X. Data collection was carried out in February 2019 for one week.

Secondary data is taken from company data that contains a general description of the company and a list of PT X workers. The first primary data collection is through interviews to find out about the identity and characteristics of the respondents (ages, work periods, and nutritional status). The heat stress measurements were carried out in the workplace that has heat exposure at PT X, the tool used is Questemp 36 heatstress monitor by looking at the Wet Bulb Globe Temperature Index (WBGT Index), after the WBGT results are obtained, they are compared to workload and working time to determine whether the results are more or less than the Threshold Value Limit (TLV) determined by law.

Measuring the level of dehydration is done on workers in areas that have heat exposure in PT. X, the measurement done is observing the color of the respondent's urine after work. The categories of dehydration work are not dehydrated, mild dehydration, moderate dehydration, and severe dehydration. The variables studied are the characteristics of workers consisted of age, years of service, nutritional status and heat stress with work dehydration. Data is processed by using statistical chi-square test for data with nominal data scale and spearman correlation test for ordinal data scale**.**

Finding

Ages

The age group of workers working in the CCM (Continuous Casting Machine) section if PT X is divided into 3; ≤35 years, 35–50 years, and >50 years. The results of the age group ≤35 years are 16 workers, the age group 35–50 years are 7 workers and the age group >50 years are 7 workers.

Work Periods

The working period of the workers in CCM (Continuous Casting Machine) section of PT X is divided into 4; ≤10 years, 11-20 years, 21-30 years, and >30 years. The results of working period ≤10 years are 16 workers, groups of working period 11-20 years are 5 workers, working period 21-30 years are 4 workers and groups working period >30 years are 5 workers.

Nutritional Status

The nutritional status group of workers in the CCM (Continuous Casting Machine) section of PT X iss divided into 5, namely mild lack of weight, severe lack of weight, normal weight, mild overweight, and heavy overweight. The results of the normal nutritional status

group are 15 workers, the mild overweight status group are 11 workers, and the severe overweight group are 4 workers.

Heat Stress

In measuring heat stress, determining the measurement point is based on the work location of the respondent. There are 3 points, namely the point A CCM located in front of the CCM Control room, point B CCM located near CCM Ladle, and point C CCM is near the Horizontal CCM Burner. The lowest Wet Bulb Globe Temperature Index (WBGT) results is 30.1 ^{o}C at Point A CCM which located in front of the CCM control room and the highest Wet Bulb Globe Temperature Index (WBGT) is 42.3 ^{o}C at point B CCM near the Horizontal CCM Burner. Setting working hours on the CCM section of PT. X is 25-50%, so the TLV for heat stress is 32 ^{o}C for light workloads, 30 ^{o}C for medium workloads, and 29 ^{o}C for heavy workloads.

Work Dehydration

Measurements of work dehydration is achieved by observation of after working color urine. Furthermore, the measurement results are classified into 4, namely not dehydrated, mild dehydration, moderate dehydration and severe dehydration. The results of not dehydrated group is 2 workers, mild dehydration group is 8 workers, moderately dehydration is 16 workers and severe dehydration is 4 workers.

Relationship Between Age Of Workers And Work Dehydration

Table 1. Cross Tabulation of Relationship between Age and Work Dehydration

Ages	Work Dehydration Status								Total	
	Not Dehydrated		Mild		Moderate		Severe			
	N	%	n	%	N	%	n	%	N	%
≤ 35 years old	2	6,7%	6	20%	8	26,7%	0	0%	16	53,3%
36 – 50 years old	0	0%	1	3,3%	5	16,7%	1	3,3%	7	23,3%
> 50 years old	0	0%	1	3,3%	3	10%	3	10%	7	23,3%
Total	2	6,7%	8	26,7%	16	53,3%	4	13,3%	30	100%

The table above shows that most workers aged ≤35 years old experience moderate work dehydration as many as 8 workers with a percentage of 26.7%. Most workers 36-50 years old also experience moderate work dehydration by 5 workers with a percentage of 16.7%. Then the most work dehydration status experienced by workers aged >50 years is moderate work and severe dehydration are 3 workers with a percentage of 10%. The results of statistical tests, namely the Spearman correlation test showed that there is a significant connection between ages and work dehydration with a value of $p = 0{,}000 < \alpha = 0.05$ and the correlation coefficient value showed a number of 0.619, which means the age of workers has strong level of correlation strength with dehydration.

Relationship Between Work Period Of Workers And Work Dehydration

Table 2. Cross Tabulation of Relationship between Work Period and Dehydration Work

Work Period	Work Dehydration Status								Total	
	Not Dehydrated		Mild		Moderate		Severe			
	N	%	n	%	N	%	N	%	N	%
≤ 10 years	2	6,7%	5	16,7%	8	26,7%	1	3,3%	16	53,3%
11–20 years	0	0%	1	3,3%	4	13,3%	0	0%	5	16,7%
21-30 years	0	0%	2	6,7%	2	6,7%	0	0%	4	13,3%
> 30 years	0	0%	0	0%	2	6,7%	3	10%	5	16,7%
Total	2	6,7%	8	26,7%	16	53,3%	4	13,3%	30	100%

The table above shows that most work dehydration status experienced by workers with a work period ≤ 10 years are moderate work dehydration with 8 workers by the percentage of 26.7%. The most work status experienced by workers with a working period of 11-20 years experienced moderate work dehydration is 4 workers with the percentage of 13.3%. The most work dehydration status of work experienced by 21-30 years working period is moderate dehydration and heavy with 2 workers by 6.7%. The most work dehydration status experienced by workers with working period >30 years is severe work dehydration by 3 workers with the percentage of 10%.

The results of statistical tests, namely Spearman correlation test shows that there is a significant correlation between work period and work dehydration. with a value of $p = 0.047 < \alpha = 0.05$ and the correlation coefficient showed a number of 0.365 which meanswork period has a low level of correlation strength with dehydration.

Relationship Between Nutritional Status Of Workers And Work Dehydration

Table 3. Cross Tabulation of Relationship between Nutritional Status and Work Dehydration

Nutritional Status	Work Dehydration Status								Total	
	Not Dehydrated		Mild		Moderate		Severe			
	N	%	n	%	N	%	N	%	N	%
Normal	2	6,7%	4	13,3%	9	30%	0	0%	15	50%
Mild Level Overweight	0	0%	4	13,3%	5	16,7%	2	6,7%	11	36,7%
Severe Level Overweight	0	0%	0	0%	2	6,7%	2	6,7%	4	13,3%
Total	2	6,7%	8	26,7%	14	53,3%	4	13,3%	30	100%

The table above shows that the most work dehydration status experienced by workers with normal nutritional status was moderate work dehydration status as many as 9 workers with percentage is 30%. The Most work dehydration status experienced by workers with mild level overweight nutrition status were moderate work dehydration as many as 5 workers with a percentage of 26.7%. The most work dehydration status experienced by workers with severe level overweight nutritional status were moderate working and severe dehydration as many as 2 workers with a percentage of 6.7%.

The results of statistical tests, namely the Spearman correlation test showed that there is a significant relationship between nutritional status and work dehydration with a value of $p = 0.034 < \alpha = 0.05$ and the correlation coefficient showed a number of 0.388 which means the age of workers has a weak level relationship with dehydration.

Relationship Between Heat Stress And Work Dehydration

Table 4. Cross Tabulation of Relationship between Nutritional Status and Dehydration Work

Heat Stress	Work Deydration Status								Total	
	Not dehydrated		Mild		Moderate		Severe			
	N	%	N	%	N	%	N	%	N	%
≤ TLV	2	6,7%	4	13,3%	4	13,3%	0	0%	10	33,3%
> TLV	0	0%	4	13,3%	12	40%	4	13,3%	20	66,7%
Total	2	6,7%	8	26,7%	16	53,3%	4	13,3%	30	100%

The table above shows that heat stress measurements ≤TLV (Threshold Limit Values), the most workers experience mild and moderate dehydration are 4 workers with the percentage of 13.3%. The heat stress measurement >TLV, the most workers experience moderate work dehydration are 12 workers with a percentage of 40%. By using the chi-square test statistical calculations to see the relationship produced p is 0.045 where p <α, it means that heat stress and work dehydration are correlated. This research is supported by research conducted by Sari (2014) there is a relationship between hot work climate and dehydration in the boiler part of the workforce at PT. Albasia Sejahtera Mandiri Semarang Regency with a p value of 0.023 <0.05[7].

This research is in line with the theory from Suma'mur (2009), the workforce working in a workplace that exceeds the TLV of the work climate can experience the effects of heat stress. The effect of heat stress occurs as a result of the body's process of maintaining body heat unsuccessfully. The effects of heat stress can be in the form of subjective complaints due to heat stress such as complaining of heat, sweating, always thirsty, feeling bad and loss of appetite caused by loss of fluid from the body by evaporation of sweat[5].

Exposure to a physical work environment such as heat stress can lead to health problems, one of which is dehydration. Consumption of drinking water needs to be considered because lack of fluids can cause dehydration as well. Prolonged dehydration can cause impaired kidney function. In addition, dehydration can also affect one's weight due to sweat and urine that comes out during activities. Dehydration is excessive loss of body fluids due to insufficient fluid replacement intake that does not meet the body's needs and an increase in water expenditure[8].

Conclusion

The results show that the heat stress measurement in CCM (Continuous Casting Machine) section of PT X already pass the NAB with a moderate workload and 25-50% working hours setting, namely the WBGT (Wet Bulb Globe Themperature Index) exceeding 30ºC. The measurement of worker work dehydration in CCM (Continuous Casting Machine) section of PT X has the most moderate dehydration with 16 workers. There is a relationship between heat stress and dehydration work in the CCM (Continuous Casting Machine) section of PT X.

Advice that can be given to the company is that the company provides several places for workers to take their drinks close to their work area, when workers feel thirst or dehydrated, they can easily take the drinking water. Adding electrolyte salt to the workers' drinks also strongly recommended.

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