

Water Consumption and Incidence of Dehydration on Workers Exposed to Heat Stress (Study in Tofu Industry Worker's in Semarang Indonesia)

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Abstract:

Background: Heat stress exposure in the workplace that occurs continuously will affect the increment of fluid expenditure through sweat and if it is not accompanied by adequate fluid intake, it will cause dehydration. One of the workplaces that have a physical hazard in the form of heat stress is the tofu industry. Preliminary measurement results for all locations are above the threshold value limit.

Method: This descriptive study uses a cross-sectional approach, the sample is 31 workers in the tofu industry, Jomblang Village, Semarang Indonesia. The variables analyzed were the amount of drinking water consumption, the habit of drinking diuretic drinks, and the incidence of dehydration. Research instruments are questionnaires, beaker glass, urinometers, and cameras. Data analysis was carried out univariately.

Results: Heat stress averages 33.01°C, most workers are >40 years old (67,7%), 83.9% are male, water consumption (freshwater) averages 2,1 liter for 24 hours, and 87.1% have less water intake. 87.1% of workers have a drinking diuretic habit both at work and at home, with the most types consumed are tea and coffee. The urine specific gravity averages 1.016, a minimum of 1.009, and a maximum of 1.026 of which 58.1% is unhydrated.

Conclusion: Lack of drinking water consumption to replace body fluids lost through sweat due to heat stress will increase the specific gravity of urine. The specific gravity of urine can be an early marker of kidney problems.

Keywords: Water consumption, dehydration, USG, heat-stress

I. INTRODUCTION

Heat stress is found in many industrial and commercial jobs both indoors and outdoors. For countries with a hot climate, such as Indonesia, heat stress is a problem that is often encountered in various sectors. Work-related to heat sources requires a lot of energy, and the use of waterproof clothing presents a high potential risk to the workers.⁽¹⁾

Heat in the workplace that comes from the production process will spread throughout the work environment. This causes the air temperature and humidity in the work environment increase at the same time. One of the workplaces

that has a source of danger in the form of a hot working climate is the tofu-making industry. One of the tofu industry centers is on JalanTandang Raya, Jomblang Village, Candi Sari District, Semarang.

Heat stress puts physiological stress on workers which has an impact on the emergence of diseases and health problems, work accidents, absenteeism from work, decreased productivity, and chronic kidney disorders⁽²⁻⁷⁾. Exposure to heat in the work environment that occurs continuously will affect the increase in fluid expenditure through sweat and if it is not accompanied by adequate fluid intake it will cause dehydration⁽⁸⁾. Dehydration is the loss of fluids or ions in the human body where more water comes out of the human body through the skin, lungs, kidneys and digestive tract caused by an imbalance of fluids in the body⁽⁹⁾. The exposure to heat in the work environment that occurs continuously will affect the increase in fluid expenditure through sweat. So that, if it is not accompanied by adequate fluid intake it will cause dehydration⁽⁸⁾.

Several factors related to the incidence of dehydration are age, gender, temperature, environmental humidity, length of work, type of work, illness, physical activity, heat stress, fluid consumption, smoking habits, and use of clothing⁽¹⁰⁻¹⁹⁾. Measurement of dehydration can be done with several parameters such as measurement of density, color, pH, and urine volume. In general, the tofu industry has a hot production environment, in which the heat source comes from a heating furnace that produces steam for the boiling process of the raw material for making tofu. The measurement results done by a heat stress meter show that the workspace heat pressure has exceeded the threshold value (TLV). Based on a work environment that has heat stress exceeding the threshold, also the factors of drinking diuretic drinks and dehydration status in informal sector workers by measuring urine density have not been widely reviewed. Therefore, this article will analyze it. Before clinical signs and symptoms develop, the concentrated urine specific gravity can be used as an early indicator of dehydration.

II. METHODS

This descriptive study used a cross-sectional approach. The research subjects were workers at the tofu industry center on JalanTandang Raya, Jomblang Village, Candi Sari District, Semarang. Data collection was carried out in July 2021. The population size is 33 people and the sample is 31 people, because 2 peoples whose urine samples are too small. The research variables are age, gender, amount of drinking water consumption, drinking habits of diuretic drinks, and the incidence of dehydration. The research instrument was a questionnaire (to collect data on the amount of drinking water consumption and drinking habits of diuretic drinks), a measuring cup (to take urine samples), an urinometer (to measure the specific gravity of urine), and a camera (for documentation). The amount of drinking water consumption is calculated from the amount of water consumed for 24 hours. Urine is taken at 2 times, namely noon (before break) and afternoon (before workers go home), and the average of the two data are taken. Descriptive data analysis is done with univariate analysis. Research ethics were obtained from the Health Research Ethics Commission, Faculty of Public Health, the University of Muhammadiyah Semarang with certificate number 507/KEPK-FKM/UNIMUS/2021.

III. RESULTS AND DISCUSSION

1. Results

The average age of workers is 35.3 years, the youngest is 18 years, and the oldest is 67 years. The minimum heat stress in the workplace is 30.8°C while the maximum is 41.5°C, and the average heat stress is 33.01°C. The average consumption of drinking water (mineral water) is 2.1 liters with a minimum of 600 ml and a maximum of 6 liters. The most consumed diuretic drinks are tea and coffee. The average urine density is 1.016, a minimum of 1.009, and a maximum of 1.026. The results of the categorization of research variables are as follows:

Table 1. Variable Categories

Variable	Total	(%)
Age		
- < 40 years	21	67.7
- ≥40 years	10	32.3
Sex		
- Male	26	83.9
- Female	5	16.1
Water consumption		
- < 4800 ml	28	90.3
- ≥ 4800 ml	3	9.7
Drinking diuretics habits		
- Yes	27	87.1
- No	4	12.9
Dehydration		
- Euhydration	18	58.1
- Mild dehydration	12	38.7
- Moderate Dehydration	1	3.2

2. Discussion

a. Age

Young people acclimatize more quickly to heat, so they are less likely to become dehydrated. Thus, most of the research subjects were at low risk of dehydration because most of them were <40 years old. It takes 15 minutes to secrete sweat after entering a hot room at a young age, but for the elderly, it takes 29 minutes so they are at greater risk of becoming dehydrated due to the body's slow response in transferring heat from the core of the body to the skin⁽²⁰⁾. Basically, the incidence of dehydration can be experienced by anyone because of many factors related to the incidence of dehydration, but the groups that are susceptible to dehydration are the group of young children and the elderly.

b. Gender

Women are more likely to experience a fluid deficiency because most women's bodies have more fat than men⁽²¹⁾. Physically, men have better heat resistance than women. Female workers will give peripheral reactions such as weakness in the hands and feet when working in a place with a hot working climate⁽²²⁾. In this study, there were only 5 women, which 2 of whom were mildly dehydrated. In male workers, 10 people are mildly dehydrated and 1 person is moderately dehydrated.

c. Water Consumption

Water consumed by workers is mostly insufficient. Factors that influence the lack of respondents to consume water are not feeling thirsty, disliking drinking water, and prefer to consume other drinks such as tea, coffee, and syrup. Workers who work in hot places, excrete fluid in the form of profuse sweat, this causes fluid loss. Lack of fluids in the body that is not balanced with the amount of water that enters encourages dehydration.

d. Drinking Diuretic habits

The specific gravity of urine is also related to diuresis, the greater the diuresis, the lower the specific gravity of urine⁽²³⁾. Some workers have low diuresis. This is evidenced by the small volume of urine collected by each worker. Most workers have a habit of drinking diuretic drinks in the form of tea and coffee. The amount of tea consumption is around 500 ml while for coffee it is around 200 ml during work. There is one worker who used to drink tea for diet during working hours. Tea and coffee contain caffeine. Caffeine is a diuretic which increases blood flow to the kidneys to reduce excess fluid and sodium, resulting in more water loss. However, the habit of urinating workers is not frequent, even when sampling, there is a tendency for a small urine volume. This is possible because most of the body's fluids are lost through sweat.

e. Heat Stress

Thermal stress is the result of a combination of temperature, humidity, air movement speed, and radiant heat with the rate of heat dissipation from the body of the workforce as a result of their work⁽²⁴⁾. At the research site, the average heat stress is 32.1°C, which means it has exceeded the threshold value

(NAV) for work with a moderate workload, which is 28°C. Physical work carried out at high ambient temperatures pushes water easily to evaporate from the skin surface, resulting in the loss of body fluids through sweat in large quantities. Excessive evaporation of water in the skin can cause dehydration.

f. Incidence of Dehydration

Dehydration is a condition in which the fluid balance in the body is disturbed or the body is dehydrated. This loss of body fluids is accompanied by disturbances in the electrolyte balance in the body. The main cause is a lack of sodium and water. Mild dehydration is characterized by feeling weak, tired quickly, thirsty, to muscle cramps, and decreased concentration. Dehydration also causes dizziness when standing up, because the blood pressure drops. In severe dehydration, one may experience a decrease or even loss of consciousness.

There are many indices evaluating hydration status, one of which is urine specific gravity (Urine Specific Gravity = USG). USG is a good indicator of hydration status, fast, objective, non-invasive, more sensitive, and more stable^{(25),(26)}. Measuring ultrasound in addition to knowing the hydration status can also determine the functional ability of a person's kidneys⁽²⁷⁾.

The prevalence of workers exposed to heat is 41.9% dehydrated, of which 3.2% belonged to the category of moderate dehydration. Specific gravity indicates the concentration of particles in the urine and the density of the urine compared to the density of water⁽²⁸⁾. The main constituents of the urine are urea, chloride, sodium, potassium, phosphate, uric acid, sulfate, and water⁽²⁹⁾. Through the regulation of body water and electrolytes by the kidneys, the human body can maintain osmotic pressure homeostasis⁽³⁰⁾.

Physical work at high heat stress results in the expenditure of more body fluids so that the volume of body fluids decreases⁽³¹⁾. The decrease in body fluid volume encourages the kidneys to retain water, so the concentration of particles in the urine will increase compared to the density of water. Thus there will be an increase in the specific gravity of urine^{(32), (33), (34)}. According to NIOSH the ideal amount of drinking water consumption for workers in hot places is 200 ml/20 minutes or about 4800 ml for 8 hours of work. The amount of drinking water consumption in the subjects of this study is still far from the recommended limit. Insufficient consumption of drinking water for replacing body fluids that are excreted through sweat will increase the specific gravity of urine.

Antidiuretic hormone (ADH), also known as Vasopressin, plays a role in maintaining water balance in the body. When the body lacks water, vasopressin is released from the brain into the bloodstream, where it then acts on the kidneys by retaining water from being excreted in the urine. Vasopressin has an adverse effect on the kidneys if its levels

are consistently high. In heat-exposed workers, persistently high vasopressin induces an increase in intraglomerular pressure and glomerular hypertrophy. Urinary nephrin which is one of the constituents of the intercellular links in the glomerulus becomes stretched so that it is released into the urine. Nephrine is the part of the kidney glomerulus that is normally absent or exists in very small amounts in the urine. Elevated levels of nephrin in the urine indicate damage to the structure of the glomerulus. Urine-specific gravity 1.018 is associated with increased urinary nephrin. In this study, as many as 10 people (32.3%) had a specific gravity above 1.018.

USG can be interfered with by large molecules in the urine, such as glucose and protein which can increase the ultrasound value⁽³³⁾. Therefore, ultrasound is not suitable for evaluating the hydration status of patients with obvious kidney disease⁽²⁹⁾. In this study, 96.8% of workers had no history of illness such as kidney disorders and diabetes mellitus, thus the urine specific gravity in this study was not caused by the presence of disease in the worker.

In general, mild dehydration has no symptoms. It is necessary to identify workers in high-temperature environments with subclinical dehydration, for workers to benefit from adequate water intake. Insufficient water consumption or low urine output has been associated with recurrent kidney stones, an increased risk of renal insufficiency, and impaired glucose regulation⁽³⁴⁾. Visually found 2 urine samples that show a large amount of white precipitate. Thus the specific gravity of urine can be an early marker of kidney disorders. Therefore, workers who are continuously exposed to heat should check the specific gravity of urine regularly.

III. CONCLUSION

Lack of drinking water consumption to replace body fluids lost through sweat due to heat stress will increase the specific gravity of urine. The specific gravity of urine can be an early marker of kidney problems. Further research needs to be done with a larger sample to predict the risk factors for urine specific gravity due to heat exposure in workers.

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