



## LIQUID CONSUMPTION, WORKLOADS AND HEAT STRESS WITH WORK FATIGUE

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### Abstract

Work fatigue is a form of body protection mechanism to avoid further damage and to recover after having a rest. Tire patch workers who work on the roadside are very vulnerable to work fatigue. The aim of this study is to determine the relationship between fluid consumption, workload and heat stress in one side and work fatigue on the other side. This type of research is observational with cross sectional approach. The samples of this research were 44 tire patch workers on the edge of Jalan Mugas Raya Semarang. Data analysis was performed with the Pearson Chi Square test. The results show that workers experienced high category of work fatigue by 50% and obtained a relationship between fluid consumption ( $p = 0.043$ ), workload ( $p = 0.004$ ), heat pressure ( $p = 0.033$ ) and work fatigue. The conclusion is that the majority of workers who use tire patches on the roadside experience work fatigue, so they need to get health guidance.

**Keywords:** *Fatigue, workload, heat stress*

### 1. Introduction

Work fatigue affects workers' health and it decreases work productivity. Investigations from several countries show that work fatigue contributes 50% to workplace accidents (Tzeletopoulou A. et al, 2019; van Dam A, 2016). Based on data from the International Labor Organization (ILO), 1 worker dies every 15 seconds due to work accidents caused by work fatigue (International Labor Organization, 2013). The data reported by *Badan Penyelenggara Jaminan Sosial Ketenagakerjaan* show that in 2017 there were 123,041 such cases and in 2018 there were such 173,105 cases (Badan Penyelenggara Jaminan Sosial Ketenagakerjaan, 2019).

Work fatigue can cause discomfort which is indicated by a decrease in product quality, decreased speed of performance, increased errors and damage, loss of originality, decreased attention and inaccuracy in carrying out work,

and frequent accidents due to work fatigue (Atiqoh J. et al, 2014). Work fatigue can come from various things such as monotonous works, individual factors --such as years of work and use of clothing while working--, environmental factors --such as heat stress, workers' mental and physical condition--, work intensity, psychological factors, diet, health status, as well as a history of illness. In addition, work fatigue can also be caused by work duration, work capacity and also the temperature of the workplace (Setyowati D. L. et al, 2014).

Another factor of work fatigue is that high ambient temperatures can result in increased body temperature. This will cause the hypothalamus tissue to stimulate the sweat glands so that sweat will come out of the body. The sweat contains various kinds of sodium chloride salt; the release of sodium chloride with sweat will reduce the levels in the body, so that it can inhibit the transportation of glucose as an energy source. This will cause a decrease in muscle contraction (Hall J, 2014). If the water

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that comes out of the body is not replaced with an adequate amount of fluid consumption, the body's cells will lose water. And this water loss is what causes dehydration (Tamsuri, 2009).

Water consumption consists of water that is consumed and obtained from food as a result of metabolism that comes out of the body including urine, water in feces, and water released through the skin and lungs (Sari, 2017). Fluid that is lost through sweat and is not replaced will decrease the plasma volume and also cause a decrease in physical and cognitive abilities of workers (Santoso, 2011). Workload is the length of time for someone to carry out activities according to his work capacity without showing signs of fatigue. If the workload is too heavy, it will affect someone's performance (Hariono W, et al, 2009).

Heat stress is a limitation of the body receiving the heat load from a combination of the body that produces heat while doing work and environmental factors (such as exposure to ambient temperatures, humidity, air movement, and heat transfer radiation), heavy physical loads, insufficient rest periods, and clothing used (Horie S, 2013), (Wulandari K, 2016).

Previous researches have shown that there is a relationship between work fatigue and work productivity in the weaving labor in PT. Alkatex Tegal (Muizzudin A, 2013), and also a relationship between work fatigue and workplace accidents in car repair shop workers in Kendari City (Aswar E, et al, 2016). Research on labor in the Drilling Department of Pertamina EP Jambi has proven that there is a relationship between heat stress and feelings of work fatigue (Fahri S and Pasha E, 2010).

This study aims to determine the relationship between fluid consumption, workload and heat stress in one side and work fatigue on the other side in tire patch workers on the edge of Jalan Mugas Raya Semarang.

## 2. Method

This type of research is observational with cross-sectional approach. This study conducted observations and measurements of the variables at one particular point in time (Murti B, 2010). The samples in this study were 44 patch workers in the Mugas area on Jalan Tri Lomba Juang, Mugassari Subdistrict, Semarang Selatan District and all were made into samples. The study was conducted in August 2019. Independent variables in the study included liquid

consumption, workload, and heat pressure. The dependent variable was work fatigue.

The primary data source was obtained after the tire patch workers agreed to be respondents by signing an informed consent. Primary data sources consisted of results of interviews by filling out questionnaires related to subjective work fatigue from the Industrial Fatigue Research Committee (IFRC) of the Japanese Association of Industrial Health. Other variables were also measured through interviews by filling out questionnaires related to fluid consumption, workload and heat pressure variables measured using a heat stress monitor Extech HT30 WVGT Meter. Data analysis used Pearson Chi Square test.

## 3. Result and Discussion

**Table 1.** Frequency distribution of research variables

Variables	f	%
<b>Work Fatigue</b>		
Very high	10	22,7
High	22	50,0
Medium	8	18,2
Low	4	9,1
<b>Fluid Consumption</b>		
< 2.8 liters	28	63,6
> 2.8 liters	16	36,4
<b>Workload</b>		
> 100 beats /minute	37	84,1
<100 beats /minute	7	15,9
<b>Heat Stress</b>		
> NAB	35	79,5
< NAB	9	20,5

Most of the workers (22 people (50%)) experienced the most fatigue in the high category. Patch workers who consumed < 2.8 liters of fluid were 28 people (63.6%), workloads with a pulse measurement > 100 beats/minute were 37 people (84.1%) and heat stress that exceeded NAB was experienced by 35 people (79.5%) (Table 1).

In fluid consumption < 2.8 liters with high work fatigue category of 15 people (53.6%), there a relationship between fluid consumption with work discharge with a p-value of 0.043 (Table 2). Workers who work with high temperature work environments need to consume body fluids to replace the lost body fluids. Workers in hot work environments or heavy workloads require > 2.8 liters/day of fluid consumption; whereas

workers in jobs with no hot work environment or light workloads need 1.9 liters/day (Perhimpunan Spesialis Kedokteran Okupasi Indonesia, 2014)

**Table 2.** The Relationship Between The Independent Variable and The Dependent Variable

Variables	Work Fatigue								p
	Very High		High		Medium		Low		
	n	%	n	%	n	%	n	%	
<b>Liquid Consumption</b>									
< 2,8 liters	9	32,1	15	53,6	3	10,7	1	3,6	0,043
≥2,8 liters	1	63,1	7	43,8	5	31,3	3	18,8	
<b>Workloads</b>									
≥ 100 beats/minutes	9	24,3	21	56,8	6	16,2	1	2,7	0,004
< 100 beats/minutes	1	14,3	1	14,3	2	28,6	3	42,9	
<b>Heat Stress</b>									
≥NAB	9	25,7	19	54,3	6	17,1	1	2,9	0,033
<NAB	1	11,1	3	33,3	2	22,2	3	33,3	

Fluid consumption can have a positive effect to prevent work fatigue, especially workers in work environments with hot-pressure work conditions (Jamaludin J, et al, 2012). Workers at work are expected to consume as many as 11 small glasses (1 cup = 250 ml) or as much as 2.8 liters per day every 20-30 minutes both when thirsty and not thirsty to prevent dehydration which will result in work fatigue (Sari M.P, 2017). Water is one of the vital elements needed by the body. Consumption of fluids can improve the main function of blood and other bodily functions of fluids. Lack of fluid consumption can cause fatigue. This is because the body experiences mild dehydration which makes the blood thicken and the heart work harder (Perez-Gonzalez A, et al, 2012).

Water has functions in various important processes in the human body, such as regulating body temperature, forming cells and body fluids, as solvents and lubricants and as bearings, and as media elimination of metabolic waste (Hastuti Y.D, et al, 2015). Fluid consumption is needed by the body because water has many functions needed by the body as a medium of transportation, regulating body temperature, forming cells and body fluids and as a solvent. About 80% of individual needs are contributed by liquids including water, and the rest is obtained from food. Each individual's fluid needs is influenced by various factors such as age, sex, activity level, environmental factors, and nutritional status (normal, overweight, obesity). The body normally loses water through the lungs when exhaling, through sweat, urine production and during bowel movements. The loss of fluid must be replaced to keep the condition and function of body fluids undisturbed (Aprillia D.D, et al, 2014).

Research conducted on blacksmith workers shows that there is a relationship between drinking water consumption and subjective complaints of dehydration due to heat stress (Hidayat R.A, 2016). The habit of drinking water that is not done in a period of time often still allows dehydration, even though the amount is sufficient. Physiologically, humans are equipped with a response to enter fluids into the body. The thirst response is a reflex that automatically becomes a command to the body to enter fluids (Indra, et al, 2013).

Workloads > 100 beats/minute category high workload was experienced by 21 people (56.8%). There is a relationship between workload and work fatigue with a p-value of 0.004 (Table 2). Workload is a number of activities that must be completed by a person or group of people over a certain period of time with a certain speed and volume of work and under normal circumstances (Rambulangi C.J, 2016). Workload is divided into 2 namely physical workload and mental workload. Patchwork work tends to have a greater physical workload than mental workload (Maharja R, 2015). Workload is influenced by 2 factors: internal factors (somatic factors and psychological factors) and external factors (organizational tasks, work environment and workplace hazard factors). Workloads that cause physical activity can affect fatigue (Tarwaka, 2010).

Work processes that involve physical activity will increase the pulse along with an increase in workload coupled with a long work duration and monotonous work. They can cause fatigue in the body (Kusgiyanto W, et al, 2017). Physical fatigue occurs due to increased workload resulting in increased oxygen

consumption. The maximum point of oxygen consumption will reduce the supply of oxygen to the muscle resulting in the breakdown of muscle glycogen into energy and lactic acid. Lactic acid will accumulate so that the muscles become swollen and contracted. This is a symptom of fatigue (Maharja R, 2015)

Excessive workload can cause effects such as physical and mental fatigue, irritability, headaches and digestive disorders. The workload that is too little such as lack of movement can cause boredom. Boredom in routine daily work can result in a lack of employee attention to work so that it can reduce employee performance (Wulandari S, et al, 2017). If the workload is too heavy, it will affect its performance.<sup>13</sup> The results of previous studies indicated a relationship between the weight of the load and work fatigue in transport workers (Hariono W, et al, 2009).

The heat pressure exceeds (NAB) category of high work fatigue was experienced by 19 people (54.3%). There is a relationship between heat pressure and work fatigue with a p-value of 0.033 (Table 2). Heat pressure can affect bodily functions such as heart rate and pulse, blood pressure, power of concentration and physical endurance of living things. The higher the heat pressure, the faster the body will experience fatigue (Lestari D.T, et al, 2018).

If the physical environment at work is too hot, it can cause the workforce to get tired quickly due to a lot of fluid and salt loss. When the production of heat in the environment is not balanced with the production of heat released by the body, it will produce uncomfortable working conditions (Margaretha, et al, 2019)

Exposure to high temperatures can cause the hypothalamus to stimulate the sweat glands to sweat as a form of response to the state of the surrounding environment, thereby causing a reduction in fluid in the body which causes thirst, fatigue and dehydration. The skin has many functions which are useful in maintaining body homeostasis. These functions can be divided into functions of protection, absorption, excretion, perception, regulation of body temperature (thermoregulation), and formation of vitamin D. Although the stratum corneum is waterproof, about 400 mL of water can come out by evaporating through the sweat glands every day (Nofianti D.W, et al, 2019).

A person working indoors excretes 200 mL of additional sweat, and active people will excrete more. Apart from releasing water and

heat, sweat is also a means to excrete salt. Hydration status is influenced by the presence of high ambient temperature factors resulting in increased expenditure of fluids through breathing and perspiration which cause the need for increased body fluids and adequate fluid consumption according to the needs (Bates G.P, et al, 2010) (Veronica S, et al, 2010). This is in line with research conducted in the industry on male workers working in the work environment with heat pressure exceeding NAB. As much as 52% of workers are dehydrated (Andayani K and Dieny F.F, 2013). The results of this study are consistent with previous research which proves that there is a significant relationship between heat stress and labor fatigue in the Drilling Section of Pertamina EP Jambi (Fahri S and Pasha E, 2010).

#### 4. Conclusion and Sugestion

Most of the tire patch workers in the Mugas area of Semarang experience work fatigue. This can be caused by fluid consumption, workload and heat stress. In this research, there has not been an analysis of the relationship of other factors originating from individuals and measurements related to hazardous factors in other work environments. The results of this study are expected to be a reference to public health actions in fostering the safety and health of informal sector workers.

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