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The Relationship of Hot Working Climate, Nutritional Status, and Workload with Subjective Fatigue Complaints in Tofu Factory Workers in Jan Hamlet, Bantul Regency

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ABSTRACT (10PT)

Background: Subjective fatigue was a condition of a person's inability to carry out activities. Hot working climate, nutritional status and workload were several factors that cause work fatigue. The tofu industry was one of the household businesses operating in the informal sector. Workers needed high heat to produce tofu and lifting or carrying buckets is done traditionally. If it was supported by a lack of nutritional intake or the presence of workers with obese nutritional status, it can have an impact on work fatigue. The aim of this research was to determine the relationship between hot working climate, nutritional status and workload with complaints of subjective fatigue in tofu factory workers in Become Hamlet, Bantul Regency. **Method:** This research was a quantitative research with cross sectional approach. The research sample included workers in Hamlet, Massachusetts Regency as many as 97 workers. The sampling technique was total sampling. The research instrument was a Subjective Self Rating Test (SSRT) questionnaire, Wet Bulb Temperature Index results form, nutritional status assessment sheet, Wet Bulb Globe Temperature (WBGT), body weight scales and microtoise. Data analysis used the chi-square test and the alternative fisher exact test. **Results:** The results of statistical tests showed that there is no relationship between a hot working climate and complaints of subjective fatigue (p=1,000), there is no relationship between nutritional status and complaints of subjective fatigue (p=0.481), and there is no relationship between workload and complaints of subjective fatigue (p=0.787). **Conclusion:** There is no relationship between hot working climate, nutritional status and workload with subjective work fatigue in tofu factory workers in Become Hamlet, Bantul Regency.

1. Introduction

Work fatigue is a set of various complaints characterized by decreased efficiency and work resilience [1]. Data from BPJS Employment in 2022 shows that cases of work accidents and work-related diseases in Indonesia are still quite high. In 2021, the number of cases of occupational accidents and occupational diseases in Indonesia was 234,370, with 6,552 deaths, an increase of 5.7% compared to 2020 [2]. Data from *National Safety Council (NSC)* In 2017, it is known that work fatigue is a trigger for work accidents which is shown with as many as 2,010 workers in the United States, at least 13% have experienced work accidents due to fatigue [3].

Periodical of Occupational Safety and Health
Vol. 4, No. 1, April 2025, pp. 1-9
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Hot work environments are one of the physical hazards that can cause health problems in the workplace. Fatigue in workers can be affected by the temperature of the hot work environment, so it can make workers easily tired, feel sleepy, think skills weaken, and cause a high number of work mistakes [4]. Another factor that causes work fatigue is nutritional status. A worker with good nutritional status has better work capacity and body endurance. Workers with nutritional status are more or less susceptible to decreased body resistance, so that it can accelerate the onset of fatigue and cause work-related diseases [5].

The workload can also result in burnout. Physical workload is the workload that workers receive from a work activity or work environment conditions [6]. Physical workload can cause work fatigue if the workload received by a person is not in accordance with his or her work capacity. As a result, the energy required increases, so the muscles work longer in coping with the workload they receive [7].

The tofu industry is one of the fields of household business (*home industry*) engaged in the informal sector. The preliminary study was carried out in a location that is the center *of the tofu home industry*, namely in Jan Hamlet, Bantul Regency. It is known that there are several problems: (1) the work of producing tofu is included in the category of work that drains quite a lot of energy, because in making tofu, workers receive a considerable workload and are carried out repeatedly, such as lifting buckets filled with water, soybean pulp, or tofu juice, so that it can cause fatigue, (2) workers are also exposed to heat due to the tofu production process which mostly uses hot temperatures, So that it can affect the metabolism of the worker's body, such as excessive sweating, (3) workers who produce tofu have less weight and there are workers who are overweight or *obese* due to a thick layer of fat, so that it can cause workers to be less agile or slow in completing their work which has an impact on work fatigue.

2. Methods

This type of research is a quantitative-research with a cross-sectional approach. The research was conducted in the *tofu home industry* in Janten Hamlet, Ngestiharjo Village, Kasihan District, Bantul Regency in October 2023 – January 2024. The population in this study was 97 people. The sampling technique used is *total sampling*, namely all workers working in *the home industry* know into a research sample totaling 97 people.

Data collection was carried out through observation, interviews with workers, and temperature to body weight measurements so that the instruments and tools used in this study were the *Subjective Self Rating Test (SSRT) questionnaire*, the Ball and Wet Temperature Index (ISBB) measurement result form, nutritional status assessment sheet, workload assessment sheet, *Wet Bulb Globe Temperature (WBGT),* and weight scales, and *microtoise*. The research data was analyzed using *the chi square test and* the fisher exact *alternative test*. In this research, a research ethics study has been obtained in the form of Ethical Clearance with the number 012310264 issued by the Research Ethics Committee of Ahmad Dahlan University (KEP UAD).

3. Results and Discussion

The following are the results of a study on the relationship of hot working climate, nutritional status, and workload with subjective fatigue complaints in tofu factory workers. The data presentation was carried out systematically based on the results of data collection in the field through questionnaires, as well as the results of observation of respondent characteristics. The data obtained were analyzed to describe the relationship between the variables studied. The purpose of this analysis is to present an overview of the relationship between the research variables.

3.1.1. Univariate Analysis

The results of the univariate analysis are presented in the following tables.

Table 1. Distribution of Heat Work Climate Frequency, Nutritional Status, Workload and Subjective Fatigue Complaints

Category	Frequency (people)	Percentage (%)
Hot Working Climate		
Unsuitable TV	79	81,4
Suitable TV	18	18,6
Total	**97**	**100**

Category	Frequency (people)	Percentage (%)
Nutritional Status		
Underweight	11	11,3
Usual	56	57,7
Fat	30	30,9
Total	**97**	**100**
Workload		
Light	41	42,3
Medium	27	27,8
Heavy	29	29,9
Total	**97**	**100**
Subjective Fatigue Complaints		
Light	72	74,2
Medium	25	25,8
Total	**97**	**100**

(Source: Primary Data, 2024)

Based on Table 1, on the results of the measurement of the hot working climate carried out at 54 measurement points in 34 *tofu home industries* consisting of tofu production, frying, and tofu packaging using *WBGT*, it can be found that most of the workers who work in a hot work environment exceed the Threshold Value (TV), which is as many as 79 people (81.4%), compared to workers who work in a hot work environment that is in accordance with TV. namely 18 people (18.6%). The nutritional status variable of the majority of respondents had normal nutritional status, namely 56 people (57.7%), while respondents with underweight nutritional status were 11 people (11.3%) and 30 people (30.9%) had obese nutritional status. The workload variable can be found to have the most respondents with a light workload, which is 41 people (42.3%) compared to respondents with a medium workload, which is 27 people (27.8%), and a heavy workload of 29 people (29.9%). The variable of subjective fatigue complaints, the majority of respondents experienced mild subjective fatigue complaints, namely 72 people (74.2%) and 25 people (25.8%) experienced severe subjective fatigue complaints.

3.1.2 Bivariate Analysis

Table 2. The Relationship of Hot Working Climate with Subjective Fatigue Complaints in Tofu Factory Workers

Hot Working Climate	Subjective Fatigue Complaints				Total		*P-value*	RP (CI 95%)
	Heavy		Light					
	N	%	N	%	N	%		
Unsuitable TV	21	21,6	58	59,8	79	81,4	1,000	1,267 (0,375-4,284)
Suitable TV	4	4,6	14	14,4	18	18,6		
Total	25	25,8	72	74,2	97	100		

(Source: Primary Data, 2024)

Based on the results of *the fisher exact statistical test*, it was obtained that the research data did not meet the requirements *of the chi-square* test because it had a 2x2 table and there was 1 cell assessing *expected* <5, so it was continued by using the *fisher exact alternative test*. The results of the analysis using *the fisher exact* test obtained a *p-value* = 1,000 (p>0.05), which means that Ho was accepted or not there was a relationship between the hot work climate and subjective fatigue complaints in tofu factory workers in Janten Hamlet, Bantul Regency. The *Prevalence Ratio (RP)* value was obtained at 1.267 (*RP>1), which means that the hot working climate is a risk factor with the Convindence Interval* (*CI* 95%) being in the range of 0.375 – 4.284 (past 1), which means that the relationship between the two variables is unrelated or unrelated.

Periodical of Occupational Safety and Health
Vol. 4, No. 1, April 2025, pp. 1-9
e-ISSN: 2962-584X

Table 3. The Relationship of Nutritional Status with Subjective Fatigue Complaints in Tofu Factory Workers

Nutritional Status	Subjective Fatigue Complaints				Total		*P-value*
	Heavy		Light				
	N	%	N	%	N	%	
Fat	10	10,3	20	20,6	30	30,9	0,481
Usual	12	12,4	44	45,4	56	57,7	
Underweight	3	3,1	8	8,2	11	11,3	
Total	25	25,8	72	74,2	97	100	

(Source: Primary Data, 2024)

Based on Table 3, the test results using *Pearson Chi-Square* obtained a *p-value* = 0.481 (p>0.05) which means that Ho is accepted, so it can be interpreted that there is no relationship between nutritional status and subjective fatigue complaints in tofu factory workers.

Table 4. The Relationship of Workload to Subjective Fatigue Complaints in Tofu Factory Workers

Workload	Subjective Fatigue Complaints				Total		*P-value*
	Heavy		Light				
	N	%	N	%	N	%	
Heavy	7	7,2	22	22,7	29	29,9	0,787
Medium	6	6,2	21	21,6	27	27,8	
Light	12	12,4	29	29,9	41	42,3	
Total	25	25,8	72	74,2	97	100	

(Source: Primary Data, 2024)

Based on Table 4, the *Pearson Chi-Square test* was used to obtain *a p-value* = 0.787 (p>0.05) which means that there is no relationship between workload and fatigue complaints in tofu factory workers.

3.1. Discussion

Hot work climate is a mixture or combination of air temperature, air humidity, air movement speed, and radiant heat [8]. Measurement of hot working climate in this study was carried out using a *WBGT*, so that two categories were obtained, namely hot working climates that did not comply with TV (>28°C light workload, >31°C moderate workload) and hot working climates in accordance with TV (<28°C for light workloads, <31°C for medium workloads). The measurement is carried out while the respondent is doing his work, by placing the measuring instrument at the measurement point according to the predetermined time, namely reading the measurement results every 5 minutes for 30 minutes. The results of the univariate analysis showed that the majority of workers experienced a hot work climate exceeding TV by 79 people (81.4%).

The nutritional status of workers in this study was carried out by calculating the Body Mass Index (BMI) of workers through the measurement of weight and height. Based on the results of the univariate analysis, it was shown that the frequency of respondents had the most normal nutritional status, which was 56 people with a percentage of 57.7%. Workload is a worker's ability to perform a work activity. In this study, workload data was obtained through measuring the weight of workers, then direct observations were made related to work activities. The measurement of workload refers to the Indonesian National Standard (SNI) 7269 of 2009 where all data obtained will be calculated as basal metabolic values and average workload. The results of the univariate analysis can be found that the distribution of workload frequency in the respondents experienced the most-light workload, namely 41 people (42.3%).

3.2.1. The Relationship of Hot Working Climate with Subjective Fatigue Complaints in Tofu Factory Workers

Hot work climate is a combination of temperature, humidity, air movement speed, and radiant heat from a work environment. The results of the measurement of hot working climate in this study obtained an ISBB value for light workload of 28°C and a medium workload of 31°C. From the results of bivariate analysis using the *fisher exact alternative test, a* p-value = 1,000 (p > 0.05) was obtained, which means that there is no relationship between hot work climate and subjective fatigue complaints.

The results of this study are in line with a study conducted on production workers in palm oil processing mills which showed the results of statistical test analysis using the *Chi-Square* A p-value = 0.103 (p>0.05) was obtained, which means that there is no relationship between heat pressure and work fatigue. This is due to the fact that the ISBB value received by workers does not exceed TV and there are only 2 work parts that have an ISBB value above TV [9]. Another research that is in line is a study conducted on workers in the fabrication warehouse of PT Bangun Sarana Baja which shows that there is no relationship between hot work climate and work fatigue, from the results of a statistical test using the spearman test, a value was obtained *p-value* = 0.192 (p>0.05). This is because workers in the fabrication area have used appropriate PPE as a company requirement to minimize heat exposure such as using gloves, helmets, goggles, and welding aprons [10].

There is no relationship between the hot working climate and subjective fatigue complaints because factory workers are used to working in a hot environment, so they do not feel the difference between working at normal or abnormal temperatures. Acclimatization is a condition in which a person can adapt to hot temperatures. Acclimatization in the workplace can make a person work safer and more efficiently, but it takes time for the body to adapt [8]. In general, Indonesians can acclimatize to a tropical climate with a temperature of around 29-30°C with a humidity of around 85-95%. Acclimatization adjustment of a hot work climate can be interpreted as an adjustment process that occurs in a person within the first week at a work site with hot temperatures, so that they become accustomed to the hot work climate and are able to work without the influence of heat pressure. Acclimatization to hot temperatures is characterized by a decrease in the frequency of pulse and body temperature resulting from the formation of sweat. The duration of acclimatization to hot temperatures is achieved after two weeks of work in a hot working climate [11].

As a result of interviews in the field, the average tofu factory worker has been working in producing tofu for a long time, with the longest working period of about 16 years and the shortest of about 2 years. The condition of workers who have adapted to the hot climate in the workplace provides an advantage because workers can work well even in a hot work environment. The results of observations in the field show that not all workers are exposed to heat sources in the workplace. The majority of frying workers are exposed to heat sources because their work sites are always close to a heat source compared to workers who do tofu production, tofu cutting, and packaging. This also makes a difference in the level of fatigue complaints experienced by workers. In addition, the workload received by workers in producing tofu is also different, so the risk of workers' subjective fatigue complaints is also different.

Rest time can also affect the level of subjective fatigue complaints in workers. Based on the results of observations in the field, it can be seen that the majority of tofu factory workers only have a break after the tofu production activities carried out have been completed. Some tofu factories have provided a special rest area for workers and in general, the rest time is used for lunch, drinking water, or just chatting with other workers.

The habit of consuming drinking water of tofu factory workers can also be one of the factors that affect workers who only experience complaints of low subjective fatigue. Based on the results of observations, it can be seen that several tofu factories have provided drinking water in the form of water, ice water, and tea water, for the consumption of their workers. To maintain fluid balance, a worker working in a hot work climate should drink at least 200-300 cc of fluid every 30 minutes as often as possible. Although there is no such standard, the most important thing is that workers who work in hot climates should drink water as often as possible [12].

The results of this study are not in line with the research conducted on areca nut farmers. From the results of the statistical test, the *p-value* = 0.001 (p<0.05) which means that there is a relationship between hot work climate and work fatigue in areca nut farmers. This is because every day workers work in a hot environment and the majority do not wear hats or long clothes to avoid direct sun exposure, so it can trigger decreased body energy and fatigue [13].

Periodical of Occupational Safety and Health
Vol. 4, No. 1, April 2025, pp. 1-9
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A worker who is exposed to hot temperatures that exceed TV or works in excessively high heat work climates over a long period of time may cause the occurrence of hot air temperature related disorders or diseases (*heat related disease*) from mild to fatal symptoms, such as being dehydrated or losing a lot of fluids, *Heat Rash*, *Heat cramp*, *Heat syncope*, until experiencing Heat Stroke [13]. From a health perspective, preventive efforts are needed to overcome fatigue complaints in tofu factory workers due to exposure to a hot work climate, including health education related to the dangers of heat that causes work-related diseases and the importance of consuming at least 8 glasses/day drinking water. Recommendations for control efforts that can be carried out such as making sufficient ventilation in the tofu production area, providing a rest area equipped with a fan, implementing rotation, and providing sufficient rest time.

3.2.2. The Relationship of Nutritional Status with Subjective Fatigue Complaints in Tofu Factory Workers

The nutritional status in this study describes the health condition of the worker based on the proportion or body size of the tofu factory worker. The results of this study show that tofu factory workers have the most normal nutritional status and experience mild subjective fatigue complaints, which is 44 people with a percentage of 45.4%. Based on the results of bivariate analysis using *the chi-square* test, a p-value = 0.481 with p>0.05 was obtained, which means that Ho is accepted. It can be interpreted that there is no relationship between nutritional status and subjective fatigue complaints in tofu factory workers.

The results of bivariate analysis using the test *Chi Square* Score *p-value* = 0.481 (p>0.05), which means that there is no relationship between nutritional status and subjective fatigue complaints in tofu factory workers. The results of this study are in line with research conducted on employees at PT FKS Multi Agro Tbk Makassar which stated that the results of the statistical test were obtained *p-value* It was 0.131 (p>0.05), which means there was no association between nutritional status and work fatigue. This happens because most employees have paid attention to food consumption on a regular basis [14].

The absence of a relationship between nutritional status and subjective fatigue complaints can occur because most tofu factory workers have a normal category nutritional status. Thus, the majority of workers will experience a mild level of subjective fatigue complaints. This is in accordance with the theory that explains that the existence of a normal nutritional status in workers will show that the majority of workers experience a mild level of fatigue due to the fulfillment of the worker's nutritional intake, thus helping the worker's body to be more enthusiastic and stamina in work, even though the workers have done a lot of work, they will have only mild work fatigue [15].

Most factory workers know to work in hot environments and use physical abilities to do their jobs, so food intake is required that is proportional to the number of calories expended. As a result of observations in the field, there are several tofu factories that have provided food and beverage consumption to their workers. The worker is also given a lunch break to consume the food that has been provided or if the factory knows that it does not provide food, the worker will be given a break to go home that can be used to consume food. Workers with good nutritional status supported by good nutritional intake in the right amount and time, will have a positive effect on worker capacity. If workers have nutritional intake that does not meet their needs, then the worker will feel fatigue faster compared to workers who have a balanced nutritional intake [16].

The work activities of tofu factory workers require muscle strength, so they require food intake that matches the calories expended. Tofu production activities that use a lot of workers' muscle strength are part of tofu production, starting from boiling soybean porridge, filtering, giving vinegar water, to printing. In tofu cutting and packaging work activities, tofu only requires both muscles of the worker's hands. Based on this, the majority of tofu production workers show that they have a normal nutritional status compared to workers in cutting, frying, and packaging tofu who have an overweight nutritional status (*Overweight*) and obesity. The more activities that are done, the more fat is burned, which produces energy and will make the body healthier and fitter. On the other hand, a lack of movement activity will cause a person to be obese and become very difficult to perform an activity [17].

This study is not in line with the results of a study conducted on workers in the chip industry production division, which states that from the results of data analysis using *the chi square* test, a p-

value *of 0.004 (p<0.05) was obtained*, which means that there is a significant relationship between nutritional status (BMI) and work fatigue. Based on the health side, there are several preventive efforts that can be made to overcome complaints of fatigue due to nutritional status, including regulating a healthy diet for workers and on time.

3.2.3. The Relationship of Workload to Complaints of Subjective Fatigue in Tofu Factory Workers

Workload is a work activity accepted by workers. Based on the results of bivariate analysis, it can be seen that workers with light workloads experience more complaints of low subjective fatigue, namely 29 people (29.9%) and experience complaints of moderate subjective fatigue as many as 12 people (12.4%). Workers with heavy workloads who experienced complaints of low subjective fatigue were 22 people (22.7%) and 7 people (7.2%) experienced complaints of moderate subjective fatigue. The results of the statistical test in this study using the *Chi Square* Score *p-value* = 0.787 (p>0.05), meaning there is no association between workload and subjective fatigue complaints. The results of this study are in line with previous research which is based on the results of statistical tests *Chi-Square* Score *p-value* 0.099 (p>0.05), which means there is no association between workload and employee burnout. This is because the workload that employees receive varies depending on the part of the job [14].

There is no relationship between workload and subjective fatigue complaints in tofu factory workers because each worker receives a different workload and is used or skilled in producing tofu. The results of observations in the field show that some tofu factories have a division of work tasks for each worker and some tofu factories receive large quantities of tofu orders, so that they must achieve the predetermined target and make tofu workers become accustomed or able to adapt in producing tofu. Meanwhile, workers can produce tofu 10-20 times in a day, producing up to 64 tofu molds. Each human work has a different level of burden. Too high a load level allows excessive energy consumption, so that it becomes *'Overstressed'* and conversely, too low the intensity of loading allows for boredom and saturation or 'Understressed' [18].

In addition, a factor that can affect the workload is a person's work skills. If a person's work skills are getting higher, it can reduce work fatigue for that person. Conversely, if a person has low job skills it can cause work fatigue to increase. This is in line with the results of the study which shows that most tofu workers have high skills in producing tofu, so that tofu workers only experience mild subjective fatigue complaints compared to severe subjective fatigue complaints [19].

The high skill of tofu workers can be seen from the length of service or the length of a person in doing his work. A person's work can be influenced by the working period, that is, the longer a person works, the more experienced and able to adapt to their work and environment. Regarding these conditions, worker tension will decrease and vice versa worker performance will increase. Increased work skills can support the body to be more efficient in doing work to reduce workload and fatigue [20].

The results of interviews in the field, it is known that the tofu workers have a long working period, namely most of the workers who have worked for more than 3 years. The skill of the worker is also proven from the tofu cutting process using a ruler and a knife which is done quickly, but according to the size of the tofu ordered. In fact, there are some workers who rely on tofu mold containers for cutting, so there is no need to use a ruler. The tofu frying process also requires skills, such as determining the ripeness point in different types of tofu such as *muggle tofu* or pong tofu, as well as being skilled in regulating a frying fire that uses wood fuel, so that it does not die or not grow and cause the tofu in the frying pan to burn.

This research is not in line with the research conducted on production workers in palm oil processing mills which stated that the results of statistical analysis obtained a value *p-value* by 0.001 (p>0.05), which means that there is a significant relationship between workload and work fatigue. This is because the workers are still processing oil palm manually in the *Loading ramp* and *Chainman* by using labor when pushing or pulling [9].

Different work activities have different job demands and it is possible that workers who produce tofu experience a light workload because they only help the main worker or who acts as a 'driving force', so that even though they are in the same part of tofu production, the work activities and workload received can be different, and the fatigue complaints experienced are also different. Task demand

Periodical of Occupational Safety and Health
Vol. 4, No. 1, April 2025, pp. 1-9
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factors *(task requests)* is one of the factors in determining workload. Therefore, the workload can be determined from the analysis of the tasks performed by the worker and the differences of each individual must always be taken into account [18].

Another factor that causes fatigue is the age factor, the older a person gets, causing a decrease in the function of the body's organs so that they will feel tired quickly. Some workers who belong to the elderly group (46 – 65 years old) still produce tofu or help in the tofu cutting process, so they can experience complaints of fatigue faster, along with reduced muscle strength and muscle mass. Gender factors also affect fatigue even though the workload received by female workers is light. This is because women's jobs tend to be more boring and more prone to fatigue. Women can experience fatigue faster because they have a lower volume of oxygen (VO2) than men. This condition can also cause the body fat percentage in women to tend to be higher and have lower blood hemoglobin levels than men [18].

On the respondent's identity sheet, it can also be seen that there are several respondents who have a history of illness, such as vertigo (low blood pressure), back injury, leg hinge injury, ulcers, hypertension, cholesterol, and kidney stones, so that a worker can experience complaints of fatigue even though the workload received is light, because it is affected by poor health conditions. To overcome complaints of fatigue due to workload, recommendations can be made for control efforts, such as paying more attention to the body's ability to do work, paying attention to the position of the body in lifting or carrying buckets so that injuries do not occur, paying more attention to regular working hours, taking advantage of the rest time given, and paying attention to the nutritional intake needed by the body so that food intake with calorie burning in the body is appropriate

4. Conclusion

Based on the results of the research that has been carried out, it can be concluded that there is no relationship between hot work climate, nutritional status, and workload with subjective fatigue complaints in tofu factory workers in Jan Hamlet, Bantul Regency. Based on the results of the study, suggestions can be made to tofu factory owners to be able to provide fans or add more adequate ventilation to minimize heat temperatures in the workplace, provide nutritious food, and redesign the workplace with the aim of a more organized workplace. Tofu factory workers can also take several preventive and control measures, including consuming more drinking water, maintaining a healthy lifestyle, and making the best use of the rest time provided.

Statement

Conflicts of Interest: "The authors declare no conflict of interest."

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