

# Factors Associated with Heat Strains in Workers at the PT Multikarya Asia Pasifik Raya Workshop in 2019

Erdiana Yuniarti and Putri Handayani

*Department of Public Health, Faculty of Health Sciences University of Esa Unggul,  
Jl. Arjuna Utara, Kebon Jeruk, Jakarta, Indonesia*

**Keywords:** Heat Strain, Heat Pressure, Age, Obesity, Chronic Disease.

**Abstract:** Heat Strain is an acute or chronic impact caused by exposure to heat stress experienced by a person from both physical and mental aspects. Preliminary studies conducted on 20 workers using the HSSI (Heat Strain Score Index) method found that 11 people (55%) did not experience heat strains and 9 people (45%) experienced heat strains. The physical effects of heat strains range from minor complaints such as skin rashes to fainting to life-threatening situations when there is a cessation of sweat and heatstroke. This research was conducted with quantitative research methods with a cross-sectional study design using primary data on 59 workers. Research variables were analyzed using the chi-square test. The results of the bivariate analysis found a relationship between heat stress, age, and hydration status with heat strain. While the variables of obesity and chronic disease have no relationship with heat strain.

## 1 PRELIMINARY

The heat is a work environment factor that is very closely related to the health of workers. Various cases of accidents and diseases caused by work, as well as other health problems are often caused by work environment factors that do not meet the requirements, in addition, there are several other factors (Budiono, 2003). During activities in the hot environment, the body will automatically react to maintain a constant range of environmental heat by balancing the heat received from outside the body with heat loss from the body (Tarwaka, 2014).

Heat strain is an acute or chronic impact caused by exposure to heat stress experienced by a person from both physical and mental aspects. The physical effects of heat strains can range from minor complaints such as skin rashes to fainting to life-threatening situations when there is a cessation of sweat and heat stroke (OSHS, 2017). Workers who experience heat strain will reduce performance which will also impact on company productivity.

In 2016 in America, the total incidence of heat strain with a loss of working days of at least one day was estimated at 1,432 cases. According to case data due to illness due to heat exposure based on work per 100,000 workers are in the plantation area (8.13

cases), construction (6.36 cases), mining (5.01 cases), and other work (1.3 cases) (NIOSH, 2016). In Indonesia, based on the results of a study conducted by Adiningsih (2013), the results showed that workers who were in a work environment with a temperature exceeding NAV experienced complaints of heat strains such as extreme fatigue of 54.6%, dizziness 33.3% and stiffness/muscle cramps 12.1%. There are differences in body temperature, pulse, blood pressure systole and diastole between before work and after work with heat exposure, this is closely related to heat strain (Adiningsih, 2013).

NIOSH (2016) states that environmental factors affecting heat strain are heat pressure. In addition, several individual characteristic factors that can also influence heat strains are age, sex, and obesity. Other individual characteristic factors that can influence heat strains are chronic diseases such as heart disease, diabetes mellitus, and hypertension. Hydration status is also one of the main factor characteristics of individuals who play a role in the cardiovascular system of the human body (ACGIH, 2007). Apart from that, other individual characteristic factors that can influence heat strains are chronic diseases, such as heart disease, diabetes mellitus, and hypertension (Kenny et al, 2010).

PT Multikarya Asia Pasifik Raya (MKAPR) established in May 2002 is a company that provides

products and services for the oil and gas industry in Indonesia and the regions around Asia and Australia. Focusing on many lines of business rental services, repairs/recertifications, general trading and guaranteed availability of spare parts for contract outgoing call orders. In the fabrication process at the Lodan-9 PT MKAPR workshop using machines and work processes which produce heat.

Based on the results of a preliminary study conducted on 20 workers in several workshop locations (namely fabrication area, pump area, engine area, function test area, radiator transmission area, and asset area) using the HSSI (Heat Strain Score Index) method it was found that 11 people (55%) are in the green zone or do not experience heat strains and 9 people (45%) have heat strains with categories in the yellow zone category. Based on interviews with several workers, there were many workers who complained such as feeling very thirsty, sweating, fatigue, muscle aches, and even once there was a worker who was very weak and engaged to stop his work.

Based on this, researchers are interested in conducting research on "Factors related to heat strains in workers at a workshop at PT Multikarya Asia Pasifik Raya in 2019".

## 2 METHOD

This type of research is quantitative research, research using bivariate analysis because researchers want to see whether there is a relationship between heat stress, age, obesity, chronic disease, and hydration status with heat strain in workers at a workshop at PT Multikarya Asia Pacific Raya in 2019.

The design of this study was cross-sectional and there was no division between the two groups to be studied. Cross-sectional research is a type of research that emphasizes the measurement time or observation of independent and dependent variable data only once at the time of the study. In this type of dependent and independent variables are assessed simultaneously at one time, then there is no follow-up.

Sources of information in this study were obtained from primary data which included observations, examinations, or observations by questionnaire by interview and direct examination.

The population in this study were workers who worked in workshops at PT Multikarya Asia Pacific Raya, amounting to 74 people. The sample used was using the Prevalence Ratio (PR) formula of 59

respondents using a simple random sampling technique.

The research instrument used in this study was a questionnaire or list of statements in the form of a Heat Strain Score Index which consisted of 18 closed questions and filled in by selecting the specified option, heat pressure assessment using a measuring instrument in the form of a Questtemp Heat Stress Monitor, and several closed questions with choose the question option on the age, obesity, chronic illness, and hydration status variables. The data collection method used by researchers in data collection is by distributing questionnaires to workers and by measuring environmental heat pressures to analyze factors related to heat strains in workers at a workshop at PT Multikarya Asia Pacific Raya in 2019. Data analysis was carried out to obtain factors related to heat strain in workers at the workshop at PT Multikarya Asia Pasifik Raya consisted of Univariate and Bivariate analysis.

## 3 RESULT

### 3.1 Univariate Analysis

#### 3.1.1 Overview of Heat Strains for Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion was found in workers who did not experience heat strain, namely as many as 33 people (55.9%) and the lowest proportion was found in workers who experienced heat strain, namely as many as 26 people (44.1%).

Table 1: Overview of Heat Strains in Workers.

Heat Strain	Frequency	Percentage
Heat strain ( $\geq 13,5$ )	26	44,1%
No heat strains ( $< 13,5$ )	33	55,9%
Total	59	100%

#### 3.1.2 Overview of Heat Pressure on Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion is found in workers who work in areas that do not have heat stress, namely as many as 39 people (66.1%) and the lowest proportion is in workers who work in areas of heat pressure that is as many as 20 people (33.9%).

Table 2: Overview of Heat Pressure on Workers.

Heat Pressure	Frequency	Percentage
Yes (> 27,5)	20	33,9%
No (≤ 27,5)	39	66,1%
Total	59	100%

### 3.1.3 Age at Work in the PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion is in safe workers (aged <40 years), there are 40 people (67.8%) and the lowest proportion is in workers who are at risk (age ≥ 40 years), there are 19 people (32.2%).

Table 3: Age Descriptions for Workers.

Age	Frequency	Percentage
Risk (≥ 40 years old)	19	32,2%
Safe (< 40 years old)	40	67,8%
Total	59	100%

### 3.1.4 Overview of Obesity to Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion is found in workers who are not Obese (BMI calculation <25), there are 40 people (67.8%) and the lowest proportion is in Obesity workers (BMI calculation ≥ 25), there are 19 people (32.2%).

Table 4: Overview of Obesity in Workers.

Obesity Status	Frequency	Percentage
Obesity (≥ 25)	19	32,2%
Not obese (< 25)	40	67,8%
Total	59	100%

### 3.1.5 Overview of Chronic Disease in Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion is found in workers with no chronic disease, which is as many as 53 people (89.8%) and the lowest proportion is in workers who have a chronic disease, there are as many as 6 people (10.2%).

Table 5: Overview of Chronic Disease in Workers.

Chronic Illness	Frequency	Percentage
There are chronic diseases	6	10,2%
There are no chronic diseases	53	89,8%
Total	59	100%

### 3.1.6 Overview of Hydration Status of Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

The highest proportion is found in hydrated workers, which is 37 people (62.7%) and the lowest proportion is in dehydrated workers, there are 22 people (37.3%).

Table 6: Overview of Hydration Status in Workers.

Hydration Status	Frequency	Percentage
Dehydration	22	37,3%
Hydration	37	62,7%
Total	59	100%

## 3.2 Bivariate Analysis Results

### 3.2.1 Relationship between Heat Pressure and Heat Strain for Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019

Workers who experienced the highest proportion of heat strain were workers who worked in the heat stress area as many as 18 people (90.0%) and the lowest proportion were workers who worked not in the heat pressure area as many as 8 people (20.5%), among workers those who did not experience the highest heat strain proportion were workers who worked in areas that did not work in the heat stress area as many as 31 people (79.5%) and the lowest proportion were workers who worked in the area of heat pressure which was as many as 2 people (10.0 %). Based on the chi-square test results obtained the value of P = 0,000 (P-value <0.05), which means that Ho is rejected, statistically showing a relationship between heat stress and heat strain in workers at the PT Multikarya Asia Pacific Raya workshop in 2019.

Table 7: Relationship Between Heat Pressure and Heat Strain in Workers.

Heat Pressure	Heat Strain				Total		P-value
	Heat Strain		No Heat Strain		N	%	
	N	%	N	%			
Yes (>27,5)	18	90,0	2	10,0	20	100	0,000
No (≤27,5)	8	20,5	31	79,5	39	100	

### 3.2.2 Relationship between Age and Heat Strain for Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

Workers who experience heat strain equal proportions between workers who are safe / have no risk (aged <40 years) and workers who are at risk (≥ 40 years) as many as 13 people (32.5% in the safe age group, and 68.4% in age group at risk) but for workers who do not experience heat strain the highest proportion is found in workers who are safe / have no risk (aged <40 years) as many as 27 people (67.5%) and the lowest proportion is in workers who are at risk as many as 6 people (31.6%). Based on the chi-square test results obtained P-value = 0.021 (P-value <0.05), which means that Ho is rejected, which shows the relationship between age and heat strain in workers at the PT Multikarya Asia Pacific Raya Workshop in 2019.

Table 8: Relationship Between Age and Heat Strain in Workers.

Age	Heat Strain				Total		P-value
	Heat Strain		No Heat Strain				
	N	%	N	%	N	%	
Risk (≥40 Tahun)	13	68,4	6	31,6	19	100	0,021
Safe (<40 Tahun)	13	32,5	27	67,5	40	100	

### 3.2.3 The Relationship between Obesity and Heat Strain for Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

Workers who experienced the highest heat strain proportion were workers who were not obese (BMI calculation results showed <25) as many as 17 people (42.5%) and the lowest proportion was in obese workers (BMI calculation results showed ≥ 25) as many as 9 people (47, 4%), the highest proportion of workers who did not experience heat strain were non-obese workers (BMI calculation results showed <25) as many as 23 people (57.5%) and the lowest proportion was in obese workers (BMI calculation results showed ≥ 25) as many as 10 people (52.6%). Based on the chi-square test results obtained a value of P = 0.943 (Pvalue> 0.05), which means that Ho is accepted which shows no significant relationship between obesity and heat strain in the Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019.

Table 9: Relationship Between Obesity and Heat Strain for Workers.

Obesity Status	Heat Strain				Total		P-value
	Heat Strain		No Heat Strain				
	N	%	N	%	N	%	
Obesity (≥25)	9	47,4	10	52,6	19	100	0,943
No (<25)	17	42,5	23	47,5	49	100	

### 3.2.4 Relationship between Chronic Disease and Heat Strain in Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

Workers who experienced the highest proportion of heat strains were 22 workers (41.5%) and the lowest proportion were workers who had chronic illness as many as 4 people (66.7%), those without heat strain the highest proportion is workers who have no chronic disease as many as 31 people (58.5%) and the lowest proportion is workers who have chronic illness as many as 2 people (33.3%). Based on the chi-square test results obtained a value of P = 0.390 (Pvalue> 0.05), which means that Ho is accepted which shows no significant relationship between chronic disease and heat strain in Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019.

Table 10: The Relationship Between Chronic Disease and Heat Strain in Workers.

Obesity Status	Heat Strain				Total		P-value
	Heat Strain		No Heat Strain				
	N	%	N	%	N	%	
There are chronic diseases	4	66,7	2	33,3	6	100	0,390
There is no chronic disease	22	41,5	31	58,5	53	100	

### 3.2.5 Relationship between Hydration Status and Heat Strain for Workers at PT Multikarya Asia Pacific Raya Workshop in 2019

Workers who experienced the highest proportion of heat strain were dehydrated workers as many as 16 people (72.7%) and the lowest proportion were workers who were hydrated as many as 10 people (27.0%), among those workers who did not experience the highest proportion of heat strain that

was hydrated workers 27 people (73.0%) and the lowest proportion were dehydrated workers as many as 6 people (27.3%). Based on the chi-square test results obtained P-value = 0.002 (P-value <0.05), which means that Ho is rejected which shows the relationship between hydration status and heat strain on the Workers at the PT Multikarya Asia Pacific Raya Workshop in 2019.

Table 11: Relationship between Hydration Status and Heat Strain in Workers.

Hydration Status	Heat Strain				Total		P-value
	Heat Strain		No Heat Strain				
	N	%	N	%	N	%	
Dehydration	16	72,7	6	27,3	22	100	0,002
Hydration	10	27,0	27	73,0	37	100	

## 4 DISCUSSION

### 4.1 Univariate Analysis

The description of heat strain on workers that have been carried out on 59 workers in the PT Multikarya Asia Pacific Raya Workshop in 2019, the proportion of workers who did not experience heat strain was greater than 44.1% of the proportion of workers who experienced heat strain which was 55.9%. This is in line with research conducted by Fadhilah (2014) which shows that the proportion of workers who do not experience heat strains is greater than the proportion of workers who experience heat strains. The proportion of workers who do not experience heat strain is greater than workers who do not experience heat strain, this is because the company has endeavored that workers are not exposed to extreme heat from direct exposure to sunlight by installing a roof especially in work areas that have heat pressure so that workers do not expose to heat from direct solar radiation. There are workers who experience heat strains, this is because workers are at high ambient heat temperatures, in addition, there are tools and production machines that continuously ignite and produce heat to the ambient temperature. Conditions when conducting research at the Lodan-9 workshop in 6 work areas have been given a roof to prevent direct exposure to the sun's heat, the pump and engine area have been given general ventilation to regulate the ambient temperature so that there is no heat strain on workers.

The description of heat pressure that has been carried out environmental measurements of 59 workers in the PT Multikarya Asia Pacific Raya

Workshop in 2019, the proportion of workers who work in areas that do not have heat stress is greater that is 66.1% of the proportion of workers who work in areas that have pressure heat that is equal to 33.9%. This is in line with research conducted by Septiani (2017) and Fauzi (2013) which shows that the proportion of workers who work in areas that do not have heat stress is greater than the proportion of workers who work in areas that have heat stress. The high heat pressure can be influenced by several factors such as the presence of production machines and working equipment and high air temperatures of 27,950C in the fabrication area. New workers who are employed at the Lodan-9 workshop on the first day of work are immediately given a workload with a high enough heat working environment. This is done by the company considering the qualifications imposed by the company are experienced workers in their fields so that they are considered capable of working directly at high-risk locations. However, with the new work environment and possible heat pressures that are different from previous work on new workers.

Description of Ages who have done research on 59 workers in the PT Multikarya Asia Pacific Raya Workshop in 2019, the proportion of workers who have no risk age / <40 years is greater that is 67.8% of workers who have at-risk age / > 40 years which is equal to 32.2%. This is in line with research conducted by Septiani (2017) which shows that the proportion of workers who are at risk is greater than workers who are at risk of age. The proportion of workers whose age is not at greater risk is due to the qualifications carried out by the company determined by the management where the management places a productive age for work in the workshop because it is considered as heavy work so that there are many new workers employed by PT Multikarya Asia Pacific Raya.

The description of obesity that has been conducted by research on 59 workers in the PT Multikarya Asia Pacific Raya Workshop in 2019, the proportion of non-obese workers is higher at 67.8% of obese workers at 32.2%. This is in line with research conducted by Fadhilah (2014), Septiani (2017) in related industries, and Tumbol (2018) in the construction field which shows that the proportion of non-obese workers is higher than obese workers. The proportion of workers who are obese is smaller than the proportion of workers who are not obese can be caused by a variety of factors, including the high physical activity of workers such as mobilization activities by walking, sometimes accompanied by lifting weights, and so forth. These

activities can reduce body fat mass and increase body muscle mass through burning calories.

The description of chronic diseases that have been carried out on 59 workers in the PT Multikarya Asia Pacific Raya Workshop in 2019, the proportion of workers who did not have chronic illnesses was higher at 89.8% of workers who had a chronic illness at 10.2%. This shows the similarity between research conducted by Tumbol (2018) and Septiani (2017) which shows that the proportion of workers who do not have a chronic illness is higher than workers who have a chronic disease. The high number of workers who do not have chronic illnesses can be caused by information bias at the time of the interview, this is because the retrieval of research can be done in this variable only through questionnaires and no physical examination by medical personnel.

Description of hydration status that has been carried out on 59 workers in the PT Multikarya Asia Pacific Raya Workshop in 2019, the proportion of workers who are hydrated is higher at 62.7% of workers who are dehydrated at 37.3%. This shows the similarity between research conducted by Septiani (2017) which shows that the proportion of workers who are hydrated is higher than workers who are dehydrated. The proportion of workers who experience hydration is higher than workers who are dehydrated. This is because the company has provided drinking water for all workers, namely in the second-floor office area. Based on this study, there are still workers who are dehydrated. That is because there are some workers who work in hot pressure environments.

## 4.2 Bivariate Analysis

The relationship between heat stress and heat strain, based on the results of the study the results of statistical tests indicate that there is a relationship between heat stress and heat strain. Based on the results of research conducted, workers in the heat stress area experienced the most heat strain, this is because workers who are in the heat pressure area are jobs related to several production machines such as cutting tools, welding machines, and other fabrication machines apart from that mobilization of workers can also increase core body temperature so there is a potential for heat strain. The condition when conducting research in the PT Multikarya workshop did not have a rest area with cooler room conditions.

The relationship between age and heat strain, based on statistical test results showed that there was a significant relationship between age and heat strain

in workers. This is in line with research conducted by Septiani (2017) and Tumbol (2018) which shows there is a relationship between age and the incidence of heat strain. Workers who have age over 40 years experience the most heat strain (68.4%), this is because workers with age at risk of having the ability to pump blood by the heart tend to be worse so that the body's ability to channel heat from the body to the surface of the skin also becomes hampered and the group of workers with age at risk will increase the indication of the occurrence of heat strains. The current state of research at PT Multikarya Asia Pacific Raya's workshops still employed several workers of high-risk age in areas of high heat stress because the workers had a good experience in their fields.

The relationship between obesity and heart strain, based on the results of the study, the results of statistical tests showed that there was no significant relationship between obesity and heart strain. This is in line with research conducted by Tumbol (2018) which shows no significant relationship between obesity and heat strains in workers. the proportion of obese workers is more likely not to have heat strains. and there is no difference between obesity and heat strain, this is because in the obese group and most in the non-obese group have the workload that tends to be the same so there is no difference in the heat strain in the obese group and the non- obese group so that no difference is found. The situation at the time of doing research in the workshop of PT Multikarya Asia Pacific Raya had not yet implemented a nutrition program both food catering and canteen for workers.

The relationship between chronic diseases and heat strains, based on the results of the study showed that there was no significant relationship between chronic diseases and heat strains in workers. This is in line with research conducted by Tumbol (2018) and Fadhilah (2014) which show no significant relationship between chronic disease and heat strains in workers. The proportion of workers who have chronic diseases is the most among workers who experience heat strains, but there is no significant relationship between chronic diseases with heat strains, this can be due to the least known results in workers suffering from chronic illnesses, this can also be due to Other factors are more influential on workers experiencing heat strains.

The relationship between hydration status and heat strain, based on the results of the study showed that there is a relationship between hydration status and heat strain in workers. This is in line with research conducted by Septiani (2017) which shows

that there is a relationship between hydration status and heat strain in workers. the proportion of workers who were dehydrated the most was workers who experienced heat strains, and the proportion of workers who were well hydrated was highest in workers who did not experience heat strains. workers at the workshop generally complained of being tired, having headaches and feeling thirsty. This can be influenced by the environment that is too hot and will cause the metabolic process of workers to run faster because workers are more easily sweating so this if considered will lead to dehydration in workers, especially in hot pressure environments so as to increase the risk of experiencing heat strains. The conditions for conducting research in the PT Multikarya Asia Pacific Raya workshop were rarely carried out with socialization regarding the fulfillment of body fluids to workers. Generally, the socialization carried out focused on safety at work.

## 5 CONCLUSIONS AND SUGGESTION

Based on research conducted on 59 workers in the PT Multikarya Asia Pacific Raya workshop, the proportion of workers who did not experience heat strains was greater than the proportion of workers who experienced heat strains, the proportion of workers who worked in areas without heat pressure was greater than the proportion of workers who worked in areas of heat stress, the proportion of workers who are at no age is greater than the workers who have aged at risk, the proportion of workers who are not obese is higher than obese workers, the proportion of workers who do not have chronic illness is higher than workers who have chronic illness, the proportion of workers who are hydrated is higher than workers who are dehydrated, there is a relationship between heat stress and heat strain in workers, there is a relationship between age and heat strain in workers, there is no significant relationship between obesity and heat strain in workers, there is no relationship between chronic disease with heat strains in workers, there is a relationship between hydration status and heat strains in workers at the PT Multikarya Asia Pacific Raya Workshop in 2019.

Suggestions for companies to provide workloads in heat stress areas for new workers gradually, can increase routine sports activities such as joint gymnastics, provide more drinking water in certain

areas, especially in areas that have high heat pressure and close to the work area so that workers can meet the needs of fluids, provide a place to rest with a cooler temperature for workers, consider workers at risk of age placed in jobs that are at risk of causing heat strain, and the company should provide more drinking water that is affordable by workers and pay attention to aspects of fluid needs for workers by conducting socialization regarding fluid needs.

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