

## Environmental Factors that are at Risk of Heat Stress Exposure to Fishermen in Indonesia

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### ABSTRACT

**Introduction:** Workers face pressure that comes from the work environment, one of which is heat pressure. Exposure to heat, workload, rehydration, and rest period are several factors that can cause heat stress to workers. People who are uncovered to heat are much more likely to experience heat stress. Related to this, current research was carried out aiming to analyze environmental factors that are at risk of heat stress exposure to fishermen in Indonesia. **Methods:** This study was conducted through a cross sectional design in the coastal regions in Surabaya. Accidental sampling technique was applied, obtaining 42 respondents. In this case, the variables included are humidity, temperature, access to clean water, risk of heat stress, and dehydration, while the data analysis techniques used are the logistic regression and pearson correlation. **Results:** The results showed that the significant environmental factor is access to clean water, with a value of 0.009 so that the p-value is less than 0.05. Furthermore, the relationship between heat stress and dehydration is 27.1%. **Conclusion:** Therefore, this study concludes that only access to clean water is significantly related to the risk of heat stress. In addition, the relationship between heat stress and the incidence of dehydration is weak.

**Keywords:** environmental factor, fishermen, heat stress

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### INTRODUCTION

Workers will face pressure that comes from the work environment, one of which is heat pressure (Suma'mur, 2009). Exposure to heat, workload, dehydration, and rest period are several factors that can cause heat stress to the workers. In this case, people who are uncovered to heat are much more likely to experience heat stress (Boonruksa *et al.*, 2020; Krishnamurthy *et al.*, 2017).

In addition, jobs with heavy workloads additionally increase the hazard of people experiencing heat stress (Venugopal *et al.*, 2020; Tawatsupa *et al.*, 2012). Hence, adequate rehydration, suitable relaxation preparations, and the availability of heat safety will reduce the hazard of

heat stress (Pogačar *et al.*, 2019; Bodin *et al.*, 2016; Wegman *et al.*, 2018).

A significant hazard in tropical environments is heat stress, whose exposure can increase the incidence of various heat-related diseases, cardiovascular problems, kidney disease, and even death (Venugopal *et al.*, 2021). In this case, the main risk factors for kidney disease are exposure to heat stress and heavy workloads (Hansson *et al.*, 2019; Wesseling *et al.*, 2016; Glaser *et al.*, 2020).

Firefighters, bakery employees, farmers, production workers, miners, boiler room employees, manufacturing unit people, and others are people at risk of experiencing heat stress, since they belong to outdoors workers and people in hot environments (Suma'mur, 2009). Previous research on related matter found that 120 workers in South India experienced heat stress causing them to have decreased kidney function (Venugopal *et al.*, 2020). Furthermore, it was also obtained that men are more exposed to heat stress than women (Tawatsupa *et al.*, 2012).

**Cite this as:** Alayyannur, P. A., Ramdhan, D. H. and Tejamaya, M. (2023) 'Environmental Factors that are at Risk of Heat Stress Exposure to Fishermen in Indonesia', *The Indonesian Journal of Occupational Safety and Health*, 12(SI1), pp. 20-24.

The hot conditions of the oceans are exacerbated by global warming. Research conducted in 2020 showed that the average increase in ocean heat content in the last decade (2011–20) was higher than the 1981–2010 average (Cheng *et al.*, 2021). In this case, handling the impacts of climate change has been included in the 13th Sustainable Development Goals (SDGs), namely the handling of climate change in 2030. Activities carried out by various parties to achieve this goal are expected to reduce sea heat so as to reduce heat exposure to fishermen.

Fishermen is a profession that is very dependent on nature. The state of nature changes in an indefinite period of time. Boats are a means of transportation used by fishermen to catch fish with various sizes and facilities. There are boats that have roofs, toilets, and adequate drinking water facilities but many do not. It depends on the fishermen themselves (Daleno, Durand and Wasak, 2018).

Fishing locations that are far away cause fishermen to spend a long time even up to days at sea (Indrawasih, 2004). This causes fishermen to be exposed to heat from sunlight for a long time. The hot temperatures experienced by fishermen during the activities and the condition of fishing boat that is not equipped with a roof to block the sun's heat cause them to be exposed to natural heat (Dharmawirawan and Modjo, 2012).

In 2021, the Meteorology, Climatology, and Geophysics Council announced on their official website that Surabaya has reached the hottest temperature in Indonesia by 36.0 degrees Celsius. This condition affects workers who work in direct sunlight, including fishermen in Surabaya. In this case, there were 1,827,218 fishermen in Indonesia with a total of 162,827 in East Java and 2,266 of them in Surabaya (Badan Pusat Statistik Provinsi Jawa Timur, 2019). The number of fishermen in Surabaya is the largest number of fishermen among 8 cities in East Java. Therefore, it is necessary to conduct research to analyze environmental factors that are at risk of heat stress exposure to fishermen in Indonesia especially in Surabaya.

## METHODS

This research was carried out through a quantitative research with observational research, particularly a cross-sectional observation in the coastal region of Surabaya City, East Java, Indonesia.

The population observed in this case was all fishermen in coastal regions in Surabaya town. Among them, forty two respondents were acquired through accidental sampling method. The Ethical Clearance of this study was obtained from Health Research Ethics Committee, Faculty of Public Health, Universitas Airlangga No. 77/EA/KEPK/2022.

Furthermore, the variables included in this study are humidity, temperature, access to clean water, risk of heat stress, and dehydration. In this case, the humidity and temperature variables were assessed using Questemp Heat Stress monitor. Meanwhile, access to clean water is considered climate factor based on Nerbass *et al.*, (2017), which was assess using a questionnaire. Furthermore, risk of heat stress was assessed based on the guidelines proposed by the Ministry of Health (2016) with two categories, namely at risk and not at risk of heat stress. First, we measured the work environment climate using Questemp Heat Stress monitor. Second, the results of the climate of the work environment was corrected using work clothes. Third, the workload was determined based on metabolic rate. Fourth, the allocation of work and rest time in one work cycle was also determined (work-rest regimen). Fifth, the NAV value was set in accordance with the appropriate working environment. Last, the work environment climate was stated whether it exceeded the Threshold Value (NAV) or not.

The measurement of the work environment as a variable in this study was based on several previous studies. An increase in temperature exposure can increase the risk of acute kidney disease. In the previous research, among the 555 workers involved, 33% had acute kidney disease (Mix *et al.*, 2018). Furthermore, other research stated that worker heat stress can be determined from workload and heat exposure. In this case, 90 workers of the 183 workers suffered heat stress (Boonruksa *et al.*, 2020).

Urine specific gravity is categorized into 4, namely Euhydrated (the urine specific gravity is less than 1,015), mild dehydration (the urine specific gravity is in the range of 1,016-1,020), moderate dehydration (the urine specific gravity is in the range of 1,026-1,030), and severe dehydration (the urine specific gravity is more than 1,030).

Furthermore, the data obtained were analyzed using data processing software. Significance test between the two variables was carried out using the logistic regression and Pearson Correlation. In this

case, the logistic regression was used on humidity, temperature, access to clean water and risk of heat stress. Meanwhile, Pearson Correlation was used on the risk of heat stress and dehydration using Pearson Correlation.

## RESULTS

In this study, the environmental factors consist of humidity, temperature, and access to clean water. The temperature of the fishermen in this study ranged from 30.7-32.5°C, with humidity ranging from 67.2-72.1%, and the average resting time was 30 minutes per day.

Temperature and humidity were found to not have a significant effect on the risk of heat stress. Based on table 1, the factors that are part of the significant environmental factors are access to clean water, with a value of 0.009 (p-value <0.05). This indicates that workers who did not have access to clean water are 12.168 times more at risk of heat stress than workers who had access to clean water to heat stress exposure.

Furthermore, the relationship between heat stress and the incidence of dehydration is weak (pearson correlation = 0.271). Table 2 shows that the relationship between heat stress and dehydration is 27.1%, while the rest was influenced by other variables outside the model. The value of sig-2 tailed is 0.082, where  $0.082 > 0.05$ , meaning that the data is not significant.

## DISCUSSION

The working temperature of fishermen in this study ranged from 30.7 to 32.5°C with a humidity of 67.2 to 72.1%. Other study found that most fishermen (92.9%) felt disturbed by work climate in their work environment (Alayyannur and Arini, 2021). When compared with the table of recommendations for rest periods for workers who are at risk of heat stress by considering air humidity and full sun exposure, fishermen have a high risk of being exposed to heat stress and experiencing heat-related illnesses (National Institute for Occupational Safety and Health, 2017). When the ambient temperature increases, the body temperature tends to increase as well and the body pumps blood to the skin and increases sweat production to maintain a normal body temperature. If the ambient temperature is too high, the heat received by the body will be greater than the heat released by the body and the body temperature will increase, causing disturbances due to heat stress (Canadian Centre for Occupational Health and Safety, 2022).

Radiant heat source, contact with hot objects, high humidity, high air temperature, and strenuous physical activity are factors that influenced heat stress (IOWA Environmental Health and Safety, 2020). High humidity can inhibit the process of evaporation of sweat to cool body temperature. When the environment is hot and humid, the evaporation of sweat is limited because the air

**Table 1.** Work Environment Logistic Regression Test Results

Variable*	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Temperature			4.923	2	0.085			
Temperature (1)	-0.368	1.405	0.069	1	0.793	0.692	0.044	10.861
Temperature (2)	-2.334	1.289	3.276	1	0.070	0.097	0.008	1.213
Clean water	2.499	0.961	6.764	1	0.009	12.168	1.851	79.997

\*humidity do not have a significant effect from the first stage of logistic regression test

**Table 2.** Relationship between Hydration Status and Risk of Heat Stress among Fishermen in the Coastal Areas of Surabaya

Hydration	Risk of Heat Stress				N	%	Sig	Pearson Correlation
	At Risk		Not at Risk					
	n	%	n	%				
Mild Dehydration	0	0.0	8	100.0	8	100.0	0.082	0.271
Euhydrated	10	29.4	24	70.6	34	100.0		

cannot accept the additional vapor (Canadian Centre for Occupational Health and Safety, 2022).

Fishing locations that are far away cause fishermen to spend a long time even up to days at sea (Indrawasih, 2004). Fishermen are exposed to heat from sunlight for a long time. The hot temperatures experienced by fishermen was during the activities of lowering the bag nets from the boat, heading to the herding location, the land team tasked with guarding the air hose, and lifting the bag nets onto the canoe. In addition, the condition of fishing boats that is not equipped with a roof to block the sun's heat make them exposed to natural heat (Dharmawirawan and Modjo, 2012). The process of lowering and raising nets is a tough job, especially when done manually. Jobs with heavy workloads also increase the risk of workers experiencing heat stress (Venugopal *et al.*, 2020; Tawatsupa *et al.*, 2012).

The majority of respondents have access to clean water. Clean water is water used for drinking, cooking, bathing, brushing teeth, washing hands, washing clothes and so on (World Health Organization, 2011). Access to clean water is very important, especially when workers are exposed to a hot working climate. Based on research conducted at a cracker factory in Sidoarjo, it shows that the liquid consumed by workers exposed to hot temperatures is related to the location where the drinking water is placed, where the closer the worker is to drinking water, the more fluid intake the worker will have (Irwan and Paskarini, 2019).

In the case of the current research, there were only 19.0% of respondents who had mild dehydration status. Based on this result, the relationship between the risk of heat stress and dehydration in fishermen who are included in the research is weak. This is in line with research conducted in the injection molding section of a company in Sidoarjo which showed that there was a weak relationship between the work climate and the level of dehydration (Puspita and Widajati, 2017). In addition, research conducted on blacksmith workers in Semarang also showed a very weak relationship between heat stress and the respondent's level of dehydration (Ariyanti, Setyaningsih and Prasetio, 2018). There are also other research results conducted on workers in several companies in Indonesia which stated that there was a relationship between heat stress and dehydration status but with a strong and weak relationship (Wahyuni, Etianopa and Kurniawati, 2020; Sari, 2017).

## CONCLUSION

Based on the results of this study, only access to clean water is significantly related risk of heat stress. In addition, the relationship between heat stress and the incidence of dehydration is weak.

## ACKNOWLEDGMENT

Thank you for all fishermen who were willing to be involved as respondents in this research. We also would like to thank the Faculty of Public Health Universitas Indonesia and Directorate of Research, Technology and Community Service, Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia for the full support in writing this article.

This publication receives funding from Directorate of Research, Technology and Community Service, Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia. The authors declares that there is no conflict of interest in this study.

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