

## The Relationship Between Workload, Work Duration, and Water Consumption with Heat Strain Among Workers in the Purwogondo Tofu Industry, Kartasura

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### ABSTRACT

**Introduction:** The implementation of Occupational Safety and Health (OSH) standards is often neglected in the informal sector, particularly in tofu factories, leading to increased health risks for workers. Given the nature of traditional tofu production, which involves high heat exposure and potentially long work shifts, analyzing the factors that influence heat exposure is urgently needed to protect workers health. This study aims to analyze the relationship between workload, work duration, and water consumption on the incidence of heat strain among workers at the Purwogondo tofu industry center in Kartasura. **Method:** This study employed a cross-sectional design involving 80 purposively selected participants, exceeding the minimum sample size of 63 (Lemeshow formula, 95% CI, 10% error) to enhance result accuracy. Data on workload (measured via pulse rate), work duration, and water intake (both assessed through questionnaires) were collected alongside heat strain levels, which were evaluated using the Heat Strain Score Index (HSSI). Chi-square tests were subsequently utilized to analyze the relationships between the independent and dependent variables. **Results:** Chi-square tests revealed significant associations ( $p < 0.05$ ) between all three variables and heat strain, with Cramer's V indicating work duration as the strongest predictor (0.626), followed by water consumption (0.480) and workload (0.359). Results showed 60% of workers were at risk (Yellow Zone) and 27.5% experienced heat strain (Red Zone), particularly those with moderate workloads (52.2%), extended shifts (31.9%), and inadequate hydration (41.2%). **Conclusion:** The results emphasize the critical necessity for managing workloads, regulating shifts, and implementing hydration programs in small-scale food industries that are exposed to heat.

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## INTRODUCTION

The implementation of Occupational Safety and Health (OSH) has become an important standard in the formal industrial sector. However, in the informal sector, especially in small and medium-sized enterprises, the implementation of OSH is still often neglected. This is due to the lack of promotive and preventive efforts related to OHS, as well as the lack of understanding of business owners about the importance of protecting workers' health and safety. In addition, the informal sector generally has a small operational scale with limited government supervision, so the risk of work accidents tends to be higher (Fitriyani et al., 2023).

In addition, the ILO also records hundreds of millions of incidents of non-fatal work accidents that significantly exceed the death rate and often reduce workers' ability to earn a living (ILO, 2018). In Indonesia, the annual report of the Social Security Administration (BPJS) of Employment shows an increase in the number of occupational injury cases every year, with a record of 101,367 cases in 2016 which continued to increase until it reached 182,835 cases in 2019 (BPJS Ketenagakerjaan, 2019). Tofu factories are one of the informal sectors in the growing food industry in Indonesia. In making tofu in small or large factories, it is possible that there is a risk of work accidents. Workers who work in tofu factories generally have not obtained health services or insurance to deal with health problems related to their work. Potential hazards that often occur in the tofu industry include non-ergonomic work attitudes, high workplace temperatures, the risk of hot tofu spills, poor air circulation, and sanitation and lighting problems in the workplace (Badriah & Heriana, 2020).

One of the real health threats for tofu industry workers is heat stress or heat strain. Heat stress occurs when the body is unable to keep up with environmental temperature and metabolism due to strenuous physical labor or hot and humid work environments. Factors such as workload, work duration, and water consumption are important determinants in the incidence of heat strain. Workers who do not get enough fluids or work for a long time in hot environments are at high risk of dehydration, muscle cramps, heat exhaustion, and even heat stroke (CDC, 2020).

Based on initial observations at the Purwogondo tofu industry center, the production process with traditional furnace combustion results in a high temperature and high humidity work environment, exacerbated by poor ventilation, inadequate buildings, and lack of light. The work system in this industry often exceeds standards, with operating hours of more than 8 hours a day, 6 days a week, and unscheduled breaks. Increased production demand extends working hours without additional breaks, increasing workers' exposure to sustained heat. Lack of local government oversight in occupational health leads to poor implementation of OHS, creating conditions with high potential for occupational diseases such as heat strain due to heat exposure.

This study was designed to analyze the relationship between workload, work duration, and water consumption levels on the incidence of heat strain in the population of workers in the Purwogondo tofu industry center, Kartasura Village. Thus, the output of this study is expected to provide a deeper understanding of the risk factors for heat strain in the specific context of the traditional tofu industry, which in turn can contribute to the formulation of policies and implementation of more effective heat strain risk prevention strategies, as well as improving welfare and occupational safety conditions for workers in the region.

## LITERATURE REVIEW

Heat strain is the body's physiological response to accumulated heat load from external factors such as high ambient temperature, humidity, and poor ventilation, as well as internal factors such as metabolic activity during work. When the body fails to dissipate heat optimally, core temperature increases, which can lead to health problems ranging from heat exhaustion to heat stroke (Melinda et al., 2022; NIOSH, 2016). Several physiological indicators such as increased pulse rate, body temperature, and loss of body fluids through sweating are important parameters in the identification of heat strain (Hoorfarasat et al., 2015).

Physical workload is also an important factor in influencing the risk of heat strain. The more strenuous the activity, the higher the energy demand and body heat production. In the context of ergonomics, workload needs to be adjusted to the physical capacity of workers and pay attention to the conditions of the work environment (Tarwaka, 2015). External factors such as high temperatures, poor ventilation, and other environmental conditions can increase physical workload and thermal stress. Meanwhile, internal factors such as age, gender, nutritional status, BMI, aerobic capacity, metabolism, and body surface area affect individual tolerance to workload in hot environments (Anggraini, 2022; Yazdanirad et al., 2020).

The duration of work that exceeds the provisions of ideal working hours as stipulated in Law of the Republic Indonesia Number 13 of 2003 concerning Manpower also contributes to the increased risk of heat strain. The longer a person is exposed to a hot work environment, the greater the accumulation of heat in the body that is difficult to remove (Kemala et al., 2018). This condition is exacerbated if workers do not get adequate rest time or experience irregular work scheduling (Putri et al., 2021).

Water consumption plays an important role in maintaining body fluid balance and thermoregulatory processes while working in hot environments. Dehydration due to insufficient fluid intake and increased fluid expenditure through sweat can reduce work performance and increase the risk of heat strain (Herawati & Mudzakkir, 2022; Suprabaningrum & Dieny, 2017). Under working conditions, workers are recommended to consume a minimum of 2.8 liters of water per day, with a drink every 20-30 minutes of about 250 ml to maintain body fluid balance (Sari, 2017).

Therefore, heat strain is a multifactorial condition influenced by workload, work duration, and water consumption, and supported by environmental factors and individual characteristics. Understanding the interaction between these factors is important in mitigating occupational health risks, especially in the informal sector such as the tofu industry which has not fully implemented an optimal work safety system.

## METHODS

This study is an analytical observational study with a cross-sectional approach that aims to determine the relationship between workload, work duration, and water consumption with the incidence of heat strain in tofu industry workers. The study was conducted from February to April 2024 at the Purwogondo Tofu Industry Center, RW 1, Kartasura Village, Kartasura District, Sukoharjo Regency. The population in this study were all tofu industry workers in the area, totaling around 180 people. The sample was determined using the Lemeshow formula with a confidence level of 95% and a margin of error of 10%, so that a minimum number of 63 respondents was obtained, but 80 people were taken to increase the accuracy of the results. Sampling was conducted using a purposive sampling technique based on the inclusion criteria, namely workers who were willing to provide written consent (informed consent) and work in areas directly adjacent

to heat sources such as boiling or printing. Exclusion criteria included workers who were experiencing fever due to infection or who consumed alcohol during the data collection process.

The independent variables in this study consisted of workload, work duration, and water consumption, while the dependent variable was heat strain. Workload was measured by calculating heart rate per minute using the palpation method with a stopwatch, and then categorized based on Nurmantio's (2003) classification into five levels of workload, ranging from very heavy to light. Work duration was measured through questionnaires and categorized into normal work duration ( $\leq 7$  hours/day) and abnormal work duration ( $> 7$  hours/day) in accordance with Law of the Republic of Indonesia Number 13 of 2003. Water consumption was measured based on the amount of fluid intake consumed by workers in one day, which was then classified as sufficient ( $\geq 2.8$  liters/day) and insufficient ( $< 2.8$  liters/day), referring to the standards of the Indonesian Ministry of Health. Meanwhile, heat strain was measured using the Heat Strain Score Index (HSSI) questionnaire developed by Dehghan and colleagues in 2015, which includes 18 questions related to physiological conditions, the work environment, and work comfort, and the results were categorized into three zones: green ( $< 13.5$ ), yellow (13.5–18), and red ( $> 18$ ) (Dehghan et al., 2015).

Primary data were collected through direct observation, interviews, questionnaire administration, and heart rate measurements. Secondary data were obtained from various relevant scientific references. Data analysis was conducted through the stages of editing, coding, entry, and tabulation. Univariate analysis was used to describe the distribution of each variable, while bivariate analysis was performed to test the relationship between the independent and dependent variables using the chi-square test, with a significance level of 0.05. The strength of the relationships between variables was interpreted using Cramer's V.

## RESULTS AND DISCUSSION

The study on the tofu industry workers in Purwogondo identifies diverse respondent characteristics: 42.5% are aged 36–50 years, 41.3% are over 50, and 16.3% are aged 20–35. Predominantly male (65%), with 35% female respondents, most workers (60%) have less than 10 years of tenure. The majority work in the molding section (50%), followed by frying (27.5%) and cutting (22.5%) (Table 1).

Table 1. Distribution of Respondents Based on Age, Gender, Work Tenure, and Work Section Characteristics in the Tofu Industry of Purwogondo (N= 80)

Characteristic	Categories	Frequency	Percentage
		n	(%)
Age	20–35 years	13	16.3
	36–50 years	34	42.5
	>50 years	33	41.3
Gender	Male	52	65.0
	Female	28	35.0
Tenure	<10 years	48	60.0
	$\geq 10$ years	32	40.0
Work Section	Frying	22	27.5
	Molding	40	50.0
	Cutting	18	22.5

Table 2. Results of Univariate Analysis (Workload, Work Duration, and Water Consumption) in the Tofu Industry of Purwogondo (N= 80)

Variables	Categories	Frequency (n)	Percentage (%)
Workload	Light	57	71.3
	Moderate	23	28.7
Work Duration	Normal	11	13.8
	Abnormal	69	86.3
Water Consumption	Insufficient Water Intake	51	63.7
	Sufficient Water Intake	29	36.3
Heat Strain Category	Green Zone (No Heat Strain)	10	12.5
	Yellow Zone (At Risk of Heat Strain)	48	60.0
	Red Zone (Experiencing Heat Strain)	22	27.5

Table 2 presents the results of the univariate analysis regarding workload, work duration, water consumption, and heat strain category in the tofu industry of Purwogondo. In terms of workload, the majority of respondents, specifically 57 individuals (71.3%), reported a light workload, while 23 individuals (28.7%) experienced a moderate workload. The analysis of work duration indicated that 69 respondents (86.3%) worked for an abnormal duration, while only 11 individuals (13.8%) worked for a normal duration. This suggests a potentially greater strain on the workers (Table 2).

Table 3. Distribution of Heat Strain based on Workload, Work Duration, and Water Consumption (N= 80)

Variable	Category	Green Zone (No Heat Strain)		Yellow Zone (At Risk of Heat Strain)		Red Zone (Experiencing Heat Strain)		Total		P-Value	Cramer's V
		n	%	n	%	n	%	N	%		
Workload	Light	9	15.8	38	66.7	10	17.5	57	100	0,006	0,359
	Moderate	1	4.3	10	43.5	12	52.2	23	100		
Work Duration	Normal Work Duration	7	63.6	4	36.4	0	0.0	11	100	0,001	0.626
	Abnormal Work Duration	3	4.3	44	63.8	22	31.9	69	100		
Water Consumption	Insufficient Water Intake	2	3.9	28	54.9	21	41.2	51	100	0,001	0.480
	Sufficient Water Intake	8	27.6	20	69.0	1	3.4	29	100		

Regarding the water consumption variable, 51 respondents (63.7%) admitted to having insufficient water intake, while 29 individuals (36.3%) felt their water needs were met. In the heat strain category, 10 respondents (12.5%) were in the green zone (no heat strain), but 48 individuals (60.0%) were in the yellow zone (at risk), and 22 individuals (27.5%) were in the red zone (experiencing heat strain). These findings indicate a significant health challenge for the workers, which requires attention to improve working conditions and prevent health risks in this industry (Table 2).

### Relationship Between Workload and Heat Strain Among Workers

Based on Table 3, a significant relationship was found between workload, work duration, and water consumption with the occurrence of heat strain among tofu industry

workers ( $p < 0.05$ ). The majority of respondents with a light workload were in the yellow zone (66.7%), with only 17.5% experiencing heat strain. Conversely, respondents with a moderate workload experienced heat strain more frequently (52.2%). The chi-square statistical test showed a significant relationship between workload and heat strain with a p-value of 0.006 ( $<0.05$ ) and a weak association strength (Cramer's  $V = 0.359$ ). This indicates that as a worker's workload increases, the risk of experiencing heat strain tends to increase proportionally. This study's findings are consistent with research conducted by Aan Melinda at the CV. Fatra Karya Logam Factory in Tangerang Regency, which concluded a statistically significant correlation (p-value = 0.042  $< 0.05$ ) between workload and heat strain in the metal industry worker population (Melinda et al., 2022). Furthermore, another study by Sucipto (2025) also found that a p-value = 0.03 ( $<0.05$ ) indicated a significant relationship between the workload variable and the occurrence of heat strain among workers at the Suka Rasa Jombang cracker factory in Ciputat, South Tangerang (Sucipto et al., 2025).

Based on observations in the field and the results of pulse measurements, the workload experienced by respondents is generally classified as light to moderate. This is due to the repetitive nature of the work and the fact that it is done in a static position without much movement, so it only involves local muscles and does not stimulate the work of large muscles as a whole. As a result, these activities do not sufficiently increase the heart rate to a heavy workload level. In addition, work that is performed routinely and repetitively over a long period of time allows for physiological adaptations, such as increased heart capacity and efficiency of the cardiovascular system, characterized by a pulse rate that remains low despite the long duration of work (Akram, 2024).

### **Relationship Between Work Duration and Heat Strain Among Workers**

From an ergonomics perspective, physical workload needs to be adjusted to the physical and cognitive capabilities of workers; internal and external factors influence physical workload, so the level of workload should be adjusted to the working environment conditions and the body's tolerance limits (Anggraini, 2022). Poor working environments, such as high temperature and humidity, poor ventilation, inadequate buildings, and minimal lighting, create hot environments that become external factors increasing workload. Respondents with a moderate workload tended to experience heat strain more frequently than those with a light workload. This finding indicates that the heavier the physical workload performed in a hot environment, the higher the risk of heat strain. In high-temperature working conditions, the body will expend more energy to maintain a stable core temperature, so the combination of physical workload and environmental heat exposure accelerates thermal fatigue. Therefore, in managing work risks, it is important to pay attention to the interaction between workload and environmental temperature to avoid exceeding the physiological capacity of workers.

Workers with abnormal work duration were predominantly in the yellow (63.8%) and red (31.9%) zones, while workers with normal work duration were mostly in the green zone (63.6%) with none experiencing heat strain. The chi-square test results showed a relationship between work duration and heat strain with a p-value of 0.001 ( $<0.05$ ) and a strong association strength (Cramer's  $V = 0.626$ ). This demonstrates that as work duration increases, the risk of heat strain among workers also increases, which is supported by the findings of a study conducted in the cracker industry in Kincang Wetan Village, Madiun Regency, which found that the majority of respondents with a high-risk work duration (46.7%) experienced heat strain, and showed a statistically significant relationship between work duration and the occurrence of heat strain with a p-value of 0.003 ( $<0.05$ ) (Anggraini,

2022). However, in contrast to the findings of this study, research conducted by Dicky Zulhanda on tofu factory workers in the Kamboja Area of Palembang City showed non-significant results with a p-value = 0.077 ( $>0.05$ ), concluding that there was no relationship between work duration and heat strain symptoms. The study in Palembang indicated that other factors might play a more significant role in triggering heat strain symptoms in the context of the tofu industry in that region (Zulhanda et al., 2021).

The strong correlations between abnormal work duration ( $>7$  hours/day) and higher heat strain risk in Purwogondo tofu workers stems from work systems often violating standard labor regulations. Long daily (over 8 hours) and weekly (6 days) work hours, combined with poor rest scheduling, lead to constant heat exposure. Market-driven production demands worsen this by forcing longer shifts without adequate breaks, causing a cumulative increase in workers' thermal load. This progressively strains thermoregulation, raising heat strain susceptibility. Continuous work in heat reduces blood volume and stroke volume, forcing the heart to work harder. Heat also increases injury risks like slips, vision issues, dizziness, and impaired thinking, alongside direct burn hazards (NIOSH, 2016).

In accordance with the regulations stated in Law of the Republic of Indonesia Number Manpower Article 77, every employer is obligated to comply with working time provisions, which are 7 hours per day and 40 hours per week for a 6-day work week, or 8 hours per day and 40 hours per week for a 5-day work week (Republik Indonesia, 2003). The ideal work duration is between 6 to 8 hours per day, while the remainder is used for rest. However, in practice, many workers experience work durations exceeding 7 hours per day, especially in situations where the number of orders increases. This often causes workers to work longer than the stipulated provisions, potentially increasing the risk of fatigue and health problems. This condition indicates the need for greater attention to the implementation of working time regulations to protect the welfare of workers in the industry.

### **Relationship Between Water Consumption and Heat Strain Among Workers**

Regarding the water consumption variable, respondents with insufficient water intake were more likely to experience heat strain (41.2%) compared to those with sufficient intake (3.4%). A significant relationship was found with a p-value = 0.001 ( $<0.05$ ) between water consumption and heat strain, with a moderate association strength (Cramer's  $V = 0.480$ ). This finding aligns with the results of a similar study conducted on tofu factory workers in Pasar Minggu Subdistrict in 2022, which also obtained a p-value of 0.001 ( $<0.05$ ), thus concluding a significant relationship between drinking water consumption and the occurrence of heat strain (Rachim, 2023). This study also found similar results to other research conducted in Kekalik Jaya, which showed that the majority of workers with insufficient drinking water intake (16 individuals) experienced heat strain, with a statistically significant relationship (p-value = 0.000  $< 0.05$ ) between water consumption and the occurrence of heat strain among tofu production workers. These results reinforce the indication that insufficient fluid intake is a crucial risk factor for heat strain in the tofu industry work environment (Ayu et al., 2024).

The results of the study are supported by the fact that many workers are not fully aware of the importance of adequate hydration, especially in high-temperature work environments. Some workers do not know the ideal amount of water to consume during work or understand the impact of dehydration on health and work performance. In addition, although the company provides drinking water, it is not strategically located or far from the work area. In working conditions that demand the achievement of production

targets, workers tend to be reluctant to leave their work stations just to get water, resulting in low fluid intake. This evidence further confirms the important role of adequate fluid intake in reducing the risk of heat strain among workers in the tofu industry environment.

Workers are potentially at risk of fluid deficiency due to an imbalance between fluid intake and output. This condition typically occurs due to insufficient water intake to meet the body's needs and increased fluid loss, especially when performing tasks with a high physical workload or in hot working environment conditions. Other factors such as exposure to physical, chemical, biological, and psychological elements also contribute to increasing this risk. In high-temperature environments, fluid loss through sweat and respiration increases, so the body's fluid requirements also increase. Body fluids are naturally lost through urine, sweat, and respiration, making it important to replace them regularly through the consumption of food and beverages. If lost fluids are not promptly replaced, the body is at risk of dehydration (Suprabaningrum & Dieny, 2017).

Dehydration can impair cognitive function and affect behavior, including a reduced ability to make decisions. Prolonged heat exposure accompanied by dehydration can also increase the risk of injury, heighten the likelihood of heat-related illnesses, and decrease work productivity through both absenteeism and presenteeism (working while unwell) (Taggart et al., 2024; Zander et al., 2015). The habit of drinking water regularly in the workplace has proven beneficial in maintaining body hydration during working hours and reducing the perception of fatigue. This reduction in perceived fatigue helps the body adapt better to hot environments and can lower the risk of heat-related illnesses (Mansor, 2019). Individual fluid requirements are not uniform, as they are influenced by various factors such as physical activity level, body weight, age, environmental temperature, and diet. While working in hot environments, it is recommended to consume at least 2.8 liters of water per day. Ideally, fluid intake should be met by drinking one glass of water (approximately 250 ml) every 20–30 minutes (Sari, 2017).

### **Implications of Heat Strain Risk Factors in Informal Occupational Settings**

In addition to the quantitative results, field observations also indicated that the highest risks stemmed from hazards associated with hot water and hot oil during the cooking and frying stages, directly increasing the potential for heat exposure and thermal injuries. Additionally, several workers reported complaints such as excessive heat, itching on the hands due to soybean soaking, and musculoskeletal discomfort from non-ergonomic working postures. These conditions support the finding that environmental factors and light to moderate physical workloads can still induce heat strain, particularly within a work system lacking adequate rest and safety provisions (Purnamasari et al., 2023).

The results of this study provide crucial insights characteristic of the tofu industry in Purwogondo, which is a small-scale and traditional sector. In contrast to large-scale formal industries that typically have established occupational safety and health (OSH) systems, the tofu industry in Purwogondo generally lacks systematically implemented OSH standards. Workers are exposed to high heat from traditional stoves, with cramped workspaces, poor ventilation, and inadequate lighting. These local conditions exacerbate the impact of long work durations, insufficient fluid intake, and physical workloads, even if categorized as light to moderate. Therefore, the results of this research highlight the need for OSH interventions tailored to local conditions, such as the regulation of rest breaks, provision of sufficient drinking water, and education regarding heat hazards and dehydration. These strategies can be implemented at low cost but have a significant impact on worker health. These findings should be a concern for policymakers at the local level to ensure that informal sectors like the tofu industry receive adequate protection.

Based on the statistical analysis, the Cramer's V values reveal varying strengths of association between the three independent variables and the occurrence of heat strain in this study. Work duration showed the strongest relationship (Cramer's V = 0.626), indicating that this factor has the most dominant influence on the occurrence of heat strain, with workers experiencing abnormal work durations having a significantly higher risk. Water consumption ranked second with a moderate association strength (Cramer's V = 0.480), confirming that adequate fluid intake plays an important role in the mitigation of heat strain, although not as strong as the influence of work duration. Meanwhile, workload showed the weakest but still significant relationship (Cramer's V = 0.359), signifying that while workload affects the risk of heat strain, its impact is smaller compared to the other two factors.

In comparison to prior research, this study highlights a stronger association between abnormal work duration and the occurrence of heat strain. This is likely attributable to working hours exceeding recommended limits due to high production demands, without commensurate rest periods. Such work patterns are characteristic of small-scale industries reliant on order volumes and economic pressures. Furthermore, the absence of a heavy workload category in this study might be explained by the physiological adaptation of the workers, given their engagement in similar and repetitive tasks over several years. This adaptation may allow for a sustained lower heart rate even under hot working conditions.

Humans maintain a core internal temperature of approximately 37°C through a complex interplay of behavioral adjustments and autonomic physiological mechanisms, such as vasodilation and sweating. Endogenous heat generated by metabolic activity constitutes an internal heat load, which is compounded by exogenous thermal input from the surrounding environment. Elevated ambient humidity levels, a critical component of the heat index, significantly impede the body's capacity for effective heat dissipation via evaporative cooling. Under conditions of substantial thermal burden, whether originating from exogenous sources, endogenous metabolic activity, or a combination thereof, the inherent thermoregulatory capacity of the human body can become strained or ultimately overwhelmed. This physiological compromise can precipitate a spectrum of heat-related illnesses, ranging in severity from non-life-threatening conditions, including heat exhaustion, heat syncope, heat edema, heat cramps, and heat rash, to the critical and potentially fatal condition of heatstroke, characterized by a dangerous elevation of core body temperature beyond a critical threshold (Sorensen Cecilia & Hess Jeremy, 2022).

This study presents certain limitations. Data collection relied on questionnaires, which are inherently subjective and susceptible to recall or response bias. Additionally, environmental factors such as temperature and humidity were not directly measured, precluding a detailed quantitative analysis of the relationship between heat exposure and physiological responses. Future research is recommended to incorporate direct measurements of the work environment and physiological monitoring (such as core body temperature and sweat rate) to obtain more precise data. Subsequent studies could also focus on the development and testing of simple interventions aimed at reducing heat strain risk within informal sectors like the tofu industry.

## CONCLUSION

This study found a significant association ( $p < 0.05$ ) between workload, work duration, and water consumption with heat strain in Purwogondo tofu workers. Cramer's V analysis indicated work duration as the most influential factor (0.626), followed by water consumption (0.480) and workload (0.359). Most respondents with heat strain were in the

Yellow (at risk) and Red (experiencing) zones. Increased workload and work duration correlated with higher heat strain risk, exacerbated by insufficient water intake. Managing these factors is vital for worker health in hot environments. The study's limitation in controlling ambient temperature and humidity suggests avenues for future research. Consequently, preventing heat strain requires companies to prioritize workload and work duration management, including shorter shifts and job rotation. Ensuring adequate water availability and promoting regular hydration are also crucial. Furthermore, employers should improve working environment conditions through building design, ventilation, temperature and humidity control, cooling systems, and rest facilities to minimize heat exposure. Governmental agencies should oversee labor regulations regarding work duration and environmental conditions to protect worker health and safety and optimize workplace hydration to prevent dehydration and heat strain.

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