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Awareness about Heat Stress and its Preventive Practices Among Industrial Workers: A Cross-Sectional Study from the Kingdom of Saudi Arabia

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ABSTRACT

Heat stress represents a significant occupational health risk among industrial workers in Saudi Arabia due to prolonged exposure to extreme environmental temperatures. This study aimed to assess workers' awareness of heat stress, their preventive practices, experienced symptoms, and recommendations for reducing heat-related risks. A descriptive cross-sectional study was conducted using a structured questionnaire distributed electronically among industrial workers across different regions in Saudi Arabia. A total of 187 completed responses were obtained from industrial workers across different regions of Saudi Arabia. Participants were predominantly male, aged between 25–40 years, and represented a range of industrial sectors with varying levels of professional experience. The results revealed that 91% of participants recognized heat stress as an occupational hazard, and 74% knew about its early symptoms. Around 55% reported experiencing heatrelated symptoms during work. Preventive practices such as adequate hydration (70%), use of cooling equipment (65%), and regular rest breaks (90%) were commonly reported. However, a gap between awareness and effective implementation of preventive measures was observed. Furthermore, participants showed a positive attitude toward innovative protective strategies, particularly wearable cooling solutions such as air-cooled jackets and personal cooling devices. The study concludes that while awareness levels are high, improved enforcement of preventive measures and integration of advanced cooling technologies are essential to enhance worker safety and reduce occupational heat stress risks.

1. Introduction

Saudi Arabia experiences long and extremely hot summers, with temperatures often exceeding 45°C in many areas, especially in the Eastern Province and central industrial zones. These environmental conditions pose ongoing thermal risks to outdoor workers and factory labourers, many of whom operate near heat-generating machinery or are exposed to direct sunlight (Albuwarthan et al., 2019). The prevalence rate for heat stress as reported in one recent study from Jubail, Saudi Arabia, among workers in the steel industry, was around 25% (Alshammari et al., 2020). Although mitigation strategies—such as providing shaded rest areas, hydration protocols, and mid-day work bans—are in place, several studies have indicated that these measures may not be sufficient to protect workers from physiological heat stress fully (Alshammari et al., 2020; NIOSH, 2016).

Heat stress is a physiological condition that arises when the body's thermoregulation system fails due to high environmental temperatures, physical exertion, or insufficient cooling. It can lead to heat-related illnesses such as heat exhaustion, heat cramps, and, in severe cases, heat stroke. These risks are amplified by dehydration, high humidity, or prolonged exposure to direct sunlight. In Saudi Arabia, where summer temperatures often exceed 45°C, heat stress is a major occupational health concern, especially for workers in construction, agriculture, transportation, and other labor-intensive industries. These workers are frequently exposed to extreme conditions that increase their risk of heat-related illnesses. With the added impact of global climate change, the frequency and intensity of heatwaves in the region are expected to rise, making this issue even more pressing.

Heat stress is a significant occupational hazard that threatens worker health, safety, and productivity across various industrial sectors in Saudi Arabia (WHO, 2021). Saudi public health and labor authorities have taken steps to strengthen regulatory and preventive measures, improve workplace infrastructure, and increase awareness campaigns aimed at protecting workers in highheat environments. The Ministry of Human Resources and Social Development has developed procedural guidelines to mitigate the effects of exposure to direct sunlight and heat stress in workplaces, emphasising the importance of implementing preventive strategies to safeguard workers' health. Despite existing regulations and guidelines, the practical application of preventive measures remains inconsistent, and many workers have limited knowledge of the early signs and long-term effects of heat stress (Alshammari et al., 2020).

The research aims to assess the awareness of industrial workers about heat stress and its preventive strategies. The goal is to identify the challenges faced by workers in industrial environments in Saudi Arabia due to heat stress. By evaluating current knowledge and practices, the study seeks to identify gaps and propose innovative solutions to improve safety and productivity .
Some of the research questions expected to be answered through this research are following:

- What is the extent of industrial workers' awareness of heat stress risks, and how does this affect their health and daily performance?
- Are current preventive measures sufficient to provide effective protection for workers, or is there a need for new and improved methods?
- To what extent can modern technologies, such as smart cooling garments, be a practical and acceptable solution for workers to mitigate the effects of extreme heat?

2. Literature Review

2.1 Physiological Impacts of Heat Stress

When core body temperature exceeds 38°C, human performance begins to deteriorate beyond 40°C, the condition becomes life-threatening (González-Alonso et al., 2008;Sawka et al., 2011). Heat stress also impairs cognitive function and cardiovascular performance, especially when accompanied by dehydration.

2.2 Occupational Heat Exposure

Outdoor and industrial workers in Saudi Arabia are frequently exposed to extreme climatic conditions, leading to reduced productivity, fatigue, and a higher risk of occupational accidents (Kjellstrom et al., 2016). To mitigate these risks, the Saudi Ministry of Human Resources and Social Development enforces a ban on outdoor work between 12:00 PM and 3:00 PM during the summer months.

2.3 Climate Change and Regional Risks

The Middle East and North Africa (MENA) region is projected to experience some of the most severe impacts of climate change. Pal and Eltahir (2016) predicted that some Gulf areas could experience “wet bulb” temperatures that exceed human survivability thresholds. These trends have serious implications for worker safety and economic productivity in Saudi Arabia.

2.4 Worker Awareness and Preventive Practices

Studies have shown that migrant laborers often have limited awareness of heat stress and preventive measures. Language and cultural barriers may hinder effective communication about safety practices. Awareness programs and Safety training is essential to promote protective behaviors such as drinking water regularly, wearing appropriate clothing, and taking scheduled breaks in shaded or cooled areas.

2.5 Mitigation and Adaptation Strategies

Key strategies for reducing heat stress in workers include implementing gradual heat acclimatization programs, particularly for new or unacclimatized workers, to allow their bodies to adapt safely to hot environments. Maintaining proper hydration is essential to offset fluid loss and prevent heat-related illnesses, while wearing lightweight, breathable, and reflective clothing helps minimize heat absorption and enhance comfort. Providing shaded or air-conditioned rest areas offers necessary recovery periods during work shifts, thereby reducing overall thermal strain. Additionally, recent advancements highlight the use of wearable devices for real-time body temperature monitoring, enabling early detection of heat stress and timely intervention (Jay et al., 2021). Saudi public health and labor authorities have taken steps to strengthen regulatory and preventive measures, improve workplace infrastructure, and increase awareness campaigns aimed at protecting workers in high-heat environments. 2.6 Relationships of Thermal Environments to Industrial Workers

Although the relationship between thermal environments and industrial workers has long been recognised as a critical component of occupational health and safety, it has become increasingly important in hot climate regions such as Saudi Arabia, where workers are regularly exposed to extreme temperatures and humidity. These thermal conditions can overwhelm the body’s thermoregulatory mechanisms, leading to declines in physical capacity and serious health consequences (Al-Bouwarthan et al., 2019; AlMousa, 2022). This relationship is shaped by a combination of environmental and physiological stressors, including ambient air temperature, humidity, metabolic workload, and the insulation properties of personal protective clothing. Internationally recognised assessment tools such as the Wet Bulb Globe Temperature (WBGT) index and Predicted Heat Strain (PHS)have been adopted to evaluate these risks under ISO 7933:2004 standards (Willetts et al., 2013; Zhao et al., 2022).

Furthermore, empirical data suggest that even a 1°C increase in WBGT can reduce productivity by up to 2% in physically demanding occupations, highlighting the economic implications of unmanaged heat stress. Chronic exposure has also been linked to adverse symptoms such as dehydration, dizziness, elevated heart rate, and an increased incidence of workplace accidents (Habibi et al., 2025; Al-Bouwarthan et al.,2019). The reviewed literature highlights that heat stress is a growing occupational and public health challenge in Saudi Arabia. The country’s climatic conditions, combined with labor-intensive outdoor industries, create a unique vulnerability. As climate change intensifies, raising awareness among workers and implementing preventive measures are critical to ensuring safe and sustainable working environments.

3. Methodology

3.1 Study Design

This study adopted a descriptive cross-sectional research design with a quantitative approach. The design was selected to assess the prevalence of heat stress symptoms and to evaluate workers’ awareness and preventive practices related to heat stress at a

single point in time. A cross-sectional design is appropriate for occupational health research as it provides a clear overview of existing workplace conditions and workers' experiences without requiring long-term follow-up.

3.2 Study Setting

The study was conducted in heat-intensive industrial environments across Saudi Arabia. These settings included manufacturing industries, construction sites, and metal processing facilities. Such workplaces are commonly characterized by high ambient temperatures, limited ventilation, and exposure to radiant heat from machinery or direct sunlight. These environmental conditions place workers at increased risk of developing heat stress, making them suitable settings for achieving the objectives of this study.

3.3 Study Variables

- The study included both independent and dependent variables.
- The independent variables consisted of occupational and environmental factors associated with heat exposure, including job type, work shift patterns, ambient temperature, and the use of personal protective equipment.
- The dependent variables focused on workers' awareness of heat stress and their preventive practices.
- These variables were assessed using scores derived from the questionnaire responses.

3.4 Target Population

The target population of this study consisted of industrial workers in Saudi Arabia who were exposed to heat stress during their daily work activities. Workers from different industrial sectors and regions were included to ensure variability in occupational conditions and exposure levels. Sampling Method

A convenience sampling method was used to recruit participants. This method was chosen due to accessibility and feasibility, as well as the wide geographical distribution of industrial workers. Participants were recruited from various industries based on availability and willingness to participate. Organizational approval and individual informed consent were obtained prior to data collection.

3.5 Sample Size Determination

The sample size was calculated using the formula for a single population proportion. A confidence level of 95% and a margin of error of 5% were applied. The calculation was based on a previously estimated awareness prevalence of 14.2%. Based on these parameters, the required sample size was estimated to be approximately 187 participants.

3.6 Study Tool

Data were collected using a structured self-administered questionnaire developed based on an extensive review of relevant literature. The questionnaire was designed to address the objectives of the study and consisted of five main sections. The first section collected demographic information, including age, job type, and work experience. The second section assessed workers' awareness of heat stress and its associated risks. The third section focused on preventive practices adopted by workers to reduce heat stress exposure. The fourth section addressed heat stress symptoms and personal experiences related to heat exposure. The final section included participants' recommendations to reduce heat-related risks and improve occupational safety in the workplace.

3.7 Data Collection Procedure

The questionnaire was distributed electronically through online platforms and digital communication tools. Participants completed the questionnaire voluntarily after providing informed consent. This approach enabled efficient data collection from workers across various regions and industrial sectors. Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software after the completion of data collection. A total of 187 responses were included in the final analysis. Descriptive statistical methods, including frequencies, percentages, means, and standard deviations, were used to summarize participants' demographic characteristics, awareness levels, and preventive practices.

3.8 Sample Size

The sample sized comprised of (n=187) participants recruited from various industries in Saudi Arabia. There were (n=58; 92%) male respondents and (n=5; 8%) female participants. Most of them were Engineers (n=25; 40%) and others were industrial workers (n=13; 2

3.9 Survey Questionnaire

Data were collected using a structured electronic survey questionnaire developed based on relevant literature. The instrument consisted of multiple sections covering demographic characteristics, awareness of heat stress, experienced symptoms, and preventive practices. A five-point Likert scale was used to assess participants' responses, ranging from strongly disagree to strongly agree. The questionnaire was distributed online to industrial workers across different regions of Saudi Arabia.

Participation was voluntary, and all responses were collected anonymously to ensure confidentiality. The instrument was reviewed for content validity, and a pilot test was conducted to ensure clarity and reliability.

3.10 Ethical Considerations

Ethical approval was obtained prior to data collection. Participation was voluntary, and informed consent was obtained from all participants. All responses were collected anonymously, and confidentiality was strictly maintained. The data were used for research purposes only.

4. Results

A total of 187 completed responses were included in the final analysis. Participants were distributed across different regions of Saudi Arabia and represented a range of job roles and experience levels. The majority of respondents were male, and a considerable proportion had more than 10 years of work experience. Table 1 presents the demographic characteristics of the participants.

Table 1. Participant Demographics (n = 187)

Variable	Category	n	%
Gender	Male	180	88.67
	Female	23	11.33
Age (years)	<25	34	16.75
	25–30	51	25.12
	31–35	37	18.23
	36–40	43	21.18
	>40	38	18.72
Job Type	Industrial worker	26	12.81
	Administrative staff	32	15.76
	Engineer	75	36.95
	Other	70	34.48
Years of Experience	<1 year	19	9.36
	1–5 years	73	35.96
	6–10 years	46	22.66
	>10 years	65	32.02
Region	Central	48	23.65
	Eastern	71	34.98
	Western	39	19.21
	Northern	37	18.23
	Southern	8	3.94
Chronic Disease	None	183	90.15
	Present	20	9.85

4.1 Heat Stress Awareness

In terms of awareness, the majority of participants (82.74%) reported that they had heard about heat stress as an occupational hazard. Additionally, most respondents demonstrated a moderate to high level of awareness regarding early symptoms of heat stress. Formal training was identified as the primary source of information, followed by media and colleagues.

Table 2 presents the awareness-related findings.

Variable	Category	n	%
Heard about heat stress	Yes	163	82.74
	No	34	17.26
Awareness of symptoms	Strongly disagree	28	14.21
	Disagree	16	8.12
	Neutral	30	15.23
	Agree	69	35.03
	Strongly agree	54	27.41
Source of information	Formal training	110	55.84
	Colleagues	27	13.71
	Media / Social media	39	19.80
	Not heard before	21	10.66

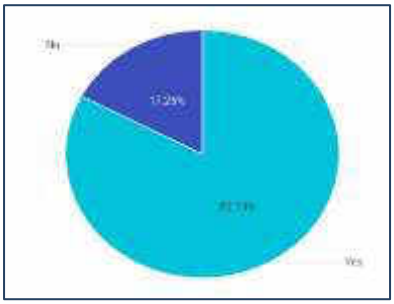

Figure 1. Awareness of Heat Stress among Participants

As shown in Figure 1, the majority of participants were aware of heat stress as an occupational hazard.

4.2 Preventive Practices

Regarding preventive practices, a majority of participants reported adopting protective measures such as adequate hydration, use of cooling equipment, and taking regular breaks in shaded or cool areas. Table 3 summarizes the preventive practices.

Table 3. Preventive Practices

Variable	Category	N	%
Drink enough water	Strongly disagree	15	7.81
	Disagree	9	4.69
	Neutral	34	17.71
	Agree	78	40.63
	Strongly agree	56	29.17
Use cooling equipment	Strongly disagree	15	7.81
	Disagree	22	11.46
	Neutral	42	21.88
	Agree	73	38.02
	Strongly agree	40	20.83
Break frequency	Every hour	74	38.54
	Every 2–3 hours	87	45.31
	Rarely	28	14.58
	Never	3	1.56

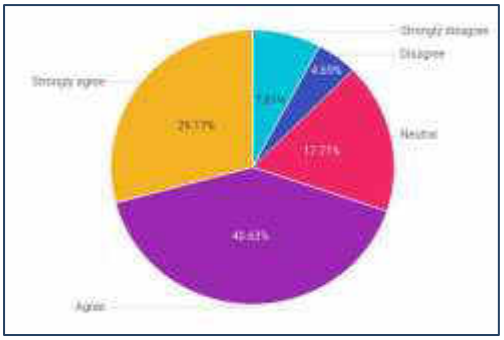

Figure 2. Water Intake during Work Hours

Figure 2 illustrates participants' responses regarding water intake during work hours, with most participants indicating adequate hydration practices.

4.3 Symptoms and Responses

Nearly half of the participants (49.47%) reported experiencing heat-related symptoms such as dizziness, headache, and fatigue during work. Table 4 presents the symptoms and responses.

Table 4. Symptoms and Responses

Variable	Category	n	%
Experienced symptoms	Yes	94	49.47
	No	96	50.53
Action taken	Took a break	110	62.86
	Reported to supervisor	23	13.14
	Ignored it	24	13.71
	Sought medical care	18	10.29

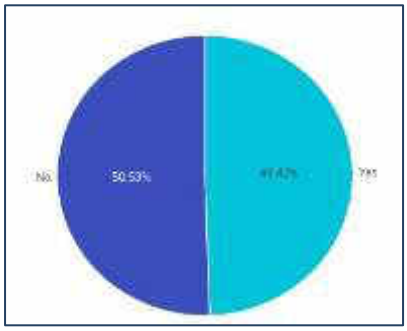

Figure 3. Experience of Heat Stress Symptoms

As shown in Figure 3, a substantial proportion of participants experienced heat-related symptoms during work.

4.4 Recommended Protective Measures

Participants showed a positive attitude toward advanced protective measures, particularly wearable cooling technologies. Table 5 shows the preferred protective measures.

Table 5. Preferred Protective Measures

Measure	n	%
Personal cooling devices	45	24.06
Air-cooled jackets	44	23.53
Cooling vests	38	20.32
Reflective clothing	34	18.18
Other	26	13.90

5. Conclusion and Recommendations

5.1 Conclusion

Based on the findings of this study, it can be concluded that occupational heat stress remains a significant hazard within industrial environments in the Kingdom of Saudi Arabia. Although most participants demonstrated awareness of heat stress as an occupational risk, the occurrence of heat-related symptoms among a considerable proportion of workers indicates a clear gap between awareness and the effective implementation of preventive measures.

The results further indicate that preventive measures are applied with varying levels of consistency, highlighting the need to strengthen organizational commitment to their proper implementation. In addition, workers showed positive attitudes toward engineering solutions and wearable cooling technologies, suggesting their potential to enhance existing preventive strategies. These findings demonstrate that awareness alone is not sufficient, and that consistent practical application is essential in reducing heat stress risks. However, the findings of this study are limited to the specific sample and context, which necessitates further research.

5.2 Recommendations

Based on the findings of this study, it is recommended to enhance the consistent implementation of preventive measures, particularly in high heat-exposure environments, by promoting proper hydration practices, the correct use of cooling equipment, and adherence to scheduled rest breaks. It is also recommended to review the availability and suitability of cooling equipment, encourage early reporting of heat-related symptoms, and assess the feasibility of adopting modern engineering solutions such as wearable cooling technologies. Furthermore, awareness and training programs should focus on practical application rather than solely on theoretical knowledge, and future research should include larger and more diverse samples to evaluate the long-term effectiveness of preventive strategies across different industrial environments.

References

[1] Albuwarthan, A., et al. (2019). Heat stress exposure among workers in Saudi Arabia. *International Journal of Environmental Research and Public Health*, 16(5), 1–10.

[2] Alshammari, M., et al. (2020). Prevalence of heat stress in industrial workers in Jubail. *Journal of Occupational Health*, 62(1), 1–8.

[3] González-Alonso, J., et al. (2008). Heat stress and cardiovascular function. *Journal of Applied Physiology*, 104(3), 1005–1012.

[4] Kjellstrom, T., et al. (2016). Impact of heat exposure on labor productivity. *Global Health Action*, 9(1), 1–10.

[5] National Institute for Occupational Safety and Health (NIOSH). (2016). Criteria for a recommended standard: Occupational exposure to heat and hot environments.

[6] Pal, J. S., & Eltahir, E. A. B. (2016). Future temperature in the Middle East. *Nature Climate Change*, 6(2), 197–200.

[7] Sawka, M. N., et al. (2011). Physiological responses to heat stress. *Comprehensive Physiology*, 1(4), 1883–1928.