

Knowledge, Attitudes, And Practices of Nurses on Heat Stroke Management During Hajj In Makkah: A Multicentric Cross-Sectional Study

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Abstract

Background: Heat stroke is a medical emergency that is life-threatening and preventable. It can be a serious public health concern during the annual Hajj pilgrimage because of the extreme heat and overcrowding. Nurses have a key role in early recognition, management and prevention of heat-related illness. However, limited literature is available on their preparedness to manage heat stroke during Hajj. So, the present study aims to evaluate the knowledge, attitudes and self-reported practices of nurses caring for pilgrims during Hajj in Makkah.

Methodology: This study is a descriptive cross-sectional multicentric study conducted among 377 registered nurses working in four Ministry of Health hospitals that serve pilgrims during Hajj 1446 in Makkah, Saudi Arabia. A validated, structured self-reported questionnaire was used to assess the nurses' knowledge, attitudes, and self-reported practices regarding heat stroke management. Data were analysed using descriptive statistics as well as the Mann-Whitney U and Kruskal-Wallis tests. Statistical significance was set at $p < 0.05$.

Results: Out of 377 participants, 87.5% were female, and 67.6% had a bachelor's degree. Nurses had a knowledge score of 13 of 18, an attitude score of 11 of 16 and a self-reported practices score of 5 of 6, regarding heat stroke management. Prior heat stroke education was significantly associated with higher knowledge scores ($p = 0.027$), and education level and professional role were significantly associated with attitude and practice scores ($p < 0.05$).

Conclusion: Nurses who provided care for pilgrims during Hajj exhibited favourable preparedness for heat stroke management, as evidenced by their appropriate self-reported practices, positive attitudes, and adequate knowledge. Continuing education based on competency, simulation training, and periodic evaluation of competency can be suggested to strengthen evidence-based management of heat-related emergencies during future Hajj

seasons.

Keywords: Heat stroke; Heat-related illness; Hajj; Mass gathering; Nurses; Knowledge, attitude and practice.

INTRODUCTION

Heat stroke is one of the most serious forms of heat-related illness (HRI). It is a life-threatening medical emergency characterised by a body temperature of more than 40°C and dysfunction of the central nervous system. Failure of prompt recognition and treatment can quickly progress to multiorgan dysfunction, permanent neurological impairment or death. Although advances in emergency medicine have enhanced patient prognosis, heat stroke remains a major cause of morbidity and mortality, especially in areas of extreme heat. Early recognition, rapid cooling and timely supportive management remain the cornerstone of treatment and are strongly associated with improved survival and reduced complications.^{1,2}

One of the world's largest recurring mass gatherings is the annual Hajj pilgrimage to Makkah, Saudi Arabia, where more than one million pilgrims from all over the world gather into a limited geographic area over a short period. Pilgrims are exposed to prolonged walking, physical exertion, crowding, dehydration and high ambient temperatures; all of which substantially increase the risk of heat-related illness. The 2024 Hajj season has seen temperatures crossing 50°C, leading to a significant increase in heat-related illnesses and deaths, even after preventive measures taken by the Saudi Ministry of Health.³

This challenge has been worsened by climate change and global warming, which have increased the frequency, duration and severity of extreme heat events around the world. Studies of climate modelling suggest that in future years, the Hajj season occurring in the summer months will be even more thermally stressful, increasing the risk of heat-related complications for pilgrims, particularly older adults and those with chronic medical conditions. Saudi Arabia has responded with a series of public health interventions including heat warning systems, shaded pedestrian routes, cooling stations, water distribution programmes and reinforced emergency medical services. However, the effectiveness of these preventive measures depends on the capacity of front-line health care providers to identify heat stroke promptly and initiate evidence-based management without delay.^{4,5}

Nurses play a central role in the management of heat-related emergencies during Hajj. Since delayed recognition and treatment are major determinants of adverse outcomes in heat stroke, nurses need adequate knowledge, appropriate clinical skills, and positive professional attitudes to provide timely and effective care. Therefore, nursing preparedness is an important factor in improving patient safety and reducing morbidity and mortality related to heat stroke during mass gatherings.^{2,6}

The Knowledge, Attitude and Practice (KAP) framework is frequently applied to evaluate the readiness of healthcare professionals, examining whether theoretical knowledge is translated into a positive professional attitude and appropriate clinical practice. Variability in the preparedness of healthcare workers and volunteers has been reported in previous studies conducted during Hajj. Education and previous training were identified as important determinants of heat stroke knowledge.^{7,8}

These studies are valuable, but most have focused on volunteers, mixed health personnel or preparedness in general rather than hospital nurses who directly care for heat-related ill pilgrims. Furthermore, there are limited multicentre studies that have appropriately evaluated the knowledge, attitudes, and clinical practices of nurses in managing heat stroke in hospitals serving pilgrims during Hajj.

Therefore, the present multicentre cross-sectional study aims to assess the knowledge, attitudes and self-reported practices of registered nurses concerning the management of heat stroke in hospitals providing care to pilgrims during Hajj 1446 in Makkah, Saudi Arabia.

Materials and Methods

Study Design

The multicentre descriptive cross-sectional study aims to evaluate the KAP of nurses regarding the management of heat stroke during Hajj 1446 in Makkah, Saudi Arabia. The study was designed and reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and Checklist for Reporting Knowledge, Attitude and Practice (CheckKAP)(Zarei et al., 2024)⁹.

Sample size calculation:

Sample size was determined using the G*Power software (Heinrich Heine University, Düsseldorf, Germany). Based on a significance level (α) of 0.05 and a statistical power of 95%, the minimum required sample size was estimated to be 337 participants. To account for potential non-response and incomplete questionnaires and to enhance the precision of the study estimates, 377 registered nurses were recruited and included in the final analysis.

Study Setting:

The study was conducted in four Ministry of Health hospitals that provide health care services to the pilgrims during Hajj in Makkah, Saudi Arabia. These hospitals are King Abdulaziz Hospital, Al-Noor Specialist Hospital, King Faisal Hospital, and King Abdullah Medical City.

Study Participants

The target population included 377 registered nurses who were involved in direct patient care of pilgrims during the Hajj. The inclusion criteria were: being registered with the Saudi healthcare system, having at least one year of clinical experience, being actively working during Hajj 1446, and being willing to give informed consent. Nurses who were not directly involved in the Hajj health services or who refused to participate were excluded from this study. A stratified random sampling technique was applied to select a sample that adequately represented nurses in the participating hospitals. Each hospital was considered a sampling stratum, and participants were selected in proportion to the nursing workforce in each institution.

Questionnaire Development:

The structured self-administered questionnaire was adapted from the validated Knowledge, Attitudes and Practices (KAP) instrument developed by AlJohani and Marzook and was used to collect data.¹⁰ The original tool was designed to measure knowledge, attitudes and practices of heat-related illness and was adapted for this study to reflect the clinical responsibilities of nurses caring for heat stroke during the Hajj season, while maintaining the original conceptual framework.

The questionnaire consisted of two parts. The first part included demographic and professional characteristics of the participants, including gender, educational qualification, years of nursing experience, professional role during Hajj, and previous education related to heat stroke. The second section assessed nurses' knowledge, attitude, and practice of heat stroke management and was comprised of three domains:

Knowledge: Eighteen items measuring knowledge of heat stroke, risk factors, clinical manifestations, prevention, and evidence-based management.

Attitude: 4 items to evaluate nurses' perception, confidence and professional responsibility in heat stroke prevention and management.

Practice: Six items assessing self-reported clinical practices on patient assessment, immediate cooling, monitoring and management of heat stroke patients.

Reliability and validity:

The adapted questionnaire was content validated by a panel of 5 experts in emergency nursing, community health nursing, and research methodology to evaluate its clarity, relevance, and appropriateness for the Hajj healthcare setting. Before data collection, slight modifications were made following their recommendations to improve the wording and contextual relevance. Then, a pilot study was conducted with 20 registered nurses to assess the clarity, feasibility and comprehensibility of the questionnaire. Participants included in the pilot study were excluded from the final analysis. The internal consistency reliability of the questionnaire was determined by Cronbach's alpha coefficient, which was overall 0.723, indicating an acceptable internal consistency for the adapted instrument.

Method of data collection:

Ethical approval was obtained from the Institutional Review Board (IRB), Makkah, Ministry of Health, Saudi Arabia (IRB No. H-02-K-076-0325-1324), and the Global Center for Mass Gathering Medicine (GCMGM), Ministry of Health, before the commencement of data collection. Data were collected before and during Hajj 1446. After obtaining administrative approval from participating hospitals, the principal investigator visited each study site to explain the study objectives and to invite eligible nurses to participate. Participants received an information sheet detailing the purpose of the research and were given access to the electronic questionnaire via a secure web link or QR code. The questionnaire took approximately 10–15 minutes to complete. Participation was completely voluntary, and no personal identifiers were gathered. Completed questionnaires were stored in a secure, password-protected electronic database with access limited to the research team.

Statistical Analysis:

The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, United States of America). Descriptive statistics were used to summarise participants' demographic and professional characteristics and knowledge, attitude and practice (KAP) scores. Categorical variables were described as frequencies and percentages, and continuous variables as means and standard deviations (SD) for normally distributed data, or medians and interquartile ranges (IQR) for non-normally distributed data. Normality of KAP scores was tested using the Shapiro-Wilk test. The KAP scores were not normally distributed; therefore, the Mann-Whitney U test was used to compare two independent groups, and the Kruskal-Wallis test was used to compare more than two groups. Statistical significance was defined as a two-sided p-value of < 0.05 .

Results

Participant Characteristics

A total of 377 registered nurses participated in the study. Most participants were female (330, 87.5%) and held a bachelor's degree (255, 67.6%). Nearly two-thirds (244, 64.7%) had ≥ 11 years of nursing experience. Staff nurses constituted the largest professional group (241, 63.9%), followed by senior nurses (108, 28.6%), while nurse supervisors and nurse managers each accounted for 3.7% of the study population. The majority of participants (360, 95.5%) reported having received previous education on heat stroke management (Table 1).

Table 1. Demographic and Professional Characteristics of Nurses Participating in the Study (N = 377)

Characteristic	Category	n	%
Gender	Male	47	12.5
	Female	330	87.5
Educational qualification	Diploma	98	26.0
	Bachelor's degree	255	67.6
	Master's degree	24	6.4
Years of nursing experience	1–5 years	14	3.7
	6–10 years	119	31.6
	≥ 11 years	244	64.7
Role during Hajj	Staff nurse	241	63.9
	Senior nurse	108	28.6
	Nurse supervisor	14	3.7
	Nurse manager	14	3.7
Previous education on heat stroke	Yes	360	95.5
	No	17	4.5

Distribution of Knowledge, Attitude, and Practice Scores

The median knowledge score was 13 (IQR = 2), with a mean $\pm$ SD of 13.12 ± 1.20 (range: 9–16). The median attitude score was 11 (IQR = 3), with a mean $\pm$ SD of 10.45 ± 1.57 (range: 5–12). The median practice score was 5 (IQR = 1), with a mean $\pm$ SD of 4.62 ± 1.02 (range: 2–6) (Table 2).

Table 2. Distribution of Knowledge, Attitude, and Practice Scores Among the Study Participants (N = 377)

Domain	Possible score	Median (IQR)	Mean $\pm$ SD	Observed range
Knowledge	0–18	13 (2)	13.12 ± 1.20	9–16
Attitude	4–16	11 (3)	10.45 ± 1.57	5–12
Practice	0–6	5 (1)	4.62 ± 1.02	2–6

IQR- interquartile range; SD- standard deviation.

Factors Associated with Knowledge Scores

Knowledge scores did not differ significantly according to gender ($p = 0.300$), educational qualification ($p = 0.290$), years of nursing experience ($p = 0.480$), or professional role during Hajj ($p = 0.191$). However, nurses who had received previous education on heat stroke demonstrated significantly higher knowledge scores than those without prior education (median 13 vs. 12; $p = 0.027$) (Table 3).

Table 3: Factors associated with the knowledge score related to Heat Stroke Among Study Participants.

Factors	Category	Knowledge Median (IQR) Score	p-value
Gender	Male	13 (1)	0.300*
	Female	13 (2)	
Education Level	Bachelor's Degree	13 (2)	0.290**
	Master's Degree	13 (2)	
	Nurse Diploma	13 (2)	
Years of Nursing Experience	1-5 years	13 (2)	0.480**
	6-10 years	13 (2)	
	11 years and above	13 (2)	
Role in Hajj Medical Team	Nurse Manager	13 (2)	0.191**
	Nurse Supervisor	13 (2)	
	Senior Nurse	13 (1)	
Medical Educational Experience in Heat Stroke	Staff Nurse	13 (2)	0.027*
	No	12 (2)	
	Yes	13 (2)	

*Mann-Whitney test; **Kruskal-Wallis test

Factors Associated with Attitude Scores

Attitude scores differed significantly according to gender ($p = 0.013$), educational qualification ($p = 0.004$), years of nursing experience ($p = 0.005$), and professional role during Hajj ($p < 0.001$). Female nurses demonstrated higher median attitude scores than male nurses (11 vs. 10). Nurses with 6–10 years and ≥ 11 years of experience had higher median attitude scores than those with 1–5 years of experience (11 vs. 10). Attitude scores did not differ significantly according to previous heat stroke education ($p = 0.732$) (Table 4).

Table 4: Factors associated with the Attitude Score related to Heat Stroke Among Study Participants

Factors	Category	Attitude Median (IQR) Score	P-value
Gender	Male	10 (4)	0.013*
	Female	11 (3)	
Education Level	Bachelor's Degree	11 (3)	0.004**
	Master's Degree	11 (1)	
	Nurse Diploma	11 (2)	
Years of Nursing Experience	1-5 years	10 (4)	0.005**
	6-10 years	11 (2)	
	11 years and above	11 (2)	
	Nurse Manager	10.5 (1)	<0.001**

Role in Hajj Medical Team	Nurse Supervisor	11 (2)	0.732*
	Senior Nurse	10 (2)	
	Staff Nurse	11 (2)	
Medical Educational	No	10 (3)	
Experience in Heat Stroke	Yes	11 (3)	
*Mann-Whitney test;		**Kruskal-Wallis test	

Factors Associated with Practice Scores

Practice scores were significantly associated with educational qualification ($p < 0.001$) and professional role during Hajj ($p < 0.001$). Staff nurses demonstrated the highest median practice score [5 (IQR = 2)], followed by senior nurses [4 (IQR = 1)], whereas nurse supervisors [3.5 (IQR = 1)] and nurse managers [3 (IQR = 1)] had lower median scores. No statistically significant differences in practice scores were observed according to gender ($p = 0.073$), years of nursing experience ($p = 0.581$), or previous heat stroke education ($p = 0.088$) (Table 5).

Table 5: Factors Associated with the Practice Score Related to Heat Stroke Among Study Participants

Factors	Category	Practice Median (IQR) Score	P-value
Gender	Male	4 (2)	0.073*
	Female	5 (1)	
Education Level	Bachelor's Degree	5 (1)	<0.001**
	Master's Degree	3.5 (1)	
	Nurse Diploma	5 (2)	
Years of Nursing Experience	1-5 years	5 (1)	0.581**
	6-10 years	5 (1)	
	11 years and above	5 (2)	
Role in Hajj Medical Team	Nurse Manager	3 (1)	<0.001**
	Nurse Supervisor	3.5 (1)	
	Senior Nurse	4 (1)	
Medical Educational	Staff Nurse	5 (2)	0.088*
	No	5 (2)	
	Yes	5 (1)	

*Mann-Whitney test; **Kruskal-Wallis test

Discussion

The present multicentre study evaluated nurses' knowledge, attitudes and self-reported practices regarding heat stroke management during Hajj 1446 in Makkah. Overall, participants demonstrated adequate knowledge, positive attitudes and favourable self-reported practices. Previous heat stroke education was significantly associated with higher knowledge scores,

whereas attitude varied according to gender, educational qualification, years of experience and professional role. Practice scores differed by educational qualification and professional role, highlighting the influence of organisational and professional factors on preparedness.^{3,7}

The nurses demonstrated good knowledge of heat stroke management, with a median score of 13 out of 18, indicating adequate recognition of risk factors, clinical manifestations and evidence-based management. These findings are consistent with Alrabie et al.⁸, who reported that nurses involved in Hajj healthcare recognised heat-related illness as a major clinical concern, and with Alamoudi et al.¹¹, who identified previous training as an important predictor of preparedness among Hajj health volunteers. Al Johani and Marzook¹⁰ reported similar observations among military personnel. Studies by Tang et al.¹², Xu et al.¹³, and Prasad et al.¹⁴, in broader emergency nursing settings, have likewise shown that structured education and institutional support improve nurses' emergency preparedness and clinical competence.

Previous heat stroke education was the only participant characteristic significantly associated with knowledge, supporting the findings of Zhao et al.¹⁵, who demonstrated that structured educational interventions improve emergency preparedness among nurses. In contrast, Xu et al.¹³ and Bini et al.¹⁶ found that demographic characteristics also influenced knowledge, attitudes and practices in community populations. The standardised training, frequent exposure and protocol-driven practice within Hajj healthcare services likely explain these differences.

Attitudes towards heat stroke management were generally positive. Female nurses, experienced nurses and those working in frontline clinical roles demonstrated higher attitude scores. Similar findings were reported by Alrabie et al.¹¹, Tang et al.¹², and Sugeng et al.¹⁷, who described strong professional commitment and positive attitudes among nurses involved in Hajj and emergency care. However, previous heat stroke education was not associated with attitude scores, suggesting that organisational culture, leadership and repeated emergency exposure also contribute to professional attitudes, consistent with Zhang et al.¹⁸ and Zhao et al.¹⁹

Practice scores were favourable but differed significantly according to educational qualification and professional role. Staff nurses achieved higher practice scores than supervisory personnel, reflecting their greater involvement in direct patient care. These findings agree with Alamoudi et al.⁸ and Prasad et al.¹⁴, who reported that regular participation in emergency response activities improves practical competence. Conversely, Bini et al.¹⁶ and Yang et al.²⁰ observed that knowledge does not always translate into appropriate practice, emphasising the importance of organisational support and structured emergency preparedness systems.

The findings have important implications for Hajj healthcare planning. As climate change increases the frequency of extreme heat events and the number of pilgrims continues to rise, maintaining a competent nursing workforce remains essential.^{3,4} Although preparedness was generally satisfactory, competency-based education should be complemented by simulation training, multidisciplinary emergency drills and periodic competency assessment, as recommended by Tremblay et al.⁶, Zhang et al.¹⁸, Zhao et al.¹⁹, and Yezli et al.²¹

Tremblay et al.⁶ and Yezli et al.²¹ further emphasised that early recognition and evidence-based management remain critical for reducing heat stroke morbidity and mortality.

Recent evidence further highlights the continuing burden of heat-related illness during Hajj despite extensive preventive measures implemented by the Saudi healthcare system. A recent prospective cohort study by Aldardeer et al.²² reported that heat stroke among pilgrims remains

associated with considerable complications and adverse clinical outcomes, particularly among elderly individuals and those with pre-existing medical conditions. Similarly, Bukhari et al.²³ identified several predictors of mortality among pilgrims with heat stroke, reinforcing the importance of rapid recognition, timely cooling, and early intensive management to improve survival. Epidemiological studies have also demonstrated that heat-related illnesses remain common during Hajj, with older age, prolonged sun exposure, dehydration, and chronic diseases consistently identified as major risk factors.²⁴ These findings emphasise the continued need for highly prepared frontline nurses who are capable of recognising deterioration early and initiating evidence-based interventions without delay.

The effectiveness of heat stroke prevention during Hajj also depends on pilgrims' awareness and adherence to preventive measures. Samarkandi et al.²⁵ reported that risky health behaviours, including inadequate hydration and prolonged exposure to high environmental temperatures, remain common among pilgrims despite public health campaigns. Earlier studies by Al Mayahi and Ali Kabbash²⁶ and Abdelmoety et al.²⁷ similarly demonstrated variable compliance with heat-protective practices and highlighted the influence of behavioural factors on heat-related illness. Furthermore, Seroji et al.²⁸ demonstrated that fluctuations in environmental temperature significantly influence the incidence of heat exhaustion during different Hajj seasons, illustrating the growing impact of climate variability on pilgrimage health. Collectively, these findings reinforce the need for continuous nursing education, effective patient education, multidisciplinary preparedness, and strengthened public health strategies to minimise heat-related morbidity and mortality during future Hajj seasons.

This study has several strengths, including its multicentre design, large sample size and use of a validated questionnaire, which enhance the representativeness and reliability of the findings. However, the cross-sectional design precludes causal inference, self-reported practices may be subject to recall and social desirability bias, and the study was limited to Ministry of Health hospitals during a single Hajj season. Future multicentre longitudinal and interventional studies incorporating objective assessments of clinical competence are needed to evaluate the effectiveness of simulation-based and competency-driven educational programmes in improving nursing preparedness during Hajj.

Conclusion

This multicentre cross-sectional study showed that nurses who provided care during Hajj 1446 in Makkah had satisfactory knowledge, positive attitudes, and favourable self-reported practices in heat stroke management. Previous heat stroke education was significantly associated with higher knowledge scores. Educational qualification and professional role were associated with selected aspects of attitudes and clinical practice. The results suggest that nurses in the Hajj healthcare services are generally well prepared to recognise and manage heat stroke, but also highlight the influence of professional and organisational factors on preparedness.

The increasing frequency of extreme heat events and the rising healthcare demands of Hajj should remain a priority for healthcare organisations to maintain nurses' preparedness. Preparedness for heat-related emergencies can be improved by complementing continuous professional education with simulation-based training, competency assessments, multidisciplinary emergency drills, and regular updates of evidence-based clinical protocols. Future multicentre longitudinal and interventional studies utilising objective measures of

clinical performance are required to assess the long-term efficacy of educational and organisational strategies in improving nursing practice and patient outcomes during Hajj.

Author Contribution Statement

The first author confirms responsibility for data curation, formal analysis using SPSS version 26.0, data collection, methodology development, and preparation of the initial manuscript draft. The co-author confirms responsibility for project management, study conceptualization, visualization, manuscript review and editing, critical review, the publication process, and post-publication activities. Both authors confirm that no third-party applications or software were used and that no artificial intelligence (AI) tools were used for manuscript preparation or data analysis.

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Declaration of Conflicting Interests

The authors declare that they have no conflicts of interest regarding the publication of this article.

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