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ORIGINAL ARTICLE

Characteristics and distribution of heat-related illnesses during Hajj 2022

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ABSTRACT

Introduction: Heat-related illnesses (HRIs) are defined as elevated body core temperatures when exposed to an intense high temperature. HRIs include but are not limited to heat exhaustion (HE) and heat stroke (HS). HE and HS are among the leading causes of morbidity and mortality among pilgrims when the Hajj season occurs during the hot cycle of the year in Makkah.

Method: A retrospective cross-sectional data analysis was conducted on HRI cases during Hajj 2022/1443 Hijri. The data were extracted from the Hajj electronic health records system software immediately at the end of the Hajj period.

Result: A total of 200 patients presented with HRI symptoms during the study period. Over half of the HRI patients were male (*n* = 116, 58%). The mean age was 44 ± 14.6 years. One hundred forty-three patients (71.5%) were diagnosed with HE, while 57 (28.5%) were diagnosed with HS. A statistically significant association between age and HRIs was observed.

Conclusion: More HRIs are expected due to the gradual elevation of ambient temperature and the global warming phenomenon. This study emphasizes the importance of education and awareness regarding preventive measures in the general population, especially among the most vulnerable subpopulations.

Keyword: Heat-related illnesses, Hajj, mass gatherings, public health.

Introduction

Heat-related illnesses (HRIs) are defined as elevated body core temperatures when exposed to an intense high temperature. HRIs include but are not limited to heat exhaustion (HE) and heat stroke (HS) [1]. HE is characterized by mild signs and symptoms, such as fatigue, vomiting, and cramps. HS is a more extreme life-threatening condition that can involve organ damage and neurological alterations [1].

Hajj is a religious mass gathering event undertaken in the Makkah region of Saudi Arabia. The Hajj season is an annual event that takes place on the 12th month of the Islamic lunar calendar (from the 8th to the 13th of Dhu al-Hijja) [2]. Makkah's climate is arid, characterized by hot desert weather with elevated daytime temperatures and relative humidity [3,4]. The hot temperature has trended upward in recent years, and future incremental increases have been predicted [3,5]. The Ministry of Health (MoH) and Hajj Committees collaborate to prepare for emergencies and communicable and noncommunicable diseases during Hajj [6]. This preparation includes providing the necessary equipment, facilities, and trained staff to hospitals in Makkah and Mashaer during the Hajj season [7].

The healthcare facilities covered by the Saudi MoH during the 2022/1443 Hijri Hajj season in Makkah and Mashaer (Mina, Arafat, and Muzdalefah) comprised 23 hospitals, and 152 total healthcare centers in Makkah, Madinah, and Mashaer. With a total of 97 emergency care centers, and 511 ambulances, alongside 716 total beds in Mashaer hospitals [8]. As part of the Hajj journey, many pilgrims (who are not necessarily citizens of Saudi

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Arabia) arrive before the beginning of the Hajj season and may stay for a few days after. During their stay, many pilgrims visit Al-Madinah Al-Munawarah, where the Holy Prophet's Masjid is located, 425 km north of Makkah [9]. In the 2021/1442 Hijri Hajj season, 46 cases of HE and no cases of HS occurred among the 58,745 pilgrims [10]. HE and HS are among the leading causes of morbidity and mortality among pilgrims when the Hajj season encounters during the hot cycle of the year in Makkah [11,12]. The Saudi MoH developed guidelines for managing HRIs in 2016. Furthermore, in 2019, the MoH updated the interim guidelines for healthcare workers. The updated guidelines comprise evidence-based pathways for pre-hospital and in-hospital management [11].

Therefore, in this study, we characterized HRIs among Hajj pilgrims in 2022, including the demographics, clinical features, case management and outcomes, and prevalence with a goal to optimize the diagnosis and management of HRI cases and the implementation of effective public health preventive measures to reduce the burden of these illnesses during future pilgrimages.

Method

Study design and settings

This retrospective cross-sectional data analysis focused on HRI cases during Hajj 2022/1443 Hijri. The study period was from the 14th Shawal 1443H to the 2nd Safar 1444H, corresponding to May 15 to August 29, 2022. The detailed study period described was as follows: (1) Pre-Hajj: May 15 to July 6, 2022; (2) Hajj rituals: July 7-11, 2022, distributed as Tarwiah Day on July 7, 2022, Arafat Day on July 8, 2022, and Mina Days on July 9-11, 2022; and (3) post-Hajj period: July 12 to August 29, 2022. Data were obtained from all hospitals and primary health centers (PHCs) in the holy Hajj sites of Makkah (Mina, Arafat, and Muzdalifah) and Madinah, KSA.

Data collection

The data were extracted from the Hajj electronic health records system software immediately at the end of the Hajj period. Data on all HS and HE patients who presented at emergency, inpatient, and outpatient departments were retrieved from these records. The data retrieved included the demographic information of the patients, including their patient file number, age, sex, nationality, country region, residency, admission department, visit date, Hajj status, and initial and final diagnoses, along with the facility name, hospital name, region (Makkah and Madinah), and health cluster.

Data analysis

Categorical variables are presented as frequencies and percentages, and comparisons were made using Fisher's exac*t test*. Associations were considered statistically significant at a *p*-value of 0.05. Quantitative variables were tested for normal distribution using the Kolmogorov-Smirnov test. Continuous variables are presented as the mean value ± standard deviation (SD).

Missing data points for continuous variables were treated with multiple imputations under the missing-at-random assumption. Pooled means and SDs were generated. Complete case analyses were conducted for categorical variables, presented as frequencies and percentages with 95% confidence intervals. Analyses were performed using SPSS Statistics version 28 (IBM, Armonk, NY, USA).

Ethical consideration

This study was approved and expedited by the General Department of Research and Study Ethical Committee at Makkah Health Affairs (IRB log# H-02-K-076-0722-771). Data were de-identified in accordance with the standards to protect the confidentiality of the patients' personal health information.

Results

Study population and demographics

A total of 200 patients presented with HRI symptoms during the study period. Over half of them were male (*n* = 116, 58%). The mean age was 44 ± 14.6 years (Table 1). Most of the HRI patients were from Saudi Arabia (*n* = 73, 37%), Egypt (*n* = 24, 12%), and Pakistan (*n* = 15, 8%; Figure 1). The HRI patient regional distribution data revealed that the majority were residents of the Eastern Mediterranean (*n* = 145, 72.5%), South-East Asian (*n* = 25, 12.5%), and African (*n* = 17, 8.5%) regions. A total of 104 (52%) HRI patients were admitted to the emergency room, while 54 (27%) and 42 (21%) were admitted as outpatient and inpatient, respectively. Most HRI patients were Hajji (*n* = 130, 65%) (Table 1).

Heat-related illness distribution

Overall, 143 patients (71.5%) were diagnosed with HE and 57 (28.5%) with HS (Table 1). Of the HE patients, 83 (58%) were admitted to the emergency room, 38 (27%) were admitted as outpatients, and 22 (15%) were admitted as inpatients (Figure 2). The location distribution of the patients (Makkah, Arafat, Mina, and Madinah) revealed that HRIs were more likely to be reported in Mina (*n* = 65, 32.5%; *p*-value: 0.01), followed by Makkah (*n* = 50, 25%), Arafat (*n* = 50, 25%), and Madinah (*n* = 35, 17.5%) (Figure3).

Regarding the HRI distribution per location, HE accounted for 78% (*n* = 39), 60% (*n* = 30), 75% (*n* = 49), and 71% (*n* = 25) of HE cases in Makkah, Arafat, Mina, and Madinah, respectively (Figure 3).

Most of the HRI cases captured during the total study period occurred during the Hajj rituals (Tarwiah, Arafat, and Mina Days), followed by the pre-Hajj and post-Hajj periods. During the Hajj rituals, the largest number of patients with HRI presented during Arafah Day (*n* = 48; 24%). Among the 3 days of Mina, most HRI cases were presented on the first day (*n* = 38, 19%; *p*-value: 0.03). Throughout the Hajj period, there were more HE than HS cases (Figure 4). The distribution of HRIs by presentation time revealed that most HRIs occurred between 14:00 and 15:00 (*p*-value: 0.01; Figure 5).

Table 1. *Demographic characteristics of patients admitted with HRI during the 2022 Hajj Season.*

Variable		HE, *n* (%)	HS, *n* (%)	Total
Age group years	<30	32 (22.4)	6 (10.5)	38 (19)
	≥60	23 (16.1)	14 (24.6)	37 (18.5)
	30-44	43 (30.1)	16 (28.1)	59 (29.5)
	45-59	45 (31.5)	21 (36.8)	66 (33)
Sex	Female	61 (42.7)	23 (40.4)	84 (42)
	Male	82 (57.3)	34 (59.6)	116 (58)
Region	African region (AFR)	12 (8.4)	5 (8.8)	17 (8.5)
	Eastern Mediterranean Region (EMR)	103 (72)	42 (73.7)	145 (72.5)
	European region (EUR)	3 (2.1)	3 (5.3)	6 (3)
	Region of the Americas (AMR)	3 (2.1)	0 (0)	3 (1.5)
	South-East Asian Region (SEAR)	18 (12.6)	7 (12.3)	25 (12.5)
	Western Pacific Region (WPR)	4 (2.8)	0 (0)	4 (2)
Hajj Status	Hajj	90 (62.9)	40 (70.2)	130 (65)
	Non-Hajj	53 (37.1)	17 (29.8)	70 (35)
Admission	Emergency	83 (58.0)	21 (36.8)	104 (52)
	Inpatient	22 (15.4)	20 (35.1)	42 (21)
	Outpatient	38 (26.6)	16 (28.1)	54 (27)
Total		143 (71.5)	57 (28.5)	200 (100)

HE: Heat exhaustion; HS: Heat stroke

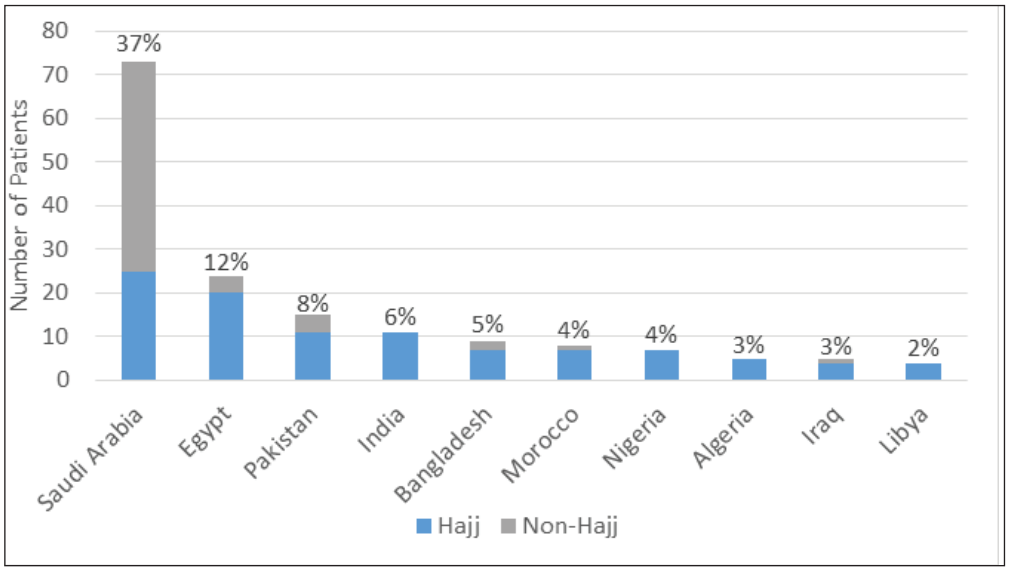

Figure 1. *Percentage of those experienced HRI per country of origin in the population of patients who developed HRI during Hajj 2022/1443H.*

A total of 25 patients (12.5%) were admitted to Al Noor Specialist Hospital in Makkah, while 20 (10%), 20 (10%), 19 (9.5%), and 19 (9.5%) were admitted to Mina PHC, East Arafat Hospital, Maternity and Children Hospital in Medina, and Mina Al Jisr Hospital, respectively (Table 2).

Association between demographics and heat-related illness

A statistically significant association between age and HRIs was observed; 44 (77%) HS patients were ≥40 years of age, while 13 (23%) were <40. Moreover, 79 (55%) of the HE patients were ≥40 years of age, while (n = 64, 45%) were <40 (Table 3; p-value: 0.004). There was no statistically significant association between HRIs and the patients' sex (p-value: 0.874) or region of origin (p-value: 0.524; Table 3).

Discussion

This study revealed that HE is the most common HRI. In addition, a quarter of patients with HRI presented during Arafat Day. Among the 3 days of Mina, most patients presented during the first day. Those older than 40 years of age were more prone than younger individuals to developing HRIs. The incidence of HRI peaked between 14:00 and 15:00 due to increased solar radiation during this time.

The timing of the Hajj season depends on the Islamic (lunar) calendar; thus, Hajj may occur during the hot summer season, when the temperature can exceed 45°C.

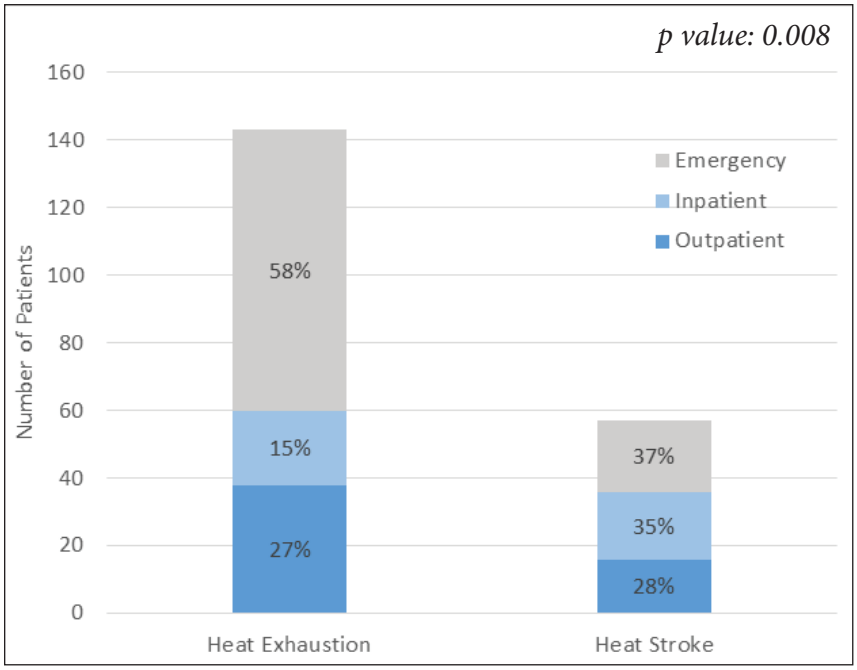

Figure 2. *ER versus inpatient versus OPD distribution of HRI patients.*

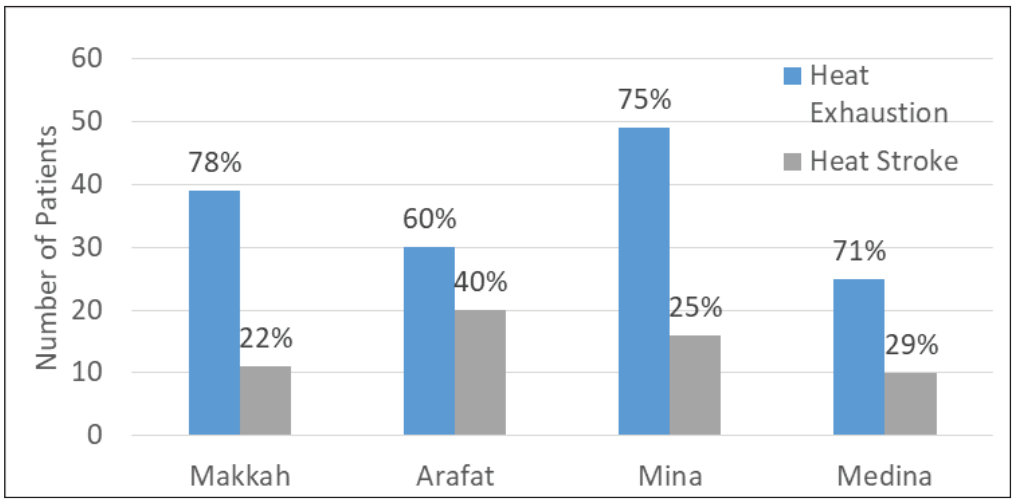

Figure 3. *Distribution of HRI per location.*

High temperatures are associated with various HRIs, ranging from minor conditions, such as heat cramps and edema, to serious conditions, such as HE and HS [7,13].

HRIs are regularly reported during the Hajj pilgrimage and at mass gathering events. HRIs result in significant morbidity and mortality [11].

A previous study was conducted during Hajj 2019 to determine the presence of acute illnesses among Hajj pilgrims; 16% of the admitted patients had HE [14]. In addition, a previous study published in 2018 involving 267 cases reported that the majority of patients had HE (68%), and (29%) had HS [7]. These findings are similar to those in the current study, in which most cases were HE (71%). Conversely, in another previous study, the prevalence of HE and HS was approximately equal (49% and 51%, respectively) [11].

A previous study showed that most patients with HRI were from India (16.7%), Egypt (16.7%), Indonesia (11.1%), Saudi Arabia (8.9%), and Pakistan (8.5%) [7]. In contrast, in the current study, the majority of HRI patients were of Saudi nationality (37%), followed by Egyptian (12%) and Pakistani (8%) nationality. The regional HRI case distribution in the current study was similar to that in previous reports; most HRI patients were residents of the Eastern Mediterranean Region, followed by the South-East Asian Region [11].

In the current study, the majority of the HRI patients in each location (Makkah, Arafat, Mina, and Madinah) were diagnosed with HE. The mean age was 44 ± 14.6 years with almost 60% of patients being male. These findings were similar to those reported in Alkassas et al. [15] in which the majority of the patients were male (56%) and the mean age was 47 years. A literature review conducted in 2017 reviewing sex differences

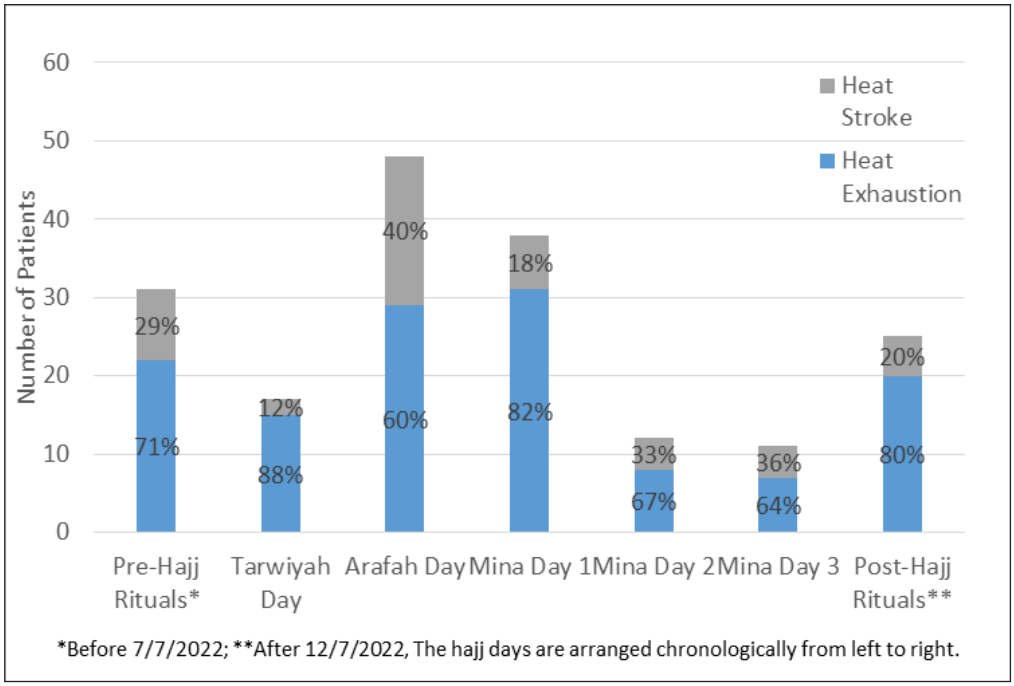

Figure 4. *Distribution of HRI cases by day.*

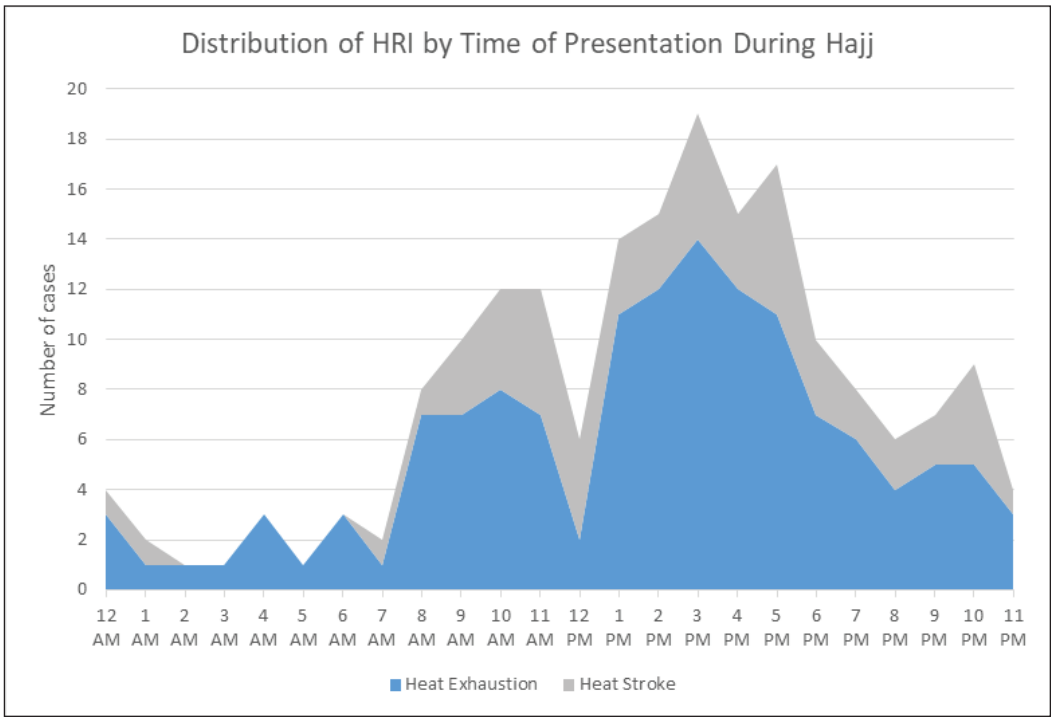

Figure 5. *Distribution of HRIs by time of presentation.*

in mortality after heat waves in Europe revealed that, while mortality among females could be twice as high as that in males, men may experience more severe illness outcomes. The review concluded that elderly females have a higher mortality rate than males in heat waves [16]. Nevertheless, the current study did not show a significant relationship between the patients' sex and susceptibility to HRIs.

A study published in 2008 indicated that the ambient temperature in Makkah ranged from 33°C to 40°C, reaching its peak at 14:00 during the time of the highest solar radiation, with relative humidity reaching 20%-40% [17]. In the present study, the peak of HRI onset was between 14:00 and 15:00.

The HRI case distribution among hospitals and healthcare centers revealed that Al Noor Specialist Hospital in Makkah had a higher administration rate than the other hospitals and healthcare facilities. The majority of HRI patients were admitted to the emergency room (52%).

Table 2. *HRI case distribution among hospitals and healthcare centers.*

	Hospital	*n* (%)
Arafat	ARAFAT PHC	4 (2)
	East Arafat Hospital	20 (10)
	Jabal Al Rahmah Hospital	15 (7.5)
	Namerah General Hospital (Arafat)	11 (5.5)
	Total	50 (25)
Makkah	Ajyad Emergency Hospital	8 (4)
	Al Noor Specialist Hospital - Makkah	25 (12.5)
	Haram Emergency Hospital	1 (0.5)
	King Abdallah Medical City	3 (1.5)
	King Abdulaziz Hospital - Makkah	7 (3.5)
	King Faisal Hospital - Makkah	6 (3)
	Total	50 (25)
Medina	Al Hamnah General Hospital	1 (0.5)
	Al Hinakiah General Hospital	1 (0.5)
	Khayber General Hospital	1 (0.5)
	King Fahad Hospital - Madinah	3 (1.5)
	King Salman Medical City - Maternity And Children Hospital - Madinah	19 (9.5)
	Madinah Hospital - King Salman City	1 (0.5)
	Miqat General Hospital	3 (1.5)
	Yanbu Al-Nakheel Hospital	1 (0.5)
	Yanbu General Hospital	5 (2.5)
	Total	35 (17.5)
Mina	MENA PHC	20 (10)
	Mina Al Jisr Hospital	19 (9.5)
	Mina Al Wadi Hospital	13 (6.5)
	Mina Emergency Hospital	8 (4)
	Mina Shara Jadid Hospital	5 (2.5)
	Total	65 (32.5)
	Grand Total	200 (100)

Table 3. *Associations between demographic characteristics and HRI during Hajj 2022.*

		HE	HS	*p*-value
Age group	Greater than or equal to 40 years	79 (55.2%)	44 (77.2%)	0.004
	Less than 40 years	64 (44.8%)	13 (22.8%)	
Sex	Female	61 (42.7%)	23 (40.4%)	0.874
	Male	82 (57.3%)	34 (59.6%)	
Region	African Region (AFR)	12 (8.4%)	5 (8.8%)	0.524
	Eastern Mediterranean Region (EMR)	103 (72%)	42 (73.7%)	
	European Region (EUR)	3 (2.1%)	3 (5.3%)	
	Region of the Americas (AMR)	3 (2.1%)	0 (0%)	
	South-East Asian Region (SEAR)	18 (12.6%)	7 (12.3%)	
	Western Pacific Region (WPR)	4 (2.8%)	0 (0%)	

During the Hajj season, the pilgrims are educated on preventive measures against HRI, such as using umbrellas, staying hydrated, and avoiding excessive exposure to the sun [7]. However, previous studies have shown that there is poor compliance with preventive measures, including the use of umbrellas. The most common reasons individuals provided for not complying were they did not have the ability or thought that they did not need it [14]. We believe that strong preventive measures can play a role in reducing the incidence of HRIs during the Hajj season.

Conclusion

This study shows that HRIs are prevalent during Hajj season and that older individuals are more likely than younger individuals to develop HRI. A substantial proportion of HRI cases occurred at 14:00; in addition, there was a noticeable rise in HRIs in the evening. More

HRIs are expected due to the gradual elevation of ambient temperatures and the global warming phenomenon. Furthermore, this study emphasizes the importance of education and awareness regarding preventive measures in the general population, especially the most vulnerable subpopulations. Future studies should focus on raising awareness and enacting preventive measures.

List of Abbreviations

HRI	Heat-related illnesses
HS	Heat stroke
HE	Heat exhaustion
MOH	Ministry of Health
SD	Standard deviation

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