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Heat stroke and heat exhaustion among pilgrims: common signs and symptoms, laboratory profile and methods of managements

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ABSTRACT

Background: In the last few years, Hajj season is characterized by high temperature reached up to 46°C.Exposure to great hot environment accompanied with fatigue may result in different heat-related illnesses including heat cramps, heat exhaustion and heat stroke. **Objectives:** To investigate the types, symptoms, signs, laboratory parameters, associated chronic disease and medical managementof heat illness experienced by pilgrims in the fields and emergency centers. **Subjects and methods:** It is an analytical cross sectional study conducted during Hajj season (2017-2018) including all patients exposed or attended the emergency departments or centers of management heat related medical problems in Ministry of Defense hospitals and centers in Makkah city, Kingdom of Saudi Arabia. A prepared checklist was used to collect data about demographic characteristics of patients, associated risk factors, signs and symptoms as well as data about managements of heat stroke and heat exhaustions. **Results:** The study included 73 patients diagnosed with either heat exhaustion (52; 71.2%) or heat stroke (21; 28.8%). Their age ranged between 30 and 80 years (57.8±12.7). Males represent 57.5% of them. History of vaccination against seasonal influenza and meningitis was observed among 60% of them.Majority of the patients (74%) exposed to heat for 2-4 hours. The most frequent encountered symptoms were headache (82.2%), extreme weakness (80.8%), and dizziness/vertigo (78.1%). Their body temperature ranged between 31.6-41.2 ˚C (37.4±1.7).Glasgow coma scale ranged between 10 and 15 (14.5±1.2). Dry tongue, sunken eyes, skin rash and complications were observed among 68.5%, 31.5%, 11% and 4.1% of them, respectively. Admission for two hours or more was reported among 20 cases (27.4%), with no significant difference between cases of heat stroke and those with heat exhaustion. Analgesics were given to 9 patients (12.3%); more significantly in cases of heat stroke (19% versus 9.6%), p=0.045. History of transfer was reported among 9 patients (12.3%); more significantly in cases of heat stroke (23.8% versus 7.7%), p=0.041. Air condition was provided to majority of patients (94.5%) more significantly among patients with heat exhaustion than heat stroke (98.1% versus 85.7%), 0.018. Water/ice with Fam was given to 41 patients (56.2%); more significantly to patients with heat stroke (85.7% versus 44.2%)

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Introduction

The Pilgrimage to Makkah, which called [The Hajj] is an ancient occasion which was established long ago in Arabia before Islam and with Islam, it is one of the five Pillars of the Islamic Religion and every Muslim has to perform its duties once in life.[1]

Exposure to great hot environment accompanied with fatigue may result in different heat-related illnesses including heat cramps, heat exhaustion and heat stroke.[2] The most serious one is heat stroke; however fortunately it is the least common.[2]

In the last few years, Hajj season is characterized by high temperature reached up to 46°C.[3] Hajj pilgrims particularly old aged and those who having chronic diseases are usually at high risk of heat exhaustion and heat strokes due to strenuous physical activities, overcrowding, lack of acclimatization, and dehydration.[4]

Signs of heat exhaustion can be developed within short time of heat exposure and may include general weakness, tiredness, feeling dizzy, hypotension, headache, muscle cramps, feeling of being sick, excessive thirst, heavy sweating, tachycardia, and less amount and darker urine. [5]

Several different factors are associated with the increase risk of heat related health problems. These factors either related to the environment such as air temperature, humidity, speed of the wind and radiation and personal-related such as being older than 60 years, heat acclimation, previous experience with heat-related illness, type of taken medications, presence of chronic diseases, excessive obesity and dehydration.[6]

The management of heat exhaustion and heat stroke depends on the severity of symptoms and signs and general medical conditions of the patient.[7]

The present study was carried out aimed to enumerate the risk factors associated with heat stroke and heat exhaustions, identify the most common associated signs and symptoms and evaluate the methods of management in the fields and emergency centers.

Subjects and methods

It is an analytical cross sectional study conducted during Hajj season 2018 including all patients exposed or attended the emergency departments or centers of management heat related medical problems in Ministry of Health [MOH] hospitals and Ministry of Defense hospitals and centers in Makkah city, Kingdom of Saudi Arabia. No specific exclusion criteria were defined. A prepared checklist was used to collect data about demographic characteristics of patients, associated risk factors, signs and symptoms as well as data about managements of heat stroke and heat exhaustions.

Heat exhaustion was considered in patients with mild-to moderate heat-related illness as a result of exposure to high environmental heat with the clinical signs and symptoms of severe thirst, general weakness, discomfort, dizziness, anxiety, and syncope. The body temperature was either normal or slightly elevated, >37°C and less than 40°C. However, heat stroke was considered in patients with a severe form of heat-related illness characterized by high temperature [>40°C] and central nervous system dysfunction due to passive exposure to environmental heat.[8]

Ethical approval was obtained from the Regional Research and Ethics committee at Al-Hada Armed Forces hospital in Taif city. Also, all ethical issues were followed throughout all steps of the study.

Data entry and statistical analysis were performed using the Statistical Package for Social Sciences [SPSS] software, version 25. Description of categorical variables was done using frequency and percentage while for continuous variables; mean and standard deviation were applied. Chi-square test was used to investigate the association between categorical variables and p-value <0.05 was considered statistically significant.

Results

The study included 73 patients diagnosed with either heat exhaustion [52; 71.2%] or heat stroke [21; 28.8%] as displayed in Figure 1. Table 1 summarizes their personal characteristics. Their age ranged between 30 and 80 years [57.8±12.7]. Males represent 57.5% of them. Majority of them were married [97%] and non-Saudis represent majority of them [78.5%]. History of vaccination against seasonal influenza and meningitis was observed among 60% of them.

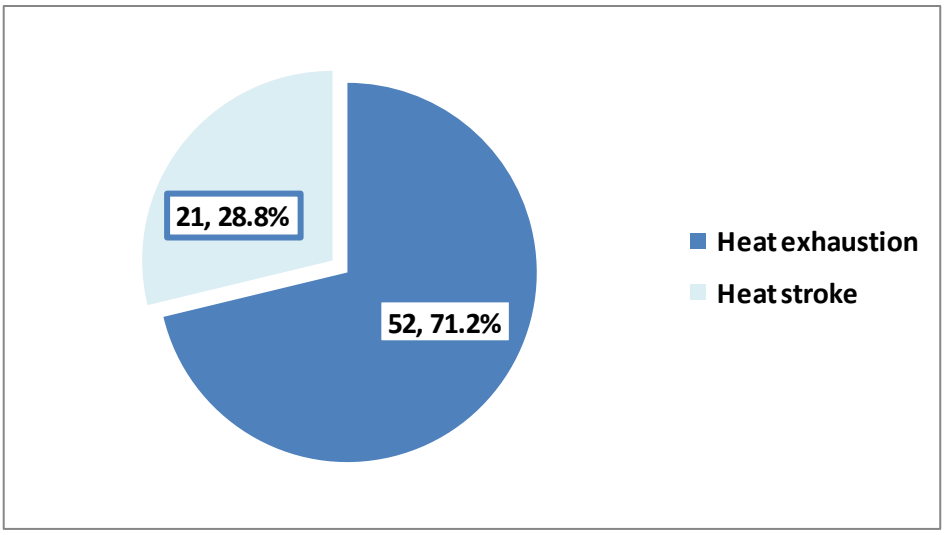

Figure 1: Frequency of heat stroke and heat exhaustion among the participants

Table 1: Personal and demographic characteristics of the participants [n=73]

Age in years [n=69] Range Mean±SD	 30-80 57.8±12.7
Gender Male [N; %] Female [N; %]	 42; 57.5 31; 42.5
BMI "Kg/m^2" [n=23] Range Mean±SD	 20.7-42.5 28.4±5.4
Marital status [n=66] Married [N; %] Unmarried [N; %]	 64; 97.0 2; 3.0
Nationality [n=65] Saudi [N; %] Non-Saudi [N; %]	 14; 21.5 51; 78.5
Ethnicity Arab [N; %] Asian [N; %] African [N; %]	 43; 58.9 16; 21.9 14; 19.2
Smoking history [n=57] Smoker [N; %] Non-smoker [N; %]	 14; 24.6 43; 75.4
History of allergy [n=64] Yes [N; %] No [N; %]	 2; 3.1 62; 96.9
History of vaccination [n=55] Yes [N; %] No [N; %]	 33; 60.0 22; 40.0

Table 2: Details of exposure to heat among the participants [n=73]

	Frequency	Percentage
Duration of exposure [hours]		
<2	15	20.5
2-4	54	74.0
>4	4	5.5
Physical activity involved prior to heat illness		
Walking	68	93.2
Running	4	5.5
Carrying luggage	11	15.1
Using umbrella	35	47.9
Stuck in crowd	29	39.7
Acclimatization to hot weather	22	30.1
Climbing	10	13.7
Kind and amount of fluid used		
Water	69	94.5
<1 liter	28	38.4
1-2 liter	39	53.4
>2-4 liter	2	2.7
Juice	55	75.3
<1 liter	8	11.0
1-2 liter	45	61.6
>2-4 liter	2	2.7
Formula	35	47.9
<1 liter	6	8.2
1-2 liter	29	39.7

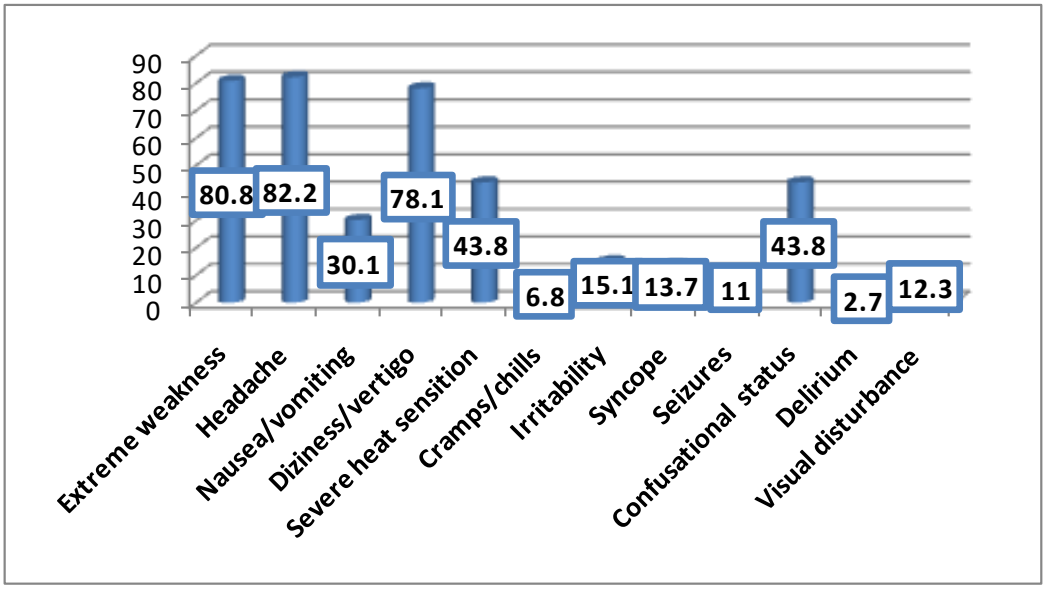

Figure 2: Symptoms encountered by the participants [n=73]

Majority of the patients [74%] exposed to heat for 2-4 hours. Regarding the physical activity involved prior to heat illness, walking was reported by the majority [93.2%], whereas using umbrella and stuck in crowd were reported by 47.9% and 39.7% of them, respectively. Concerning kind and amount of fluid used, majority of them [94.5%] used water; mainly 1-2 liter [53.4%]. Juice and formula were used by 75.3% and 47.9% of them, respectively.

As evident from Figure 2, the most frequent encountered symptoms were headache [82.2%], extreme weakness [80.8%], and dizziness/vertigo [78.1%].

Their body temperature ranged between 31.6-41.2 ˚C [37.4±1.7], heart rate between 72-150 [98.1±16.9] and respiratory rate ranged between

16 and 26 [18.9±2.2]. Glasgow coma scale ranged between 10 and 15 [14.5±1.2]. Dry tongue, sunken eyes, skin rash and complications were observed among 68.5%, 31.5%, 11% and 4.1% of them, respectively as illustrated in Table 3.

Table 3: Vital Signs and commonly reported signs among the participants

Body temperature [n=73] Range mean±SD	 31.6-41.2 37.4±1.7
Systolic blood pressure [n=67] Range mean±SD	 100-180 135.0±20.9
Diastolic blood pressure [n=67] Range mean±SD	 50-110 80.8±14.0
Heart rate [n=51] Range mean±SD	 72-150 98.1±16.9
Respiratory rate [n=43] Range mean±SD	 16-26 18.9±2.2
Oxygen saturation [%] [n=61] Range mean±SD	 90-100 95.3±2.5
Glasgow coma scale [out of 15] [n=56] Range mean±SD	 10-15 14.5±1.2
Excessive sweating [N; %]	54; 74.0
Dry tongue [N; %]	50; 68.5
Sunken eyes [N; %]	23; 31.5
Skin rash [N; %]	8; 11.0
Complications [N; %]	3; 4.1

Table 4: Comparison of vital signs and commonly reported signs between patients with heat stroke and those with heat exhaustion (* Student t-test; ** Chi-square test)

	Heat stroke	**Heat exhaustion**	**p-value**
Body temperature [n=73] mean±SD	37.1±2.6	37.5±1.2	0.396*
Systolic blood pressure [n=67] mean±SD	128.0±28.1	137.7±16.8	0.084*
Diastolic blood pressure [n=67] mean±SD	73.5±13.2	83.8±13.4	0.006*
Heart rate [n=51] mean±SD	96.9±15.0	98.5±17.7	0.761*
Respiratory rate [n=43] mean±SD	19.1±2.0	18.9±2.3	0.765*
Oxygen saturation [%] [n=61] mean±SD	92.3±2.8	96.2±1.6	<0.001
Glasgow coma scale [out of 15] mean±SD	13.6±2.0	14.7±0.7	0.003*
Excessive sweating [N; %]	16; 76.2	38; 73.1	0.409**
Dry tongue [N; %]	19; 90.5	31; 59.6	0.029**
Sunken eyes [N; %]	8; 38.1	15; 28.8	0.297**
Skin rash [N; %]	4; 19.0	4; 7.7	0.264**
Complications [[N; %]	3; 14.3	0; 0.0	0.015**

Table 5: Comparison of history of chronic diseases between patients with heat stroke and those with heat exhaustion

	Heat stroke N=21 N [%]	Heat exhaustion N=52 N [%]	p-value
Heart diseases	2 [13.3]	8 [17.4]	0.532*
Diabetes mellitus	7 [46.7]	16 [30.8]	0.253**
COPD	0 [0.0]	2 [4.3]	0.672
Hypertension	3 [18.8]	22 [44.0]	0.062*
Bronchial asthma	0 [0.0]	4 [8.0]	0.320*
Skin diseases	6 [37.0]	0 [0.0]	<0.001*
Others	0 [0.0]	4 [10.5]	0.321*

* Fischer exact test ** Chi-square test

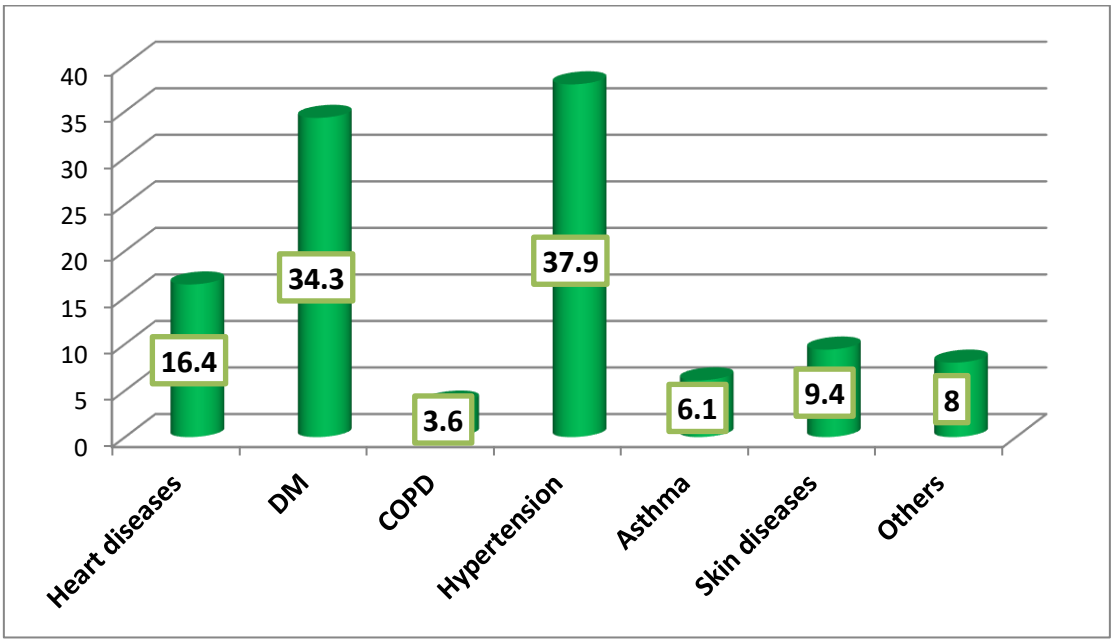

Figure 3: History of chronic diseases among the pstients.

Diastolic blood pressure was significantly higher among patients with heat exhaustion compared to those with heat stroke [83.8±13.4 versus 73.5±13.2], p=0.006. Similarly, oxygen saturation was significantly higher in heat exhaustion than heat stroke [96.2±1.6 versus 92.3±2.8], p<0.001. Glasgow coma scale was higher in heat exhaustion cases than in heat stroke cases [14.7±0.7 versus 13.6±2.0], p=0.003. On the other hand, dry tongue was more observed in heat stroke than heat exhaustion cases [90.5% versus 59.6%0, p=0.029. Complication were reported in 14.3% of heat stroke cases compared to none of heat exhaustion cases, p=0.015. Table 4

As shown in Figure 3, hypertension [37.9%], diabetes mellitus [34.3%] and heart disease [16.4%] were the commonest reported chronic diseases among the participants as illustrated in Figure 3. More than one third [37%] of cases of heat stroke had chronic skin diseases compared to none of those with heat exhaustion, p<0.001. Admission for two hours or more was reported among 20 cases [27.4%], with no significant difference between cases of heat stroke and those with heat exhaustion. Analgesics were given to 9 patients [12.3%]; more significantly in cases of heat stroke [19% versus 9.6%], p=0.045. History of transfer was reported among 9 patients [12.3%]; more significantly in cases of heat stroke [23.8% versus 7.7%], p=0.041. Air condition was provided to majority of patients [94.5%] more significantly among patients with heat exhaustion than heat stroke [98.1% versus

85.7%], 0.018. Water/ice with Fam was given to 41 patients [56.2%]; more significantly to patients with heat stroke [85.7% versus 44.2%], p<0.001. Table 6

Table 6: Comparison between heat stroke and heat exhaustion concerning the management

	Heat stroke N=21 N [%]	Heat exhaustion N=52 N [%]	p-value
Admission			
No [n=23]	15 [28.8]	8 [38.8]	
Yes, <2 hours [n=30]	7 [33.3]	23 [44.2[	
Yes, ≥2 hours [n=20]	6 [28.6]	14 [26.9]	0.653
Analgesics			
No [n=34]	5 [23.8]	29 [55.8]	
Yes [n=9]	4 [19.0]	5 [9.6]	
Unknown [n=30]	12 [57.1]	18 [34.6]	0.045
Antibiotics			
No [n=16]	4 [19.0]	12 [23.1]	
Yes [n=2]	0 [0.0]	2 [3.8]	
Unknown [n=55]	17 [81.0]	38 [73.1]	0.594
IV fluids			
No [n=22]	8 [38.1]	14 [26.9]	
Yes [n=46]	10 [47.6]	36 [69.2]	
Unknown [n=5]	53 [14.3]	2 [3.8]	0.128
Transfer			
No [n=56]	16 [76.2]	40 [76.9]	
Yes [n=9]	5 [23.8]	4 [7.7]	
Unknown [n=8]	0 [0.0]	8 [15.4]	0.041
Intubation			
No [n=60]	17 [81.0]	43 [82.7]	
Yes [n=2]	0 [0.0]	2 [3.8]	
Unknown [n=11]	4 [19.0]	7 [13.5]	0.570
Cooling			
No [n=11]	3 [14.3]	8 [15.4]	
Yes [n=58]	18 [85.7]	40 [76.9]	
Unknown [n=4]	0 [0.0]	4 [7.7]	0.412
Air condition			
No [n=3]	3 [14.3]	0 [0.0]	
Yes [n=69]	18 [85.7]	51 [98.1]	
Unknown [n=1]	0 [0.0]	1 [1.9]	0.018
Water/ice with Fam			
No [n=27]	0 [0.0]	27 [51.9]	
Yes [n=41]	18 [85.7]	23 [44.2]	
Unknown [n=5]	3 [14.3]	2 [3.8]	<0.001

Discussion

Exposure to hot weather for long time, in addition to physical effort as exactly happened during Hajj season, leads to increase in storage of heat in the body.[9, 10] As a physiologic response to the heat exposure, heat loss from the body increase in a trial to maintain a stable body temperature. However, this response sometimes fails and may lead to severe heat stroke and even death.[9, 10]

The risk of heat exhaustion or stroke stress are increased by some factors and almost all these factors are encountered during the pilgrimage, therefore, pilgrims at a greater risk for heat stroke and exhaustion compared to others. The present descriptive study explore the factors associated with heat stroke and heat exhaustions; the most common associated symptoms and signs and define the methods of management in the fields and emergency centers during the Hajj season of 2018.

The Saudi Arabia government, through its various healthcare facilities and services in collaboration with Ministry of Hajj, has

undertaken precautions against heat stroke, particularly during Hajj season as it is the most challenging problem faced by healthcare providers during Hajj. The healthcare authorities offer preventive measures to decrease the incidence of heat illness and also they enhance awareness of pilgrims about the dangers of dehydration, as well as encouraging them to seek shade, drink sufficient amount of fluids, and be aware of the dehydration symptoms.[11] The same measures were applied during the Atlanta Olympic Games, 1996 where there was a gathering of thousands of people in a limited area with high environmental temperature.[12] In addition, pilgrims are encouraged to be flexible with time with possibility of performing rites at night. [13]

In the current study, heat stroke represents 28.8% of heat illnesses. Very close figure has been reported in a recent similar study [29%].[4] However, no deaths were reported in this study compared to 6.3% in the study carried out by Abdelmoety et al.[4]

In the present study and in accordance with others,[4] the main age of patients exceeded 55 years. Old people are susceptible to heat illness as a consequence of diminished blood flow to the skin, reduced sweat gland function, cardiac output, thirst sensation, and kidney function by aging.[14, 15] Therefore; special care should be paid for these patients in the early stage of illness.

In this survey, the commonest encountered symptoms of heat illness were headache, extreme weakness, and dizziness/vertigo. This could be explained by the dysfunction of the central nervous system which is very sensitive to heat stress. [16, 17] It has been documented that in severe cases, decrease in the cerebral blood flow and increased intracranial pressure might occur and the patients commonly experienced convulsions and coma.[16, 18] In the present study, syncope and seizure were reported among a considerable percentage of patients [11-13.7%]. To prevent these unfavorable consequences, body temperature and consciousness level should be monitored early and followed up as they are important indicators of the heat illness severity.

In our study, hypertension was the most common comorbidity among heat exhaustion patients whereas diabetes was the most common comorbidity among heatstroke patients. Previous studies have shown that patients with comorbidities have an increased risk of hospitalization due to heatstroke.[4, 19, 20]

Concerning management of heat illness, the present study showed that patients with heat illness were managed according to specific guidelines including blood investigation to exclude organ damage, cooling, and fluid replacement depending on patient status.[21, 22]

Up to our knowledge, this study is one of the very limited studies carried out in recent years to evaluate the problem of heat stroke and heat exhaustion among pilgrims and describe its clinical signs and symptoms factors associated with it and its management. However, it has some important limitations. The first is the fact that we included only cases with either heat stroke or exhaustion without control subjects to identify associated risk factors by comparisons. However, because of shortage of time, manpower and resources, we could not recruit control subjects with full information as cases. Second, our results might be underpowered to detect a significant associations, because the relatively small sample size. Therefore, caution is warranted in interpreting results. Third, some important associated factors were not investigated such as sleep quality, previous history of heat-related illness, heat acclimatization, use of medications, and the general health status at the time of exposure to heat. Therefore, further larger study covering all these defects and adequately financed is warranted. In addition, proper education of the pilgrims about preventive measures of heat stroke and heat exhaustion before to arrival to the Kingdom should be provided in collaboration with authorities of their countries.

In conclusion, heat-related illness, that possibly occur during Hajj and responsible for considerable morbidities and even mortalities, can be reduced by proper education and increase awareness of pilgrims regarding the various preventive measures. Findings of the present study might offer a clue for healthcare planners to provide better arrangements for pilgrims in summer seasons. Screening of pilgrims in their home countries is essential to prepare a special Hajj program for unfit persons. Further study is recommended including a control group of pilgrims to look for the possible risk factors for developing heat-related illness.

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