



# Emergency Response of Indian Hajj Medical Mission to Heat Illness Among Indian Pilgrims in Tent-Clinics at Mina and Arafat During Hajj, 2016



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## Abstract

**Introduction:** Extreme heat claims more lives than all other weather-related exposures combined. Hajj rituals at Mina, Arafat, and Muzdalifah involve a minimally-clothed, moving assemblage of 3.5 million pilgrims who are exposed to a harsh, hot, desert climate during physically challenging outdoor rituals and unsheltered night stays, rendering them prone to heat illness, dehydration, and sunburn. This cross-sectional study assessed the emergency response of the Indian Hajj Medical Mission to overwhelming heat illnesses in Mina and Arafat among Indian pilgrims during Hajj, 2016.

**Methods:** In 2016, 88 patients affected by the heat were brought to central tent-clinics at 36 maktabas in Mina and Arafat that were established by the Indian Hajj Medical Mission. Patients were offered rapid external evaporative cooling (wet towels) and cold intravenous saline infusion on patient couches and wheelchairs.

**Results:** The incidence of heat illness among Indian pilgrims in 2016 was 0.62/1000. The ratio of males to females was 1.8:1. Mean ages of males and females were  $62.2 \pm 7.43$  and  $52.6 \pm 9.3$ , respectively. Pre-existing conditions, such as diabetes mellitus and hypertension, were present in 93.2% of the patients. The most common presentations included hyperthermia, fatigue, and restlessness. Heatstroke presented in five patients and resulted in one fatality. Twenty-eight patients were referred to Saudi hospitals, and 12 of them were institutionalized. Exertion related to the stoning of Satan ritual during late morning and afternoon hours was the leading cause of heat illness.

**Conclusion:** The overwhelming incidence of heat illness among Indian pilgrims in the critical five-day period of the Hajj represents the tip of the iceberg as the Hajj attracts over 3.5 million pilgrims from 200 countries annually. Heat illness is difficult to manage in the presence of pre-existing comorbidities and mandates clientele education and outreach warning systems to enhance resilience capital amongst Hajj pilgrims, sportspersons, outdoor enthusiasts, and military personnel.

**Keywords:** Hajj, Heat Illness, Heat Exhaustion, Heat Stroke, Mass Gathering Medicine

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## Introduction

Heatstroke has been a major cause of concern worldwide throughout the second half of the 20th century owing to rapid urbanization, industrialization, and consequent climate change. In the United States, extreme heat claims more lives than all other weather-related exposures combined

(hurricanes, tornadoes, floods, and earthquakes).<sup>1</sup> Heatwaves in 2003 and 2015 claimed 70 000 lives in Europe and the Indian subcontinent, respectively. The 2001 and 2007 Intergovernmental Panel on Climate Change (IPCC) warned about increased heat-related premature mortality among vulnerable populations.<sup>2</sup>

The Hajj is an annual peaceful mass gathering of over 3.5 million pilgrims congregating in densities of nine people/m<sup>2</sup> from 200 countries at Mecca, Saudi Arabia. The Hajj involves effort-intensive prayers, supplications, and rituals for spiritual edification. Mina, located five km away from the main city of Mecca, upholds the simultaneous congregation of 3.5 million Hajj pilgrims for five days at a stretch. Hajj pilgrims are accommodated in several thousand allotted and labeled fire-resistant tents spread over an area of 18 km<sup>2</sup> in the Saudi Arabian desert, which witnesses harsh climatic conditions. Arafat, located a further 22 km from Mina, is the scene of what is considered the most important ritual of the Hajj pilgrimage. The crowd from Mina attends Arafat on a required day, followed by a night of sleeping under the open sky at Muzdalifah.<sup>3-5</sup>

Mass-gathering medicine at the Hajj is challenged by issues of healthcare accessibility, emergency response systems, on-site treatment, referral, and evacuation in addition to challenges of human support such as shelter, food and water, transportation, sanitation, and overcrowding. The Hajj has historically experienced high morbidity and mortality due to heat illnesses. The critical five days in Mina, Arafat, and Muzdalifah involve a minimally-clothed moving assemblage exposed to a harsh, hot, desert climate during physically challenging outdoor rituals and an unsheltered night stay in Muzdalifah, which renders them prone to heat illness, dehydration, and sunburn.<sup>4-6</sup>

This cross-sectional study assessed the emergency response of the Indian Hajj Medical Mission to overwhelming incidence, presentation, management, and follow up of heat-related illnesses such as heat hyperpyrexia/syncope, heat exhaustion, and heat stroke among Indian pilgrims during Hajj, 2016.

## Methods

A total of 88 patients affected by the heat who presented at 36 tent-clinics at different maktab in Mina and Arafat during the critical days of the Hajj, 2016 from the 8th to the 12th of September, 2016 were included in this prospective cross-sectional study after approval and consent were obtained. Patients reporting/brought to the maktab tent-clinics were referred/brought to central tent-clinics, one each in Mina and Arafat, established to cater to the moving assemblage during the Hajj. All patients presenting with effects of heat at any time of day or night were included in the study under inclusive sampling. Similar presentations under conditions attributable to pre-existing comorbidities were excluded.

The emergency response plan comprised rapid cooling followed by an assessment of related risk factors such as diabetes mellitus, hypertension, cardiovascular morbidity, respiratory disease, mental health disorders, and a contributory history of medication. Clinico-demographic parameters, headache, fatigue, thirst, dizziness, vomiting, cramps (abdomen/extremities), edema, breathlessness, confusion, restlessness, agitation, irritability, delirium, perspiration, flushed dry skin, vitals, syncope, unconsciousness, coma, hematuria, and loss of bowel and bladder control were assessed. Heat exhaustion and heat stroke were deduced from pale perspiring skin

and flushed dry skin, respectively, along with suggestive features. Due to limitations of time, patient couches and patient monitoring infrastructure were set up in low resource, makeshift tent-clinics. Patients were managed on patient couches, plastic chairs, and wheelchairs during treatment and observation until disposal, referral, or evacuation due to the absence of beds in the maktab clinics and the Arafat clinic and fewer beds in the central tent-clinic in Mina. Heat exposure variables such as duration of sun/outdoor exposure and physical exertion were assessed.

Random blood glucose testing could only be done for 42 patients at the central tent-clinic in Mina. Rectal temperatures and postural drops in blood pressure could not be evaluated due to the high patient throughput. Rapid cooling was achieved with external evaporative cooling (wet towels) and cold intravenous saline infusion. Clinico-demographic parameters, pre-existing health conditions, clinical presentation, treatment, referral, and mortality were analyzed using descriptive statistics with SPSS version 21.

## Results

The 88 (57 males and 31 females) patients of Indian/South Asian descent reporting with effects of heat included walk-in or brought-in cases and patients reported by other clinics. Patients who were found restless, lost, or unconscious along the route or in their tents were brought by relatives, friends, or tent-mates or by philanthropic volunteers identifying them as Indians through wrist bands. Foreigners without wrist bands who appeared to be Indian were also brought. One patient was received by the Moassasa clinic.

The total number and incidence rate of heat illness among Indian pilgrims were 140000, 0.62 per 1000 for Hajj, 2016. The male-to-female ratio was 1.8:1. The most common age brackets for males and females were 51-70 years and 41-60 years, respectively. Mean age was 62.2 ± 7.43 (95% CI: 47.3-77.2) for males and 52.6 ± 9.3 (95% CI: 41.6-63.5) for females. Pre-existing conditions, i.e. diabetes mellitus and hypertension, were present in 93.2% (95% CI: 85.9-96.8) of cases, and 67.1% of patients were on medications; albeit, compliance was poor (Table 1).

The most frequent etiology for heat illness was physical exertion, related to the stoning of Satan ritual during late morning and afternoon hours. The round-trip distance for the stoning ritual from the pilgrim's residential tent and back was approximately 6 km, and only part of the route was shaded. Most pilgrims deteriorated on the way back to their tents as they walked on roads exposed to the sun. Most patients were exposed to the heat for 2-4 hours. The most common signs of heat illness were hyperthermia, fatigue, and restlessness (Table 2). Twenty-four patients had hypoglycemia at presentation. Five patients presented with heatstroke which resulted in one fatality at the Mina hospital. Twenty-eight patients were referred from tent-clinics to Saudi hospitals in Mina and Arafat; 12 of these patients were kept under institutionalized care.

## Discussion

Mass gatherings evoke a high incidence of environment

**Table 1.** Age, Gender, Comorbidity Profile, and Lead Diagnosis of Patients With Heat Illnesses During Hajj, 2016

Age (y)	Males	Females	Cumulative percentage	95% CI
31-40	1	3	4.5	1.7-11.1
41-50	3	11	15.9	9.7-24.9
51-60	16	14	34.1	25-44.5
61-70	31	4	39.8	30.2-50.2
>70	4	1	5.6	2.4-12.6
<b>Pre-existing Comorbidity</b>				
Diabetes mellitus (DM)	18	13	35.2	26.1-45.6
Hypertension	13	9	25	17.1-34.9
Other cardiovascular disease	1	3	4.5	1.7-11.1
Respiratory disease	1	1	2.3	0.6-7.9
DM + Hypertension	24	5	32.9	24-43.3
Mental health disorder	2	0	2.3	0.6-7.9
Individuals on medications	37	22	67.1	56.7-75.9
<b>Heat Illness</b>				
Heat Hyperpyrexia/syncope	28	20	54.5	44.2-64.5
Heat Exhaustion	24	11	39.8	30.2-50.2
Heat Stroke	5	0	5.7	2.4-12.6

**Table 2.** Etiology and Clinical Features of Heat Illness and Pre-Existing Health Conditions

	No. of Patients	Percent	95% CI
<b>Etiology</b>			
History of outdoor exposure in shade	12	13.6	7.9-22.3
History of sun exposure	76	86.4	77.7-92
History of physical exertion while exposed	79	89.8	81.7-94.5
Duration of exposure 1-2 hours	10	11.4	6.3-19.7
Duration of exposure 2-3 hours	41	46.6	36.5-56.9
Duration of exposure 3-4 hours	37	42.1	32.3-52.5
<b>Symptoms</b>			
Headache	12	13.6	7.9-22.3
Weakness/Fatigue/Lethargy	45	51.1	40.9-61.3
Thirst	15	17.1	10.6-26.2
Dizziness	32	36.4	28.1-46.8
Nausea	34	38.6	29.2-49.1
Vomiting	2	2.3	0.6-7.9
Cramps (Abdomen/extremities)	15	17.1	10.6-26.2
Edema	2	2.3	0.6-7.9
Breathlessness	16	18.2	11.5-27.5
<b>Signs</b>			
Confusion	12	13.6	7.9-22.3
Restlessness/Agitation/Irritability	34	38.6	29.2-49.1
Delirium	18	20.5	13.3-30
Pale perspiring skin (Exhaustion)	47	53.4	43.1-63.5
Flushed dry skin (Stroke)	11	12.5	7.1-21.1
Rash	Nil	-	-
Hot to touch	59	67.1	56.7-75.9
Strong bounding pulse	21	23.9	16.2-33.7
Rapid weak pulse	32	36.4	28.1-46.8
Tachypnoea	34	38.6	29.2-49.1
Hypertension	59	67.1	56.7-75.9
Hypotension	15	17.1	10.6-26.2
Syncope/Unconsciousness/Coma	4	4.5	1.7-11.1
Hematuria	2	2.3	0.6-7.9
Loss of bowel and bladder control	4	4.5	1.7-11.1
Death	2	2.3	0.6-7.9
Hypoglycemia	24/42	57.1	42.2-70.9

specific medical challenges such as zoonotic diseases, vector-borne diseases, heat illnesses, accidents, and outbreaks requiring emergency medical and public health response systems.<sup>7-9</sup> The Hajj is regarded as the best mass gathering preparedness effort worldwide; nevertheless, the history of the Hajj is replete with heat illnesses. Major contributors to overall heat stress are mean temperatures reaching 45°C, humidity approaching 80%, and stagnant atmospheric conditions potentiated by heat dissipation from asphalt and concrete surfaces, vehicle exhaust, Hajj crowds, and human activities. The absence of trees and open spaces contributes further to the urban heat island effect. The heat index climbs to 90°C or more.<sup>5,10-12</sup> Special heat exposure has been reported to have a ten-fold mortality rate compared to annual heat-related mortality which is primarily attributable to multiorgan damage and cardiovascular compromise. A core body temperature above 41°C may be lethal; however, recovery has been reported even at 46°C.<sup>5,11,13</sup>

Despite the availability of climate control technologies, heat illnesses continue to cause morbidity and mortality in the backdrop of old age; pre-existing cardiorespiratory, renal, endocrine and neuro-psychiatric health conditions; the use of diuretics, sedatives, stimulants, or antihypertensives; and compromised nutrition, hydration, and living standards, especially during the critical five days of the Hajj. Diabetic and hypertensive patients are at higher risk due to peripheral neuropathy, autonomic dysfunction, nephropathy, and antihypertensive medication. The complications of heatstroke include hematuria, psychosis, pulmonary edema, lactic acidosis, renal failure, consumptive coagulopathy, and metabolic abnormalities.<sup>14-18</sup> Extreme heat, overcrowding, physical exertion, dehydration, language barriers, tough living conditions, and presence in a foreign country for a long duration precipitate stress-related problems.<sup>4-6,19,20</sup> Extreme heat affects performance and productivity and predisposes people to societal conflicts, violent crimes, and civil wars.<sup>2,21-24</sup> The emerging incidence of heat illnesses in the backdrop of pre-existing morbidities and complications thereof needs

active surveillance and threat assessment with pre-determined mathematical models comparable to those of cold injury and altitude illnesses.<sup>25-28</sup>

This study was conducted in limited resource tent-clinics, which prevented the detailed assessment of heat illness, complications, differential diagnoses, and documentation due to the overwhelming throughput of patients. Patients were lost to follow-up during the Hajj pilgrimage due to high mobility. The emergency response to heat illness comprises rapid cooling with ice water immersion/cold shower, iced gastric/peritoneal lavage, and monitoring of rectal temperature; however, these approaches were not available in tent-clinics. At best, tent-clinics could offer limited investigations and external evaporative cooling. The overwhelming number of patients compromised standards of care and clientele satisfaction, and it led to physical, mental, and compassion fatigue among healthcare personnel. First response along with on-site management form the most important determinants in prognosis.<sup>29-32</sup> This concept has been elaborated as the “golden hour in heatstroke.”<sup>23</sup>

A comprehensive, public health surveillance system enabled Hajj organizers to recognize heatstroke as a significant cause of morbidity, which was noticeably reduced after the provision of gratis potable cold water, sun cover, water sprinklers, and air misters along the pilgrimage routes.<sup>33-35</sup> Nevertheless, opportunities exist for intervention in the preparedness, clientele, and technology fronts. The provision of better heating-ventilation-air conditioning (HVAC) in tents, shaded/sun-proofed roads/causeways and heat relief shelters, more water sprinklers in Arafat and Mina, rapid cooling technology in tent-clinics, and ample ambulance services is mandated.<sup>4-6,12</sup> Clientele education is required for both self-help and first response. Self-help heat preparedness efforts involving choosing to perform the Hajj at a younger age; environmental assessments of temperature, humidity, and dry winds; risk assessment for physical exertion; availability of water, shade, and medical aid; and self-preparedness with light-weight heat/sun protective clothing, increased fluid intake, and intermittent avoidance of heat/sun/exertion are required. Education on religious concessions to Hajj rituals so as to minimize heat exposure and enhance health protection, hydration, and behavioral modification can be disseminated in mosques.<sup>36,37</sup> Information on first response training on moving patients to shade, administering cold baths/sponging, providing cold non-alcoholic fluids, elevating feet, and evacuating patients to a medical facility needs to be disseminated to pilgrims in mass gatherings. Pilgrims, caretakers, administrators, and healthcare personnel should be kept in sync with health protection against heat illness through Heat Alert Response Systems based on Wet Bulb Globe Temperature-based assessment so as to prevent social attenuation in lean periods.<sup>12,36</sup> Technological advancements such as healthcare robots and drones can facilitate rapid relief, the provision of medical supplies, and can minimize human resource deployment in future Hajj pilgrimages.<sup>38</sup>

The IPPC warns about the increasing frequency and/or intensity of heat waves leading to heat-related premature mortality of the urban poor and primarily the elderly in cities

## Research Highlights

### What Is Already Known?

The critical 5 days of the Hajj in Mina, Arafat, and Muzdalifah involve a minimally-clothed moving assemblage exposed to the harsh, hot desert climate during physically challenging outdoor rituals and unsheltered night stays in Muzdalifah, rendering the pilgrims prone to heat illness, dehydration, and sunburn.

### What This Study Adds?

The overwhelming incidence of heat illness among Indian pilgrims in the critical five-day period during the Hajj represents the tip of the iceberg, as the Hajj attracts over 3.5 million pilgrims from 200 countries annually. Heat illness is difficult to manage in the presence of comorbidities; thus, clientele education and outreach warning-systems are mandated to enhance resilience capital amongst Hajj pilgrims, sportspersons, outdoor enthusiasts, and military personnel

of temperate regions where the largest increases in thermal stresses occur.<sup>1,2</sup> Thermal balance is regulated through biological heat gain through metabolism, thermogenesis, and muscular activity along with physical heat exchange through evaporation, radiation, conduction, and convection. Heat acclimatization occurs over 7-10 days, enabling a reduction in the sweat threshold, increased sweating, and the increased capacity of sweat glands to reabsorb sweat sodium, thereby enhancing heat dissipation. An enhanced focus on heat acclimatization may help develop community resilience in the long term.

## Conclusion

The overwhelming incidence of heat illness among Indian pilgrims in the critical 5-day period of the Hajj represents the tip of the iceberg, as the Hajj attracts over 3.5 million pilgrims from 200 countries annually. Heat illness is difficult to manage in the presence of comorbidities. Heat illness mandates a greater emphasis on Hajj health preparedness in times of ongoing climate change. A previously targeted endeavor through clientele education and outreach warning systems will enhance resilience capital among people at risk, such as pilgrims, sportspersons, outdoor enthusiasts, and military personnel.

## Authors' Contributions

All authors contributed equally to the study.

## Conflict of Interest Disclosures

None.

## Ethical Approval

Ethical approval was covered by the institutional committee.

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