

REVIEW ARTICLE

Neurological Problems during Hajj Season: Review

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ABSTRACT

Worldwide gatherings at religious festivals raise the possibility of disease transmission among attendees and the local populace. The enormous gathering of pilgrims may impact the country's health system. Infectious diseases with epidemic characteristics threaten global health security, demonstrating the significance of preparedness for any public health catastrophe. This literature review describes the extensive neurological diseases related to hajj pilgrims and the importance of preventive methods to control these diseases. Our systematic review was conducted from many sources, including credible websites and journals. We found about 23 articles about the most common neurological disease in hajj pilgrims. A clear result was observed about increased incidents of meningitis as a global health neurological disease related to hajj pilgrims of total PubMed indexed publications studies, and one review article was done in 2019. This review study summarizes the neurological health challenge from infectious, non-infectious to stroke mimics presentation and the heatstroke prevalence in Hajj and the process of how the body adaption to heat stress may influence the body systems and brain function to be reported the most common presentation may mimic to a neurological cause.

KEYWORDS: Religious Festivals, Neuro-infectious, Stroke, Heatstroke, Hajj, Makkah

INTRODUCTION

The Hajj season is a special event for Muslims. The pilgrimage to Makkah in Saudi Arabia is one of the essential rituals of Islam; many Muslims from all over the world come to Makkah during the twelve lunar months of the Islamic calendar. Annually, it begins on day eight of the month and ends on the thirteenth day of the same month. Hajj is performed in three prominent locations in Makkah: the sacred Kaaba (in the holy city of Makkah), Mena, and Arafat. A large number of pilgrims from more than 150 countries perform Hajj. It starts with them when they arrive 20 to 25 days before the Hajj dates. In performing the Hajj rituals, pilgrims travel from one religious site to another by different means of transportation; due to overcrowding, pilgrims are at risk for transmission of infectious diseases. Giving the appropriate healthcare services during Hajj is a significant challenge as many pilgrims of different ages and health statuses meet in small areas for a while.

Health challenges during Hajj: The Kingdom has taken on the role of custodian of the holy sites of Makkah and took the responsibility to offer a safe Hajj for pilgrims with solid commitment and breathtaking energy; the annual pilgrimage results in more than 3 million visitors to the Kingdom in addition to the current population of Makkah. Such mass gatherings have the potential risk for infectious and non-infectious hazards¹.

The Ministry of Health (MOH) and the Government of Saudi Arabia have accepted the duty of delivering a safe Hajj by equipping each facility with the necessary tools for all objectives, including prevention, diagnosis, treatment, ambulatory care, and awareness. Beginning with Preventive Medicine and Public Health Services, MOH took numerous steps to protect the Kingdom from any outbreak of epidemic and quarantine diseases. These steps included an annual review of the health requirements for pilgrims during the Hajj season, the establishment of 15 Centers for Disease Control at Pilgrim's Entry Points, and applying technical control and quarantine measures to various transportation modes, incoming pilgrims, and imported foods. Second, the Ministry has prepared 25 hospitals as part of its Therapeutic Medicine Services (four in Arafat, four in Mina, seven in the Holy City of Makkah, and nine in Madinah, to be added to King Abdullah Medical City)¹. The Hajj sites include 5,000 inpatient beds, 500 IC beds, and 550 ER beds. One hundred fifty-five permanent and temporary health facilities, including 18 in Madinah, are supported across the Hajj locations, including 43 in Makkah, 80 in the Holy locations (46 in Arafat, 6 in Muzdalifah, and 26 in Mina).

All hospitals are staffed by highly qualified medical and nursing personnel and have modern ventilators and monitoring equipment available. Pilgrims can only receive medical care at the temporary hospitals in Mena and Arafat during the Hajj. In contrast to Arafat hospitals, which are open for just one day on the ninth day of Dhul-Hijjah, Mena hospitals are available from the seventh day of the month of Dhul-Hijjah until the evening of the thirteenth day. Patients are then moved to permanent tertiary hospital facilities in Makkah for further management and closure¹⁻³.

A review study was carried out, including PubMed, Google Scholar, and Elton B. Stephens Company (EBSCO) databases, using the following terms in different combinations: Heatstroke, Stroke, Neurological illness or disease or disorder or disability, Neuroinfectious, and Hajj or pilgrimage. We included all full-text review articles and observational studies that were reviewed during the Hajj period. The authors extracted the data, adding heat exhaustion and stroke to **Table II**, along with the author's names, years, place of publication, study type, time frame, and results.

We found about 23 articles about the most common neurological disease in Hajj pilgrims; while inspecting the overall data, an apparent result was observed about increased incidents of meningitis as a global health neurological disease related to Hajj pilgrims of total PubMed indexed publications studies and heat stroke is one of the most common causes of death for pilgrims during the Hajj season. Our studies have investigated heat stroke during Hajj in a total of 5 studies. Four of these studies have aimed

to know the characters and the manifestations of heat illness in Hajj. In non-infectious neurological disease, stroke is a high incidence in Saudi Arabia; as studied by the recent 2020 systematic review and meta-analysis study, there were 29 stroke cases per 100,000 persons annually.

Neuro-infections during Hajj: 12 cases were confirmed to have W135 meningococcal disease in 2000, and in 2001, it was reported that about 8 of them (67%) were infected in the Hajj⁵. The rate of cases diagnosed as w135 meningococcal was 25 cases from 100,000 in 2000. After the appearance of the quadrivalent meningococcal vaccine to be given in the Hajj in 2001, no cases were documented.

Our data shows the ratio of *N. meningitidis* is increased in the cities hosting the Hajj and Umrah compared with other cities in the country⁶. Of about 729 cases confirmed, 42% were coming for religious rituals, and 58% were the original population living in the country. About one half of them, 48%, were confirmed at the Makkah and Madinah, KSA. 39% of the reported cases were children aged <2 years, and 58% were <5 years of age. The diagnosed patients with serogroup W135 multiplied to 95%, and there is a noticeable effect in children aged <5 years ($p < 0.001$)⁷. These are the most common diseases that must be admitted during the Hajj season. 1: Acute stroke with altered mental status 2: Intracranial hemorrhage 3: Subarachnoid hemorrhage 4: Meningitis with altered mental status or respiratory compromise meningococcal meningitis raises concern in any patient during the Hajj season 5: Metabolic coma from a different cause, for example, electrolyte disturbances, uremia, and hepatic encephalopathy 6: Status epilepticus and 7: Traumatic brain injury⁸. The obtained serum samples were taken from 796 pilgrims; rSBA results were for serogroups for 741. A total of 6.5% of people who attended Hajj before, about 1 to 14, and 98.2% took the quadrivalent meningococcal vaccine in the previous three years. Of the thirteen who had not originated from Bangladesh, around four had not taken the meningococcal Vaccination before, and nine had received the vaccine for more than three years. For serogroup A, the documented case from Indonesia only had an rSBA titer <8. For serogroups C, W, and Y, the rate of pilgrims with rSBA titers <8 was 9.9%, 17.4%, and 9.4%, respectively, the high prevalence of non-complement-mediated lysis in pilgrims reported from Nigeria at 59.6% and Afghanistan at 44.7%, this shows us the type and pattern of antibiotic that is used for these populations⁹. Hajj is an annual and national event that increases the risk of public health problems and diseases within the host country and worldwide. It's related to the risk of many infectious disease¹⁰. Vaccination is one of the significant measures used to prevent and control contagious diseases worldwide. It decreases the overall morbidity and mortality associated with many infectious diseases; the World Health Organization (WHO) estimates that Vaccination protects 2.5 million people annually from infections. Some studies confirm the effectiveness of the influenza vaccine, while others are not effective enough. Meningococcal immunization successfully prevents meningococcal disease in Hajj pilgrims, and pilgrims have high compliance with this vaccine. Invasive Meningococcal Disease dissemination at non-pilgrims season Mass Gatherings are less common than in Hajj-related regions, and it affects mainly young age people, so the appropriate Health education about Vaccination should be received for those who come from high-risk non-pilgrims region, especially the young age group. There is a study done for 2000 people; among them, only 1146 people between 18-91 years (mean age 37.6) agreed to join to get the polysaccharide ($n = 561$) or the conjugate ($n = 561$) vaccine, 60.8% of them male, and 93.5% from Saudi Arabia. And among those who agreed to do oropharyngeal swabs before Hajj, only 0.2% tested positive for *Neisseria meningitidis*. Likewise, meningococci were identified in one sample for the post-Hajj and the follow-up visits later. No one from those who received the vaccines is considered isolated¹¹. In the first two weeks after returning from the Hajj in Turkish, about 296, which means 62.7% of the original 472 pilgrims, were placed and done for them another nasopharyngeal swab. 81/296 (27.4%) were positive for meningococcal carriage, and 74/296 (25%) carried serogroup W-135¹², as described in **Table I**.

Table I: Serotype results for Hajj pilgrims¹²

Number (%) of subjects ^a			
After returning from the Hajj			
Group	Before travelling to Mecca	Subjects among Hajj pilgrims who had cultures after returning back	Negative before travel to Mecca and positive after the return back
Provided swabs	472 (100)	296 (100)	NA
Positive for meningococcal carriage	63/472 (13)	81/296 (27)	39 (100)
Serogroup W-135	52/63 (83)*	74/81 (91)*	39 (100)
Serogroup B	9/63 (14)	5/81 (6)	0 (0)
Serogroup A	1/63 (2)	1/81 (1)	0 (0)
Serogroup Y	1/63 (2)	1/81 (1)	0 (0)

^a*Percentages do not add up to 100 because of rounding. NA, not applicable

Neuro non-infections during Hajj: More than 2 million Muslims gather for Hajj in a limited region seeking Islamic rituals such as Makkah and Madinah, causing a significant challenge for healthcare workers and services, mainly the intensive care until 47416 individuals were admitted to the intensive care unit (ICU) in Makkah hospitals during the 2001 Hajj as shown in a systematic review some of the neurological sufferers in Madinah were 23675 required the ICU monitoring and airway secure airway protection since various neurologic illnesses can compromise the respiratory muscle, which can cause respiratory failure one of the most frequent non-infectious diagnoses during the Hajj season included: status epilepticus, traumatic brain injury, intracranial and subarachnoid hemorrhage, acute stroke with altered mental status, and acute stroke without altered mental status⁸.

The annual stroke incidence in Saudi Arabia, as studied by the recent 2020 systematic review and meta-analysis study, was 29 stroke cases per 100,000 persons annually¹³. There is a lack of a recent 5-year stroke incidence study in Hajj thus far; the incidence of stroke patients during the Hajj season in 2015 with diagnosis confirmed by imaging in six hospitals was 8.9/100,000 of total pilgrims (2,084,238) based on the official numbers. The admission rate peaked on the day after Arafat (the second day of the Hajj); ischemic were the most common, while hemorrhagic stroke patients (18.8%) presented at the age of sixties was related to risk factors commonly being hypertension (57%) and diabetes (40.9%), Hemorrhagic stroke was the only predictor that came close to being statistically significant in predicting mortality, Hospital stay was four days with an outcome of 21 patients (11.3%) passed away while they were hospitalized¹⁴.

Intraparenchymal hemorrhage, epidural hemorrhage, subdural hemorrhage, and subarachnoid hemorrhage are the four major subtypes of intracranial hemorrhage ICH in contrast to a general Saudi study compared older patients with hypertension ICH; relatively young patients had a higher prevalence of diabetes and a worse clinical prognosis¹⁵.

For whom recessive intervention with intravenous tissue plasminogen activator (tPA) patients were only five patients due to the inability to get to the hospital within the window period (72.2%), and the existence of tPA contraindications (19%) were the most frequently mentioned reasons for not administering tPA(14%). When compared to a cross-sectional analysis of the causes of delayed hospital admission for acute stroke patients in Makkah, it was revealed that (45%) of patients presented late (after 4.5 hours), where there was a statistically significant relationship between the time of presentation

and stroke understanding ($P = 0.013$), with the majority of cases being related to low educational attainment and unemployment¹⁶.

A cohort study of Iranian pilgrims between 2007 and 2008 in Makkah city compared with Mashhad city as it's the second largest town in Iran with 92,974 Iranian pilgrims cases of stroke occurring noted: seventeen first-time strokes happened during the Hajj pilgrims group 40 for first-ever strokes occurred in the Mashhad group the risk of first-ever stroke was noted in females more than 65 years old among the Hajj pilgrims from Iran¹⁷.

Heatstroke (HS): A medical condition known as heatstroke (HS) happens when the body temperature rises above 40 degrees Celsius. Heatstroke is divided into two types. The first is classical forms, which can affect an older person with a chronic medical disease. In contrast, exertional heatstroke (HE) involves healthy young who exercise in hot weather. Initial symptoms include dizziness, Headache, nausea, vomiting, behavioral changes, confusion, and delirium. Complications may occur, which include loss of consciousness, Seizures, and vital organ damage in addition to death if not treated early. Evaluation of the patient with heatstroke includes taking history, doing a physical examination, and doing an investigation, including ECG, chest x-rays, CBC, coagulation profile, blood gasses, liver function test, serum CPK, and urine myoglobin. Treatment mainly supports applying a good rehydration or Ice bath over the skin or any cooling method that can help treat heatstroke. No proof exists that one cooling technique is better, and treatment aims to lower body temperature¹⁸.

Table II: The difference between heatstroke and stroke¹⁸

	Heatstroke	stroke
Definition	Elevated body temperature over 40	Decrease blood supply to the brain
Classification	Classical and heat exertional	Ischemic and hemorrhagic
Symptoms	dizziness, Headache, nausea, vomiting, confusion, delirium, loss of consciousness and seizures	Weakness, numbness, confusion, dizziness, severe Headache, loss of consciousness
Treatment	Ice bath or any cooling method	Ischemic: Thrombolysis (TPA), Mechanical thrombectomy, and Craniectomy Hemorrhagic: Surgery

During the Hajj season, heatstroke is one of the leading causes of mortality for pilgrims. The weather in Makkah is characterized by hot weather, which increases heatstroke. Previous studies have investigated heat stroke during Hajj in a total number of 6 studies. Five of these studies have aimed to know the Characters and the manifestations of heat illness in Hajj¹⁹⁻²⁴, Two epidemiological studies^{3,25}, and one review article²⁶. On 28 January 2021, a cross-sectional survey study was released. The study aimed to gauge the health professionals' adherence to the new standards established by the Saudi Ministry of Health in 2019. According to their findings, essential management had a compliance rate of 5.5 out of 10, and advanced management had a compliance rate of 4.7 out of 10¹⁹. Another cross-sectional survey study was conducted in February 2018 to examine the characteristics of heat illness during the Hajj. Of the 267 patients involved, 80 (29%) and 187 (67.75%) were identified as having heat exhaustion and suffering from heat stroke, respectively, with mortality rates of 6.3% and 0.0%. The researchers also concluded that diabetes is the most prevalent comorbidity in both groups. Most of the patients were treated according to pre-illness guidelines²⁰. Another study done during Hajj in 1984 was conducted by a group of medical teams of the Islamic Republic of Iran on 304 patients. They described that 68 % of the temperature was between 38-40 while the other 28 % was more than 40. Also, they found 82% had mild

Hs compared to 18, which is severe. They also found the most common symptom was Headache & dizziness, hot, dry skin, and Skin flushing²¹. One study was done in 1987 on 89 patients to determine the neurological manifestations and characteristics of heat stroke. It showed that 25 patients had absent reflexes, 17 patients had automatic movement defects, and 75 recovered without any complications, while two recovered but developed pan cerebellar syndrome and 11 patients died²². A case report study done on 30 pilgrimage patients in Makkah during Hajj 1984 showed that two patients died. Three individuals made a full recovery but experienced ataxia and myocardial infarction, while 25 others recovered without complications²³.

The last cross-sectional study that examined the prevalence of heat illness among Indian pilgrims in Makkah in 2016 found that it occurred 0.62/1000 times more frequently in men than in women and that the ratio was 1.8:1. They also discovered that the most typical signs of heat illness included hyperthermia, fatigue, and restlessness²⁴. Two epidemiological studies were done on Hajj's heat stroke in Makkah^{3,25}. The first study was done in 1980 from September to October over four weeks. One hundred seventy-six cases of heatstroke were seen, and the same in 1981 over the same period gathered 467 heatstroke cases³. The second study was published in 1987 and showed the Number and Rate per 100,000 heatstroke and heat exhaustion cases during the Hajj over five years from 1980 to 1985, and showed the rate of heatstroke and heat exhaustion increased over the years until it reached its highest rate in the last year in 1985 ²⁵ (**Table III**). One review article was done in 2019. This review study summarizes the prevalence of heatstroke in Hajj, how the body adapts to heat, and how heat stress impacts the body systems. It also reports the most common presentation of heatstroke²⁶.

Table III: The numbers and rates of heat stroke and heat exhaustion during Hajj

			Heat Stroke		Heat exhaustion	
Year	Date	No. of pilgrims	Case	Rate/100,000	Case	Rate/100,000
1400 H (1980)	19 October	813,000	176	22	NA	---
1401 H (1981)	8 October	479,000	258	54	NA	---
1402 H (1982)	27 September	854,000	1,119	131	5,595	655
1403 H (1983)	16 September	1,005,000	1,365	136	5,950	592
1404 H (1984)	5 September	920,000	1,058	115	4,337	472
1405 H (1985)	25 August	852,000	2,134	251	15,560	1,826

CONCLUSION

In conclusion, this study showed that neurological illnesses contribute to the most common causes of mortality & morbidity during hajj season. Yet there is a lack of studies on the region, mainly on the non-infectious neurological disease in the Hajj season in Makkah. In our focused study, we recommend conducting more studies on stroke and updating its incidence.

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Data Sharing Statement: The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publically.

AUTHOR CONTRIBUTIONS

Alkhotani A: Designed the study, conducted research, provided research materials, and analyzed it.

Alamoudi MN: Wrote initial draft, collected and organized article.

Almuwallad NT: Wrote the initial and final draft of the article, collected and organized articles, and reviewed the final draft.

Abu Zahirah MO: Wrote initial draft, collected and organized article.

Alatawi NA: Wrote initial draft, collected and organized article.

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