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## Morbidity and mortality amongst Indian Hajj pilgrims: A 3-year experience of Indian Hajj medical mission in mass-gathering medicine



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### ABSTRACT

The Hajj, a mass-gathering of over 3.5-million pilgrims, faces challenges to global health-security, housing, food, water, transportation, communication, sanitation, crowd-control and security. The Indian Medical Mission extended health-security to approximately 140,000 pilgrims, through outreach medical teams, primary-care clinics, tent-clinics, secondary-care hospitals and evacuation capabilities. Data on medical attendance, bed-occupancy, investigations, referrals, medication usage and deaths was compared. Outpatient attendance was 374,475 in static-clinics, 5135 in tent-clinics and 13,473 through task-forces. 585 (62.90%) in-patients were hospitalized amongst 930 secondary-care referrals. Secondary-care bed-days were 2106 with average bed-occupancy being 77.78%. 495 patients were institutionalized in tertiary-care Saudi-Arabian hospitals. Infectious diseases were most commonly (53.26%) encountered due to overwhelming respiratory-infections, followed by trauma (24.40%). Analgesics (66.38/100 patients) and antibacterials (48.34/100 patients) were frequently prescribed. Crude mortality amongst Indian pilgrims was 11.99/10,000. Risk-factors associated with high morbidity were old-age and pre-existing comorbidities. Overwhelming surge of patients facilitates transmission of communicable infections and leads to stress induced physical, mental and compassion fatigue amongst healthcare personnel. Respiratory infections are highly prevalent and easily transmissible during Hajj leading to significant morbidity, increased burden to existing health facilities, overwhelming costs on health systems and globalization of multiresistant pathogens. Diabetic patients should avoid heat exposure and use protective footwear during Hajj rituals. Mass-gathering medicine at Hajj can be optimized by improving patient knowledge on performing Hajj at a younger age, medicine compliance, avoiding self-medication, self-monitoring of hypertension, blood glucose, and preventive health measures; screening of pre-existing comorbidities; and resource augmentation with telemedicine networks and decision-support systems.

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### Introduction

The Hajj pilgrimage exemplifies one of the world's largest peaceful mass-gatherings fostering globalization in a multicultural environment. The five critical days of Hajj witness simultaneous congregation of over 3.5 million Hajj pilgrims from 200 countries

in a harsh hot desert climate either unsheltered or in tent accommodation, with limited human assistance. The ever-increasing numbers of pilgrims pose a challenge to global health security along with housing, food, water, transportation, communication, sanitation, crowd-control and security. Mass-gathering medicine at Hajj is challenged by issues of high morbidity, healthcare accessibility, patient management and evacuation especially in emergencies [1–3].

The Indian Medical Mission extends health security to approximately 140,000 Indian pilgrims annually through outreach medical

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### Advances in knowledge

1. The ambispective study adds to the existing knowledge on mass-gathering medicine, its implications, morbidity and mortality statistics for public health interventions in the international dimension.
2. Infectious diseases occurring in massive proportions (53.26%) pose a multipronged challenge during Hajj.
3. High prevalence and transmissibility of respiratory infections in an environment of Hajj cough remains a significant health hazard. Respiratory infections can increase burden to existing health facilities, overwhelm costs on health systems and lead to globalization of multiresistant pathogens.
4. The study highlights the occupational hazards associated with Hajj medical missions such as transmission of respiratory infections and stress amongst medical mission personnel.

### Application to patient care

1. The spectrum of diseases presenting amongst 400,000 patients reported in the study forms a representative subset for planning of Hajj health systems by various nations.
2. The morbidity data can be utilized by Saudi Arabian hospitals to cater for specialty care, bed planning and ancillary services.
3. The study gives an insight to doctors and paramedics about the distribution of disease patterns and can thus help in institution of advance training programmes for both healthcare personnel and preventive health programme for pilgrims.

teams, primary-care clinics, tent-clinics and secondary-care hospitals in Mecca, Medina and Jeddah. The endeavour encompasses mass-gathering and travel-medicine perspectives, the reflections of which are presented through this ambispective study on morbidity and mortality amongst Indian pilgrims.

### Methods

For Hajj-2016, the Indian Medical Mission comprising of 144 doctors and 146 paramedics, established, operated and coordinated a tiered healthcare network including primary-care static-clinics, tent-clinics and mobile medical task-forces; secondary-care hospitals; referral and evacuation capabilities; at Mecca, Medina and Jeddah from Aug to Oct 2016. (a) Twenty-two static-clinics having 5–6 doctors, 5–6 paramedics per shift and basic first-aid capabilities catered for 6000–9000 pilgrims/clinic extending medical cover to 400 buildings in Mecca, Medina and Jeddah, and onward referral to secondary-care hospitals. (b) 35 tent-clinics having one doctor, one paramedic per shift and medical attendance facilities only, catered for 3000–4000 pilgrims/clinic extending medical cover to total of 5000 tents in Mina and Arafat, as well as 1.4 million unsheltered pilgrims in Muzdalifah. (c) One mobile referral tent-clinic having 5–6 doctors, 5–6 paramedics per shift at Mina and Arafat during the five critical days of Hajj catered to 35 satellite tent-clinics. (d) Mobile medical task-forces having one doctor and two paramedics per shift covered mass-gathering congregations along the pilgrimage assemblage expected to have 5000–100,000 Indians. Onward referral was to secondary-care or tertiary-care Saudi hospitals. (e) Two 40-bedded secondary-care referral hospitals having 8–10 doctors, 8–10 paramedics per shift catered to 13 static-clinics in Mecca, a 14-bedded facility catered to five static-clinics in Medina. Secondary-care referral hospitals catered for critical care, internal medicine, general surgery, orthopaedics, gynaecology, paediatrics, psychiatry, dermatology, isolation, lab-medicine and radiology. (f) Tertiary-care transfers were coordinated with

30 Saudi-Arabian hospitals in Mecca, Medina and Jeddah. Data on medical attendance, bed-occupancy, procedures, investigations, referrals, medication usage and deaths for 2016 was compiled and compared with previous years.

### Results

The Indian Medical Mission provided health-security to approximately 400,000 patients in a period of 60 days from Aug to Oct 2016 by a team of 144 doctors including 50 specialists, 146 paramedics and 74 ancillary staff. The doctor: patient and paramedic: patient ratio in Indian, Thailand and Malaysian Hajj Medical missions was approximately 1:944 and 1:931, 1:250 and 1:950, 1:320 and 1:140.

The patient beneficiaries included both pilgrims and non-pilgrims from India, Saudi Arabia and other countries totaling approximately 140,000 annually. For 2016, outpatient attendance in static-clinics was 374,475 (89.27%) comprising 213,162 males (56.90%), and 161,295 females (43.10%). Attendance in tent-clinics was 5135. 13,473 (3.40%) patients were treated through task-forces. Average stay per pilgrim in Saudi Arabia was 45 days and average medical attendance per pilgrim was 3.2. 585 (62.90%) in-patients comprising 245 (41.80%) males and 340 (58.10%) females (mean ages 62.7 and 56.7 years) were hospitalized for secondary-care amongst 930 secondary-care referrals. 323 hospitalized patients were between 70 and 90 years with a mean of 73.89 years. Total secondary-care bed days were 2106, average bed occupancy being 77.78% for 30 days prior and 15 days after Hajj, and 32% otherwise. Pooled unadjusted average length of stay of all patients was 3.6 days. Total referrals to Saudi-Arabian hospitals were 523 out of which 495 were institutionalized for treatment. The details of procedures and investigations are depicted in [Table 1](#).

Infectious disease was the most common (53.26%) outpatient diagnosis. Upper and lower respiratory infections, gastroenteritis and diabetes related skin and soft-tissue infections were seen. Respiratory infections outnumbered all other forms of illness. 90% healthcare personnel reported respiratory infections presenting as cough and viral prodrome, sometimes leading to sickness absenteeism. Upper respiratory infections presented as throat pain, sinusitis or otitis after a viral prodrome resembling common-cold

**Table 1**

Indian Medical Mission statistics and operations for Hajj pilgrimage from 2014 to 2016.

S. no.	Year	2016	2015	2014
<b>Patient attendance/hospitalizations</b>				
1	Outpatients – static clinics	374,475	379,791	402,407
2	Outpatients – tent clinics	5135	8405	4908
3	Mobile task force patients	13,473	13,003	11,358
4	Secondary-care referrals	930	1097	835
5	Secondary-care hospitalizations	585	678	665
6	Tertiary-care referrals	523	578	458
7	Tertiary-care hospitalizations	495	565	421
<b>Procedures (surgical)</b>				
1	Wound debridement/dressing	1045	834	767
2	Minor surgical procedures	335	298	290
3	Urinary catheterization	125	111	98
4	Fracture/dislocation reduction	275	188	108
5	Plaster casts/slabs	495	333	338
<b>Investigations</b>				
1	Haematology tests	2090	1780	1656
2	Clinical chemistry tests	4456	4043	3989
3	Infectious disease screening	140	99	76
4	Clinical pathology	770	612	446
<b>Imaging and electrocardiogram (ECG)</b>				
1	X-rays	1722	1525	1446
2	Ultrasonography	352	328	287
3	ECG	1159	1094	922

or influenza like illness. Lower respiratory infections presented with productive cough, dyspnoea and fever more so in pre-existing lung conditions such as bronchial asthma or chronic obstructive pulmonary disease (COPD). Acute gastroenteritis presented with vomiting and diarrhoea, with a history of food intake from multiple sources. Diabetic patients largely presented with pneumonia and cellulitis foot. There was inadequate glycemic control at presentation due to poor medication and precautionary compliance despite prescriptions of insulin and oral antihyperglycemics from India. Urinary tract infections (UTI) were found to have a predilection for female sex, diabetes and benign prostatic hypertrophy.

Orthopaedic, trauma and musculoskeletal diseases included fractures, dislocations, myalgia, osteoarthritis, sprains, low backache, sciatica and crush injuries. 45% of all fractures were Colle's fracture due to fall on outstretched hand from escalators, beds or washroom flooring. Blunt trauma during mass-gatherings led to shoulder dislocation and chest wall injuries. Myalgia, osteoarthritis, sciatica and low backache precipitated due to stress, exertion, dehydration and old age. Crush injuries and metatarsal fracture occurred from overstepping of feet and wheelchairs during moving assemblage.

Acute myocardial infarction, congestive cardiac failure (CCF) and angina were frequently encountered cardiovascular diseases. COPD

and asthma were common respiratory diseases of non-infectious aetiology. Complications of COPD with cardiomegaly and CCF were seen. Complications of diabetes mellitus such as diabetic foot and cellulitis were seen. Acute urinary retention due to prostatic hypertrophy in geriatric patients needed catheterization. Abnormal heavy uterine withdrawal bleeding due to deliberately delayed menstruation was seen. Mean percentage of psychiatric diseases was 0.006%. Stress related disorders, acute psychosis, anxiety, phobia, depression and obsessive-compulsive disorder; behaviour, mood and sleep disturbances were common. 16.67% psychiatric patients were hospitalized under secondary-care. Heat illness predominantly heat-hyperpyrexia (28 males and 20 females) and heat-exhaustion (24 males and 11 females) was seen in tent-clinics, some of which presented with delirium. Drug induced gastritis was common after self-medication of analgesics and antimicrobials. Various forms of de novo contact dermatitis and intertrigo along with pre-existing chronic skin conditions were seen. Most common pre-existing conditions were diabetes mellitus, hypertension, coronary artery disease, bronchial asthma and chronic obstructive pulmonary disease (Table 2).

29.20% in-patients were treated in secondary-care for gastrointestinal disorders followed by 20.90% for respiratory diseases (Table 3). Most secondary-care hospitalizations were done for

**Table 2**  
Indian Medical Mission primary-care morbidity analysis during Hajj pilgrimage from 2014 to 2016.

S. no.	Year	2016	Percentage	2015	Percentage	2014	Percentage
<b>Infectious disease</b>							
1	Respiratory infections	209,856	53.26	220,755	54.87	237,943	56.72
2	Gastrointestinal infections	194,719	49.42	205,789	51.15	215,523	51.38
3	Diabetes related infections	6852	1.74	6399	1.59	12,689	3.03
4	UTI	6662	1.69	6892	1.71	8201	1.96
		1623	0.41	1675	0.42	1530	0.37
<b>Orthopaedics and musculoskeletal diseases</b>							
1	Fractures & dislocations	96,151	24.4	99,624	24.76	98,499	23.48
2	Myalgia	801	0.20	832	0.21	1043	0.25
3	Osteoarthritis	38,967	9.89	41,876	10.41	41,631	9.92
4	Sprain	1054	0.27	1042	0.26	1143	0.27
5	Low backache	14,789	3.75	16,333	4.06	15,672	3.74
6	Sciatica	39,512	10.03	38,655	9.61	38,101	9.08
7	Crush injuries	590	0.15	496	0.12	507	0.12
		438	0.11	390	0.09	402	0.10
<b>Cardiovascular disease</b>							
1	Acute myocardial infarction	18,314	4.64	16,528	4.11	17,331	4.13
2	Congestive cardiac failure	90	0.02	64	0.02	98	0.02
3	Unstable angina	108	0.03	93	0.02	94	0.02
4	Systemic hypertension	78	0.02	14	0.01	68	0.02
		18,038	4.58	16,357	4.07	17,071	4.07
<b>Respiratory diseases</b>							
1	COPD	18,621	4.73	12,456	3.10	14,123	3.37
2	Bronchial asthma	12,345	3.13	8723	2.17	9210	2.20
		6276	1.59	3733	0.93	4913	1.17
<b>Urogenital/gynaecological diseases</b>							
1	Benign prostatic hypertrophy	1260	0.32	1521	0.38	1294	0.31
2	Abnormal uterine bleeding	714	0.18	862	0.21	837	0.20
		546	0.14	659	0.16	457	0.11
<b>Endocrine disorders</b>							
1	Diabetes mellitus	17,230	4.37	14,256	3.54	15,876	3.78
2	Thyroid disorders	16,670	4.23	13,476	3.35	15,304	3.65
		560	0.14	780	0.19	572	0.14
<b>Neurological/psychiatric disease</b>							
1	Cerebrovascular accident	297	0.07	271	0.07	312	0.07
2	Psychiatric disorders	255	0.06	245	0.06	284	0.07
		42	0.01	26	0.01	28	0.01
<b>Gastrointestinal disease</b>							
1	Acute gastritis	4456	1.13	4186	1.04	4524	1.08
2	Gastrointestinal reflux disease	3350	0.85	3188	0.79	3414	0.81
		1106	0.28	998	0.25	1110	0.26
<b>Miscellaneous diseases</b>							
1	Skin diseases	2243	0.57	2682	0.67	2134	0.51
2	General surgery	20,567	5.22	24,598	6.11	21,987	5.24
3	Eye diseases	358	0.09	234	0.06	349	0.08
4	ENT diseases	245	0.06	130	0.03	236	0.06
5	Dental disorders	60	0.01	65	0.02	55	0.01
6	Unclassified	4355	1.11	4990	1.24	4845	1.16
<b>Total outpatients</b>		394,013	–	402,296	–	419,508	–

**Table 3**  
Indian Medical Mission secondary and tertiary-care morbidity analysis during Hajj pilgrimage from 2014 to 2016.

S. no.	Year	Secondary-care hospitalizations				Tertiary-care referrals							
		2016	%age	2015	%age	2014	%age	2016	%age	2015	%age	2014	%age
1	Cardiovascular disease	28	4.79	26	3.82	25	4.09	134	27.10	109	17.10	98	18.60
2	Neuro/psychiatric disease	20	3.42	24	3.52	12	1.96	27	5.45	18	2.83	12	2.28
3	Gastrointestinal disease	171	29.20	180	26.40	161	26.40	57	11.50	76	11.90	79	14.99
4	Renal disease	18	3.08	15	2.20	23	3.76	38	7.68	42	6.60	34	6.45
5	Respiratory diseases	122	20.90	108	15.90	98	16	60	12.10	71	11.20	72	13.66
6	Endocrine disorders	63	10.80	50	7.34	68	11.10	26	5.25	31	4.87	37	7.02
7	Dehydration & shock	6	1.03	5	0.73	8	1.31	6	1.21	12	1.89	16	3.04
8	Fever (investigations)	52	8.89	60	8.81	45	7.36	12	2.42	17	2.67	19	3.60
9	General surgery	64	10.90	117	17.20	92	15.10	52	10.50	93	14.60	68	12.90
10	Orthopaedics & trauma	41	7.01	96	14.10	79	12.90	83	16.80	167	26.30	92	17.46
	Total hospitalizations/referrals	585	–	681	–	611	–	495	–	636	–	527	–

pneumonia, bronchitis, uncontrolled diabetes, COPD, analgesic abuse gastritis, gastroenteritis, fever of unknown origin, hypertension, acute abdomen, dehydration and shock. Thirty-three malaria cases were treated using arte-ether, pyrimethamine and sulphadoxine. A total of 1045 wound debridements, 335 minor surgeries, 495 plaster casts/slabs and 25 fracture/dislocation reductions were conducted. Wound debridement and dressings were done for diabetic foot, shoe-bites, abscesses and post-operative wounds. Incision and drainage, suturing of lacerations and excision of avulsed nail were done. Aggressive therapy including empirical antimicrobials was administered as there were no facilities for culture and susceptibility testing. A total of 1722 X-rays, 352 ultrasonography, 1159 electrocardiograms and 7456 laboratory investigations were conducted (Table 1). The consumption of medications is depicted in Table 4.

Frequent referrals for tertiary care were made for acute myocardial infarction, congestive cardiac failure, unstable angina, arrhythmia, COPD with complications, severe pneumonia, hemiparesis, chronic kidney disease, heat stroke, diabetic foot requiring amputations, fractures requiring internal/external fixation, advanced investigations and imaging. 21% were referred to tertiary-care for cardiovascular diseases followed by 16.80% for orthopaedic surgeries. Most of the referred cases had pre-existing

**Table 4**  
Indian Medical Mission for Hajj-2016: average consumption of medications (expressed as number of tablets/capsules in usually available strengths).

S. no.	Medications	Average total consumption	Average/100 patients
<b>Oral medications</b>			
1	Analgesics	300,000	66.38
2	Antibacterials	216,000	47.79
3	Antifungals	1000	0.22
4	Antivirals	1500	0.33
5	Antacids	198,000	43.81
6	Antidiabetics	186,000	41.16
7	Antihypertensives	60,000	13.28
8	Antihistaminics	60,000	13.28
9	Antitussives	36,000	7.97
10	Rehydration salts	7200	1.59
11	Hemostatics	3400	0.75
12	Norethisterone	2800	0.62
13	Psychotropics	1200	0.27
<b>Topical medications</b>			
1	Analgesics	18,000	3.98
2	Antibacterials	3700	0.82
3	Antifungals	3600	0.80
<b>Parenteral medications</b>			
1	Analgesics	1800	0.40
2	Antibacterials	6600	1.46
3	Antacids	1800	0.40

**Table 5**  
Indian Medical Mission mortality analysis during Hajj pilgrimage from 2014 to 2016.

S. no.	Year	2016	2015	2014
1	Sudden death (cause unknown)	0	2	2
2	Cardiorespiratory arrest	150	164	102
3	Acute myocardial infarction	0	5	11
4	Congestive cardiac failure	0	3	5
5	Respiratory failure	0	5	10
6	Renal failure	1	5	2
7	Environmental exposure	1	10	2
8	Swine influenza	0	1	0
9	Sepsis/multiorgan dysfunction	5	11	12
10	Road traffic accidents	4	2	2
11	Unnatural incidents	2	103	0
12	Found dead (cause unknown)	0	2	1
	Males	81	196	105
	Females	58	117	44
	Total	163	313	149

comorbidities (Table 3). Few patients of Chronic Kidney Disease on maintenance hemodialysis attempting Hajj were hemodialyzed at Saudi hospitals.

Crude unadjusted mortality amongst pilgrims was 11.99/10,000 compared to 27.02/10,000 in 2015. 24 Out of 163 deaths, there were 112 males and 51 females. Most common terminal event was cardiorespiratory arrest. Risk factors associated with high morbidity were old age and pre-existing comorbidities (Table 5).

## Discussion

The present study highlights high medical usage rates in static-clinics compared to tent-clinics which is attributable to longer duration of establishment of static-clinics compared to five days for tent-clinics. It also emphasizes upon an important role of mobile medical task force which catered to medical emergencies on-site. The secondary-care and tertiary-care medical usage rates exemplify that most patients report with low acuity complaints which can be handled in primary-care, provided it is accessible to Hajj pilgrims. Similar age, sex, comorbidity and admission profile has been reported by other studies [4–10]. Overwhelming surge of patients is a triple edged challenge. One, it downgrades standards of care, compromises resource security and patient satisfaction. Two, it facilitates transmission and acquisition of communicable infections. Three, it leads to stress induced physical, mental and compassion fatigue amongst healthcare personnel.

Infectious disease including respiratory and gastrointestinal infections poses a huge burden to Hajj health system and a threat to healthcare professionals and public-health security [3,5–7]. There are operational challenges at diagnosis, therapy and control

of globalization of potentially multiresistant pathogens [2,11–13]. The prevalence of respiratory symptoms has been found to be as high as 77.60% amongst Hajj pilgrims which can lead to epidemics and pandemics [14]. Increased post-Hajj prevalence of respiratory viruses from 7.40 to 45.40%, and bacteria from 15.40 to 31%, and consequent globalization has been proven [2,14,15]. Overcrowding during mass-gatherings increases the risk of transmission of respiratory pathogens such as rhinovirus, respiratory syncytial virus, Middle-East Respiratory Syndrome (MERS) and other coronaviruses, influenza A H1N1, influenza B, parainfluenza virus, adenovirus, metapneumovirus, enterovirus, multidrug resistant tuberculosis (MDRTB), *Streptococcus pneumoniae* during “Hajj-cough”. Ebola, MERS, Alkhumra viral haemorrhagic fever, and Rift Valley Fever have high outbreak potential during Hajj. Both pandemic and seasonal influenza are simultaneously transmitted during Hajj [16]. In turn, this also leads to increased antibacterial prescription, increased self-medication, empiricism and incompletely antimicrobial regimens, furthering the emergence of multiresistant bacteria. Prescription audit and promotion of non-pharmaceutical preventive measures are mandated, however it remains a resource intensive effort in the realm of mass-gathering medicine. Syndromic surveillance can form early warning outbreak detection system, however it may have limitations due to short duration of diseases, asymptomatic carriage of pathogens, oligosymptomatic presentation, under-reporting to healthcare facility by patients, and inter-observer variation in research cohorts [2,14,17].

Geriatric pilgrims are prone to minimal insults due to low physiological reserves. Physically demanding rituals attempted by elderly under analgesic abuse leads to gastrointestinal problems, drowsiness; worsens hypertension, renal and liver functions; and increases the risk of myocardial infarction and stroke. Outdoor pilgrimage rituals are associated with dehydration, heat exhaustion, heat stroke and sunburn. Multiple comorbidities seen in approximately 20% patients represent a big burden on tertiary-care Saudi hospitals and form the main risk factor for mortality during Hajj [8,14,16,18–21]. Diabetic patients are prone to heat illness, cellulitis and respiratory infections due to poor glycaemic control, relative immunocompromised state, peripheral neuropathy and autonomic dysfunction [19]. Other studies have reported surgery, orthopaedics and trauma related issues during Hajj [3,10,14,18,19]. Various psychiatric disorders observed in the study have rarely been reported during Hajj [14,18]. Extreme heat, overcrowding, physical exertion, dehydration, language barriers, tough living conditions and being in a foreign country for a long duration precipitates stress related problems [3].

Though the history of Hajj pilgrimage is replete with disasters such as stampedes, building collapse, fires and accidents leading to polytrauma and mass-mortality; the Hajj-2016 was astoundingly successful on various fronts. There were no unmanageable crowds and disasters. Saudi Arabia, in association with the Global Centre for Mass gatherings, has boosted infrastructure and logistics while reducing the number of pilgrims for Hajj from 4 million to 3 million, and Indian pilgrims from 2.5 million to 1.4 million in 2016 accordingly, for better control of situational complexity. Disaster risk reduction measures have been adopted by alteration in space, scope and time, in situations such as crowd around a religious, food distribution or entry/exit spot.

Mortality in Indian Hajj pilgrims is largely attributable to patient-specific causes comparable with pilgrims of other countries, due to large geriatric population with pre-existing health conditions [2,14,21–23]. Environment-specific mortality is due to heat illness and incident-specific mortality may be due to incidents such as 2015 stampede causing death of 103 Indian pilgrims amongst overall toll of approximately 1200.

## Conclusion

Overwhelming surge of patients facilitates transmission of communicable infections and leads to stress induced physical, mental and compassion fatigue amongst healthcare personnel. Respiratory infections are highly prevalent and easily transmissible during Hajj leading to significant morbidity, increased burden to existing health facilities, overwhelming costs on health systems and globalization of multiresistant pathogens. Diabetic patients should avoid heat exposure and use protective footwear during Hajj rituals.

Mass-gathering medicine at Hajj can be optimized by improving patient knowledge on performing Hajj at a younger age, medicine compliance, avoiding self-medication, self-monitoring of hypertension, blood glucose, and preventive health measures; screening of pre-existing comorbidities; and resource augmentation with telemedicine networks and decision-support systems.

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## Competing interests

None declared.

## Ethical approval

Not required.

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