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ORIGINAL RESEARCH

Mass Gatherings and Public Health: Case Studies from the Hajj to Mecca

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Abstract

BACKGROUND Many new and challenging risks can be introduced during mass gatherings. The Hajj, as one of the largest mass gatherings, provides an excellent annual opportunity to reflect on the public health risk posed by international and multicultural crowds and the value of mitigation strategies.

OBJECTIVES To identify the gap between preparation and training taken before being exposed to the mass gathering and postexposure experiences, and the breach between the expectations and reality of the holy place.

METHODS This was a qualitative study with in-depth interviews using semistructured questionnaires among Hajjis from 4 different countries (Bangladesh, Pakistan, Myanmar, and New Zealand). Purposive sampling was done. The present study was also supported by literature review.

FINDINGS Findings pointed to weaknesses in implementation and enforcement of law, for both the custodian country and countries of origin of Hajjis. Disparities among developed and developing countries were also noticeable.

CONCLUSIONS From a global health and human security perspective, strengthening of core capacities in managing mass gatherings as well as researching risks posed by such gatherings are paramount to safeguard the public's health. Attention of health professionals worldwide and adoption of strategic planning at custodian country and sending countries are obligatory.

KEY WORDS Hajj, mass gatherings, public health

INTRODUCTION

The World Health Organization describes a mass gathering as "An organized or unplanned event where the number of people attending is sufficient to strain the planning and response resources of the community, state or nation hosting the event," whereas the US-based National Association of Emergency Medical Service Physicians defines it as "Spectators and participants at events in which at least 1000 persons are gathered at a specific location for a defined period of time."[1]

The Hajj, one of the world's largest mass gatherings, takes annually place in Mecca, Saudi Arabia.[2] In 2015, approximately 2.8 million Muslims from more than 183 countries visited this holy place for

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5 days of rituals compulsory for all Muslims capable of undertaking the journey.[3] This challenge to the country perhaps is no less than organizing an Olympic every year. Saudi Arabia, being the custodian of the 2 holy cities (Mecca and Medina), provides extensive, multifaceted programs to serve these "Guests of God." However, the annual event is confronted with public health challenges besides immigration, crowd, and crime management. In addition to the formidable logistics, the risk for spread of infectious diseases is well recognized in the era of globalization. Contemporary outbreaks of Middle East respiratory syndrome coronavirus (MERS-CoV), Ebola virus, and Zika virus have drawn much attention to global health. The annual Hajj event definitely calls for precautions.

This paper is informed by a review of the literature and case studies among 2015 Hajj pilgrims.

PUBLIC HEALTH CHALLENGES IN MASS GATHERINGS

Infectious Diseases. The 5-day ritual causes extensive physical and mental stresses. Heat, sun exposure, thirst, crowding, traffic congestions, steep inclines, rough terrain, and cultural diversity present extensive stressors. During Hajj, pilgrims are also challenged by various prevention and infection control measures. Weather conditions, along with overcrowding within a confined area, make pilgrims also more susceptible to acquiring and spreading infections, particularly acute respiratory infections.[4]

These major challenges have been witnessed when outbreaks of epidemics have occurred; for example, outbreaks of plague and cholera in ancient times involved large numbers of pilgrims, when quarantine was the prime means of control[5,6]; a global meningococcal serotype W135 outbreak in 2000 was widely linked to either a recent return from the Hajj or contact with returned pilgrims[2,7]; in recent years notable threats were avian influenza viruses, severe acute respiratory syndrome coronavirus, Middle East respiratory syndrome coronavirus (MERS-CoV), and multidrug-resistant tuberculosis.[8,9] In 2012, the Hajj received political and scientific attention when MERS cases were detected in France, Germany, Italy, and the United Kingdom. MERS-CoV was first isolated from a patient who died of a severe respiratory illness in Jeddah, Saudi Arabia.[8]

According to Bakhsh et al,[10] in 2 health care centers near the Holy Mosque, most of the patients were suffering from respiratory problems followed by skin and gastrointestinal problems during the 2013 Hajj season. "Hajj cough" was considered by pilgrims the most reported complaint, and 1 in 3 pilgrims were found to be affected. The severity and clinical spectrum of respiratory disease varies from mild sickness to severe pneumonia, hospitalization, and even death.[11] Unfortunately there are no comprehensive studies on the epidemiology of respiratory infections during Hajj; most investigations involved cross-sectional studies on a relatively small number of cases.[12,13]

Although governments of Hajji's countries of origin recommend flu vaccinations for Hajj pilgrimages before departure, most hajjis do not adhere to these recommendations. Influenza vaccine has been recommended since 2005 for all pilgrims, especially people at high risk, which includes those >65 years of age and people with preexisting medical or immune-compromising conditions.[14] Despite all these recommendations, the influenza vaccine acceptance rate among Hajj pilgrims varies by country and by year. Many pilgrims refuse vaccines; the main reasons identified were reliance on "natural immunity," lack of awareness or knowledge, and lack of access to vaccines. Many people have misperceptions about vaccines, including that they contain toxic preservatives and are themselves the cause of disease. Moreover these vaccinations do not cover variants of different strains of influenza. According to Alborzi et al.,[13] in their study on Iranian Hajj pilgrims, influenza vaccination could not prevent respiratory infections in pilgrims statistically ($P = .19$), but the consequences of this limitation remains less. Two hundred fifty-five pilgrims were examined for respiratory infections, and influenza virus was identified more in unvaccinated than in vaccinated pilgrims (16.5% vs 9.2%) in laboratory tests of their nasal swabs.[13] Another study among Malaysian pilgrims found that influenza vaccine was effective for 50%-60% in preventing hospitalization and pneumonia; it was 80% effective in preventing death in patients older than age 60.[15] Eventual vaccination failures might be explained by a new drift of variants or inappropriate vaccine handling and storage.[*] Therefore examining the circulating influenza strains is recommended in

[*]For men, the special outfit for the hajj consists of 2 pieces of white, unsown cloth. One of the pieces is wrapped around the midriff to cover the lower body, and the other is draped around the shoulders to cover the upper body. Women must cover their bodies in a loose-fitting outfit and cover their hair. However, they are not permitted to cover their faces.

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addition to strict enforcement of vaccination policy.[13,15] Among other precautionary measures, the use of a face mask is considered by some pilgrims religiously prohibited while wearing ihram. Some consider using alcohol-containing products (eg, hand sanitizers) as prohibited during Hajj ritual too, although recently religious scholars have allowed the use of alcohol for medical purposes. However, the challenge remains to endorse use of mandatory face masks in the crowd and organize screening at arrival.[9] The Saudi government faces extreme pressure during the time of Hajj because there are multiple routes of entry for pilgrims.[16] Therefore it is recommended to enforce the law on compulsory vaccinations and control for dishonesty and corruption by the home countries as prerequisites for visa processing. Also, a supply of adequate vaccines at limited or no cost is strongly suggested.[14]

Skin infections among pilgrims are very common because of lengthy rituals of standing and walking, heat, and unfavorable conditions.[17] Primary pyoderma (including impetigo), carbuncles, furuncles, folliculitis, pyoderma complicated eczema, and cutaneous leishmaniosis are commonly found. Pilgrims are barefoot while walking in some holy places, or emotionally climb some rocky places. Accidental injury, severe burns, and soreness of the sole are common occurances,[18] and these kinds of injuries increase the chance of secondary skin infections, especially among elderly and comorbid people.

Noncommunicable Diseases. Many studies and the Saudi Arabian government's health statistics have indicated that noncommunicable diseases, particularly cardiovascular diseases and diabetes, pose critical health challenges for pilgrims and the government's health system during Hajj.[19-21] Pre-hajj medical states, being of old age, rigorous physical activities, exhaustion, fatigue, heat, and trauma are related to and cause exacerbation of chronic noncommunicable diseases during Hajj.[19,22,23]

Cardiovascular diseases were the main cause of hospitalization and intensive care. Almalki[24] reported in his Hajj study that out of 110 inpatients from 20 different countries, 34% had ischemic heart disease, 20% had elevated blood pressure, and prevalence of stroke was 17%. According to Madani et al,[19] more than 60% of the intensive care unit admissions in 7 hospitals in Mina and Arafat were due to cardiovascular origins. Among these cases, myocardial infarction and left ventricular failure were of the highest occurrence.[19] Furthermore, cardiovascular events were the major cause of death during pilgrimage. The review study of Al Shimemeri[25] confirmed that cardiovascular diseases during the Hajj period caused more death than other communicable and noncommunicable diseases. In 2008, 66% of deaths were due to cardiovascular diseases out of 446 deaths among Indonesian pilgrims.[26]

Many factors been identified that lead to poor diabetes control during Hajj.[27] A study by Khan et al[21] revealed that 31.9% of 689 emergency patients had diabetes; meanwhile 34 patients were diabetic among 160 acutely hospitalized patients.

Mortazavi et al[28] observed that in the 2012 Hajj, 106 Iranian patients were referred back to Iran for health reasons. Among them were 13 cardiac, 28 psychiatric, 11 neurologic, 4 endocrine, and 4 nephrology patients.[28]

Crowd Safety. Crowd management requires enormous skills, experience, and efficiency. Research on crowd psychology has been going on since at least Gustave Le Bon's work in the 1890s, and more advanced techniques and models have been used by the entire world during the last 20 years.[29] Hajj is one of the most crowded gatherings of all, and it is expected that the number of pilgrims will increase by 10% each year. Furthermore, most of the pilgrims are from underprivileged countries and are elderly, poor, and illiterate, and the Hajj is often their first international trip.[2,16] The major concern of this mass gathering is that the entire Hajj event must be completed over a limited and fixed schedule of only 5 days. The rituals are performed in a specific unchangeable sequence following a fixed route within a geographic area that does not exceed 4 km^2.[16] Such rigor and strictness leads to a series of disasters almost every year, keeping pressure on the authorities.

The Holy Mosque covers an area of 356,800 m^2, including the outdoor and indoor prayer spaces. Its total capacity is about 2 million people. When fully occupied, the buildings could accommodate an average crowd density level of 4 people per square meter (4 ppm^2). However, at certain locations, and closer to the Kaaba, the level of density becomes 6-8 ppm^2 and 12 ppm^2. A similar crowd density is observed near Jamarat,[†] and incidences like stampedes occur commonly.[30]

The Saudi government has involved religious scholars, administrators, immigration and security personnel, health officials, and other officials to

[†]Three stone pillars that are pelted as a compulsory ritual of hajj in imitation of the Prophet Abraham (Peace on Him).

manage the Hajj. In spite of all these efforts, several disasters have taken place every year, such as stampedes, fires, bottlenecks, and more. Although during the past few years several scientific and technological efforts have been applied to assist in the management of crowds, in 2015 a devastating stampede occurred. The use of crowd simulation models, assessment of the efficient ways of grouping and scheduling pilgrims, luggage management, video monitoring, and changes in the transport system are the latest measures to improve the management of the pilgrimage event.[31]

There are many methods for modeling and simulating pedestrian crowds followed worldwide, such as agent based, social force, cellular automata, fluid dynamic, fixed GPA monitoring and queuing models, and so on. Pedestrian crowd dynamics have different scales, such as the microscopic scale, dealing with individual pedestrians, and the macroscopic scale, dealing with the characteristics of a crowd. These methods have shown several self-organizing principles about the patterns of crowd phenomena; corresponding patterns have been noted in real crowds. These included macroscopic crowd patterns that result from local interactions of multitudes of pedestrians at the microscopic level.[29]

Some studies reported that people moving in groups had positive psychological effects, including less feeling of being lost, and that proper guidance from a group leader had a positive effect as well.[30] In absence of these factors, real crowds are perceived to pose a threat. However, updates on the crowd flow must be announced and displayed by electronic boards at different parts of the roads to assist in crowd management.

Heat-Related Sickness. The ambient temperature in the Kingdom of Saudi Arabia remains very high, particularly during summer. Even during winter, the temperature is higher than in many parts of the world. Weather during Hajj season shows extreme variations, with average temperatures >38°C during daytime and >25°C at night and a monthly rainfall averaging 3 mm.[4] The heat island effect—that is, heat radiance from vehicles, high-rise buildings, pitched roads, ongoing construction, dust particles, and noise—is a recent concern in both Mecca and Medina.

The pilgrims come from different countries worldwide, and their acclimatization to the local temperature is equally diverse. Therefore, exhaustion syndromes may or may not be accompanied by increased body temperature. With a body temperature of 40.0°C (105°F), one person may be able to walk to a clinic for help, whereas another person might die after heat stroke. Moreover, supplicating pilgrims remain unware of the extreme heat exposure until symptoms are noticeable. Addressing the diagnostic criteria of heat stroke thus remains challenging for Hajj pilgrims.[32] Although water mist sprayers are operated in the desert of Arafat, those places remain highly crowded. However, there are various measures that can be applied in performing rituals (eg, using an umbrella, applying sunblock creams, performing rituals at night).[17]

METHODS

Objectives. This paper describes gaps between pre-exposure preparation to the mass gathering and postexposure experiences, as well as the disparities between expectations and the reality of the holy place.

METHODOLOGY

We collected 4 case studies by using a semistructured questionnaire facilitating in-depth interviews among Hajjis who were purposively selected from Bangladesh, Myanmar, New Zealand, and Pakistan. Participants were selected following critical case sampling method. Questions covered pre-exposure preparations and postexposure experiences, as well as health and safety concerns. Interviews were audio-recorded in the interviewees' own languages and transcripts translated into English.

Case Studies. ***Pakistan.*** A 60-year-old retired government officer of the Water and Power Development Authority of Pakistan and electrical engineer went to perform Hajj by government quota with his family and friends. He and his group were vaccinated against polio, influenza, and meningitis 1 week before departure, and vaccination cards were provided along with visas.

On arrival at Jeddah International Airport at Dhur prayer, they had to wait 3 hours for transportation to Mecca. Accommodation was arranged at Mecca 16 km from the Holy Mosque. However, rooms were overcrowded and lacked proper ventilation. Washing machines at a laundry area were provided, and although pilgrims were guided to dry their clothes on the top roof of the hotel building, many pilgrims dried their clothes inside the rooms. Medical facilities and food supply and delivery were inadequately available and not properly managed in the vicinity of the accommodation in Mecca, but in

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Medina, they were managed properly. The transport system was not properly arranged either. The respondent and his group had to change 2 buses with pilgrims from various other nationalities to reach haram 5 times a day. To avoid this hassle, they tried to spend most of time inside the haram. There was a lack of enforcement on the use of mataf.[‡] Although there were different mataf areas for wheelchair users, people tried to conduct circumambulation with wheelchairs in the same mataf area, and as a result, many accidents happened. A couple from their group witnessed a crane crash accident in haram, but they survived. The pilgrimage route between Mina, Arafat, and Muzdalifah, presented in Figure 1, posed multiple challenges for pilgrims. The respondent, with his family, had to stay inside a heat-resistant cloth tent for 5 days in Mina. However, tents in Mina had few cooling facilities and were overcrowded. The temperature in Arafat was around 55°C, and they had to stay in open tents without any cooling system. They spent the night in Muzdalifah in an open space; however, the place was overcrowded and untidy. Sanitation was available with sufficient facilities, but cleanliness was not well managed; there was garbage and litter all around. Transportations were overcrowded with poor safety arrangements; many got injured while boarding. Because all Hajj rituals had to be performed at specific times and places and all pilgrims wanted to complete the pilgrimage route as early as possible, there was obvious struggle among all. Many pilgrims traveled long routes on foot. In Mina, many pilgrims experienced heat stroke, and many were killed in a stampede at Jamarat during the stoning of Satan. The respondent thinks extreme hot weather, overcrowding, language barriers, and challenged pilgrimage management made the Hajj difficult.

Myanmar. A 30-year-old medical doctor performed his fourth Hajj from Myanmar in 2015. He went as a medical officer recruited by a hajj service company. He prepared medicines and medical requirements for more than 600 pilgrims. He gave a 15-minute health session to them during a dinner gathering hosted by the company. The session was too short to cover all health-related matters. Despite mandatory cholera and meningococcal vaccinations for visa application, nearly all Hajj agents including his company provided fake vaccination certificates. He led a 120-pilgrim group to Mecca. The hotels at Mecca were next to Kaaba and were well furnished, but rooms were overcrowded by sneaking in extra beds. In case of emergency such as a fire outbreak, people might get into trouble. Moreover, the condition contributed to increased risk of transmission of airborne diseases. For many pilgrims, the visit was their first international trip and they had never experienced such a huge gathering of people before.

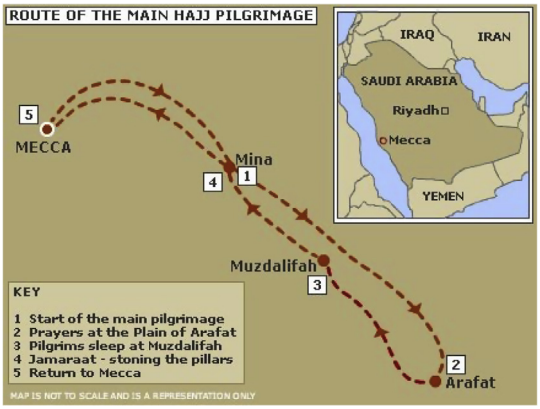

Figure 1. Hajj pilgrimage route. (From BBC Religion and Ethics. Available at http://www.bbc.co.uk/religion/galleries/hajj/.)

In the Kaaba compound, many tower cranes were assembled at the time of the pilgrimage. Although the crane operations were temporarily shut down, pilgrims were worried about the hazard of cranes after a crane accident occurred earlier. Squeezed into a corner of the holy black stone, with vigorous pushes and wild rushes, was a dangerous place for the old, the sick, and children. Surprisingly, there were some hazardous places like collapsed billboards and unhygienic out-of-order public toilets in walking distance from the holiest mosque. The holy city's waste management was very good, yet sorrowfully, many pilgrims did not care about being at holy places and they littered carelessly in public places.

At Mina, the camps and toilets were very crowded. At Arafat, camps were also crowded and there was no electricity supply. The camp had a mud floor. The weather was too hot on the day of Arafat. Thus, people suffered from heat exhaustion, back pain, and exacerbation of hypertension. Leaving to Muzdalifah, routes were heavily crowded by pilgrim pedestrians. This posed a potential challenge causing delay for the emergency medical teams to reach patients. Although security squads were deployed, their number became significantly

[‡]Open white area immediately around the Kaaba where circumambulation takes place.

increased only after the devastated stampede at Jamarat.

In Medina, the conditions were relatively comfortable in all aspects, particularly good accommodation and fewer crowds. One very dangerous attempt of pilgrims during visiting Islamic historic sites was climbing steep sides of the Hira Cave[§] wall, eager to reach the cave, and once inside pushing to perform supererogatory prayers.

Bangladesh. A 36-year-old young government officer of Bangladesh Army's engineering core said that his group didn't receive any vaccinations because their visas were done with fake vaccination cards. Yet they arranged meningitis vaccines by themselves on the advice of experienced persons. The accommodations at Mecca and Medina were not up to their expectations and the deposit they provided to the agency. The rooms were tiny and overcrowded, with no or minimal ventilation. No arrangement for drying wet clothes made the room damp and unhygienic. The building had no elevator and no emergency exit. The electric cables and wirings had no secure fittings, posing an increased risk of short circuit. Littering on the road was found beyond limitations. For the reasons of convenience and avoiding various challenges, the respondent spent most of the time inside the Holy Mosque, and thus he witnessed the most tragic accident of a crane collapsing. Being an army officer, he was better equipped to cope with casualties and volunteered to assist the injured. He found many warning signs stating "Construction Site, Do Not Sit" inside the mosque, but enforcement of those warnings was lacking. Escalators were used by elderly in wheelchairs besides pedestrians. Because of overcrowding and neglect of regulations, he witnessed the fall of one old person rolling down with his wheelchair. There were different and tidy arrangements for circumambulation of wheelchair holders, but many pedestrians used the same circle in front of law enforcers. The front wheel of wheelchairs thus hurt the backs of the ankles (Achilles tendons) of many pilgrims.

From the respondent's perspective, Mina and Arafat were the most mismanaged places. Pilgrims from developing countries were assigned to stay in overcrowded tents with a low-capacity air cooler. In Arafat, the tents were open without any cooling facilities. One of their groupmates died from heat stroke.

New Zealand. A New Zealand pilgrim went to Hajj alone with an agency. According to the respondent, vaccination and doctor's certificate were mandatory for visa approval. The agency didn't provide any health training or Hajj-ritual education. On arrival in Mecca, accommodation and transportation were facilitated in a well-organized manner. They were provided a 5-star hotel in the vicinity of the Holy Mosque, both in Mecca and Medinah. Even in Mina, Arafat, and Muzdalifah they were provided air-conditioned tents with clean-hygiene sanitary facilities, although he was of the opinion that it could have been improved. A doctor visited their tents and provided medicines. In his language, the "NZ-AUS Hajj camp was of superior quality. I went for Hajj for spiritual purpose. If someone remains calm, the spiritual side can be felt by overcoming worldly limitations."

DISCUSSION

In short, our study clearly revealed dissatisfaction and discontentment regarding the management among Hajj pilgrims from developing countries. This sacred ritual was hijacked as a business opportunity by broker agencies of developing countries, infested with corruption, dishonesty, and greed to make profit from pilgrims. Implementation and enforcement of law from both the custodian country and sending countries were found to be weak in several aspects. Notwithstanding the custodian country's adoption of various recent research insights, techniques, and models to enhance security and safety, and arrangement of relevant annual conferences and capacity-building initiatives, a significant gap was found between planned and actual implementation strategies. A discriminatory and judgmental attitude of the custodian country officials was encountered toward pilgrims from developing countries.

CONCLUSIONS

Case studies adopt a retrospective approach; therefore, a potential recall bias among respondents should be considered. We also acknowledge the limitations of a purposive sampling that may enhance the risk for selection bias. Interanalyst reliability testing was employed to minimize potential bias in the analysis. In the absence of post-travel surveillance in respondents' home countries, follow-up on the post-travel period except about their own was not feasible. The value of our study

[§]The place where Muhammad PBUH is believed to have received the first revelation of the Qura'n.

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is that it gave a voice to Hajj pilgrims themselves and offers a benchmark in revealing practices that undermine health and safety of pilgrims from developing countries.

Although Saudi Arabia keeps pilgrims' health and safety as their top priority, inevitably causalities do happen. Many recent incidences and risks of morbidity and mortality suggest that it is not the sole responsibility of one country but should be attributed to all home countries of pilgrims. Especially to meet the challenge of infectious diseases, a well-coordinated global approach is priority. Epidemiological modeling at the microscopic level is suggested by many researchers and already monitored in other mass gatherings, such as Notting Hill Carnival. Dishonesty related to vaccination and treatment ultimately endangers the whole world as illustrated in the literature. Henceforth international collaboration, law enforcement, and research are vital to ensure accessibility of vaccines and prescribed medications for the pilgrims. Capacity building within host and sending countries focusing on prevention of infectious disease, heat-related sicknesses, and injuries before Hajj are important and should be adopted worldwide. Hajj causalities data should be shared accurately; and the custodian country should welcome global participation and deal with criticism in a constructive way. Furthermore, an international event of this magnitude such as the Hajj creates communication challenges. To minimize language barriers, law enforcers must be proficient in English, and written instructions or directions should make use of main global languages.[29]

Hajj is a unique mass gathering provides excellent is annual opportunity to reflect on the public health risk posed by international and multicultural crowds and the value of mitigation strategies. New and challenging risks can be introduced during mass gatherings. From a global health and human security perspective, strengthening of core capacities in managing mass gatherings and researching risks posed by such gatherings are paramount to safeguarding the public's health.

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