



COMMENTARY

The impact of crowd control measures on the occurrence of stampedes during Mass Gatherings: The Hajj experience



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Summary *Background:* Mass gatherings present enormous challenges for emergency preparedness. Planners must anticipate and prepare for communicable and non-communicable disease outbreaks, illnesses, and injuries to participants, crowd control, and disaster responses to unforeseen natural or man-made threats. The Hajj, the largest annually recurring mass gathering event on earth. It attracts about 3 million pilgrims from over 180 countries who assemble in Mecca over a 1-week period.

Methods: A literature review was conducted using Medline and OVID, while searching for published data concerning human stampedes and crowd control measures implemented to prevent human stampedes. The review was further extended to include media reports and published numbers and reports about Hajj from the Saudi Arabian government, in both the English and Arabic languages.

Results: Because millions of pilgrims undertake their religious ritual within strict constraints in term of space and time; this rigour and strictness have led to a series of large crowd disasters over several years, thus putting pressure on the authorities. In the past few years, the government of Saudi Arabia have put an enormous effort to solve this difficulty using state of the art innovative scientific means. The use of crowd simulation models, assessment of the best ways of grouping and scheduling pilgrims, crowd management and control engineering technologies,

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luggage management, video monitoring, and changes in the construction of the transport system for the event.

Conclusions: A large gathering such as the Hajj still holds an increasing risk for future disasters. International collaboration and continued vigilance in planning efforts remains an integral part of these annual preparations. The development of educational campaigns for pilgrims regarding the possible dangers is also crucial. Lessons gleaned from experiences at the Hajj may influence planning for mass gatherings of any kind, worldwide.

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1. Introduction

Mass gatherings present enormous challenges for emergency preparedness. Planners must anticipate and prepare for communicable and non-communicable disease outbreaks, illnesses, and injuries to participants, crowd control, and disaster responses to unforeseen natural or man-made threats [1,2]. Historically, non-communicable illnesses (particularly heat-related illnesses) and traumatic injuries, including fires, have had the greatest impacts on morbidity and mortality [3,4]. Hajj, an Islamic pilgrimage, is considered the largest annual planned mass gathering in the world. Every year, about two million Muslims from over 180 countries travel to the holy city of Mecca, Saudi Arabia, to undertake this religious journey, an obligation required of every able-bodied Muslim at least once during his/her lifetime as a religious tenant [5].

In comparison to other mass gatherings, Hajj is considered unique in several respects. Because of limited attendance allocations to each country (country quota), majority of pilgrims have to wait a life time before their turn comes, leading to a majority older pilgrims, and consequently members of a large elderly population perform their rituals in extreme environmental conditions (temperatures can reach 100 °F in the summer months in Mecca). Pilgrims stay in overcrowded lodgings for an extended period, and move about in large groups.

This journey is completed over a period of five days, during which pilgrims move through a series of rituals. Starting at the holy mosque in Mecca, with the performance of tawaf, the clockwise circling of the Kaaba (the sacred building Muslims consider the house of God) takes place. The pilgrims then leave for Mount Arafat, which lies a few miles east of Mecca, and make an overnight stop in the tent city of Mena. After spending the afternoon in Arafat, they return to Mina, where the symbolic ritual of the devil stoning (Jamarat) is conducted. Finally, the pilgrims return to Mecca, where they perform the farewell tawaf to mark the conclusion of their pilgrimage.

Despite the peaceful nature of the Hajj as a mass religious gathering, and the enormous efforts undertaken by the multi-sector organizing bodies that plan around the clock in preparation for this event, at least 3000 people have died over that past 30 years while performing Hajj. In the past two decades, most of the incidents that resulted in death at the Hajj ritual were the result of stampedes, demonstrations, and fires. Terrorist incidents have also plagued this peaceful gathering. One person was killed

when a bomb exploded near Mecca's Grand Mosque in 1989 [6]. Human stampedes are one of the most feared and fatal incidents to occur during any mass gathering, claiming hundreds of lives each year [7].

From 1980 to 2007, 215 human stampedes were reported around the globe, resulting in 7069 deaths and 14,078 injuries [8].

2. Overview of previous stampedes during Hajj

In an attempt to categorize stampede events, Ka Ming Nagi et al. described a stampede classification according to the recorded mortality rates of each incident, using a scale from I to V, with class I being (mild): 0 deaths; class II (moderate): 1–10 deaths; class III (severe): 11–100 deaths; class IV (devastating): 101–1000 deaths, and class V (catastrophic): >1000 deaths [9]. Using this scale, most Hajj stampede incidents fall into classes IV and V, a finding highlighting the potential magnitude of similar events that could occur in the future. Particularly given the worldwide growth of Islam, and the ever-increasing number of Hajj participants. In the 1990 Hajj season, a stampede in which pilgrims spontaneously rushed to leave Mecca by means of a pedestrian tunnel led to the deaths of 1426 pilgrims [10].

The Jamarat Bridge was originally constructed in 1975, with pillars that extended up through three openings in the bridge, thereby enabling pilgrims to throw stones from the ground level or from the bridge [11]. Before that, pillars were approached only from the ground, and stoning was performed in a less organized fashion (see Table 1).

More than 1000 people lost their lives in stampedes on the Jamarat Bridge between 1994 and 2006 [6,9,12]. Causes

Table 1 Reported stampede events at Jamarat in recent years.

Year	Number of deaths	Number of pilgrims (million)	Classification ^a
1994 [3,6,9]	270	1.0	IV
1998 [9]	119	1.8	IV
2001 [3,9]	35	2.2	III
2003 [9]	14	2.0	III
2004 [6,9]	251	2.2	IV
2006 [6,9]	380	2.2	IV

^a According to Nagi et al. [6].

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