

Public Health Threats in Mass Gatherings: A Systematic Review

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ABSTRACT

Mass gatherings (MGs) are held throughout the world. The aim of this review was to assess and identify the health threats based on the type of the MG, type of diseases, and injuries. Research platforms such as Web of Science, Medline, and Scopus were searched through June 2017. All epidemiologic studies that investigated the health threats during the MGs, such as communicable diseases, injuries, high-risk behaviors, and environmental health problems, were included in this review. Out of 1264 references, 45 articles were included in the review.

Three main types of MGs include religious, festival, and sporting event; and fairs such as trade, book, and agricultural types were also reported in the selected studies. In the religious MGs, infectious diseases were the most common health threat. Road traffic accidents and environmental health problems were additional health threats. At MG sporting events, injuries were the most common health problems. Infectious diseases and alcohol and drug-related disorders were other reported public health concerns. In the festival MGs, alcohol and drug-related problems were commonly reported. This review showed that health threats vary, based on the type of mass gathering. The health organizers of MGs should consider the type of the MG and the health needs and safety of the participants to help them plan their action and provide the needed health care services.

Key Words: illness, infectious diseases, injuries, mass gatherings

Today, mass gatherings (MGs) are commonly held events throughout the world. According to the World Health Organization (WHO), an MG is an event in which the participants affect the capacity of the available resources to support their health needs and to successfully deliver health services.¹ Each year, religious, sport, and various festival MGs are held at the national and international levels. Public health issues of MGs are becoming more complicated in national and international levels.² Important implications of MGs to health security risks such as infectious diseases, outbreaks, noncommunicable diseases, and injuries have encouraged research.³⁻⁶

People who participate in MGs may be threatened by communicable diseases such as water and foodborne infectious diseases, respiratory infectious diseases, injuries, terrorism, and bioterrorism.⁷⁻¹¹ In addition, noncommunicable diseases and accidents are other concerns in MGs for participants and health systems.¹² The health of the people in MGs may be affected by the interaction of the biologic, environmental, psychological, and social factors.¹³ So the characteristics of participants such as age, sex, and chronic underlying disorders are determinants of health in MGs.¹²

In recent years, health and safety provisions for participants in these MGs have been raised as 1 of the major concerns of governments, as well as national and international organizations.^{8,9,14} The occurrence of communicable and noncommunicable diseases in an MG is related to the presence of risk factors during the event. Accordingly, the identification of such risk factors in each MG can be useful in the planning of preventive actions.¹⁵ Moreover, based on WHO recommendations, the hosts of international and large MGs should have the preparedness to respond appropriately to preventable diseases and injuries and to manage potential threats effectively during MGs.^{5,16}

To date, several studies have been published regarding the health threats among participants during MGs. Some of these studies evaluated the required health care of participants in MGs. However, the more precise knowledge regarding the potential risk factors of prevalent diseases and injuries can be useful for planning preventive interventions during the MGs. Therefore, the aim of this review was to assess and identify the health threats in MGs based on the type of the MG, type of risk factors, and types of diseases and injuries.

METHODS

Searching and Eligibility Criteria

This systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).¹⁷ We designed a search strategy using the key words: *mass gathering, health, diseases, illness, infectious diseases, emerging diseases, re-emerging diseases, and injuries*. The major international scientific databases – Web of Science, Medline, and Scopus – were searched up to August 2018, using the mentioned key words. In addition, to obtain more articles, the reference lists of included studies were scanned.

All epidemiologic studies that investigated the health threats of participants in MGs were included in the review. The studies regarding the required health care in MGs were excluded from the review. In addition, review articles, editorials, and letters to the editor were excluded.

Two authors (ADI, ZB) were responsible for screening the retrieved articles. In the first step, the title and abstract of articles were scanned independently. Any disagreement between authors in the selection of the studies was resolved by discussion and the judgment of the third author (MK). In the next step, the full text of selected articles was assessed

based on the eligibility criteria. Finally, 2 authors (ADI, ZB) extracted from the selected studies these data: (1) first authors, (2) year of publication, (3) date of the MG, (4) location of the MG, (5) type of study, (6) alternation in the MG holding, (7) number of participants in the MG, (8) type of MG, (9) type of health threats or risk factors, (10) tools of data gathering, (11) type of surveillance system during the MG, and the (12) main results of the study.

The Microsoft Excel program was used for extraction and the management of extracted data from the included studies. The selected studies in the review were categorized based on the type of the MG, type of health threats, and the time and location of the MG.

RESULTS

Description of Studies

A total of 1276 references were obtained from the electronic search of international databases. After finally checking the eligibility criteria, 45 articles^{3,16,18-62} regarding the health issues in the MGs were included in the review (Figure 1). The characteristics of the included study are shown in Table 1.

FIGURE 1

A Flow Diagram for the Process of Study Selection in the Review.

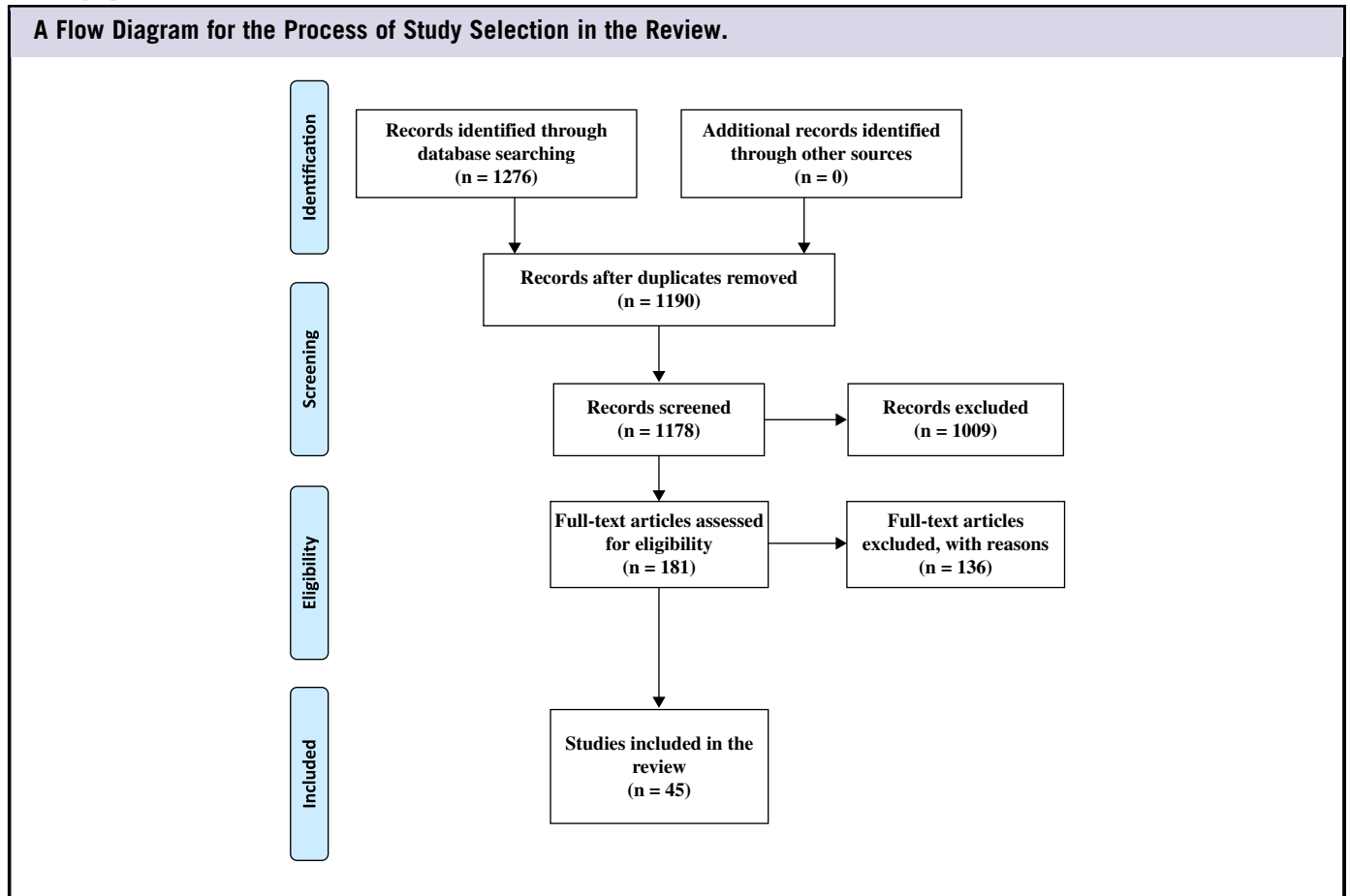


TABLE 1

Characteristics of Included Studies in the Review

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
1	Abdullah	2013	Cross-sectional	Jordan	2010	Yes	Religious	Injuries	Researcher designed	Road traffic crash, injury caused by marine creatures, and drowning were the most common injuries during this MG. The road traffic crashes increased by more than 300%.
2	Alqahtani	2016	Prospective cohort	Saudi Arabia	2014	Yes	Religious	Infectious diseases	Questionnaire	Respiratory symptoms began from the 4 th day of Hajj. Sore throat (20%) and cough (12%) were the most common. Three participants (12%) reported respiratory symptoms after returning home.
3	Baranwal	2015	Cross-sectional	India	2013	Yes	Religious	Environmental hazards	A closed-ended questionnaire	Health care services and water sanitation and hygiene conditions were found to be satisfactory. Some of the shortfalls identified were that drainage was a major problem and some fire incidents were reported. The number of persons per toilet was high and there were no separate toilets for males and females.
4	Bortolin	2013	Retrospective analysis	Italy	2010	Yes	Religious	Injuries and illnesses	Register in a standard database	The patient presentation rate and transport to hospital rate were both low (0.27 and 0.039, respectively). Cardiac and trauma emergencies were the most common categories of presentation. About 2 million persons participated in this event.
5	Gocotano	2015	Descriptive	Philippines	2015	No	Religious	Cold stress	Patient records	Of the 1051 people seeking medical care, 231 people were experiencing symptoms of cold stress.
6	Hassan	2013	Descriptive	Pakistan	2010	Yes	Religious	Infectious diseases, injuries, and non-communicable diseases		In this event, 58% of health services were because of communicable diseases, 21% of which were respiratory tract infections and 26% gastrointestinal illness. Injuries accounted for 31% of cases, and non-communicable diseases included asthma, chronic obstructive pulmonary disease, and hypertension for 11%.
7	Joseph	2016	Qualitative	India	2014	Yes	Religious	Injuries and illnesses		Based on the risk ranking indexes, human stampedes and person-to-person communicable diseases have the highest rank in the risk identification. Lack of coordination, difficulty in access to medical facilities, and shortage of paramedical staff are the main challenges of health care providers.
8	Memish	2014	Cross-sectional	Saudi Arabia	2013	Yes	Religious	Middle East respiratory syndrome coronavirus (MERS-COV)	Standardized data collection form and vaccination documents of participants	MERS-COV was not detected in the samples tested (3210 pre-Hajj and 2025 post-Hajj screening). Based on the vaccination documents, all participants had received meningococcal vaccine. Only 22% and 4.4% of the pilgrims had received flu and pneumococcal vaccine, respectively.

TABLE 1

Characteristics of Included Studies in the Review (continued)

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
9	Mirza	2011	Cohort	Saudi Arabia	2008	Yes	Religious	Asthma	Prospective tool questionnaire	The study involved 58 subjects. The frequency of mild, moderate, and life-threatening asthma attack were 46.6%, 31%, and zero, respectively. The risk of asthma among women, people ages 46–60 years, pilgrims (Hajis) who did not belong to a Hajj group, non-Hajis, illiterates, and nonsmokers was more than other groups. In this event, 211 patients were evaluated. Acute severe asthma and injuries were the major problems. There were 2 deaths related to heat stroke. The proportion of injuries varied from an average of 3.7% pre- and post-event to 14.8% during the event. In addition, a significant increase was observed in digestive diseases. Among 544 fecal samples, 228 were positive. In the positive samples, the proportion of bacteria, viral, and parasitic were 82.9%, 6.1%, and 5.3%, respectively. Salmonella, Shigella, Escherichia coli, and enterotoxigenic E. coli were the main detected associated with severe symptoms.
10	Sindy	2015	Cross-sectional	Saudi Arabia	2013	Yes	Religious	Illnesses and injuries		
11	Youbim	2013	Retrospective	Moroccan	2009–2010	Yes	Religious	Illnesses (infectious diseases) and injuries	Medical records and semi-structured questionnaire	
12	Abd El Ghany	2017	Case-series	Saudi Arabia	2011–2013	Yes	Religious	Infectious diseases (enteric infections)		
13	Khan	2018		Saudi Arabia	2016	Yes	Religious	Infectious diseases, orthopedics and musculoskeletal diseases, and cardiovascular disease	Medical records	Infectious diseases such as respiratory, gastrointestinal, and diabetes related infections, and UTI were the most common (53.26%) outpatient diagnosis.
14	Sokhna	2017	Cross-sectional	Senegal	2015	Yes	Religious	Infectious diseases, injuries, and non-communicable diseases	Surveillance data	Trauma, fatigue and heatstroke, infectious diseases were prevalent with a high rate of febrile systemic illnesses and malaria, diarrheal diseases, and respiratory tract infections.
15	Athanasopoulos	2007	Observational study	Greece	2004	Yes	Sport	Injuries	Researcher designed	The most prevalent site of injury was the thigh (21%), followed by the knee (14.1%) and the lumbar spine (13.5%). Most patients were athletes (74.8%), although team officials accounted for a considerable number (14%).
16	Burton	2012	Retrospective study	UK	2008–2009	Yes	Sport	Injuries and illnesses	Standardized patient report forms	Soft tissue injury, laceration, and burns were the major reported injuries. Alcohol was related to 5% of presentations.

TABLE 1

Characteristics of Included Studies in the Review (continued)

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
17	Chen	2010	Descriptive	China	2008	Yes	Sport	Injuries and illnesses	Standard medical encounter form system	802 patients were divided into 12 types of diseases, that is, injury (39.03%), digestive disorder (21.82%), cardiovascular disorder (7.36%), respiratory disorder (6.48%), nervous-sensory disorder (6.23%), skin diseases (4.49%), eye disorder (4.24%), ear-nose-throat disorders (3.74%), heat related illness (3.37%), genitourinary disorder (1.87%), dental disorder (1.37%), psychiatric disorder (0). Headaches, soft tissue injuries, blisters, and other wounds accounted for 64.1% of presentations. Traumatic injuries accounted for 42.0% of patients. The patient presentation rate and transport to hospital rate across all venues was 0.857 and 0.0186 per 1000 participants, respectively.
18	Dutch	2008	Case series	Australia	2006	Yes	Sport	Injuries and illnesses	St John Ambulance National Diagnosis Data set	The insect bites and sunburns were environmental risk factors. Every third traveler suffered from diarrheal complaints in both groups, whereas the proportion of travelers with flu-like symptoms was higher in the case group (Travelers to the FIFA). Travelers to the FIFA World Cup 2014 indicated alcohol intake and sexual contacts outside of a relationship more frequently than regular travelers.
19	Eberhardt	2016	Prospective case control survey	Germany	2014	Yes	Sport	Illnesses and environmental hazards	Standardized questionnaire	The mean daily attendance per emergency department was 257 (range 38-435). Syndromic indicators were developed, including respiratory, gastrointestinal, cardiac, acute respiratory infection, gastroenteritis, and myocardial ischemia. Respiratory and acute respiratory infection indicators peaked during December 2010.
20	Elliot	2012		UK	2012	Yes	Sport	Respiratory, gastrointestinal, cardiac, acuterespiratory infection, gastroenteritis, and myocardial-ischemia.	Standardized Emergency Department Sentinel Syndromic Surveillance System (EDSSS) minimum data set	The mean daily attendance per emergency department was 257 (range 38-435). Syndromic indicators were developed, including respiratory, gastrointestinal, cardiac, acute respiratory infection, gastroenteritis, and myocardial ischemia. Respiratory and acute respiratory infection indicators peaked during December 2010.
21	Hadjichristoulou	2005	Descriptive	Greece	2004	Yes	Sport	Foodborne and waterborne diseases, heat-related illness, and traffic accidents		Foodborne diseases, waterborne diseases, and heat-related illnesses were considered of high priority during the Olympic period, as were traffic accidents.
22	Lim	2010	Experience	Singapore	2009	No	Sport	Influenza A (H1N1)		With close collaboration with the Olympic Council of Asia Medical Commission, Singapore AYG Organizing Committee and other government agencies, the Medical Services Committee was successful in preventing the local transmission of influenza H1N1, which would have been a threat to continue the games, exposing athletes and other participants.

TABLE 1

Characteristics of Included Studies in the Review (continued)

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
23	Morimura	2004		Korea/Japan	2002	No	Sport	Illness and injuries, alcohol/drugs	Internet mailing list (e-mail, medical information network)	A total of 1661 patients presented for assessment and care from all 32 games in Japan. The patient presentation rate per 1000 spectators per game was 1.21, and the transport-to-hospital rate was 0.05.
24	Piat	2010	Retrospective	Italy	2006	No	Sport	Illnesses and injuries	Medical records (National Olympic Committee's database)	A total of 330 athletes received medical care. The overall medical utilization rate was 12.66%. Skeleton, snowboard, bobsleigh, and alpine and freestyle skiing were at more risk of illness and injuries than other disciplines. The majority of injuries and illnesses were of a minor nature. Hospital admission rate was 3.40%.
25	Selig	2013	Retrospective	United States	2007-2010	Yes	Sport	Illnesses and injuries	An electronic database (patients care records)	A total of 1305 patients were evaluated, and the means of patient encounter rate and transfer-to-hospital rate were 1.3 and 0.24 per 10 000 attendees, respectively. Each 0.55°C (1°F) increase in daily mean temperature was associated with a 4% increase in the rate of total complaints and a 6% increase in major trauma presentations.
26	Todkill	2016	Cross-sectional	UK	2012		Sport	Infectious nature, trauma (fracture), environmental (bites and stings), lifestyle (acute alcohol intoxication) factors	-	A statistically significant increase was observed in attendances for chemicals, poisons, and overdoses, including alcohol and acute alcohol intoxication
27	Milisten	2003	Retrospective	United States	1997-1999	Yes	Sport	Injuries and trauma	Medical forms	There was an association between the medical usage rate (MUR) and temperature at events. The MUR at 80°F was lower than < 80°F.
28	Varon	2003	Prospective	United States	1996-1997	No	Sport	Trauma and medical complaints	A standardized encounter form designed	There were 2762 patient encounters. A wide variety of illness was seen with trauma (39.5%), headache (31%), and other medical complaints (29.5%).
29	White	2018		Micronesia	2014	No	Sport	Infectious diseases	Reports of public medical centers	Influenza-like illness was the most common reported syndrome. Other reported syndromes were fever and rash.
30	Yazawa	2007		Japan	2004	Yes	Festival	Alcohol-related problems, injuries, and illnesses	Patient report forms	A total of 1.8 million audiences attended the festival during the 12-day study period; a total of 237 patients presented to the medical station. Of the total, 57% suffered from trauma, and 43% had heat-related illness.
31	Bledsoe	2012	Retrospective, observational	United States	2011	Yes	Festival	Injuries and illnesses	Registration	Attendance at Burning Man 2011 was 53 735. Of these attendees, 2307 were treated in the field hospital. The most common conditions treated were soft-tissue injuries, dehydration, eye problems, and urinary tract infections.

TABLE 1

Characteristics of Included Studies in the Review (continued)

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
32	Friedman	2017	Descriptive	United States	2014	No	Festival	Illnesses	Data collection list	Thirty-eight (45%) initially presented with abnormal vital signs; 4 (5%) were hyperthermic. Of these latter patients, 34 (90%) reported ingestions with 3,4-methylenedioxy methamphetamine or other drugs. Eleven (65%) patients were diaphoretic or mydriatic. A total of 58 celebrants received medical care. Most of them had complaints associated with alcohol (65%). Of those presenting for hospital evaluation, 30% (15/49) had burns associated with fire-jumping.
33	Hawkins	2010	Cross-sectional	United States	2005	Yes	Festival	Injuries	Standardized data collection form	More females presented with minor illnesses, such as headaches, than males. Males presented with injuries, such as lacerations to their face and their hands. Alcohol and substance use led to 15% of all presentations.
34	Hutton	2014	Observational study	Australia	2010		Festival	Injuries and illnesses	Ranse and Hutton1 minimum data set	
35	Hoy	2016	Develop syndromic surveillance	Solomon Islands	2012	Yes	Festival of Pacific Arts	Communicable diseases	Reporting forms	Of the patients with 1 or more syndromes, influenza-like illness was the most common syndrome, prolonged fever (24%), non-watery diarrhea (23%), and acute fever and rash (12%).
36	Hutton	2015	Descriptive	Australia	2010		Music festival	Illness, injury, environmental health	Ranse and Hutton minimum data set	The majority of the illnesses included headaches (53%), pain (10%), asthma (8%), and nausea/vomiting (8%); the majority of the injuries were superficial laceration (20%), sprain/strain (19%), head injury (12%), and foreign body to the eye (8%); the environmental-related presentations were alcohol-related (32%), heat exhaustion (19%), substance-related (18%), substance- and alcohol-related (16%).
37	Munn	2016	Descriptive	Canada	2014	Yes	Music festival	General	An established event registry database	In this festival, 67 120 people participated. The patient presentation rate was 20.8 per 1000. The majority of these (90.9%) were for non-urgent complaints. Harm reduction services included mobile outreach teams, distribution of educational materials, pill checking facilities, a dedicated women's space, and a "Sanctuary" area that provided non-medical peer support for guests.
38	Loncarevic	2009	Experience	Serbia	2009	No	Sport and music festival	Influenza A (H1N2)		Both MG events went ahead as planned. Transmission of influenza A(H1N1)v at both events was inevitable due to the nature of the infection, but preparations were put in place to mitigate the situation, including detection, isolation options, and treatment of cases, during this early stage of the epidemic in Serbia.

TABLE 1

Characteristics of Included Studies in the Review (continued)

ID	Author	Year	Study	Location	Time	Time Trend	Type of MG	Type of Reported Diseases or Hazard	Data Collection Tools	Main Results
39	Feldman	2004		United States	2003	No	Music festival	Injuries and illnesses		More than 450 000 people attended the concert and 1870 sought medical care (42/10 000 attendees). Common complaints included headache (27%), heat-related complaints (12%), nausea or vomiting (7.6%), musculoskeletal complaints (6.9%), and breathing problems (6.6%). A total of 28 cases needed medical services. Approximately 50 000 participants were in the stadium for this 2-night festival; the medical use rate was roughly 5.6 patients per 10 000 attendees. The most common major problem was fainting, which accounted for 13 cases (46%).
40	Kao	2001	Descriptive	Taiwan		Yes	Music festival	General		The most common presenting problems were headaches, neck pain, blisters; minor injuries, such as sprains, abrasions, and insect bites; and major injuries, such as fractures and lacerations.
41	Anikeeva	2018	Descriptive	Australia	2015-2016		Sport, cultural, entertainment	General	Standard paper questionnaire	The majority of presentations were injuries (49%) and illnesses (46%). Extremes of temperature were associated with a lower crowd size and higher patient presentation rate (PPR), but had no impact on transfer or referral rates to the hospital.
42	Crabtree	2017	Retrospective	Australia	2012-2014	Yes	Agricultural	Injuries and illnesses	Minimum data set for mass-gathering health research	More than 90 000 people participated in this show. Patient presentation rate was 2.0 and the transport to hospital rate was 0.1 per 1000 subjects. Wounds, lacerations, and abrasions made up 23.2% of all presentations, followed by foot and lower limb blisters at 17.8%. Hypertension (10%) and asthma (6%) were the most common medical history, respectively. Of 750 987 participants, 794 (0.1%) patients were medically evaluated. There were no complicated medical cases. A favorable impact of preventive strategies was observed.
43	Pakravan	2013	Cross-sectional	UK	2011	Yes	Fair (trade and sport)	Injuries and illnesses	The standard records	The risk of importation, transmission, or exportation of measles and foodborne and waterborne infections was medium/high; legionella and West Nile virus disease transmission was medium; and active transmission of meningococcal meningitis in the EXPO 2015 venue and of introduction of chikungunya and Zika viruses was low.
44	Perez-Gomez	2015	Cross-sectional	Mexico	2013	No	Book fair	Illness, injury, environmental health	-	
45	Riccardo	2016	Event-based surveillance	Italy	2015	No	Fair	Infectious diseases	Designed forms	

MG = mass gathering; UTI = urinary tract infection.

Types of MGs

In terms of the types of MGs, the 3 main types – religious, festival, and sport – were reported by the included studies.

Religious MGs

Fifteen articles were related to the religious MGs. Infectious diseases were the most common health threat in these MGs. Infectious diseases, such as respiratory^{19,35,60,61} and gastrointestinal,^{35,55} were the most reported public health concerns. Middle East respiratory syndrome-related coronavirus was assessed during the 2013 Hajj in Saudi Arabia, but it was not detected in the samples tested in the pre-Hajj and post-Hajj screening.⁴⁴

Injuries, such as road traffic accidents,^{18,35,52,55} injury caused by marine creatures, drowning,^{18,55} falls, riots,³⁵ intentional injuries,⁵⁵ and crowded disaster-related injuries,⁴⁰ were the most reported injuries in the religious MGs.

Asthma was another health problem among participants in the religious MGs.^{35,45,52} The higher risk of asthma attack was observed among women and people ages 40–60 years. Other noncommunicable diseases, such as hypertension, ischemic heart disease, and diabetes mellitus, were the major health problems during MGs, especially for elderly participants.³⁵ Environmental problems, such as hygiene conditions, water sanitation, number of persons per toilet, drainage,²³ and exposure to cold weather,³³ were the most reported health problems in these MGs.

Sport MGs

Sixteen articles were related to sporting events. Injuries were the most common health problems in these MGs.^{22,26,27,29,50,59,62} Athletes and participants both were affected by injuries in the sport MGs. During the 2004 Olympic games, the most common site of injuries was the thigh, knee, and lumbar spine, respectively.²² Motor vehicle accident and drowning were reported in the Athens 2004 Olympic and Para-Olympic games.³⁴ During the 2002 FIFA World Cup, the most prevalent traumatic injuries included blisters, scrapes, bruises and fractures, sprains, and lacerations.⁴⁶ Soft tissue, head, laceration, fracture, fall, dislocation, leg and hands, dermal, eye injuries, traffic accidents, and burns were the other reported injuries in the sport MGs.^{26,29,51,53,54,56}

Infectious diseases were another health threat in the sport MGs.²⁷ In the London 2012 Olympic and Para-Olympic games, a syndromic surveillance system was established. In this surveillance system, the indicators of gastrointestinal and respiratory infection symptoms peaked during December 2010.³⁰ During the Athens 2004 Olympic games, traveler's diarrhea, foodborne and waterborne diseases, and sexually transmitted diseases were the high-risk potential public health concerns.³⁴ Lim et al.⁴² reported a successful experience in the prevention of influenza H1N1 during the Asian Youth Games in

Singapore in 2009. During this event, 7 cases of influenza H1N1 were confirmed.⁴²

Alcohol and drug-related disorders were another reported public health concern.^{3,26,46,53} The proportion of alcohol intake during the 2014 FIFA World Cup in Brazil among travelers to the games and regular travelers was 71.74% and 40.53%, respectively.³ During the 2002 FIFA World Cup in Korea/Japan, 0.7% of illness/injuries were related to alcohol and drug use.⁴⁶

Casual sex encounters were reported as a risky behavior during the 2014 FIFA World Cup. The proportion of casual sex occurrences among the FIFA World Cup travelers and regular travelers was 8.76% and 2.59%, respectively.³

Festival MGs

Eleven articles reported health issues in the festival MGs. Alcohol/drug-related problems were commonly reported in these MGs.^{32,36,38,39,63} In music festivals, alcohol, drug, and combined alcohol and drug-related presentations were commonly reported as 32.8%, 17.7%, and 16.4%, respectively.³⁸

Injuries were another health problem in this type of MG. The commonly reported injuries were trauma, soft-tissue injuries, burns, lacerations, sprain/strain, head injury, and a foreign body in the eye.^{24,36,38,39,63}

Infectious diseases affected the health of participants in 2 festivals. The first one was at the 11th festival of Pacific Arts in the Solomon Islands, where an enhanced syndromic surveillance was used. In this MG, the most important reported syndromes were influenza-like illness (44%), prolonged fever (24%), non-watery diarrhea (23%), and acute fever and rash (12%).³⁷ Influenza (H1N1) was confirmed in 62 participants in the second music festival.⁴³

Other MGs

Other MGs in this review were related to fairs such as trade, book, and agricultural fairs. Like the previously mentioned MGs, injuries, illness, and infectious diseases were the main health problems reported^{16,28,48,49} (see Table 1).

DISCUSSION

Included studies in this review were related to three types of MGs – religious, sport, and festivals. The major public health threats in these MGs were determined. In the religious MGs, infectious diseases, injuries, road traffic accidents, and environmental health problems were the main problems for participants. In addition, noncommunicable diseases such as asthma, hypertension, ischemic heart disease, and diabetes mellitus, especially among elderly people were the other health problems. In the sport MGs, injuries were the most common problems. In addition, infectious diseases such as influenza were an

important problem. The high-risk behaviors such as alcohol drinking, drug use, and illicit sexual behaviors were reported in the sport MGs. At the festivals, alcohol drinking, drug use, injuries, and communicable diseases were the main health problems.

The findings of this review show that religious MGs are more prevalent in Asian countries than in other regions. There are numerous published studies regarding the Hajj, which is the most important religious MG for Muslims. In addition to concerns regarding infectious diseases and noncommunicable diseases among older people,^{64,65} especially in recent years, injuries were the most important problems for participants.⁶⁶ Apart from the mentioned health conditions, environmental risk factors such as sunburn, foot burns, and heat-related problems threaten the health of participants during their pilgrimage.^{64,67} Likewise, these same conditions threaten the health of participants in other religious MGs.^{18,23,25,35}

Injuries, communicable diseases, and some risky behaviors were reported as the main concerns in the sport and festival events. Alcohol misuse is prevalent during sport MGs,⁶⁸⁻⁷¹ and alcohol misuse and drug use are prevalent in the festivals,^{64,72} which would explain the prevalence of alcohol-related complications among participants of sport and festival MGs. In addition, other factors such as age, gender, type of event, and weather conditions have an important role in the patient presentation and required health care.⁷³

The results of our review indicate that the health conditions of participants in the MGs are related to the type of MG. On the other hand, it seems that the basic characteristics of participants in each type of MG are different. For example, the participants of the Hajj are older than those in other MGs, therefore, chronic diseases may be an additional threat for these participants and health care providers. Also, because participants of sport and festival MGs are younger than participants in religious MGs, high-risk behaviors may be more prevalent in the former.

According to our results and a previously published review,⁶⁴ the health organizers of MGs should have specific health planning for each type of MG. Health managers should know the characteristics of each type of MG, such as the characteristics of participants, the environmental conditions, the epidemiology of prevalent infectious diseases, and the cultural conditions in the location of the event. In the reviewed articles, there was not a standard tool used for data collection. Different tools such as researcher designed questionnaires, patients' records, and medical records were used in some MGs. Nevertheless, in some MGs, a standard minimum data set was based on the syndromic surveillance system,³⁰ and the Ranse and Hutton minimum data set^{38,39} was used.

The appropriate knowledge and, consequently, management of health conditions during the MGs are required in order

to collect the higher quality data and information. The health-related data can be very useful for the planning of preventive interventions and delivery of needed health services during future MGs. The quality of data gathering is an important issue in the reporting of health problems. Human, logistic, and environmental factors can affect the quality of data gatherings.⁷⁴ So it seems for each type of MG a standard specific tool is needed for data collection.

As a new insight for reducing MG-related health threats, published literature provides advice for public health authorities of host countries to consider preventive and fundamental activities, including "implementation of syndromic surveillance systems or enhanced surveillance systems, educating participants on occurred health events, and other activities according to relevant guidelines in light of the situation."⁷⁵

CONCLUSION

According to the results of this review, the health threats are different based on the type of the MG. Religious MGs are more affected by infectious diseases and injuries. Injuries and high-risk behaviors, such as alcohol drinking and illicit sexual behaviors, are more common in sporting events in comparison with other MGs. Festivals are more affected by alcohol and drug-related problems and injuries.

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Conflict of Interest Statement

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