

# The Impact of Mass Gatherings on Emergency Department Patient Presentations with Communicable Diseases Related to Syndromic Indicators: An Integrative Review

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#### Abbreviations:

ED: emergency department  
ICD-10: International Classification of Diseases 10th Revision  
MGE: mass-gathering event  
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses  
SI: syndromic indicator

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#### Abstract

**Background:** Mass-gathering events (MGEs) are commonly associated with a higher than average rate of morbidity. Spectators, workers, and the substantial number of MGE attendees can increase the spread of communicable diseases. During an MGE, emergency departments (EDs) play an important role in offering health care services to both residents of the local community and event attendees. Syndromic indicators (SIs) are widely used in an ED surveillance system for early detection of communicable diseases.

**Aim:** This literature review aimed to develop an understanding of the effect of MGEs on ED patient presentations with communicable diseases and their corresponding SIs.

**Method:** An integrative literature review methodology was used. Online databases were searched to retrieve relevant academic articles that focused on MGEs, EDs, and SIs. Inclusion/exclusion criteria were applied to screen articles. The Standard Quality Assessment Criteria for Evaluating Primary Research (QualSyst) assessment tool was used to assess the quality of included papers.

**Results:** Eleven papers were included in this review; all discussed the impact of an MGE on patient presentations with communicable diseases at EDs/hospitals. Most included studies used the raw number of patients who presented or were admitted to EDs/hospitals to determine impact. Further, the majority of studies focused on either respiratory infections ( $n = 4$ ) or gastrointestinal infections ( $n = 2$ ); two articles reported on both. Eight articles mentioned SIs; however, such information was limited. The quality of evidence (using QualSyst) ranged from 50% to 90%.

**Conclusions:** Limited research exists on the impact of MGEs on ED presentations with communicable diseases and related SIs. Recommendations for future MGE studies include assessing differences in ED presentations with communicable diseases regarding demographics, clinical characteristics, and outcomes before, during, and after the event. This would benefit health care workers and researchers by offering more comprehensive knowledge for application into practice.

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#### Background

Mass-gathering events (MGEs) refer to large events that frequently occur internationally and can include sports tournaments, music festivals, and religious activities. Arbon<sup>1</sup> defines MGEs as events that can attract many people gathering in one place during a specific period for the same purpose, which may delay the response of health services to emergency situations due to limited access to patients or the location of event(s). Given the number of MGE attendees can range from 1,000<sup>2</sup> to 8.8 million,<sup>3</sup> it is essential to understand the potential effects on emergency health care services.

Health services available for participants of MGEs include in-event health services, such as first aid and/or medical tents, and external health services, such as local ambulance services and hospitals.<sup>4</sup> Emergency departments (EDs) play an important role not only in offering health care services to residents of the local community and visitors, but in managing the

	Mass Gatherings	Emergency Departments	Syndromic Indicators
Keywords	Large events, Major events, Large-scale event, Sport events, Music festival, Religious events/festivals, Open-air events/festivals, Mass gathering medicine, Planned events	Triage, Hospitalization, Admitted to hospitals, Transportation to hospital rate, Presentation to hospital rate	ICD-10 diagnostic codes, Syndromic surveillance, Coding systems, Outbreak detection, Symptom-based surveillance, Disease indicators
MeSH Terms		Emergency hospital services, Emergency units, Emergency rooms, Emergency wards, Accident and emergency department, Hospital emergency service	

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**Table 1.** Keywords and MeSH Terms used in Article Selection

Abbreviations: ICD-10, International Classification of Diseases 10th Revision; MeSH, Medical Subject Heading.

Inclusion Criteria	Exclusion Criteria
Peer-reviewed cases of real-world events, Published only in English, Published between 2008 and 2018, Articles related to MGEs, Discussed the impact of MGEs on EDs or hospitals, Articles reported communicable diseases that happened in past MGEs, AND/OR Reported the usage of SI based surveillance system in the ED or at MGEs	Peer-reviewed articles that are published in a language other than English, Articles not related to communicable diseases brought by MGEs, Articles not related to EDs or hospitals, Online newspapers and press released news, Systematic literature reviews summarizing previous MGEs, Academic forum discussion papers, Published abstract only

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**Table 2.** Inclusion and Exclusion Criteria

Abbreviations: ED, emergency department; MGE, mass-gathering event.

increased health demand from MGE attendees.<sup>5</sup> A systematic review by Ranse, et al<sup>4</sup> reported the number of patients transported to EDs can range from one to 190 during an MGE. Emergency departments already confronted by issues of over-crowding may struggle to cope with managing the possible increase in patient load during MGEs<sup>6,7</sup> if plans are not in place for practical prevention measures to mitigate the workload. These considerations are required alongside understanding characteristics of the event, such as the nature of the event (planned/unplanned), the demographic characteristics of event attendees (young/old), and possible influencing confounders, such as if alcohol is sold at the event and the weather.

Public health structures and personnel play a key role in the planning, detection, and monitoring of potential health threats during MGEs to prevent outbreaks of communicable disease, therefore limiting the impact on EDs.<sup>8</sup> Emergency department sentinel surveillance systems can be operationalized during MGEs (and at other times) to assist with this monitoring by using a wide-range of syndromic indicators (SIs). Syndromic indicators refer to a specific set of signs and symptoms (such as influenza-like illness) used to capture abnormal health events (such as thunderstorm asthma or communicable disease outbreaks).<sup>9</sup>

At MGEs, the surge in the local population and the concentration of people may increase the spread of communicable diseases, which can place a strain on local emergency health care services.<sup>3,10</sup> Communicable diseases can result from infectious agents, such as human immunodeficiency virus (HIV) and measles, are contagious, and can be transferred from person-to-person.<sup>11</sup> While research has emerged regarding outbreaks of communicable diseases,<sup>3,12,13</sup> the characteristics of ED presentations, and the use of ED resources during MGEs,<sup>4,14</sup> there is sparse literature regarding the impact of MGEs on ED presentations with communicable diseases related to SIs.

By examining current academic literature, this review aims to answer the question: What is the impact of an MGE on ED patient presentations with communicable diseases related to SIs?

**Methods**

*Design*

This literature review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement<sup>15</sup> and followed Whittemore and Knaff's<sup>16</sup> methodology for conducting integrative reviews.

*Data Collection*

Online databases MEDLINE (Medical Literature Analysis and Retrieval System Online; US National Library of Medicine, National Institutes of Health; Bethesda, Maryland USA); CINAHL (Cumulative Index to Nursing and Allied Health Literature; EBSCO Information Services; Ipswich, Massachusetts USA); PubMed (National Center for Biotechnology Information; Bethesda, Maryland USA); EBSCO (EBSCO Information Services; Ipswich, Massachusetts USA); and ProQuest (ProQuest LLC; Ann Arbor, Michigan) were used to search available literature, limited to the 10-year period between 2008 and 2018. The keywords listed in Table 1 were used to locate and obtain peer-reviewed academic papers, published in the English language, that were related to the question. The linking word “or” was used between keywords listed in each row, while “and” was used between keywords listed in each column. The inclusion and exclusion criteria for the review are presented in Table 2.

After title and abstract screening (YQ), full-text articles were retrieved and reviewed for relevance (YQ). References of related articles were also screened for additional relevant papers. Clarification of article inclusions (when required) was made with other authors (JR, PAZ, and JC). The PRISMA Guidelines,

checklist, and flow diagram<sup>15</sup> were used to guide the article inclusion process.

#### Data Analysis

Data extracted from included studies and entered into a Microsoft Word (Microsoft Corp.; Redmond, Washington USA) table were: author, MGE type, MGE location, duration of the MGE, the number of MGE attendees, study design, level of evidence, study aim, reported communicable diseases, related SIs, key findings, and limitations. The Standard Quality Assessment Criteria for Evaluating Primary Research (QualSyst) assessment tool was used to determine the quality of the research reviewed.<sup>17</sup> Using the QualSyst assessment tool, the quality of each article was scored independently by two authors (YQ and PAZ) on a range from 0% to 100% where over 80% reflects strong quality; 71%–80% reflects good quality; 50%–70% reflect adequate quality; and less than 50% reflect limited quality.<sup>18</sup> The final score of each article was the sum of scores obtained from each question listed on the checklist for assessing the quality of studies divided by the total possible score.<sup>17</sup> A quality score of  $\geq 50\%$  was the threshold for articles to be included in this review.

#### Results

In total, 11 articles met the inclusion criteria and were included in this review (Table 3). The PRISMA flow diagram provides information on the number of articles excluded and included in each step, and the reason for exclusion (Figure 1). The QualSyst assessment quality score for the 11 included articles ranged from 50% to 90%, indicating adequate to strong levels of evidence (Table 3). Both independent reviewers assigned the same score to four papers with small discrepancies for the remaining seven papers. Articles that were assigned different scores were discussed by both reviewers reaching consensus on the final score of these articles.

#### Communicable Diseases in Past MGEs

Within the 11 studies on MGEs and communicable diseases, the type of events included religious events (five studies), sporting events (four studies), and other outdoor MGEs (two studies). Specific to communicable diseases, seven studies discussed respiratory infections, one study discussed gastrointestinal infections, and another reported both respiratory and gastrointestinal communicable diseases. Two studies discussed neurological infection and zoonotic diseases separately.

#### Measurement of ED Activities during MGEs

Variation existed in the studies regarding the impact of MGEs on local hospitals. Eight studies reported a raw number of patients who presented or were admitted to EDs/hospitals, (ranging from three to 401),<sup>19,20</sup> while the other three studies reported either the rate of patient presentations to EDs (0.005/1000)<sup>21</sup> or hospital administration rate (3.6–102/1000).<sup>22,23</sup>

#### Syndromic Indicators used in EDs for Communicable Diseases

Most studies ( $n = 7$ ; 64%) mentioned the use of a surveillance system based on patients' signs and symptoms. Of these seven studies, three presented specific syndromes (which included febrile, acute respiratory symptom, rash at least three days, and sore throat)<sup>23–25</sup> for detecting communicable diseases, whereas the remaining four only briefly mentioned the role of SIs in the surveillance system during MGE periods.

#### Discussion

From the literature reviewed, despite a growing body of knowledge about MGEs, EDs, and SIs, there is a lack of evidence regarding the effects of MGEs on ED attendances with communicable diseases.

#### Communicable Diseases in Past MGEs

There is evident diversity in the type of communicable disease(s) that may occur during an MGE, which place certain challenges on the ED. With the influx of a large population and rapid population movement, MGEs greatly facilitate the transmission of communicable diseases.<sup>26</sup> Of the 11 studies included in this review, respiratory and gastrointestinal communicable diseases were the most common type of communicable diseases reported. However, other uncommon communicable diseases such as Type B *Neisseria meningitidis* and Leptospirosis were also noted.<sup>20,27</sup> It is therefore essential to review communicable diseases that occur during MGEs to enhance ED syndromic surveillance systems.

Another challenge with communicable diseases evident from the literature reviewed is that they may have long incubation periods resulting in secondary communicable disease cases that are delayed in detection, and sometimes result in further transmission in other countries.<sup>22–24,28–30</sup> Due to the immense scope for travel and advanced transportation technologies, the number of international participants at MGEs is gradually increasing world-wide.<sup>31,32</sup> Along with the growing number of foreign visitors, infectious pathogens can be carried by these international travelers to other countries within a few days, which requires considerable attention from the host and home countries.<sup>31,32</sup> This illustrates the importance of good history taking by medical and nursing staff, especially for people arriving in the ED who have recently travelled.

#### Measurement of ED Activities during MGEs

Variation exists in the literature regarding the impact of MGEs on EDs. While the hosting of an MGE can increase patient volumes in local EDs, sometimes by as much as 400 patients/day,<sup>19</sup> the actual number, demographic, clinical characteristics, and outcomes of patients presenting to EDs tend to vary by the type of MGE. This information, although limited, may be helpful to inform the planning of future MGEs that are similar in nature. None of the included studies examined the impact on the ED over time (ie, before, during, and after the MGE) in terms of clinical characteristics or outcomes of ED presentations. The absence of more detailed information about actual ED presentations makes it difficult to prospectively determine the impact of MGEs on EDs and the resources required to care for this cohort, not only during the MGE, but potentially after the event proper has finished.

#### Syndromic Indicators used in EDs for Communicable Diseases

Syndromic indicators have been widely used in the emergency system for public health surveillance. Syndromic indicators are helpful to measure prospectively as they can predict the incidence of communicable diseases, as well as potential increases in health care resource requirements.<sup>33</sup> Previous studies have reported some syndromes used to detect communicable diseases during MGEs, such as fever, rash, and abdominal pain, indicating diseases such as measles, influenza, and respiratory tract infections.<sup>23–25</sup> However, information as to the exact SIs and corresponding diagnosis codes (ie, International Classification of Diseases 10th Revision [ICD-10]) used to detect the impact of communicable diseases on EDs in MGE is still very limited,<sup>21,30</sup> which makes comparative research and recommendations for standardized

Author	Year, Event, Location, Length, Attendees	Study Design (Quality of Evidence)	Study Aim	Communicable Disease, SIs & Key Outcomes	Limitations
Cummiskey, et al (2008) <sup>27</sup>	2007 European Youth Olympic Sports Festival (EYOF) in Spain Length: 7 days Attendees: 1500 athletes	Retrospective case study LOE = 75%	To discuss a case of Type B <i>Neisseria meningitidis</i> occurring in a sporting event	CD: Neurological (Type B <i>Neisseria meningitidis</i> ) SIs: NS One athlete transferred to ED	Only one specific case was discussed. Limited info about the impact of EYOF on ED. Related SIs difficult to ascertain.
Brockmann, et al (2010) <sup>20</sup>	2006 triathlon event in Germany Length: 1 day Attendees: 507 triathletes	Retrospective cohort study LOE = 70%	To study the possible outbreak of <i>leptospirosis</i> and explore risk factors for this disease	CD: Zoonotic disease ( <i>Leptospirosis</i> ) SIs: NS Three participants were admitted to hospitals.	Low (28%) response rate to questionnaires. Limited info regarding the actual impact on ED.
Lim, et al (2010) <sup>25</sup>	2009 Inaugural AYG in Singapore Length: 11 days Attendees: 2020 attendees from 43 nations	Retrospective observational study LOE = 50%	To describe the experience of on-site medical center and local hospital staff in managing MGE during the influenza pandemic	CD: Respiratory (Influenza (H1N1)) SIs: fever, acute respiratory symptom Six cases were admitted and isolated in hospitals.	Analysis at broad aggregate level, rather than at patient-level. Info limited regarding the impact on ED.
Chen, et al (2010) <sup>24</sup>	2007 International Youth Sporting Event in Pennsylvania Lengths: 10 days Attendees: 265,000 attendees	Retrospective observational study LOE = 75%	To describe the outbreak of measles occurring at an international sporting event in the United States	CD: Respiratory (Measles) SIs: febrile, rash $\geq 3$ days, cough, conjunctivitis, coryza Seven patients confirmed with measles (one patient presented to ED; one patient was hospitalized for 4 days)	Limited info about the impact of this outbreak on ED. No further follow-up for visitors who returned to their home country.
Verhoef, et al (2008) <sup>30</sup>	2008 Christian pilgrimage in Lourdes, France Length: NS Attendees: 8 million	Retrospective observational study LOE = 50%	To assess the impact of <i>Norovirus</i> (gastroenteritis) to Netherlands and Ireland, related to the pilgrimage in Lourdes, France	CD: Gastrointestinal ( <i>Norovirus</i> ) SIs: NS Netherlands: Four patients died and one patient was hospitalized. Ireland: One patient was admitted to hospital; 11 secondary cases of infection occurred at the hospital.	No detailed analysis of patient-level data. The impact of the outbreak on other EDs not clear.
Smith, et al (2008) <sup>21</sup>	2008 World Youth Day (WYD) in Sydney, Australia Length: over six days Attendees: 22300 pilgrims and 110,000 visitors across 170 nations	Retrospective cohort study LOE = 90%	To measure ED presentations related to WYD pilgrims	CD: Respiratory; Gastrointestinal (Upper respiratory tract infections/Gastroenteritis) SIs: NS 7.8% (191 pilgrims) of pilgrim present to EDs (PPR: 0.05/1000). Most pilgrims triaged as 4/5. Admission rate of pilgrims was lower than other patients ( $P < .001$ ).	No comparisons were made before, during, and post-events. No specific description of signs/symptoms that pilgrims presented to ED related to communicable diseases.
Pfaff, et al (2010) <sup>29</sup>	2010 Taizé Christian pilgrimage in France Lengths: 6 days to 5 weeks Attendees: 3500 participants	Retrospective observational study LOE = 75%	To analyze the measles outbreak among young pilgrims in France	CD: Respiratory (Measles) SIs: NS Three patients were hospitalized.	No follow-up study for patients who were diagnosed with measles. No detailed patient-level data.
Al-Lami, et al (2013) <sup>19</sup>	2010 the celebration of Ashura at Karbala, Iraq Length: NS Attendees: NS	Cross-sectional study LOE = 85%	To highlight immunization gaps among young adults. To identify the risk of communicable diseases in MGEs that may be reintroduced by travelers	CD: Respiratory (Respiratory tract infection) SIs: NS ED attendance increased by 292 per day across three EDs during the event periods ( $P < .001$ ). 37% of hospital admission was due to CD. A significant rise in ED attendance was noticed. Hospital admission/death rates remained the same.	Lack of standardized classification of diseases across three hospitals. No specific description of specific signs and symptoms to be monitored for communicable diseases.

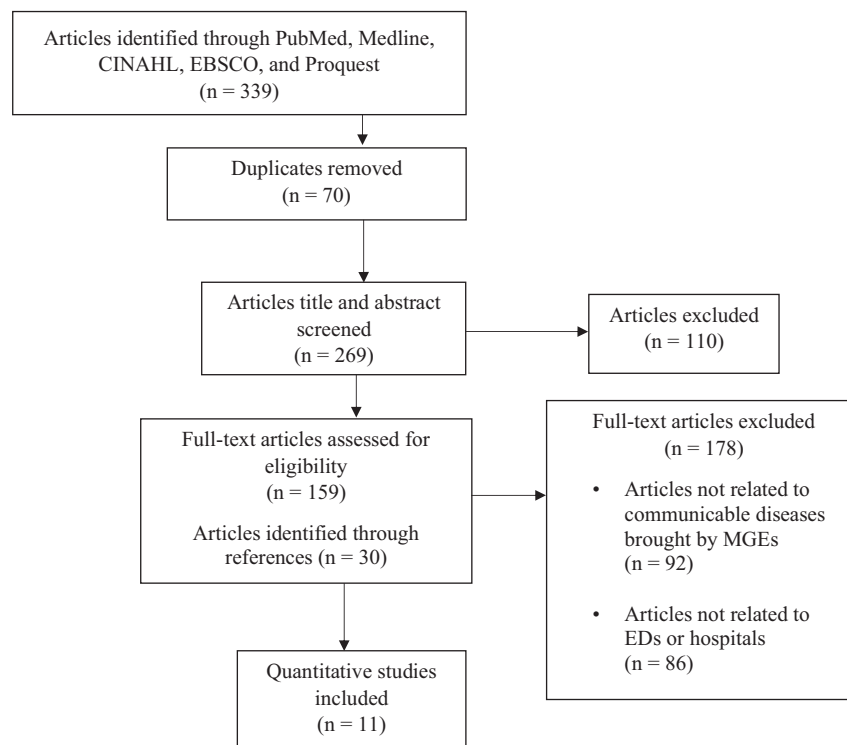
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Table 3. Summary of Literature on Communicable Disease in MGEs and the Impact on ED (continued)

Author	Year, Event, Location, Length, Attendees	Study Design (Quality of Evidence)	Study Aim	Communicable Disease, SIs & Key Outcomes	Limitations
Zepeda-Lopez, et al (2010) <sup>23</sup>	2009 Izatapalapa Passtion Play in Mexico Length: NS Attendees: 2 million attendees	Retrospective cohort study LOE = 75%	To provide more information about infectious cases during the MGE in Mexico	CD: Respiratory (Respiratory tract infections) SIs: fever, cough, headache, sore throat, nasal obstruction, runny nose, and abdominal pain. 12 patients required hospitalization. Two patients died. Hospital admission rate for first wave was 73/1000, second wave was 102/1000.	Some heterogeneity may exist in the data due to lack of standardization at health care facilities in different Mexican States. Did not analyze data from Southern part of Mexico. No detailed info on the ED presentations.
Botelho-Nevers, et al (2010) <sup>22</sup>	2009 Sziget music festival in Europe Length: NS Attendees: 113,000 attendees	Retrospective case study LOE = 75%	To discuss influenza outbreak. To identify the impact of influenza outbreak on the current health care management in Europe.	CD: Respiratory (Influenza A (H1N1)) SIs: NS 14 people admitted to hospitals (Admission rate: 3.6/100,000).	No detailed info on patients admitted to hospitals.
Grgič-Vitek, et al (2015) <sup>28</sup>	2014 International dog show in Slovenia Length: 2 days Attendees: 1100 participants	Retrospective observational study LOE = 71%	To discuss the outbreak of measles during an international dog show in Slovenia	CD: Respiratory (Measles) SIs: NS Two adults hospitalized in Slovenia.	Very limited patient-level information.

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**Table 3.** (continued). Summary of Literature on Communicable Disease in MGEs and the Impact on ED  
Abbreviations: CD, communicable disease; ED, emergency department; LOE, level of evidence; MGE, mass-gathering event; NS, not specified; PPR, patient presentation rate; SIs, syndromic indicators.



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**Figure 1.** PRISMA Flow Diagram, Adapted from Liberati, et al.<sup>15</sup>

Abbreviations: ED, emergency department; MGE, mass-gathering event; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

prospective data collection difficult. Future research in this area is thus recommended to inform a minimum data set, as recommended by Ranse and Hutton.<sup>34</sup>

### Limitations

This review only included peer-reviewed articles published in English. Therefore, some articles, such as media reports, academic forum discussion papers, and articles published in other languages were not included. The title and abstract of articles were screened by one author (as part of an honors thesis). Final clarifications regarding final articles included in this review were however made with another author (PAZ). Furthermore, the quality of included studies was assessed by two authors.

### Conclusion

Few studies exist that identify the impact on EDs from communicable diseases that may emerge during MGEs. Various type of communicable diseases can arise during and after MGEs based on varying incubation periods. Research is also limited in noting specific syndromic symptoms, indicators, or standard diagnostic codes (ie, ICD-10) used in ED surveillance systems. As such, future research is needed that uses patient-level data to identify and evaluate the impact on EDs before, during, and after an MGE. This information will not only address gaps in current literature, but will also provide in-depth information on improving the performance and preparation of existing emergency care systems for future MGEs.

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