ORIGINAL RESEARCH

Patient Presentation Trends at 15 Mass-Gathering Events in South Australia

Olga Anikeeva, PhD;[1] Paul Arbon, PhD;[1] Kathryn Zeitz, PhD;[1] Murk Bottema, PhD;[1] Adam Lund, MD;[2] Sheila Turris, PhD;[2] Malinda Steenkamp, PhD[1]

1. Torrens Resilience Institute, Flinders University, Adelaide, Australia
2. Department of Emergency Medicine, University of British Columbia, Vancouver, British Columbia, Canada

Correspondence:
Olga Anikeeva, PhD
Torrens Resilience Institute
Flinders University
GPO Box 2100
Adelaide, South Australia 5001, Australia
E-mail: olga.anikeeva3@gmail.com

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PPR: patient presentation rate

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Abstract

Introduction: Mass gatherings are complex events that present a unique set of challenges to attendees' health and well-being. There are numerous factors that influence the number and type of injuries and illnesses that occur at these events, including weather, event and venue type, and crowd demographics and behavior.

Problem: While the impact of some factors, such as weather conditions and the availability of alcohol, on patient presentations at mass gatherings have been described previously, the influence of many other variables, including crowd demographics, crowd behavior, and event type, is poorly understood. Furthermore, a large number of studies reporting on the influence of these variables on patient presentations are based on anecdotal evidence at a single mass-gathering event.

Methods: Data were collected by trained fieldworkers at 15 mass gatherings in South Australia and included event characteristics, crowd demographics, and weather. De-identified patient records were obtained from on-site health care providers. Data analysis included the calculation of patient proportions in each variable category, as well as the total number of patient presentations per event and the patient presentation rate (PPR).

Results: The total number of expected attendees at the 15 mass gatherings was 303,500, of which 146 presented to on-site health care services. The majority of patient presentations occurred at events with a mean temperature between 20°C and 25°C. The PPR was more than double at events with a predominantly male crowd compared to events with a more equal sex distribution. Almost 90.0% of patient presentations occurred at events where alcohol was available.

Conclusion: The results of the study suggest that several weather, crowd, and event variables influence the type and number of patient presentations observed at mass-gathering events. Given that the study sample size did not allow for these interactions to be quantified, further research is warranted to investigate the relationships between alcohol availability, crowd demographics, crowd mobility, venue design, and injuries and illnesses.

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Introduction

Mass gatherings are complex events that involve the interplay between numerous elements, such as weather, venue characteristics, and crowd demographics.[1] Therefore, they present a unique set of challenges to attendees' health and well-being, as well as to the provision of appropriate health care.[2] In Australia, on-site medical care is provided at the majority of mass-gathering events, aiming to deliver timely health interventions that reduce the strain on local communities' health services. Well-resourced, on-site health care providers can effectively manage and treat many illnesses and injuries, reducing the need to transport patients to hospitals and other health care facilities, thereby avoiding associated transportation difficulties and delays in accessing appropriate treatment.

There are numerous factors that have been shown to influence the likelihood of injuries and illnesses occurring at mass-gathering events. Weather is perhaps one of the most widely researched of these factors.[3-5] Previous studies have demonstrated that hot weather influences the number of heat-related illness complaints among attendees, including dehydration, headaches, and nausea.[6-12] Despite these associations being described in the literature, the actual effects of factors such as temperature, humidity, and wind speed on

patient presentations are difficult to quantify.[13] For example, while there appears to be a positive linear relationship between humidity and patient presentations, the relationship between temperature and patient presentations is more complicated and does not appear to be linear in nature.[13]

Alcohol also appears to influence the type and number of patient presentations at mass gatherings, with a higher number of presentations observed at events where alcohol is readily available.[13] The type of event indirectly influences the number of patient presentations through attracting different types of crowds and facilitating or encouraging certain behaviors.[3] For example, events at which attendees are predominantly seated, such as sporting matches, generally have a lower incidence of injuries among attendees than events with a predominantly mobile crowd, such as markets, fairs, and some concerts.[13]

Similarly, some crowd characteristics have been previously shown to have an effect on the number of patient presentations. Generally, although larger crowd sizes produce a higher absolute number of patients presenting to on-site health care services, they are associated with a decrease in the patient presentation rate (PPR).[3,13,14] Crowd mood appears to be an important contributing factor to the number of patient presentations at events; however, its impact is difficult to accurately quantify.[3] Anecdotal evidence suggests that crowd mood may be influenced by factors such as music, rivalry between sporting teams, and unexpected occurrences, which in turn can contribute to an increase in patient presentations as a result of paranoia and mass hysteria leading to crowd crushing and violence between attendees.[3,15,16]

The research reported here contributes to a larger, multi-year study that will analyze event data from several jurisdictions and underpin efforts to develop nonlinear models for the interaction between event variables and clinical presentations. The current study collected data at 15 mass-gathering events in South Australia, with the aim of exploring the impact of a range of event and crowd variables on the patient presentations observed at these events.

Method

Sampling

Data were collected at a convenience sample of 15 mass-gathering events in South Australia over the 2015-2016 summer and autumn seasons. Mass-gathering events were eligible for inclusion in the study if they met the following criteria: expected number of attendees ≥5,000; outdoor setting; fenced or naturally bounded by roads or natural barriers; and did not involve active participation among attendees (eg, walks, fun runs, and bike races).

Data Collection

The variables of interest included weather, event characteristics, crowd characteristics, and patient presentation data. Weather data including temperature, humidity, and wind speed were captured by freestanding, electronic weather stations (n = 2) deployed at each event. The weather stations were positioned at opposite outer boundaries (east and west) of each event, to enable the calculation of the average temperature, humidity, and wind speed at each event location. The weather stations automatically recorded weather data at 30-second intervals, to capture weather conditions throughout the duration of each event.

Using a standard paper questionnaire, event and venue characteristics were recorded at the beginning of each event, while crowd characteristics were captured once per hour by trained fieldworkers (n = 2). The fieldworkers completed the crowd characteristics questionnaires while standing in close proximity to their assigned weather station, in order to capture the conditions at each location and enable the calculation of mean values for each variable. The information recorded on the event and venue questionnaire included event type, location, and duration; availability of alcohol; and presence of security and emergency personnel. The crowd characteristics questionnaire captured data such as demographics, crowd size, mobility, density, and behavior.

De-identified patient presentation records were obtained directly from the event health care service provider at the conclusion of each event. Information contained in the records included sex, year of birth, presenting problem, treatment and medication provided, and final disposition of each patient.

Data Analysis

Data were analyzed using IBM SPSS Statistics, version 23 (SPSS, Inc.; Chicago, Illinois USA). For some crowd and event variables for which data were collected, the amount of missing data was too large, while some recorded information was essentially the same for all events and therefore did not have any discriminatory value. Therefore, these variables were excluded from the analyses.

Ethics Approval

Ethics approval was obtained from the Social and Behavioural Research Ethics Committee of Flinders University (Adelaide, Australia) and the Human Research Ethics Committee of St John Ambulance Australia (Canberra, Australia).

Results

Weather Conditions

Table 1 summarizes the key weather and event characteristics. The events included in this study took place during summer and autumn, under temperate conditions. The average temperature and humidity did not vary substantially across events, with only 13.3% recording a temperature above 25°C and a relative humidity over 60.0%. There were no extreme weather conditions recorded at any event, such as storms or high winds.

The majority of patient presentations occurred at events where the mean temperature was between 20°C and 25°C (60.3%); noting that in this dataset, weather conditions did not vary greatly across the events. These events also had the highest number of patient presentations per event (12.6 presentations per event).

Event Characteristics

The majority of mass gatherings included in the study were entertainment events (53.3%), including concerts and agricultural shows. A further 40.0% were sporting events, including soccer, motor racing, and Australian rules football matches. The majority of events occurred in metropolitan Adelaide (80.0%), while 20.0% of events were held in rural locations across South Australia. The events varied in crowd size ranging from 5,000 to 53,000 expected attendees, with 46.7% of events having between 10,000 and 20,000 expected attendees.

More than one-half of total patient presentations occurred at entertainment events (n = 79); however, the single cultural event included in the study had the highest number of patient presentations per event. The highest PPR (1.2 per 1,000 attendees) was recorded at the cultural event.

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Event Characteristics	n	%	Patients (n)	Patients (%)	Patients per Event	PPR (/1,000)
Event Type						
Sporting	6	40.0	55	37.7	9.2	0.3
Cultural	1	6.7	12	8.2	12	1.2
Entertainment	8	53.3	79	54.1	9.9	0.6
Event Location						
Urban	12	80.0	125	85.6	10.4	0.4
Rural	3	20.0	21	14.4	7	0.8
Event Venue						
Stadium	8	53.3	100	68.5	12.5	0.4
Showgrounds	3	20.0	15	10.3	5	0.5
Park	3	20.0	18	12.3	6	0.6
Vineyard	1	6.7	13	8.9	13	1.6
Expected Crowd						
< 10,000	3	20.0	18	12.3	6	0.9
10,000- < 20,000	7	46.7	39	26.7	5.6	0.5
20,000- < 30,000	1	6.7	8	5.5	8	0.3
30,000- < 40,000	1	6.7	35	24.0	35	1.0
≥ 40,000	3	20.0	46	31.5	15.3	0.3
Alcohol Availability						
Alcohol available for purchase	12	80.0	129	88.4	10.8	0.5
Dry event	3	20.0	17	11.6	5.7	0.5
Mean Temperature						
< 20°C	6	40.0	50	34.2	8.3	0.4
20°C- < 25°C	7	46.7	88	60.3	12.6	0.6
≥ 25°C	2	13.3	8	5.5	4	0.4
Mean Humidity						
< 50%	6	40.0	71	48.6	11.8	0.8
50%- < 60%	7	46.7	58	39.7	8.3	0.4
≥ 60%	2	13.3	17	11.6	8.5	0.3
Mean Wind Speed (knots)						
< 1	3	20.0	37	25.3	12.3	0.7
1- < 2	6	40.0	47	32.2	7.8	0.7
2- < 3	3	20.0	16	11.0	5.3	0.4
≥ 3	3	20.0	46	31.5	15.3	0.3

Table 1. Number and Proportion of Patients Presenting to On-Site Health Care Service by Event Characteristics Variables
Abbreviation: PPR, patient presentation rate.

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Crowd Characteristics	n	%	Patients (n)	Patients (%)	Patients per Event	PPR (/1,000)
Crowd Density						
Very low (approx. 2 persons per m^2)	3	20.0	16	11.0	5.3	0.6
Low (approx. 3 persons per m^2)	6	40.0	37	25.3	6.2	0.5
Medium (approx. 4 persons per m^2)	5	33.3	88	60.3	17.6	0.5
High (approx. 5 persons per m^2)	1	6.7	5	3.4	5	0.4
Male to Female Ratio						
100 M / 0 F	1	6.7	35	24.0	35	1.0
75 M / 25 F	5	33.3	34	23.3	6.8	0.4
50 M / 50 F	9	60.0	77	52.7	8.6	0.4
25 M / 75 F	0	0	0	0	-	-
0 M / 100 F	0	0	0	0	-	-
Proportion of Crowd Seated or Stationary						
0%	0	0	0	0	-	-
25%	3	20.0	16	11.0	5.3	0.6
50%	5	33.3	67	45.9	13.4	0.8
75%	5	33.3	32	21.9	6.4	0.3
100%	2	13.3	31	21.2	15.5	0.3
Proportion of Crowd in Motion						
0%	0	0	0	0	-	-
25%	6	40.0	83	56.8	13.8	0.4
50%	7	46.7	59	40.4	8.4	0.6
75%	2	13.3	4	2.7	2	0.2
100%	0	0	0	0	-	-
Proportion of Crowd Displaying Cohesive Behavior						
0%	2	13.3	13	8.9	6.5	0.7
25%	2	13.3	17	11.6	8.5	0.4
50%	7	46.7	68	46.6	9.7	0.7
75%	3	20.0	31	21.2	10.3	0.3
100%	1	6.7	17	11.6	17	0.4
Proportion of Crowd Wearing Cohesive Dress						
0%	6	40.0	46	31.5	7.7	0.6
25%	1	6.7	7	4.8	7	0.7

Table 2. Number and Proportion of Patients Presenting to On-Site Health Care Service by Crowd Characteristics Variables *(continued)*

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Crowd Characteristics	n	%	Patients (n)	Patients (%)	Patients per Event	PPR (/1,000)
50%	3	20.0	12	8.2	4	0.4
75%	3	20.0	49	33.6	16.3	0.5
100%	2	13.3	32	21.9	16	0.3

Table 2 *(continued)*. Number and Proportion of Patients Presenting to On-Site Health Care Service by Crowd Characteristics Variables
Abbreviation: PPR, patient presentation rate.

Crowd Characteristics

Table 2 presents the key crowd characteristics. Although 60.0% of events had an approximately equal sex distribution among attendees, 40.0% were skewed towards a male-dominated crowd. The 33.3% of events where a high degree of cohesive dress was observed among attendees were predominantly sporting events where a South Australian team was competing against an interstate opponent. Some degree of cohesive dress was also observed at a number of concerts.

The majority of patient presentations were recorded at events where the expected crowd size exceeded 40,000 (31.5%). The highest number of presentations per event (35 presentations per event) was observed at events with an expected crowd size of between 30,000 and 40,000, followed by events with a crowd size exceeding 40,000 (15.3 presentations per event).

Over 60.0% of patient presentations occurred at events with a medium level of crowd density, where movement through the crowd was difficult and partially restricted. Medium crowd density events also had the highest number of patient presentations per event (17.6 presentations per event). The PPR did not vary considerably across crowd density categories.

Just over 20.0% of patient presentations were recorded at events where nearly all attendees were seated or stationary. Total patient presentations and PPRs were reasonably evenly distributed between crowd cohesive behavior and cohesive dress categories. However, patient presentation per event tended to increase with increasing degrees of crowd cohesive behavior and cohesive dress.

The highest number of patient presentations per event occurred at events with a predominantly male crowd (35 presentations per event), and were substantially lower at events with a 75:25 and 50:50 male to female ratio, at 6.8 and 8.6 presentation per event, respectively. The PPR was more than double at the event with a predominantly male crowd compared to events with a more equal sex distribution.

Patient Characteristics

The total number of expected attendees at the 15 South Australian mass gatherings included in the study was 303,500. Of these, 146 presented to on-site health care service providers, giving a PPR of 0.48/1,000 attendees. The total number of patients transported to hospital by ambulance was 13, giving a transport-to-hospital rate of 0.04/1,000 attendees.

Table 3 presents a summary of the patient presentation characteristics across 15 South Australian mass-gathering events. Of the 146 event attendees presenting to on-site health care service providers, 91 (62.3%) were able to return to the event after receiving care on site, while 13 (8.9%) required urgent further treatment and were transported to hospital by ambulance. The most common presenting problems were minor conditions, such as headaches, neck pain, and blisters, which accounted for 41.1% (n = 60) of all presentations. This was followed by minor injuries, such as sprains, abrasions, and insect bites (26.7%) and major injuries, such as fractures and lacerations (13.7%).

Almost 90.0% of patient presentations occurred at events where alcohol was available for purchase. The number of patient presentations per event at licensed events was almost double that of dry events. However, the PPR was the same across licensed and unlicensed events.

Discussion

The results of this study suggest the presence of several relatively poorly understood interactions that may determine the number and type of clinical presentations at mass-gathering events.

Fewer than 10.0% of event attendees who presented to on-site medical facilities required transportation by ambulance to health care services, suggesting that, given the numbers attending each individual event, the impact of the 15 events included in this study on local hospitals and other medical facilities was minimal. This is likely to be, at least in part, the result of effective event planning and on-site medical facility resourcing, which enable health care providers to effectively and efficiently manage the majority of presenting problems at each event. The data suggest that in the range of 10.0%-20.0% of clinical presentations may have required hospital-based care if on-site health care services were not present. This is a broad estimation and underlines the need for further research concerning hospital avoidance strategies. The majority of presenting problems observed in this study would lend themselves well to being treated and effectively managed within on-site health care facilities, as they did not require access to specialized medical equipment or services (eg, imaging and pathology). The most commonly observed health issues such as headaches, blisters, insect bites, lacerations, and asthma attacks can generally be effectively managed using timely first aid interventions.

The majority of events included in this study were representative of mass-gathering events typically occurring in Australia over the summer and autumn seasons and included primarily entertainment and sporting events, such as outdoor concerts, agricultural shows, motor sport, and Australian rules football matches.[13,17,18] The majority of events occurred in venues throughout metropolitan Adelaide and were licensed, with a range of alcoholic beverages available for purchase. Somewhat atypically, fewer than 15.0% of mass gatherings included in this study had a mean temperature over the duration of the event above 25°C. However, this may be explained by the fact that numerous events,

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Patient Presentation Characteristics	n	%
Sex		
Male	67	45.9
Female	76	52.1
Unknown	3	2.0
Age		
< 10	8	5.5
10- < 20	19	13.0
20- < 30	26	17.8
30- < 40	23	15.8
40- < 50	18	12.3
50- < 60	19	13.0
60- < 70	13	8.9
≥ 70	6	4.1
Unknown	14	9.6
Presenting Problem		
Cardiac or respiratory (non-asthma)	6	4.1
Asthma	4	2.7
Mental health (anxiety, panic attack, etc)	5	3.4
Heat-related illness (dehydration, etc)	5	3.4
Drug and/or alcohol-related illness (intoxication, vomiting, etc)	6	4.1
Fracture or laceration	20	13.7
Minor injury (sprain, insect bite, etc)	39	26.7
Minor problem (headache, blister, etc)	60	41.1
Unknown	1	0.7
Outcome		
Refused treatment	1	0.7
Referred to hospital	12	8.2
Referred to General Practitioner	2	1.4
Advised to return home	17	11.6
Returned to event	91	62.3
Transported by ambulance	13	8.9
Unknown	10	6.8

Table 3. Summary of Patient Presentations at 15 South Australian Mass-Gathering Events

such as most concerts and football matches, occurred during the evening.

The majority of events in the study had low to medium crowd density and a male-to-female ratio close to 50:50. The proportion of the crowd displaying cohesive behavior and wearing cohesive dress varied between events, with higher levels of cohesiveness generally observed at sporting matches, which involved a large proportion of attendees supporting the same team and wearing

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team merchandise. Conversely, cohesive dress and behaviors were less common at events such as markets and agricultural shows, which typically encourage attendees to participate in a range of activities within the venue.

Given the small sample size, it is difficult to speculate about associations between patient presentations and event and crowd characteristics. Nevertheless, the study findings indicated that a higher number of patient presentations per event were observed for mass gatherings held in stadiums and vineyards compared to those held in showgrounds and parks. Similarly, the number of patient presentations per event was approximately double at licensed events compared to dry events, which is consistent with previous studies that demonstrated an increase in patient presentations at events where alcohol was readily available.[3,17] While the reasons for these trends are unclear, it is possible that the presence of numerous flights of stairs and uneven terrain in stadiums and vineyards, respectively, may present tripping hazards, particularly when combined with easily accessible alcohol. This may therefore contribute to a greater likelihood of event attendees sustaining injuries such as scrapes, bruises, lacerations, and fractures. Intoxication among event attendees may also contribute to commonly treated complaints such as nausea, vomiting, and headaches.[3,17]

The highest number of patient presentations per event was observed at mass gatherings where the mean temperature was between 20°C and 25°C. Somewhat surprisingly, events with the highest average temperature of over 25°C had the lowest number of patient presentations per event, which is at odds with previous findings that have demonstrated a positive correlation between high temperatures and heat-related illness presentations.[6–12] This may be explained by the tendency for attendees to take extra precautions, such as applying sun protection and staying hydrated, on warmer days when they may be more likely to be reminded to do so by environmental cues and health promotion initiatives at events. These cues to action are less likely to be present on cooler days, resulting in attendees being less likely to take protective measures.

The number of patient presentations per event appeared to increase with increasing levels of cohesive behavior and cohesive dress. At first, this finding may be surprising, given that social cohesion generally implies greater levels of respect and courtesy among members of a crowd. However, in this study, cohesive dress and behavior were most commonly observed during sporting matches, which may explain the observed trends. Sporting matches were held in stadiums and, as discussed, these venues may present greater tripping hazards and result in a higher number of fall-related injuries. Furthermore, alcohol intoxication and rivalries between opposing team supporters may also contribute to a higher incidence of injuries.[3,15,16]

Limitations

Although the results of the study demonstrated that patient presentations appear to be influenced by certain event and crowd variables, the number of events included in the study was too small to enable analysis of data in order to establish the actual impact of event and crowd characteristics on patient presentations.

The study was limited to events occurring over the summer and autumn season in South Australia, which are not necessarily representative of all mass gatherings in Australia. Associations between on-site patient presentations and crowd and event variables should be further explored and quantified in future studies that collect data at numerous mass gatherings in Australia and worldwide.

Conclusions

This study provides some useful conclusions for event planners, health service providers, and researchers. It is clear that a broad range of environmental, behavioral, and demographic features of mass-gathering events interact to produce the clinical demand on on-site health care services. An understanding of these features and their interactions will likely assist in developing more effective service models. Generally, it seems that up to 10.0% of individuals who present to on-site health care services at these events (under normal circumstances) will require hospital care and, consequently, it is the largest mass-gathering events that may overwhelm local health services. Lastly, the interactions among alcohol consumption, crowd mobility or activity, venue design, and injury causation warrant further investigation.

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