

The Use of Haddon's Matrix to Plan for Injury and Illness Prevention at Outdoor Music Festivals

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OMF: outdoor music festival

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Abstract

Introduction: Mass-gathering music events, such as outdoor music festivals (OMFs), increase the risk of injuries and illnesses among attendees. This increased risk is associated with access to alcohol and other drugs by young people and an environment that places many people in close contact with each other.

Aim: The purpose of this report was to demonstrate how Haddon's matrix was used to examine the factors that contributed to injuries and illnesses that occurred at 26 OMFs using data from the Ranse and Hutton's minimum data set.

Methods: To help understand the kinds of injuries and illnesses experienced, Hutton et al identified previous patterns of patient presentations at 26 OMFs in Australia. To develop effective prevention strategies, the next logical step was to examine the risk factors associated with each illness/injury event. The Haddon matrix allows event practitioners to formulate anticipatory planning for celebratory-type events.

Results: What was evident from this work was that the host, the agent, and the physical and social environments contributed to the development of injuries and illness at an event. The physical environment could be controlled, to a certain extent, through event design, safety guidelines, and legislation. However, balancing cultural norms, such as the importance placed on celebratory events, with the social environment is more difficult.

Discussion: The use of the Haddon matrix demonstrates that interventions need to be targeted at all stages of the event, particularly both pre-event and during the event. The opportunity to promote health is lost by the time of post event. The matrix provided vital information on what factors may contribute to injury at OMFs; from this information, event planners can strategize possible interventions.

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Introduction

Mass-gathering music events, such as outdoor music festivals (OMFs), increase the risk of injuries and illnesses among attendees.¹⁻³ Compared with similar sized mass gatherings, OMFs have a higher incidence of injury and illness.^{4,5} This increased risk is associated with access to alcohol and other drugs by young people and an environment that places many people in close contact with each other.⁴ To help understand the kinds of injuries and illnesses experienced, Hutton et al⁵ identified previous patterns of patient presentations at 26 OMFs in Australia. To develop effective prevention strategies, the next logical step was to examine the risk factors associated with each illness/injury event. A common framework used in other injury investigations is the Haddon matrix.⁶ The purpose of this report was to demonstrate how Haddon's matrix was used to examine the factors that contributed to injuries and illnesses that occurred at 26 OMFs by using data from the Ranse and Hutton's⁷ minimum data set. Guided by the resultant matrix, the authors provide recommendations for prevention strategies to promote the health and safety of participants at these OMFs and to prevent injury and illness.

	Host	Equipment	Physical Environment	Social Environment
Pre-event				
Event				
Post Event				

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Table 1. Haddon’s Matrix (Inkpen, 1990)

Haddon	Arnold Disaster	Hutton et al Mass Gatherings
Human (the individual) Factor	<ul style="list-style-type: none"> ● Create the hazard ● Bring about the event (release energy) ● Are at risk for health damage ● Carry out the health response ● Individual motivations ● Behaviors ● Knowledge ● Competencies of people across the hazard-health event continuum 	<ul style="list-style-type: none"> ● Individual motivations ● Behaviors ● Knowledge ● Competencies of people across the hazard-health event continuum
Material Factors (such as equipment, agent, or vehicle)	<ul style="list-style-type: none"> ● The hazard (stored energy) ● Materials that affect energy release from the hazard ● Materials that affect health damage, materials that affect health response ● The quality and quantity of materials, their design, and construction ● Basic biological/chemical/physical properties across the hazard-disaster continuum 	<ul style="list-style-type: none"> ● The quality and quantity of materials used ● Design and construction of event
Physical Environment Design Safety Features	<ul style="list-style-type: none"> ● The setting of the hazard production, event occurrence (energy release), or health damage ● Health response ● Location ● Geography ● Terrain ● Climate ● Temperature ● Lighting of each environment 	<ul style="list-style-type: none"> ● Occurrence/health damage measured in patient presentations ● Health response ● Staff/equipment required for health response ● Location ● Geography ● Terrain ● Layout ● Climate ● Temperature ● Humidity ● Lighting of each environment
Social Environment Laws and Social Norms	<ul style="list-style-type: none"> ● Hazard production ● Event occurrence ● Health damage ● Health response ● Ideology (cultural, religious, and political belief systems) ● Values ● Mores ● Funding ● Systems ● Organization ● Information ● Laws ● Regulations that affect each risk 	<ul style="list-style-type: none"> ● Hazard production ● Event occurrence ● Health damage ● Health response ● Ideology (cultural, religious, and political belief systems) ● Values/attitudes ● Mores ● Funding ● Systems ● Organization ● Information ● Laws ● Regulations that affect each risk

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Table 2. Adaptation to Haddon’s Matrix by Arnold and Hutton et al

Background

Outdoor music festivals are common in Australia, prompting the study of injuries and illnesses experienced by those attending these

events. Outdoor music festivals are unique events that are, for the most part, bounded, ticketed, and alcohol is served. The genres at OMF include hard rock, electronic house music, and anything in

Illness (2,626)	f	%
Asthma	216	8%
Nausea/Vomiting	211	8%
Headache	1389	53%
Pain	264	10%

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Table 3. Illnesses Sustained at Mass Gatherings in Australia

between. They frequently have a higher incidence of injuries and illnesses when compared with similar sized mass gatherings.^{4,5} In addition to high injury and illness rates, OMFs are identified as often having a high transport to hospital rate, due to the combination of drugs and alcohol and the population predominantly being young people aged 18 to 25.⁵

Many case studies of mass-gathering music events have been conducted over the years to understand what types of injuries and illnesses occur at these events, and to ensure ways in which these can be prevented.¹⁻³ Hutton and colleagues⁵ documented the number and types of injuries and illnesses for 4,950 young people presenting for medical assistance at 26 OMFs during the summer of 2010. These presentations were categorized as illness, injury, environmental (sunburn, alcohol, and other drugs), and mental-health-related.^{5,6} In line with most mass gatherings, Hutton et al⁵ found that the majority of presentations were minor, preventable injuries (n = 1,377; 27.7%) and illnesses (n = 2,766; 55.9%). Further analyses of these data can be done through the lens of an epidemiologic model comprised of influencing factors, including the host, the agent, and the environment (physical and social environment)⁷ in order to develop more effective interventions.

As mass-gathering science evolves, public health strategies and policies are recognized as increasingly important components to support the safety of participants, staff, and those attending these types of events. Thus, health promotion strategies and public health information should be integral in planning any mass gathering to minimize public health risk, support harm reduction, and to provide opportunities for the promotion of healthy behaviors and changes in environmental approaches in the local population. As demonstrated by Barnett et al,⁸ Haddon's matrix provides a logical approach to studying the factors that influence preventable illness and injury at OMFs. Given the popularity of OMFs in Australia, health promotion and protection efforts should be directed toward preventing and minimizing harm to young people.

Haddon's Matrix

Haddon's matrix grew out of the classic epidemiological model of agent-host-environment.⁸ The matrix is a useful means of examining factors related to personal attributes (eg, young people attending OMFs), vector or agent attributes (eg, access to alcohol and drugs and festival atmosphere), and environmental attributes (eg, physical and social) pre-event, during the event, and post event. Even though Haddon's matrix was designed initially to be used on a single issue, such as a single traffic accident, the principles of examining the interrelationships between causal factors, pre, during, and post event, can provide insight into the complexity of public health planning at mass gatherings.⁹ Haddon's matrix serves as a theoretical basis for understanding injury

causation and is depicted as either a three by three or three by four table.^{7,8,10} Use of the matrix aids investigators in identifying factors that explain injuries by dividing the causative factors into host, agent, physical, and social environment. The host is defined as the human that sustained the illness or injury, the agent is defined as the vehicle/vector responsible for the injury or illness, and the environment is divided into the physical environment and the social environment⁷ (Table 1).

The matrix also assists the investigators in identifying risk factors related to the timing of the event: pre-event, the event, and post event.^{9,11} This framework is useful in evaluating the relative importance of different factors that contribute to those harms and for designing interventions. Haddon's matrix has been used in the disaster context to help plan for disaster events.^{7,12,13} Thus, applying this framework to mass-gathering events holds promise for understanding the influencing factors. Haddon's matrix also has been used in other contexts. It has been used to structure an analysis of systematic reviews for purposes of better understanding risk factors. In a recent review, 20 studies focused on motor vehicle crashes among Canadian Aboriginal people revealed that additional research should focus on the role of the social environment.¹⁴

Based on the potential utility of the Haddon matrix in providing a better understanding of preventable illness and injury at OMFs, the authors examined data on the illnesses, injuries, and environmental-related presentations for the 4,950 patients from the 26 OMFs. These data then have been related to the following factors: host (individual factors), agent (availability of alcohol and other drugs), physical environment, and social environment in respect to pre-event, during event, and post event data.

Methods

This was a descriptive study using secondary data analysis. Illness and injury data from 26 OMFs during the Australian summer of 2010⁵ were used for this study using the Ranse and Hutton⁷ minimum data set. Each patient presentation to the medical tent (or station) and related data were placed into one of four categories: illness, injury, environmental health, and mental health.

This database included 4,950 separate patient presentations to on-site care from the 26 OMFs.⁵ To achieve the aims of this report, the Haddon matrix was used to categorize key influences of patient presentations at these events, and to identify contributing factors. For each adverse event, data were entered into the matrix related to the host, the agent, and the environment related to pre-event, the event itself, and post event. Arnold's⁹ guide was used as the model for capturing the temporal and unpredictable nature of a mass gathering. The authors modified the guide for use in the event/mass-gathering setting, and subsequently, expanded on Haddon's matrix (Table 2). Social environmental

Asthma	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Past history of exacerbation of asthma Lack of compliance to medication	Not taking inhaler to event	Transportation to event: driving, walking, or public transport Mowing of lawn pre-event Pollen in air (season)	Rushing to get to event and forgetting to bring inhaler
During Event	Intrinsic/extrinsic triggers at event	Not taking inhaler to event	Open field, ground may be dusty Open to elements: wind and sun exposure Lawn	Density of Crowd Dancing/Moshing Drinking alcohol during event with friends Stress
Post Event	Experience of having asthma at an event	Reflect on not taking inhaler	Have to walk to find medical tent	Self-report to medical tent
Nausea/Vomiting	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Not eating before event Has a pre-existing illness or condition Menstruating Irritable Bowel Syndrome	No food eaten prior to event	Lack of food available on way to event	Rushing to get to event and forgetting to eat/bring money for food
During Event	Not eating at event Drinking alcohol or taking drugs at the event	Not wanting to spend money on food at event	Food vendors not open when event opens Alcohol tents open as soon as event opens May vomit in the toilets	Density of Crowd Dancing/Moshing Drinking alcohol Stress Excitement
Post Event	Experience of having nausea at an event	Will reflect on not eating at event	Have to walk to find medical tent May vomit in the toilets or on the way home	Self-report to medical tent or take yourself home
Headache	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Not eating before event Has a pre-existing illness or condition Menstruating Has existing stress	No food eaten	Lack of food available on way to event	Rushing to get to event and forgetting to eat/bring money for food
During Event	Not eating at event Drinking alcohol or taking drugs at the event	Not wanting to spend money on food at event	Food vendors are often not open when event opens Alcohol tents open as soon as event opens	Density of crowd Dancing/Moshing Drinking alcohol during event with friends Stress
Post Event	Experience of having headache at an event	Will reflect on not eating at event	Have to walk to find medical tent	Self-report to medical tent or take yourself home
Pain	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Comes to event with pre-existing condition	Dress in a way to cause pain Not sun safe: sunscreen Inappropriate footwear No hat: sun stroke	Transportation to event: driving, walking, or public transport	Rushing to get to event
During Event	Activity at event increases pain Drinking alcohol	Loud noise – headache	Open field, ground may be dusty, can't see Hard ground Undulating environment Sharp objects on ground	Density of crowd Dancing/Moshing Drinking alcohol during event with friends Stress
Post Event		Will continue to seek treatment to relieve pain	Have to walk to find medical tent and can't see	Self-report to medical tent

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Table 4. Factors That Contribute to Illness at Events

factors were considered to be the most important group of risk factors, since they are often the most amenable to manipulation by governing bodies.⁹ The data were categorized into three

areas: illness, injury, and environment (the category mental illness was excluded from this report due to low numbers). Data for each category were subsequently utilized to populate

Injury (1,377)	f	%
Superficial Laceration	281	20
Sprain/Strain	264	19
Head Injury	163	12
Foreign Body in Eye	110	8

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Table 5. Injuries Sustained at Outdoor Music Festivals in Australia

Haddon's matrix. A separate matrix was developed for each of the categories based on the top four presenting categories from the Hutton study.⁵

Findings

The majority of those who presented to on-site care were less than 25 years of age ($n = 3,875$; 78%) with a mean age of 21.3 years. In addition, over one-half of those who presented were female ($n = 3,087$; 52%).⁵

Illness

The majority of the illness complaints were headaches (53%), followed by pain (10%), asthma (8%), and nausea/vomiting (8%; Table 3). These four were also the most frequent illnesses. Pre-event, the host factors were memory or lack of preparedness (these being forgetting to bring equipment, such as a puffer, or forgetting to eat and drink prior to attending, which could then contribute to presentations of headaches or nausea and vomiting). During the event, the social and physical environments appeared to be the main contributors to all four illness presentations. These were: the density of the crowd, the activities undertaken (such as the availability of alcohol and drugs), and the loudness of the music. Post event, there was a reliance on self-reporting of illnesses, which could have been impacted by the size of the event and the amount of walking that the audience members had to travel to seek care. For many of these misdemeanors, audience members may have delayed treatment until they got home (Table 4).

Injury

The majority of the injury complaints were superficial laceration (20%), followed by sprain/strain (19%), head injury (12%), and foreign body to the eye (8%; Table 5). Pre-event, host factors identified were rushing to the event as a main precipitator of sprain/strains and lacerations. During the event, the social environment of dancing and moshing contributed to injury. The agent, being the availability of alcohol, contributed to all four recorded injuries. Coupled with the physical environment (the music type, the density of the crowd, the uneven terrain, and the length of time it took to walk between stages) these factors all contributed to injuries at OMFs. Post event, the common influence to the injury was the physical and social environment itself, having to walk to the medical tent, negotiating with peers to seek medical treatment, and the influence of alcohol and drugs. These factors all contributed to injuries at this phase of the events. As most events finished late at night, any injuries may not have been apparent until the next morning (Table 6).

Environmental

The majority of the environmental presentations were alcohol-related (32%), heat exhaustion (19%), substance-related (18%), followed by substance- and alcohol-related (16%; Table 7). Prior and during the events, the physical environment contributed to heat exhaustion if the temperatures were between 30°C and 40°C (86°F to 104°F). In the pre-event sphere, the availability of alcohol and the consumption of drugs before an event were agents that led to presentations. Again within the social environment, activities such as moshing, dancing, and going to and from different stages during the day led to the exacerbation of environmental presentations. In addition, the physical environment supported the consumption of alcohol with alcohol being served. As it is legal to drink alcohol, regardless of the time of day, people may have started drinking as early as 10 AM as alcohol was often served as soon as the gates were opened. Post event, people may have presented to the medical tent if they felt that they couldn't get home safely from the event; again, the physical environment was at play here if the medical tent was not accessible. Post event, the common influence to injury was the physical and social environment itself, having to walk to the medical tent, negotiating with peers to seek medical treatment, and perhaps the influence of alcohol and other drugs may have contributed to injuries at this phase of the events (Table 8).

Discussion

Health promotion, public health information, and environmental considerations are at the core of any mass gathering as a means to promote health behaviors and reduce the risk of harm. Central to this is a clear understanding of the factors that increase the risk for harm. The Haddon matrix allows event practitioners to formulate anticipatory planning for celebratory-type events. What was evident from this work was that the host, the agent, and the physical and social environments contributed to the development of injuries and illness at an event. The physical environment can be controlled, to a certain extent, through event design, safety guidelines, and legislation. However, balancing cultural norms, such as the importance placed on celebratory events, with the social environment is more difficult.

Using Haddon's matrix, this report has highlighted how social and physical environments heavily influence the safety of young people attending OMFs. In addition, human factors, including the individual motivations, behaviors, knowledge, and competencies of these people across the continuum, impact the presentation of people at the event.^{5,9}

Pre-event messaging can promote individual planning. Such messaging can be disseminated on official web sites of the mass

Superficial Laceration	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Drinking alcohol during the event Excited/rushing to do things	Decision on type of shoe worn	Transportation to event Jumping fence to get in	Rushing to get to event Excited
During Event	Drinking alcohol during the event	Type of shoe worn Presence of glass and foreign objects on ground	Open field Large crowds Dark /poor lighting Lack of rubbish bins/trash cans	Music type Density of crowd Dancing/Moshing Stages in separate areas/need to walk from one to another Bands play at the same time/ audience member needs to rush from one stage to another Drinking with friends
Post Event	Hung-over post event Headache Deciding to seek medical aid	Type of shoe worn Think about wearing something different to next event	Events can be quite large in terms of participant numbers Tired from walking Self-report to medical tent Have to walk to medical tent once injured: difficult to navigate to aid	Self-report to medical tent Have to walk to medical tent once injured: difficult to navigate to aid
Sprain/Strain	Human/Individual Factor	Equipment Agent/ Vehicle	Physical Environment	Social Environment Laws/Norms
Pre-event	Drinking alcohol prior the event Excited	Decision on type of shoe worn	Transportation to event No health information about what to wear to a music festival	Rushing to get to event Excited Peer pressure to wear types of clothing
During Event	Alcohol or drug intoxication/impairment	Type of shoe worn	Open field Large crowds Ground may be uneven/ different surfaces As walking, cannot always see where you are going Hard surface or asphalt	Music type Density of crowd Dancing/Moshing Stages in separate areas/need to walk from one to another Bands play at the same time/ audience member rushes from one stage to another Drinking with friends
Post Event	Hung-over post event Headache	Type of shoe worn Think about wearing something different to next event	Events can be quite large Tired from walking Self-report to medical tent Have to walk to medical tent once injured: difficult to navigate to aid	Self-report to medical tent Have to walk to medical tent once injured: difficult to navigate to aid
Head Injury	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event (what factors affect before the event)	Vulnerable part of body Drinking alcohol prior to event Past history of epilepsy or head injury	Lack of protective head gear	Long way to event: drive or take public transport Long time waiting in cues	Rushing to get to event Having to line up
During Event (what factors affect during the event)	Drinking alcohol during the event/impeding cognition Fist fighting	Drinking alcohol during the event Taking drugs at event	Open field Large crowds Hard surface or asphalt	Music type Density of crowd Dancing/Moshing
Post Event (what factors affect after the event)	Headache Not able to think clearly/ tired	Lack of protective head gear	Have to walk to find medical tent Height of entry/exits Egress/access Jumping fence to get out	Self-report to medical tent Rushing to get home

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Table 6. Factors That May Contribute to Injury at Events (*continued*)

Eye Injury	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event (what factors affect before the event)	Vulnerable part of body Drinking alcohol prior to event	Lack of protective head gear Not wearing sunglasses or glasses	Long time waiting in cues/ windy environment	Having to line up/windy environment
During Event (what factors affect during the event)	Drinking alcohol during the event/impeding cognition	Drinking alcohol during the event Taking drugs at event	Open field – grass/pollen Large crowds Windy or dusty environment	Density of crowd Dancing/Moshing Foreign objects being thrown through the air
Post Event (what factors affect after the event)	Not able to think clearly/ tired	Lack of protective head gear Not wearing sunglasses or spectacles	Have to walk to find medical tent Jumping fence to get out	Self-report to medical tent Rushing to get home

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Table 6 (continued). Factors That May Contribute to Injury at Events

Environmental (656)	f	%
Heat Exhaustion	146	19
Alcohol Related	250	32
Substance Related	135	18
Substance & Alcohol Related	125	16

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Table 7. Environmental Presentations Sustained at Outdoor Music Festivals in Australia

gathering and when receiving or purchasing tickets. The health messaging topics can be predetermined from retrospective analysis of injury and illness data from the same or similar mass gatherings. Some messaging may include: “What do you need to bring to the event that will make you feel most comfortable?” “Do you take medication during the day; do you need to take that with you?” “Are you travelling with people; do you have a plan of where to meet throughout the day?” and “Will you be dancing a lot; do you need to wear comfortable shoes that will keep you on your feet throughout the day?”

This type of health messaging may appear rudimentary; however, these positive proactive messages serve as a reminder to audience members to make the most of the mass gathering through ensuring it is a success for them, and subsequently, resulting in a reduction of patient presentation rates at these events.

In addition, messages need to be audience and event specific. At OMFs, this messaging can be placed on the side of performance stages, on big screens, at food outlets, or in toilets. This positioning of health messages can be coupled with the use of health promotion tents during the event. The use of volunteers to distribute and reinforce positive health messaging has been a successful health strategy used at other festivals, such as Schoolies (end of school celebrations) events in South Australia,^{15,16} and could be adapted to OMFs in more general terms. Such messages could remind participants to: “Keep hydrated - drink water” and “Look after your mates!” Event planners can provide meeting/resting places around events, and these places can also be used to distribute health information and allow access to water, high energy snacks, and sunscreen. A further understanding of the

physical and social conditions will contribute to health messaging during the event.

Post event, safe health messages can be posted onto social media within follow-up marketing campaigns to either reinforce health promotion at mass gatherings, to obtain participant feedback about the safety of the event, or to trace communicable diseases, such as influenza. The use of the matrix demonstrates that the use of drugs and alcohol can contribute to many of the injuries at OMFs.

Limitations

This report draws on data that were restricted to those patrons receiving on-site care, and thus, limits the ability to assess accurately the amounts of injuries and illnesses that happen at these events. Therefore, the results may not be generalizable to another population or setting. In addition, the care provided to those who present is given to treat the presenting symptoms, such as a headache. Since the cause of the headache was not explored or documented, other confounding contributors, such as dehydration, sun exposure, or alcohol use, are unknown. Similarly, nausea and vomiting can be linked to food poisoning, communicable diseases, and so on, but as symptoms are documented and not the underlying illness, it is difficult to determine the cause. Lastly, post event issues and presentation data were not captured in this study.

Conclusion

This report has demonstrated how the Haddon matrix can be used to examine factors that contributed to injuries and illnesses at OMFs. The findings were that interventions need to be targeted

Heat Exhaustion	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Does not cope with the heat	Not sun safe: sunscreen Inappropriate footwear No hat: sun stroke Water availability	Transportation to event: driving, walking, or public transport Long wait to get into event in full sun	Rushing to get to event, forgetting to drink enough water Drinking with friends before event Local resource capability
During Event	Does not sit in shade Does not wear a hat Wearing dark clothing Does not drink water Drinking alcohol	Does not wear hat Water availability	Open fields/long way to walk between stages Lack of shade Open to elements: sun exposure Access to medical tent	Density of crowd Dancing/Moshing Drinking alcohol during event with friends Stress Local resource capability
Post Event	Feels exhausted post event		Access to medical tent	Local resource capability
Alcohol Related	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Drinks alcohol before the event	Not sun safe: sunscreen Inappropriate footwear No hat Band stubbie holders for sale Water availability	Transportation to event: driving, walking, or public transport Long wait to get into event in full sun	Rushing to get to event, forgetting to eat prior to event Local resource capability
During Event	Drinks more than five standard drinks at the event Does not wear a hat at event Does not drink water	Does not wear hat Alcohol served at event Purchase two to three drinks at a time Water availability	Open fields/long way to walk between stages Lack of shade Open to elements: sun exposure A number of alcohol tents Can buy more than one beer/drink at a time Access to medical tent	Density of crowd Dancing/Moshing Drinking alcohol during event with friends Using alcohol to have fun Local resource capability
Post Event	Feels drunk post event	Water availability	Access to medical tent	Local resource capability
Substance Related	Human/Individual Factor	Equipment	Physical Environment	Social Environment
Pre-event	Takes drugs before the event	Not sun safe: sunscreen Inappropriate footwear No hat: sun stroke Water availability	Transportation to event: driving, walking, or public transport Long wait to get into event in full sun	Rushing to get to event, forgetting to eat Local resource capability
During Event	Drinks more than five standard drinks at the event Takes drugs at events Does not drink water	Alcohol served at event Water availability	Open fields/long way to walk between stages Lack of shade Open to elements: sun exposure A number of alcohol tents Can buy more than one beer/drink at a time Access to medical tent	Density of crowd Dancing/Moshing Drinking alcohol during event with friends Using alcohol to have fun Local resource capability
Post Event	Feels drunk post event	Water availability	Access to medical tent	Local resource capability

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Table 8. Factors That May Contribute to Environmental Injuries at events

at all stages of the event, particularly both pre-event and during the event. The opportunity to promote health is lost by the time of post event. The matrix provided vital information on what factors may contribute to the injuries at OMFs; from this

information, event planners can strategize possible interventions. The physical environment can be manipulated to promote public health and reduce injury. However, the social factors are more difficult to control.

References

1. Krul J, Blankers M, Girbes ARJ. Substance-related health problems during rave parties in the Netherlands (1997-2008). *PLoS ONE*. 2011;6(12):e29620.
2. Milsten AM, Maguire BJ, Bissell RA, Seaman KG. Mass-gathering medical care: a review of the literature. *Prehosp Disaster Med*. 2002;17(3):151-162.
3. Nardi R, Bettini M, Bozzoli C, et al. Emergency Medical Services in mass gatherings: the experience of the Formula 1 Grand Prix 'San Marino' in Imola. *Euro J Emerg Med*. 1997;4(4):217-223.
4. Raineri A, Earl C. Crowd management for outdoor music festivals. *J Occup Health and Safety Aust New Zeal*. 2005;21(3):205-216.
5. Hutton A, Ranse J, Verdonk N, Ullah S, Arbon P. Understanding the characteristics of patient presentations of young people at outdoor music festivals. *Prehosp Disaster Med*. 2014;29(2):1-7.
6. Haddon W. On the escape of tiger: an ecologic note. *J Am Public Health Nations Health*. 1970;60(12):2229-2234.
7. Ranse J, Hutton A. Minimum data set for mass-gathering health research and evaluation: a discussion paper. *Prehosp Disaster Med*. 2012;1(1):1-8.
8. Barnett DJ, Balicer RD, Blodgett D, Fewes AL, Parker CL, Links JM. The application of the Haddon matrix to public health readiness and response planning. *Environ Health Perspectives*. 2005;113(5):561-566.
9. Arnold J. The London bombings and the Haddon matrix Editor's Corner. *Prehosp Disaster Med*. 2005;20(5):278-281.
10. Baker SP, Guohua L. Epidemiologic approaches to injury and violence. *Epidemiologic Reviews*. 2012;34:1-3.
11. Inkpen R. Environmental Geography Blog 2010. file://usergh/H/hutt0019/prefs/Desktop/haddons%20matrix/Environmental%20Geography%20Blog%20%20Haddon%20Matrix%20and%20Hazardous%20Events.htm. Accessed May 7, 2014.
12. Lund A, Gutman S, Turris S. Mass-gathering medicine: a practical means of enhancing disaster preparedness in Canada. *Can J Emerg Med*. 2011;13(4).
13. Zhong S, Clark M, Hou X, Fitzgerald G. 2010-2011 Queensland floods: using Haddon's matrix to define and categorize public safety strategies. *Emerg Med Australasia*. 2013;25:345-352.
14. Short MM, Mushquash CJ, Bedard M. Motor vehicle crashes among Canadian Aboriginal people: a review of the literature. *Canadian Journal Rural Medicine*. 2013;18(3):86-98.
15. Hutton A, Cusack L, Zannettino L, Shaefer S, Verdonk N, Arbon P. What are school leavers' priorities for festival preparation? *Australian J Primary Health*. 2013.
16. Hutton A, Cusack L. The perspectives of young people on their use of alcohol and risks at School Leavers Festival. *Neonatal Paediatric Child Health Journal*. 2013;16(3):16-19.