There is sufficient evidence to indicate that music events including outdoor music festivals are associated with an increased risk of public health issues (Arbon 2003). These risks are increased if an OMF has a general admission area or ‘mosh pit’ (Milsten et al. 2003). Australia has experienced a fatality within the mosh pit at an OMF that occurred at the 2001 Big Day Out in Sydney (Crowd Management Strategies [CMS] 2002). Raineri (2004) believed that it has taken this incident to generate change and major improvements to crowd safety, infrastructure and production safety for many Australian events. However, there is still more that can be done.

The aim of this article was to encourage EHPs to consider having a larger role in crowd safety for OMFs. The discussion was based on evidence found from an extensive review of the literature on public health risks, crowd safety, and event planning, and management at OMFs.

### Risks to Crowds

There are numerous public health risks associated with OMFs. The following section provides an overview of recent crowd related incidents from the media, morbidity and mortality figures, and patrons risk perceptions.

#### Recent crowd related incidents

The following Table (Table 1) shows notable incidents reported in the media that occurred in the last five years and their causes. This gives an indication of the trends in incidents with fires, terrorism, and gun violence among the most recent reports.

#### Mortality data

As shown in Table 1, deaths have occurred at OMFs. CMS (2003) reported that between 1992 and 2002, 232 people have died at music events. Upton (2004) presented alternative data from 1974 to 2003 that identified 136 crowd-related deaths. These deaths occurred during (i) ingress, and (ii) egress into events, (iii) at
the front of (or diving off) a stage during a performance, and (iv) falling from the balconies at arenas and stadiums (Upton 2004). For Australia, there has been no more significant an incident than the death of a young girl at a festival in 2001. Deaths are infrequent, with injuries being much more prevalent.

**Morbidity data**
Crowd Management Strategies (2002), an American based organisation, has collected injury data from 306 events globally, with an estimated 66,787 injuries recorded for the period between 1992 and 2002. The highest number of injuries for a single event was recorded in 1999 where the Woodstock 1999 festival had 10,000 people treated for injuries sustained (CMS 2002).

Importantly, the majority of the injuries at events are minor, with critical illnesses infrequent occurrences (Varon et al. 2003). Varon et al. (2003) and Milsten et al. (2003) found that more than 80% of the patients returned to the event. Both authors explained that this was due to most presentations being for minor trauma and headaches. Arbon (2002) found considerable variations with injury rates for mass gatherings throughout Australia, but the highest recorded rate was at a summer OMF (26.85 patient presentation rate per 1000 spectators). Generally, when compared toOMFs around the world, Australia’s rates were on a par (Chapman, Carmichael & Goode 1982; CMS 2001b; Forrest 1999; Furst & Sandor 2002; Janchar, Sammaddar & Milzman 2000; Kao et al. 2001).

**Risk perceptions**
Earl and Van der Heide’s (2001) study on patron risk perception found there was particular concern about being in the mosh pits of OMFs. A wide range of public health issues are of high concern, including access to drinking water, toilets, safe food, transportation to and from the venues, the size of the crowds, and having valuables lost or stolen. This study also highlighted the importance of having a huge focus on safety in mosh pits. The participants linked mosh pits to numerous other risks, such as being
grabbed, the need for first aid, items thrown, crowd size, losing valuables, and alcohol related behaviour.

Commons, Baldwin and Dunsire (1999) warned against using excessive control as it would limit expression for the patrons. This was an interesting point of view, however, others were adamant that public safety needs to remain the main priority for event organisers and licensing authorities (e.g. EMA 1999; HSE 1999; Upton 2004; Wertheimer 2001).

### Event Characteristics and Risks

Research has identified a number of characteristics that contribute to the risks at mass gatherings (e.g. Arbon, Bridgewater & Smith 2001; Earl et al. 2004; Milsten et al. 2002, 2003; Zeitz et al. 2002). However, it was Arbon (2004) who provided the most recent and complete list of these characteristics, which included (i) the weather (temperature and humidity); (ii) the duration of the event; (iii) whether the event is predominantly an outdoor or indoor event; (iv) whether the crowd is predominantly seated or mobile; (v) if the venue is bounded (fenced and secured) or unbounded; (vi) the type of event; (vii) the crowd mood; (viii) availability of alcohol and drugs; (ix) crowd density; (x) the geography of the event (topography and locality); and (xi) average age of the crowd.

These studies focused on a variety of different types of mass gatherings such as sporting events, so what about OMFs specifically?

All of the characteristics identified by Arbon (2004) relate to OMFs. A study by Earl et al. (2004) found that OMFs were different from many mass gatherings. These differences were attributed to the large crowds in attendance, the influence of music on those attending and crowd mood (usually volatile with greater security demands) and demographics (often younger patrons). Arbon (2002) found there were links between increased public health risks and rock music events, particularly OMFs. Earl et al. (2004) explained that crowd crushes and intoxication were the most common factors associated with these public health risks with both influenced by changes in crowd mood and performance.

The recognition, tempo or rhythm of songs, the type and attitude of the performers or any combination of these, were closely linked to changes in crowd behaviour (Earl et al. 2004). Earl et al. reported that heavy metal, hardcore punk, and rap performances were considered highly influential on crowd behaviour.

Milsten et al. (2002) and Earl et al. (2004) considered that crowd mood was associated with a number of factors. Milsten et al. said that mood was linked to the closeness of crowds, the occurrence of incidents (such as a crowd rush), and/or the effect of the music. While Earl et al. considered that these crowds have lots of energy with a “group mentality” (“...more likely to become unruly” and “because they are much louder and they tend to follow each other”) and attitude (“...there is less respect for authority at music events”) that also influences mood.

Additional factors of interest were crowds that have predominantly young males in attendance, overcrowding of venues, lack of appropriate emergency management planning, or insufficient numbers of trained, experienced security staff (Earl et al. 2004).

### Tools Used in Crowd Management

Risk management has been recognised as a useful tool in crowd management (Tatrai 2001, 2004). The risk-based approaches were described as two basic processes that were (i) risk assessment and (ii) the selection and implementation of management options (National Research Council 1983).

(i) **Risk assessment**

There was considerable endorsement for risk management for OMFs within the literature reviewed (e.g. Department of Health 2004; Emergency Management Australia [EMA] 1999; Federal Emergency Management...
The strength of risk management is that it provides a systematic approach to the identification and management of risks. However, the quality of risk assessments at Australian OMFs has been heavily criticised in recent years (Weir 2002). Tatrai (2001), an event and crowd specialist, recommended the national Australian Standard AS/NZ 4360: 1999. Tatrai (2001) argued that its robust process and good guidance notes make it an ideal choice. Tatrai (2001) has had considerable success with this approach and was confident it would be as useful for others.

The HSE (1999) considered that any assessment should reflect current best practice. For advice on best practice, useful standards can be found in EMA (1999), HSE (1999) documents or the new draft Department of Health (2004) event guide from Western Australia. It is important to remember that risk assessments are not perfect processes. Langley (cited in Cromar, Cameron & Scott 2003) advised that it is not always possible to arrive at a definite outcome. Oosthuizen (2001) said that factors such as cost blowouts, insufficient data, poor methodology or inadequate staff capacity contributed to this (Oosthuizen 2001). In terms of OMFs, gaps within the evidence base (Arbon 2004), and limitations in event planning capabilities were highly likely to affect these processes (Au et al. 1993; EMA 1999).

The following sections provide insight into (a) the risk compliance review (or establishing the context), and (b) the risk analysis within the risk assessment processes for OMFs that EHPs may find useful.

(a) Risk compliance review

Tatrai (2001) described the first step in the risk management process as undertaking a risk compliance review. This involves undertaking an audit of all operations for the event, the intended site, the identification of key stakeholders (e.g. venue manager, promoters, contractors and sponsors) and assets (e.g. infrastructure, goodwill and publicity) (Tatrai 2001). An evaluation of crowd characteristics should be undertaken as part of the risk compliance review (HSE 1999).

Raineri (2004) considered that the evaluation of crowd should identify (a) different social groups likely to attend (b) previous experience with these groups (c) potential behaviour patterns (d) staffing implications, and (e) the methods of communication between staff and the crowd. OMFs have become important cultural foci (Ministry of Culture 2001) and there were associations between youthful expressions and music events, and public health risks were identified within the literature (e.g. Bennett 2002). The expressions of particular interest include moshing, crowd surfing, swirling, drug and alcohol consumption, and the likelihood of violence. The likelihood of this type of expression can vary depending on the different social cliques present within the crowd (Bennett 2002).

There are many social cliques with close links to music such as Mods, Hippies, Beats, Punks, Metal Heads (also called ‘Headbangers’), Skinheads, Disco, and Ravers (Forsyth, Barnard & McKeganey 1997; Weir 2000). Each of these groups brings specific values (e.g. skinheads like to be aggressive), norms (e.g. heavy metal crowds are big alcohol and drug consumers; ravers like ecstasy) and expectations (e.g. punks expect to be able to slam dance or mosh) to each event they attend. Behaviour in mosh pits should be of the most concern (Earl & Van der Heide 2001).

(b) Risk analysis

Figure 1 provides a model of behaviour within a crowd at a music event. This model shows the basic individual and group cognitive and crowd degeneration processes that can lead to adverse public health outcomes at music events. These are described as steps.
Step 1 Individual Behaviour & Step 2 Crowd Decision

EMA (1999) suggested that crowd responses are based on a series of individual and collective behaviours. The individuals in the crowd are exposed to stimuli, make decisions, and formulate personal responses based on factors such as experience, knowledge and expectations. These responses are then communicated out through the crowd in order to affiliate with others, reduce confusion, and evaluate emotional responses. Based on decisions made within these stages, changes within the crowd behaviour are likely to result.

Step 3 Collective behaviour

Tatrai (2001) reported that there are three main classifications for crowds. These are individuals in collective groups without leadership, groups with common interests, and mobs that are responsible for the extreme reactions in crowds. Each of these crowd classifications has implications for event planning and management.
Importantly, crowds can move readily between each classification and the subcategories within them. 

Type 1: Individuals within a collective group having no leadership or focus.

Type 2: Groups with common interest and the following sub-categories within these groups: 
- curious crowds, such as stopping to watch a busker or spectators at the scene of an accident; 
- cohesive crowds, such as attending a sporting event or theatre; and 
- expressive crowds, such as patrons at a classic rock event or State of Origin rugby league crowds.

Type 3: Mobs do not occur often and form from the degeneration of Type 2 crowds. These mobs require extreme responses and expert skills to manage them. There are sub-categories to this crowd type that are: 
- expressive mobs, such as post New Year’s Eve crowds; 
- escape mobs, such as crowds escaping a fire or explosion; 
- acquisitive mobs, such as looting crowds after disasters; and 
- aggressive mobs, such as the crowd at the Woodstock 1999 festival (Tatrai 2001).

Step 4 Consequences 
Fruin (2002) spent many years researching crowds and has developed a model that can assist with the analysis of risks at OMFs by providing insight into the causes of crowd disasters, prevention and mitigation approaches. The elements of the model form the acronym ‘FIST’ that is defined as the following: 
- Force: These forces are the result of pushing from within the crowd (Fruin 2002). For example, steel railings bending after crowd related incidents indicating forces exceeding 4500 N or 1000lbs. 
- Information: Fruin (2002) considered that information which had affected group perceptions included sights and sounds from within the crowd, public address announcements, training and experience, actions of staff, signs, and ticketing. 
- Space: Fruin (2002) said that the main features of space included projected occupancy rates, audience viewing areas, and the capacities of corridors, ramps, stairs, doors, escalators and elevators to manage crowd movement. 
- Time: Fruin (2002) explained timing as the more gradual and lighter density arrival process before an event compared to the rapid egress and heavy crowd densities after an event.

(ii) The selection and implementation of management options 
It is important to manage public health risks at OMFs (EMA 1999). Critical elements such as the types of barriers used, security staffing, composition of the crowds, the type of music, or choices of venues all have an effect on risks at these events. As a result, the planning stage becomes critical to ensure that appropriate and effective management options are used at these events.
(a) Event planning

Comments on event planning in Australia suggest that current methods have been inconsistent (Arbon 2004) and often ineffective (EMA 1999). Wertheimer considered that many deaths and injuries were attributable to poor event planning (Wertheimer 2000, 2001, 2002). For example, a death, 140 injuries, and significant environmental damage to Brighton beach in England occurred when 250,000 people attended an event with a planned capacity of 60,000 people (Wertheimer 2002). According to Au et al. (1993), many event organisers rely too heavily on previous experience when planning their events. This could explain deficiencies in specialist areas such as risk management (Weir 2002) and emergency planning and response (Davies 1998; EMA 1999; Wertheimer 1993). Clearly event organisers would benefit from good guidance in event planning.

The following are points for EHPs to consider regarding event planning:

- The HSE (1999) event planning guide (also known as ‘The Purple Guide’) that is considered the international benchmark for event planning, provides guidance on standards for (1) structures, (2) sanitation, (3) waste management, (4) sound, noise and vibration and (5) food, drink and water.

- Particularly valuable are the checklists found in the EMA (1999), FEMA (2003), Department of Human Services or Department of Health (2004) event planning guides. These checklists are useful for both event organisers and EHPs.

- The use of risk assessments was strongly encouraged (e.g. City of Edinburgh Council 2002; Civil Defence and Emergency Management 2003; EMA 1999; HSE 1999; Liquor Licensing Division [LLD] 1999; Department of Human Services 2003).

- Event planning should be able to respond to new and emerging risks, for example terrorist threats (Weir 2002) and must be based on up-to-date, thorough risk assessments with a continuous improvement focus.

(b) Event management

Both EMA (1999) and HSE (1999) asserted that good operational and strategic structures were critically important. Operationally, this means using competent staff; maintaining good control of the event (e.g. crowd numbers) and cooperation within the stakeholders (e.g. security and police) and ensuring that public health and safety remains high on the operational agenda (HSE 1999). Strategically, this means undertaking comprehensive pre-
event planning processes, establishing emergency response capabilities, and putting management processes in place as early as possible (EMA 1999; LLD 1999). Emergency management was identified as being a weakness for events in Australia, specifically emergency response, contingency planning, and consideration of extreme events (Davies 1998; EMA 1999).

(c) Crowd management
Crowd management is a major component of event planning and management. There is good guidance information available to support crowd management for OMFs. The following are features that should be considered in good crowd management.

Crown management services
The following provides an introduction to the services and activities that make up crowd management at OMFs:

- fire safety involving safe escape routes, assembly areas, fire fighting equipment, and use of appropriate, trained staff (HSE 1999);
- first aid and medical services involving medical triage facilities, ambulances and medical and first aid staff (including mobile patrols) (Arbon 2002; EMA 1999);
- emergency management planning required for structural faults, equipment or amusement ride failure or malfunction, bomb threats, and crowd control (Department of Human Services 2003); and
- security and stewarding involving crowd control, guarding of back house, back stage, front of stage areas, cash and equipment protection, and control of entry and exits (Ministry of Civil Defence and Emergency Management [MCFEM] 2003).

Venue/site design
The HSE (1993) considers that the design and layout of the venue has a big influence on public safety. Designing for good crowd management requires maximum occupancy levels to correlate to movement capabilities of all pathways within the event (Fruin 2002). It is important to check for such features as steep slopes, dead ends, the convergence of routes, uneven or slippery flooring and the placement of facilities throughout the site (e.g. food outlets, bars, and toilets). It is also necessary to watch for reverse flows, obstructions created by queues or gathering crowds, flows mixing with traffic, and moving attractions within the crowd (Raineri 2004). Finally, ensuring there is continuous electricity for lighting within the site is also important (Fruin 2002).

Mosh pits and barriers
The HSE (1993) asserted that the management of crowds was dependent on good systems and staff experience. Upton (2004a) argued that 5% of a crowd generate up to 75% of the energy released at an event. The 5% is generally made up of the patrons located at the front of the stage in the mosh pit and therefore controlling the effects of this group is critical. Hill (2002) considered that the provision of separate mosh pits to isolate the main moshing activities from the rest of the crowd was the preferred option. This can be done using barrier systems (often referred to as ‘secondary barrier systems’) and there was some discourse within the literature on this topic. The examples of secondary barrier systems reported in the literature were:

- The ‘D’ shape barrier system where a barrier surrounds the mosh pit area with egress and access managed by security personnel (HSE 1999; Raineri 2004). Upton (2004) recommended for very large crowds to use double or triple ‘D’ systems if possible. This system has been used for the Big Day Out events (Raineri 2004).
The ‘finger’ barrier system where there is a barrier that runs perpendicular to the stage and is connected to the front of stage barrier and divides the mosh pit laterally (HSE 1999). Security staff are positioned within the barrier system to manage crowd activities. This system was used at the Livid Festival in 2003.

Another system is used to divide the entire general admission area into two completely separated sections with their own entrances, exits, and associated services (Upton 2004). This system was used at the Wave Aid Concert in 2004.

The final and most advanced method to date is where the mosh pit is divided into four unique, penned zones. Each of these zones has a limited capacity (maximum of 500 patrons) with its own ingress, egress, and emergency evaluation systems and is self-contained in terms of facilities, welfare and concessions (Upton 2004). This system was used at the Roskilde Festival in recent years.

Upton (2004) recommended that the following considerations were important when making decisions about barrier configurations for mosh pit areas:

- Have a realistic approach to establishing the capacity and densities within these areas;
- Crowd conditions must be assessed by individual areas not the overall site (e.g. large video screens are most likely to be the focus of the crowds at large OMFs and this needs to be considered while undertaking risk assessments);
- An accurate assessment of the topography (e.g. incline, drainage, grass coverage, and hard standing features), crowd composition, and performers’ impact is critical;
- Consideration for medical and security teams to respond, triage, and retrieve victims of crowd incidents is also important.

Information
The amount and quality of knowledge people have about the venue and the event affects the way they act, especially in emergencies. Fruin (2002) and the HSE (1993) suggested that clear sign posts and simple, audible public address messages are vital as poor communication can lead to confusion and crowd flow blockages. Also, those around them can influence the behaviour of individuals. It is important to identify leaders within the crowds, as they are likely to influence the behaviour of others.

Timing
Raineri (2004) said that the objective of temporal strategies is to keep pedestrian densities below critical levels. Examples of these strategies include staggering start times for activities within the event or mixing up the line-up for the day to allow popular acts to perform throughout the day.

Security staff
Security and stewarding services are critical to good crowd management. The HSE (1993) recommend that it is important that event organisers: (i) establish clear roles and responsibilities; (ii) document all crowd management systems; (iii) have effective review processes; and (iv) use properly trained staff. Tatrai (2001) advised that professional security staff personnel have specific operational standards and best practice approaches that describe staff ratios, training requirements, barrier systems, and related site infrastructure and it is useful to be aware of these.

The HSE (1993) added that crowd safety teams should: (i) understand crowd demographics and behaviour; (ii) regularly assess crowd safety systems for effectiveness and appropriateness during the event;
(iii) set and manage targets for crowd management; (iv) work collaboratively with key agencies (e.g. the police and the emergency services); and (v) maintain good communication and coordination with event management (HSE 1993, 1999).

Volunteer staff

It was considered important that all staff who have contact with crowds at these events are aware of the importance of good crowd safety (HSE 1993). However, for some events volunteer staff undertake these roles without the same level of training, and often experience, that the professional security staff have. Au et al. (1993) argue that there should be no distinction between paid and volunteer staff. The Glastonbury Festival has led the way in volunteer capacity development by introducing tailored training programs for its volunteers (Glastonbury Festival Limited 2001).

Earl et al. (2005) undertook a study to assess the capacity of volunteer stewards working at the 2003 Glastonbury Festival. The findings from that study showed that the volunteers within the study reported a good knowledge in public health and emergency management for that festival. There was considerable evidence from that study that the training had successfully increased volunteer capacity. Additionally, the event organisers undertook a volunteer evaluation of their own and reported similar findings. Overall, the “stewarding [volunteer] standards at the 2003 festival were the highest ever” (ACCESS 2003, p. 2). Earl et al. (2004, 2005) recommended that volunteer capacity be boosted by giving volunteers access to tailored training programs similar to those offered for the Glastonbury Festival.

Environmental Health Professionals in Crowd Management

There is sufficient evidence to indicate that music events including OMFs are associated with an increased risk of public health issues. A considerable proportion of these risks can be attributed to mosh pits and other crowd safety concerns at these events. It is clear from the evidence reported within the literature that effective event planning is critical to ensure the provision of good management strategies at OMFs. EHPs have involvement in event planning through local government event licensing programs and are well placed to influence the event planning process and achieve better public health outcomes at OMFs.

Undertaking risk assessments (HSE 1993, 1999) supported by comprehensive strategic, for example, emergency response capabilities (Davies 1998), and effective operational structures, for example, security capabilities (HSE 1993) were considered critical. Minimising variations and inconsistencies within these planning processes was considered important to improving public health outcomes (Arbon 2004; EMA 1999). To help minimise these issues, there were volumes of easily assessable, resource material, and literature available electronically and in hard copy (e.g. HSE 1999 and Department of Health 2004). Some authors such as Arbon (2002, 2004) and Milsten et al. (2002) suggested that comprehensive knowledge and understanding of all the event characteristics was also beneficial. EHPs have the fundamental skills that would allow meaningful contributions to crowd management for music events, particularly OMFs. EHPs have an excellent understanding of risk assessment processes and are often involved in the event planning and approval processes so could become more involved in crowd management. It was the intention of this article to provide readers with information on crowd management and contribute to an increased understanding of that management, thus encouraging further involvement through the event planning, approval, and monitoring processes for these events.
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