

# A literature review of the health and safety risks associated with major sporting events

Learning lessons for the London 2012 Olympic and Paralympic games

Prepared by the **Health and Safety Laboratory**  
for the Health and Safety Executive 2010

# A literature review of the health and safety risks associated with major sporting events

Learning lessons for the London 2012 Olympic and Paralympic games

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This work was commissioned by the Health and Safety Executive (HSE) to provide an understanding of the potential hazards and risks associated with hosting the Olympic Games in Great Britain in 2012, as well as potential control measures that could be applied to these. The literature search yielded 384 papers, of which 80 met the inclusion criteria. These papers were then reviewed by the research team and summarised by emergent topics. The topics included: construction, public health and safety risks, road accidents, injuries, musculoskeletal disorders (MSDs), crowd safety, emergency planning and response, volunteers, workplace violence, fire safety, electrical hazards and carbon monoxide/gas safety.

Each of the topics is summarised by the risks identified from previous Olympic events and major sporting events, followed by controls that were applied or identified as potentially useful. The controls often provided practical ways to reduce risks, or to mitigate negative outcomes.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

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First published 2010

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## ACKNOWLEDGEMENTS

The authors wish to thank Shila Patel, Louise Brearey, Helen Bolt and Simon Armitage for their contribution to guiding the scope of this work. Thanks are also due to Liz Yeomans, Simon Bates and Amy Jones who supported the review of articles.

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# EXECUTIVE SUMMARY

## Background

In the year 2012 London will be hosting the Olympic and Paralympic Games. The Games will bring cultural and economic benefits to the UK, but also have the potential to introduce greater health and safety risks to workers and the public. As a regulating body it is beneficial for the Health and Safety Executive (HSE) to understand the range of risks that may arise, as well as the measures for control and prevention that may be applied. In order to contribute to this, the HSE commissioned the Health and Safety Laboratory (HSL) to conduct a literature review drawing on the experience of previous Olympic and major sporting events.

Search criteria, inclusion and exclusion criteria were developed to assist with the review. Articles that were identified from the search were included if they related to a major sporting event and had a health and/or safety link. Examples of articles excluded include those with a focus on sports-related injuries and those with a focus on security. The work was primarily completed over a period of 14 weeks. A variety of databases and the Internet were searched, identifying 384 potentially relevant articles, from various sources, including peer reviewed literature, as well as 'grey' literature. Of the 384 articles, 80 met the inclusion criteria for the review.

## Objectives

The following research questions were developed to define the scope of the literature review:

1. What are the potential risks to health and safety that are, or may arise before, during and after major sporting events?
2. What can HSE or other bodies/organisations do to prevent or mitigate potential/foreseeable risks?

## Main Findings

The resultant articles identified for the review were predominantly descriptive in nature, rather than empirical research. For example, articles tended to describe the process used to identify risk (e.g. with a risk assessment by gathering intelligence) followed by a description of the measures put in place to control the identified risks. This is an important point to be borne in mind, as many of the measures to control health and safety risks identified are not directly underpinned by an evidence base. This is not to say, however, that such measures lack effectiveness. Rather, it means that they are largely untested in the examples provided, but there may be underpinning evidence in the wider risk management domain.

The findings from the literature review were distilled into a number of topic areas, which are covered in more detail in the remainder of this executive summary. It is also noteworthy that two cross cutting factors stood out to the research team, arising in a number of the risk topics, these being risk assessment and competence.

## Cross cutting issues

*Cross-cutting control:* Risk assessments were commonly used for the wide variety of hazards that may be present at major sporting events. A number of articles focussed on the intelligence aspect of the risk assessment process, for example embracing a variety of information sources in an attempt to ensure risks were effectively controlled. This was achieved in some cases by involving individuals from a variety of bodies and academic institutions, as well as using sources such as literature reviews. Competence of personnel in the risk assessment process was

also identified as important for example for ensuring that personnel involved in the risk assessment had adequate knowledge of the hazards.

*Cross cutting risk:* Competence of personnel also stood out across the key topics, as already highlighted with the risk assessment process. Due to the generally unprecedented scale of Olympic events and other factors such as time pressure and financial restraints, there was often concern over the competence of workers and volunteers. Training provision often appeared to be a panacea for controlling/mitigating risk, when there may have been potential to have greater impact during design. Often when training was discussed in articles there was little reference to competence assurance. Competence of volunteers is something that will need to be considered for the Olympics, with previous events highlighting limitations with the amount of training provided to this part of the Olympic workforce. There was also concern in some instances that volunteers did not receive appropriate site orientation.

### **Specific risks**

*Construction:* Construction emerged commonly as a topic in the articles selected for the review. Issues identified included: lack of consideration of hierarchy of controls, with potential reliance on personal protective equipment (PPE), lack of availability of PPE, poor walkways, and lack of signage on site. Consideration of design was noted to be important, with a structural collapse at one Olympic event tracing back to a design error. There was also concern in some cases over the structural integrity of some installations when crowd movement was factored in, with vibrations and certain resonances having the potential to cause structural problems. In relation to issues during events, temporary stadia were highlighted as a possible concern. A previous Olympic event had resulted in increased awareness of the importance of maintenance of temporary structures, although a structural failure did not actually occur. To control and mitigate risks related to construction activities, interventions suggested included: health and safety awareness sessions/training of workers (including contractors), health and safety monitoring and reporting procedures, health surveillance, reduction of performance pressures where possible, including safety in contractor agreements, and ensuring availability of PPE. Other factors such as the importance of leadership, worker engagement, control of contractors, and encouraging a positive safety culture were covered, although prescriptive guidance was generally not provided. The importance of following the Construction Design and Management (CDM) regulations (2007) was also identified for work at the 2012 Olympics.

*Public health and safety risks:* Key public health and safety risks identified included waterborne disease outbreaks and airborne and communicable<sup>1</sup> diseases. The key waterborne disease identified was legionella. In order to manage this risk a variety of measures were suggested, including: maintenance of cooling towers, use of technology such as geographical information systems by local councils to gather intelligence, education of facility owners, and surveillance programs with a particular emphasis on inspections and microbiological testing (prior and during the event, and also of decorative fountains & swimming pools). The literature also identified that there may be an increased risk of legionella from water sources at both sporting venues and seasonal hotels. Microbiological testing was suggested to help identify sources of escherichia coli, staphylococcus coli, staphylococcus aureus, pseudomonas areuginosa and heterotropic plate.

*Airborne and communicable diseases:* Airborne and communicable diseases were identified as a real threat during mass gatherings, due to the volume of people and the movement of populations. Epidemic intelligence was suggested as a useful tool to help identify when potential outbreaks are likely. This approach refers to the identification, assessment, verification and investigation of potential health risks. The use of surveillance systems was the most

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<sup>1</sup> A contagious disease that can be contracted directly, e.g. by touch, or indirectly, e.g. bodily fluids.

commonly cited control for the identification and management of airborne and communicable diseases. Surveillance systems typically include an increase in the frequency of reporting of potentially infectious diseases (from various sources including on-site clinics) and a compilation of daily reports on public health risks. Piloting of such systems were noted as important and may be required up to a year before the event. Other measures, included provision of information packs to general practitioners and accident and emergency departments about communicable diseases that are not prevalent in the UK. Establishing appropriate mechanisms to allow immediate reporting of communicable diseases; staff training in collecting and analysing surveillance data; information to the public on how to protect themselves; and immunisation where possible/appropriate for staff and volunteers also emerged as measures for controlling airborne and communicable diseases.

*Non-Infectious Risks:* Key non-infectious risks included exposure to heat and cold. The risk of heat related illness tended to be related to local temperatures and exposure to the sun. Factors such as age and alcohol consumption were noted to exacerbate the negative outcomes of heat exposure, such as exhaustion. Measures to reduce risk of heat related illness included use of data to help assess risk (such as climatic heat measurements), public information/announcements to educate visitors, water fountains (particularly in areas likely to be crowded), provision of protection (such as sunscreen hats and portable shade canopies), and use of fans. Staff rotation was suggested to help prevent staff from prolonged heat exposure.

*Respiratory Diseases:* Respiratory diseases identified in the literature included air pollutants, such as sulphur dioxide, and/or aeroallergens, such as pollen. Measures to mitigate the risks here included the testing of seasonal allergens to provide intelligence, then provision of public information and the availability of respiratory specialists.

*Road Traffic Accidents:* As might be expected with increased volumes of people, road accidents tend to increase during major events, particularly with international visitors. Measures to reduce such incidents were fairly limited, including advising on seatbelt use and avoiding driving when tired.

*Injuries to public:* As with the increased occurrence of road accidents, major sporting events tend to result in increased injuries incurred by the public, often including falls and traumatic injuries. Information on public injuries was limited from this review, although it was acknowledged that injuries at beaches, swimming pools and licensed premises were common. Measures tended to focus on mitigation by ensuring medical preparedness.

*Crowd control:* In relation to crowd safety, the design process was considered to be important, by accounting for crowd size and crowd movement. Measures to mitigate and control crowds included: systems to manage crowds, attempting to keep stewards and security staff collocated to improve communication (between security and stewards), identifying steward numbers based on risk rather than crowd size, crowd announcements, use of broadcast screens to give exit information, ensuring staff are competent, considering groups such as the disabled, considering crowds beyond the venues (e.g. the transport network).

*Strain on health care:* Major events, such as Olympics were noted to have an impact on emergency planning, with increased strain on health care. Mitigation measures suggested included: public health response teams at location, ensuring response teams are quickly mobile for the environmental conditions (e.g. use of bikes and golf carts), coordination between authorities hospitals and police, adequate design – ensuring good site layout with clear access (e.g. medical access not near public drop off).

*Workplace violence:* Workplace violence was identified in some articles, noting that certain public-facing job roles were particularly likely to be exposed to violence. Such roles included hospitality staff, health staff, sales, security staff and taxi drivers. Suggested controls/mitigation measures were limited and tended to focus more on intelligence gathering. They included: violence audits, workplace inspections, incident investigations and injury and illness records.

*Fires:* Incidents involving fires were noted at previous Olympic events. These involved structural fires and small-scale fires, such as litterbin fires. It was suggested that inspections could be completed by accredited officers at sites before an event to address underlying problems. It was added that additional resources should be considered, such as temporary fire stations.

Little information was identified relating to carbon monoxide and gas safety, although anecdotally there are likely to be inexperienced landlords 'cashing in' on the Olympics. Lack of knowledge and experience of landlords could increase the potential for carbon monoxide related incidents.

### **Recommendation**

- While this report will have a great deal of relevance for HSE, it may also provide useful information to other bodies and regulators. It is therefore suggested that wider dissemination of this report occurs, for example to local authorities, the Health Protection Agency and other government departments.

# 1 INTRODUCTION

## 1.1 BACKGROUND

With the city of London hosting the 2012 Olympic and Paralympic Games there is potential for an unprecedented level of activity in the capital city as well a wider impact across GB. Associated with this is increased work from a variety of sectors, including construction, transport and services. Whilst the Olympic Games will bring many benefits to the city it also has the potential to increase the number of hazards, and due to the large volume of people, also increase the impact of any health and safety incidents.

The Health and Safety Executive (HSE) has a role in ensuring health and safety risks are managed effectively, whether arising from the preparations for the event (including construction), during the Games, or afterwards into deconstruction and legacy programmes.

Although the 2012 Games present an unprecedented scale of event for GB (and HSE), the Olympics are held in different countries every four years and other major sporting events have been hosted by Britain in recent years. There is therefore an important opportunity to draw lessons from the prior experience of others. This may help in identifying potential risks and appropriate controls as well as disseminating good practice in terms of risk management arrangements when planning and running the events.

The Health and Safety Laboratory were commissioned to complete a literature review in order to capture information that may be beneficial for HSE and other bodies to learn lessons from previous major sporting events; especially what the likely hazards are and the measures that were used, or could be used, to prevent or mitigate incidents. The focus of this literature review was to identify hazards and controls with relevance to HSE. However, hazards relating to regulation by other bodies (e.g. Local Authorities) were also included for wider dissemination.

## 1.2 AIM

The research is intended to provide insight on key health and safety risks and control measures at major sporting events to inform the planning and management of risks for the 2012 Olympic and Paralympic Games.

### 1.2.1 Research questions

The following research questions were developed in order to provide a clear objective for the literature search:

- What are the potential risks to health and safety that are, or may arise before\*, during and after\* major sporting events?
- What can HSE or other bodies/organisations do to prevent or mitigate potential/foreseeable risks?

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\* Including: preparation, planning, construction, deconstruction, handover/legacy etc. And also including overlay between Olympic and Paralympic games

## 2 METHOD

### 2.1 INCLUSION AND EXCLUSION CRITERIA

The stakeholder group worked together to develop inclusion and exclusion criteria. These factors were used for the initial sift when reviewing abstracts and then for classification into the database used to record extracted information. Starting with the most relevant to the study, these criteria were:

- An Olympic event from the last 25 years (or older if issues identified still appear current).
- A major sporting event involving multiple sports or events with multinational representation in the last 25 years (e.g. Commonwealth games), or Olympic events older than 25 years.
- A major sporting event with international representation for a single sport (e.g. World Cup (rugby or football), Tour de France).

Other events that were not sports related were to be excluded. Common examples of articles excluded were those with a focus on sports-related injuries and those with a focus on event security. Some discretion was left to the research team, as the stakeholders did not wish other papers that may have been flagged in the search to be excluded if they added additional useful information.

The stakeholders also wished for the search to include ‘grey’<sup>2</sup> literature. An Internet search was therefore also conducted. Articles were restricted to English language only.

### 2.2 SEARCH TERMS

A set of search terms for the review was devised by a stakeholder group within HSE. This group included members of the research team and the customer. After a number of iterations of refinement the stakeholder group decided on the following primary search terms:

- Olympic
- Paralympic
- Commonwealth Games
- World Championships
- World Cup
- Euro
- Major Event

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<sup>2</sup> i.e. articles that were not peer reviewed, such as anecdotal information or news reports.

The search terms listed previously were used in combination with the following terms in order to retain a focus on issues likely to be covered by the remit of the Health and Safety Executive:

- Health
- Safety
- Illness
- Disease
- Accident
- Incident
- Risk
- Hazard
- Controls
- Near Misses
- Harm
- Legionella

‘Wildcards’<sup>3</sup> were used where appropriate to enable a broader search.

### **2.3 RESOURCES**

For the Internet search the engine Metacrawler was used. This was considered to be more inclusive, as it covers several dominant search engines, including Google, Yahoo and Ask. A range of databases were also searched. These included:

- EMBASE
- Medline
- Psycinfo
- ICONDA
- EiCompendex
- Healsafe
- Oshrom
- Science Citation Index
- Social Sciences Citation Index
- Arts & Humanities Citation Index
- Ergonomics abstracts online

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<sup>3</sup> A wildcard allows the search to detect multiple derivatives of a search term. This is achieved by use of an asterisk in the term, for example ‘Olympi\*’ would detect articles with the terms Olympic, Olympics, and Olympian etc.

The databases listed above cover a diverse range of journal articles, including:

- Accident Analysis and Prevention
- American Journal of Surgery
- American Journal of Tropical Medicine and Hygiene
- Annals of Occupational Hygiene
- Atmospheric Environment
- Australian and New Zealand Journal of Public Health
- British Journal of Sports Medicine
- Clinical Journal of Sport Medicine
- Emergency Medicine
- Emerging Infectious Diseases
- Environmental Science and Technology
- Epidemiology and Infection
- European Journal of Allergy and Clinical Immunology
- Event Management
- Fire Engineers Journal
- Fire International
- Health Physics
- Industrial Health
- International Journal of Hygiene and Environmental Health
- International Journal of Occupational Safety and Ergonomics
- Job Safety and Health Quarterly
- Journal of Athletic Training
- Journal of Epidemiology and Community Health
- Journal of Management in Engineering
- Journal of Occupational and Organizational Psychology
- Journal of Occupational Health and Safety
- Journal of Sports Sciences
- Journal of Traffic Medicine
- Journal of Travel Medicine
- Medical Journal of Australia
- New Civil Engineer
- Public Health
- Public Health, Social Medicine and Epidemiology
- ROSPA Occupational Safety and Health Journal.
- Safety and Health
- Safety Express
- Safety Science
- Security Journal
- Tourism Review International
- Travel Medicine and Infectious Disease.

## **2.4 RECORDING FINDINGS**

A spreadsheet was devised (see Annex 3 for an example of the format) to help capture the key information about articles in line with the research questions. The initial aim was also to use evidence statements in order capture the weight of evidence for interventions that had been applied. However, the papers identified in the search were largely descriptive (i.e. they explained risk assessment activities such as risks identified and what controls were then applied, rather than testing the utility of risk assessment and control measures), therefore evidence statements were not applied. Instead, general summaries were used to capture key points from the articles. The account on the following page provides an example of a narrative summary from one of the papers in the review by Weiss et al (1988), which captures an outline of the article, the key risks identified and the control measures identified. The full list of article summaries can be found at Annex 4.

**Author(s): Weiss et al 1988.**

**Title: Public Health at the 1984 Summer Olympics: The Los Angeles County Experience.**

**Article summary:**

*The paper describes the preparations, strategies and surveillance system that was developed for the 1984 Summer Olympics in Los Angeles. Public health concerns included safety and sanitation of food, drinking water, housing, waste disposal, diseases that could be transmitted through the use of swimming pools and other water sports venues as well as poisoning of water supplies (bio terrorism). These concerns were addressed and controlled through the enhancement of the County's active surveillance system - for instance, reports were collected by telephone 3 times a day from 198 participating facilities including hospitals, prepaid health plans, private physicians and Olympic sites. A telephone hotline and emergency public health response teams were also established as well as arrangements made with local law enforcement agencies for the transportation of individuals through the County during heavy traffic. The most frequently reported health problem was heat-related illnesses. Overall, fewer illnesses were reported during the Olympics compared to the same period for the three preceding years.*

**Key risks identified:**

*Public health issues of concern included: excessive exposure to the sun, safety and sanitation of food, drinking water, housing, waste disposal, swimming pools and other water-sports venues and potential poisoning of water (bio terrorism).*

**Key control measures identified:**

*Disease surveillance and control was carried out by a central disease control unit - reports were collected 3 times a day from 198 participating facilities, including hospitals, private physicians and Olympic sites. A telephone hotline was also established to facilitate immediate reporting of diseases. The hotline was available 24 hrs a day, 7 days a week and the number was published six weeks prior to the start of the games in the Health Department's newsletter for use by the medical community. Emergency public health response teams were established that consisted of a physician, an epidemiologist and appropriate support staff. Fourteen medical epidemiologists were located at Olympic venues and hospitals to facilitate local active surveillance. Health surveillance data were collected prior to the opening of the games and for the whole duration of the Olympic events. Other measures included: provision of ample water fountains, provision of well-marked first aid stations for spectators and training for Olympic staff to inform them of public health concerns.*

## **2.5 INTER-RATER AGREEMENT**

Inter-rater agreement of the interpretation of articles was attained by a second member of the project team reviewing the articles, in at least 20% of cases. The second reviewer then verified their understanding with the article summary produced in order to produce the results in the report.

### 3 RESULTS

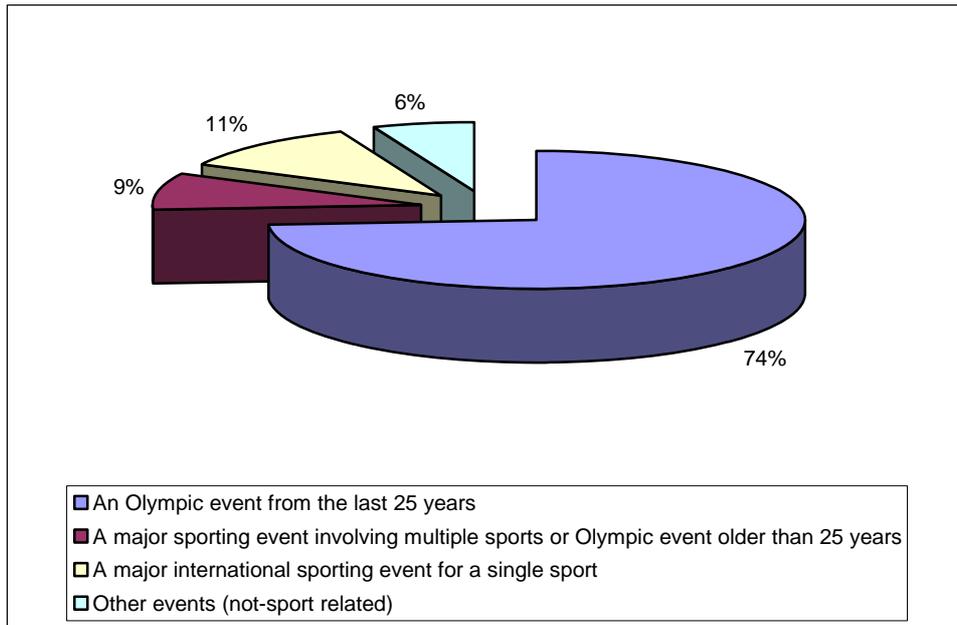
#### 3.1 BACKGROUND TO ARTICLES INCLUDED

A number of articles were identified that dealt with risks associated with mass gatherings and sports events in particular, it should be mentioned that many articles were anecdotal and descriptive case reports rather than analytical/empirical in nature. Specifically, one third of the papers included in this review were identified in trade journals and/or newspapers that summarised the key risks that arose from major sporting events, such as Olympic Games, and the key lessons learnt. The value of these types of papers notwithstanding, the evidence for risk control strategies may lack the robustness and rigour that is usually characteristic of peer-reviewed journal papers and should be noted. This is because articles tended to describe the process used to identify risk (e.g. with a risk assessment by gathering intelligence) followed by a description on the measures put in place to control the identified risks, rather than evaluating the effectiveness/impact of risk assessment tools and control measures. Table 1 summarises the characteristics of the articles that were included in the literature review.

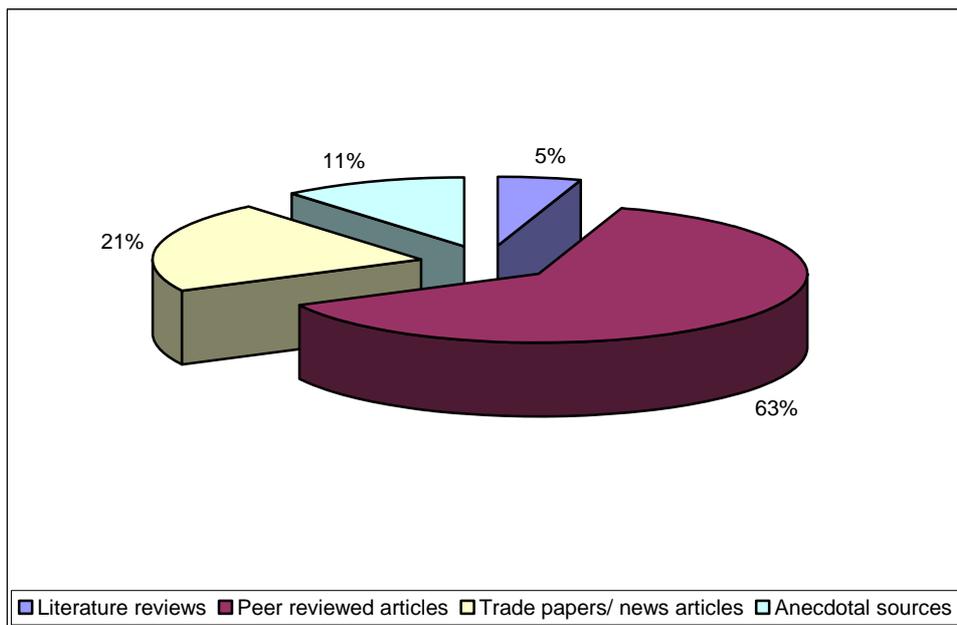
Remit of article / relevance to the Olympics				Article type / scientific robustness			
An Olympic event from the last 25 years	A major sporting event involving multiple sports or Olympic event older than 25 years	A major international sporting event for a single sport	Other events (not-sport related)	Literature reviews	Peer reviewed articles from journals	Trade papers/news articles	Other sources from the 'grey' literature
59	7	9	5	4	50	17	9
<b>Total = 80</b>				<b>Total = 80</b>			

**Table 1.** Characteristics of literature review articles

The figures on the following page illustrate the proportion of articles in each of the categories listed in Table 1.



**Figure 1:** Remit of article illustrated as percentages of the articles included in the review



**Figure 2:** Article type illustrated as percentages of the articles included in the review

The total number of abstracts identified from the initial database search was 328. For the Internet search 56 articles were identified, giving a grand total of 384. Following the application of the inclusion and exclusion criteria this was reduced to a total of 122 papers. A further 42 articles were then also excluded, due to them focussing primarily on security issues during major sporting events, which were outside the scope of this review. Thus, a total of 80 papers were included in the review. Out of these, 59 papers dealt with an Olympic event from the last 25 years, 7 papers focused on a major sporting event involving multiple sports (e.g. Commonwealth Games) or an Olympic event older than 25 years, 9 papers focused on a major international sporting event for a single sport (e.g. rugby or football), and 5 papers

focused on other, general mass gathering related topics that were not always related to sporting events.

Finally, of the 80 papers, 50 were peer-reviewed articles and 4 were systematic literature review papers (a total of 54), 17 were trade papers and/or news articles, and 9 papers were from other, 'grey' sources.

The following sections summarise the articles that were included in the review. The topics covered in the articles have been distilled into key themes in order to provide structure to the findings. The health and safety themes/topics were developed after the review of articles, to ensure they were inclusive of emergent issues, not just those that may have been identified by the research team. The themes/topics identified are: construction, public health and safety risks, road accidents, injuries, musculoskeletal disorders (MSDs), crowd safety, emergency planning and response, volunteers (recruiting and training), workplace violence, fire safety, carbon monoxide and gas safety, housing and accommodation, and electrical hazards. Table 2 below summarises the number of articles referenced for each risk topic. It is important to note that some articles covered more than one topic.

<b>Risks identified</b>	<b>Number of articles</b>
• Traditional construction related risks	20
• Public health and safety risks – infectious diseases:	
○ Waterborne diseases	8
○ Airborne and communicable diseases	21
• Public health and safety risks – non-infectious diseases:	
○ Heat related illness	8
○ Respiratory illness	6
• Road accidents	4
• General injuries to the public	5
• Musculoskeletal disorders	1
• Crowd safety	13
• Emergency planning and response	12
• Workplace violence	2
• Fire safety	3
• Carbon monoxide and gas safety	1
• Electrical hazards	1

**Table 2:** Number of articles referenced for each risk topic

### **3.2 CONTROL MEASURES AND TOOLS TO SUPPORT RISK ASSESSMENT**

Articles covered a range of controls that could be applied as well as tools that could be used to help with risk assessment and application of controls (e.g. computer modelling). Some articles also highlighted measures to control or mitigate the negative outcome of incidents, e.g. by use of personal protective equipment or having specialists and medical staff on site at the Olympics. These control measures and tools are identified throughout the results section and are summarised in the discussion and conclusions section of the report.

### **3.3 CONSTRUCTION**

#### **3.3.1 General construction issues**

There was no discussion in the literature about the impact on the health and safety of construction workers due to the sheer scale of the works that need to be carried out. However, anecdotally, the Olympic sites tend to be situated in areas that are in need of major redevelopment as this can attract significant investment. Organising committees need to offset at least part of the cost of the project. They then have a comparatively short period of time between winning their bid to host the Olympic Games and ensuring the completion of all building works. The resultant time pressures could potentially create issues during the design and construction phases of the installations in relation to safety, as there is unlikely to be room for negotiation on the completion date for Olympic facilities/installations. There are also potential risks attached to the decommissioning phase with the need for a speedy handover to developers and Local Government.

There were a few papers that discussed under design (e.g. inadequate consideration of the application of a structure and the loads etc it will be placed under), which has been an issue at past Games. The under design of light towers at the Atlanta Olympic Stadium caused a cantilevered canopy to collapse, killing a construction worker (Engineering News Record, 1995). The Sydney Games also experienced problems with the design of temporary grandstands that moved and as a result required regular checking (Anon, 2001). As structures become more streamlined vibration problems in stadia are becoming more common and this is more likely to occur where crowds are more dynamic (Reynolds and Pavic, 2006) or where crowd activity becomes synchronised (e.g. during Mexican waves).

#### **3.3.2 Controls**

It is only in more recent times that lessons have begun to be learned for future Olympic Games, as the following quote illustrates:

*“In past Games, health and safety programs have not always been formalized and little information has been passed from one Games to the next. We hope to create a new way. In partnership with WorkSafeBC... VANOC hopes to establish a new level of health and safety awareness, monitoring and reporting for the 2010 Games and beyond.”*  
([www.vancouver2010.com](http://www.vancouver2010.com)).

- *Risk Management:* Since the Atlanta Games, there has been a move towards a systematic approach to managing risk at Olympic sites. Building on what lessons have been learned from previous Games, the Athens Organising Committee reduced their health and safety risks by introducing a specific Risk Management section that had responsibility for monitoring and ensuring compliance with health and safety (ATHOC,

2004). The Beijing Organising Committee for the Games of the XXIX Olympiad (BOCOG, 2008) had for example 26 functional departments responsible for the preparation and operations of the Games including oversight of security and public health preparedness. The literature search unearthed one paper that looked at the safety risk identification and assessment for the construction of Olympic venues in Beijing (Sun, et al., 2008). The methodology used by this author was to conduct a literature review, consult experts from government agencies, the construction industry and academia. The risks were prioritised (based on experts' perceptions) and a risk assessment form developed. This was used to assess the risk profile of two Olympic venues.

The Olympic Delivery Authority (ODA) for the 2012 London Olympic Games has responsibility for the health and safety environment of the London 2012 Games. It may be useful to note that the ODA has produced a Health, safety and environment policy statement to reflect best practice (ODA, 2008) that includes a list of design risks as well as issues relating to the management of the construction phase with the health and safety hazards and risks laid out. There are a number of detailed appendices containing a specific approach to a comprehensive range of hazards and risks. Examples of those include Appendix 2 (ODA, 2008) of the policy statement that provides a list of design risks, and Appendix 3 (ODA, 2008) that cover the health and safety risks that need to be taken into consideration as part of the management of the construction phase.

- *Safety culture:* Prior to the Winter Games in Vancouver 2010 ([www.vancouver2010.com](http://www.vancouver2010.com)) the Vancouver organising committee (VANOC) for both the 2010 Olympic and Paralympic Winter Games worked in partnership with WorkSafeBC a workers' compensation board to drive high standards of health and safety for construction workers. Their focus was on developing a safety culture as a means of minimising accidents and ill-health.
- *Training and awareness:* In practical terms VANOC ensured that there was a commitment for all construction workers to receive health and safety awareness sessions. Health and safety monitoring and reporting procedures were established along with record keeping, partnership working. As there were numerous subcontractors on site they reinforced the safety messages via their contracting requirements with all contractors.

### **3.3.3 Construction – installation, maintenance and decommissioning**

The experiences at both the Atlanta and Sydney Games suggests that temporary structures may pose potential health and safety risks, not just to workers on site but also to members of the public. (Anon, 2001, Reynolds and Pavic, 2006). In Atlanta, an engineer's design error was blamed for a collapse of a tower in the Olympic stadium which killed an ironworker. The engineer was aware of the error but failed to call a halt to the work on the tower or to suggest that there was an urgent need for "retrofitting." (Construction Week, 1996) There are risks associated with scaffolding safety (Construction News Portal, 2009) and there is a need for temporary structures to be suitable for their intended purpose, to be in good condition and erected by competent workers.

### 3.3.4 Controls

The controls for this section have been divided into site safety controls and those that require earlier consideration at the design phase.

#### 3.3.4.1 Site safety controls

- There is no indication that any control or mitigation measures were put in place after the fatality in Atlanta other than the observation in the report that the engineer had ‘learned his lesson’ (Engineering News Record, 1996). Therefore lessons may not be being learnt as well as they could be. If controls were put in place after this incident, then it would be good for these to be captured in the public literature.
- *Safety culture:* Developing a health and safety culture by taking a systematic approach to controls and mitigations of known or potential risks is also a feature in the literature. (Sun et al, 2008). This systematic approach has developed further by The Olympic Delivery Authority for London 2012 who have amongst their priority themes established that they will take a comprehensive approach to health and safety including leadership and worker involvement ([www.london2012.com](http://www.london2012.com)). This approach has also been a feature of the Winter Olympic Games in Vancouver in 2010. In an article published by the Vancouver Organising Committee (VANOC, on their website [www.vancouver2010.com](http://www.vancouver2010.com)), their health and safety manager is quoted as saying:

*“We’re creating a culture of safety.”*

- *Monitoring and reporting:* VANOC have established Games-specific monitoring and reporting procedures and records which as yet have not been published. Trainer and facilitator guides have been developed and there is a contractual requirement for all contractors and sub contractors to provide health and safety training to both workers and volunteers. The ODA (2008) have published guidance on their risk assessment process having drawn on experience and planning from principal contractors, and all relevant partner organisations. All their policies and procedures are specified in detail for all construction related activities as per the Construction (Design and Management) Regulations 2007.
- *Supervisory checks and technology:* Within the grey literature there is mention of electronic scaffolding systems that ensure that a skilled scaffolder is always required to operate a visual tagging system ([www.constructionnewsportal.com](http://www.constructionnewsportal.com), 2009). There is no evidence to suggest that this technology leads to a decrease in the potential for human error, but it does enable them to check that scaffolding structures conform to the legislation because the visual tag has to be scanned by a qualified scaffolder. Factors such as competence and vigilance would be critical to the individual with the scanning role.

#### 3.3.4.2 Controls for consideration at the design phase

- *Temporary structures:* Whether as a result of past lessons, controls and mitigation measures are more apparent in the recommendations made for temporary structures. In the guidance provided by Lincolnshire County Council (2009) it is suggested for instance that:
  - Temporary structures should where possible be made from flame resistant materials.
  - Any structure that is load bearing should be erected in strict compliance with Health and Safety legislation.

- The competence of contractors is key here, particularly with the installation of electrical systems.
- *Computer simulation:* There have been a number of advances in the application of computer simulation and that will be touched on again in the discussion of control measures for crowd management. Some structures may be more prone to collapse in the event of fire so advanced computational simulation software can now track the fire dynamics for the safety evaluation of gymnasiums to establish any weaknesses (Ren, et al, 2007). The Sydney Organising Committee for the Olympic Games used a simulation software package called *Legion* which predicted that a pedestrian bridge would aid the flow of pedestrian traffic (Connor, 2004).
- *Stadium design and layout:* A study was made during the 1988 Winter Olympics of spectator behaviour and facility design with the aim to develop information on which to base design guidelines and codes for the construction of seating and standing areas at large scale outdoor winter athletic events (Wardell, et al 1988). This paper identified issues with riser height and tread depth of stairs which might impede the safe access and egress of crowds. Although faster descent was associated with greater riser height, the presence of handrails did not influence speed of vertical movement. They also suggested that temporary bleachers (seating) at the stadium were found to be more efficient at vertical movement of spectators than permanent stands under certain conditions.
- *Design tests:* There have been instances of modal testing and in-service monitoring of large contemporary cantilever grandstands in the UK that are primarily used for football matches (Reynolds et al, 2006). Testing has identified that designers should consider vibrations and resonances during the design and construction of stadia.
- The London Olympic Delivery Authority has published a Design and Construction, Health, Safety and Environment Standard, which suggests the importance of considering manual handling and the prevention of musculoskeletal disorders (MSDs) during the design stage. This is covered in the later section on MSDs.

### 3.3.5 Health and Safety Risks in Construction

The literature search has revealed very little in the way of peer-reviewed literature in relation to the health and safety risks faced by construction workers employed in and around Olympic sites. It did identify a peer reviewed study that looked at the factors that led to occupational fatalities in the five years prior to the Athens Games (Kathsakiori et al 2000) and this seems to suggest that the lack of PPE may have been a contributory factor. However, it is also important to bear in mind the traditional hierarchy of controls. More effective control measures may have been possible, in addition to the last line of defence with PPE.

Interestingly, the ODA (2008) suggests that PPE should be the least favoured option in the control hierarchy. They also, however, suggest PPE be made universal. There is a report from the Industrial Workers of the World (IWW) Construction Workers Industrial Union (IWW, 2009) operating on the 2012 Olympics site that there is a lack of PPE available. They also cite lack of adequate walkways for workers carrying large heavy materials some distance and that whilst there is a good level of signage around the perimeter of the site there is a lack of signage within. This report may need to be treated with some degree of caution as the authors themselves add a disclaimer that the observations are based on feedback from December 2008 to April 2009 during which time and since when circumstances may have changed.

### **3.3.5.1 Controls**

Personneltoday.com (2007) carried a special report on occupational health in the construction industry and the preparation for the London 2012 Olympics and they suggest a control regime following the Constructing Better Health (CBH) principles could be beneficial. Some of the steps the CBH programme promotes include:

- Asking workers to complete a health questionnaire assessment.
- Carrying out practical health checks on site.
- Conducting occupational health toolbox talks, training and health surveillance.
- Encouraging culture change within construction companies.
- Investing in health facilities on site.
- Ensuring a programme of work/schedules/planning to ensure safe and healthy construction activities.

In light of their examination of the fatalities that occurred in the lead up to the Athens Olympic Games, Kathsakiori et al (2000) make a number of suggestions including:

- Thorough site orientation for workers.
- Appropriate and adequate job training for workers.
- Personal protective equipment (PPE) should be easily accessible.
- Supervisors should actively encourage the use of PPE.
- Supervisors and managers should be made aware of the impact of workers' inexperience on the workplace.
- Where possible performance pressure on workers should be reduced.

The recommendations made in the ODA's "health, safety environment" document (2008) is that there should be universal wearing of eye protection that is mandatory on the 2012 Olympic site. However, normal prescription glasses with plastic lenses are deemed to offer suitable protection against wind blown grit and dust. Foot protection is also mandatory.

## **3.4 PUBLIC HEALTH AND SAFETY RISKS**

A large proportion of papers focused on the public health and safety risks that are inherent in mass gatherings, and on the challenges of managing those risks when planning for major sporting events. The review showed that there are two main categories of public health and safety risks: infectious risks including food borne, waterborne and communicable or airborne diseases, and non-infectious risks including heat-related illnesses, respiratory diseases, road accidents and injuries, with emphasis on those sustained by athletes, and air pollution. The

key issues associated with food borne diseases and air pollution are discussed in Annexes 1 and 2. These Annexes are potentially less relevant to the remit of HSE, but may still be useful to other organising or regulatory bodies such as Local Authorities.

This section discusses the key issues that relate to waterborne and airborne diseases, heat-related illnesses, respiratory diseases, road accidents and injuries as well as their associated controls, drawing on previous major sporting events in general and the Olympics in particular.

### **3.4.1 Infectious risks**

#### **3.4.1.1 Waterborne diseases**

Consumption of tap water as well as the use of swimming pools and other water sports venues by both athletes and tourists during major sporting events can increase the potential for the spread of waterborne diseases (Hadjichristodoulou et al., 2006a). The risk of the potential transmission of waterborne diseases has been a focus of several articles that have discussed the management of health risks in major sporting and Olympic events.

Among the different types of waterborne diseases, minimising the risk of Legionnaires' disease has been a concern for several major sporting events, including the Olympic Games. Legionnaires' disease is a serious pneumonia infection; water supply systems, cooling towers and decorative fountains have been associated with the outbreak of the disease (e.g. Hadjichristodoulou et al., 2006a). For instance, in the Sydney 2000 Olympics, raising awareness regarding the risks associated with Legionnaires' disease and controlling for a potential outbreak was one of the main priorities, especially of the high concentration of people in areas where cooling towers were located (Banwell, 2000). The Legionella prevention plan involved a co-ordinated response between public health unit Olympic Coordinators and environmental health officers from local government (Banwell, 2000). Banwell (2000) discussed the strategies that were used to maximise compliance with the cleaning and maintenance provisions for cooling towers, which included:

- Maintenance of Geographical Information Systems database of all cooling towers registered with local councils,
- Inspections of cooling towers in areas of potential risk and,
- Educating facility owners on best management.

#### **3.4.1.2 Controls**

A number of measures have been implemented in major sporting events, and in Olympic events in particular to successfully manage waterborne risks. These include:

- *Raising awareness of waterborne risks:* During the 2004 Athens Olympics, a series of guidelines were distributed to environmental health inspectors and facility owners to promote the safe operation of swimming pools, Legionella prevention in cooling towers, water systems and decorative fountains and educate on water sampling procedures. Instructions for safe swimming were also distributed to the public (e.g. Hadjichristodoulou et al., 2006c).
- *Training in standardised inspections:* Environmental health inspectors received training in the use of separate standardised inspection forms for swimming pools and water supply systems for the 2004 Athens Olympics; this allowed the systematic

collection of comparable data (e.g. Hadjichristodoulou et al., 2006b; Hadjichristodoulou et al., 2006c)

- *Swimming pool and water supply inspections:* Environmental health teams inspected water cooling systems prior to the commencement of the Sydney Games and at regular intervals throughout the competitive period (Banwell, 2000; Jorm et al., 2003). During the Athens Olympics, a total of 196 public health inspectors carried out health inspections during the pre-Olympic and Olympic periods. The main inspection issues focused on drinking water, cooling towers, swimming pools and other water sport venues (as well as pest control, waste management and food safety) (Hadjichristodoulou et al., 2005).
- *Microbiological testing of swimming pools and water supply systems:* During the Athens Olympics, microbiological testing of swimming pools involved the collection of 2-6 samples (depending on the size and complexity of the pool), which were analysed for escherichia coli, staphylococcus coli, staphylococcus aureus, pseudomonas areuginosa and heterotropic plate count at 37° degrees. Sampling conducted in water supply systems of hotels and Olympic venues included the collection of up to six representative samples from kitchen taps, cooling fountains and water tanks. The samples were examined for the presence of E-coli, and intestinal enterococci, among others (e.g. Hadjichristodoulou et al., 2006b; Hadjichristodoulou et al., 2006c; Mouchtouri et al., 2007).
- *Surveillance:* Implementation of a surveillance program (both prior and during the duration of sporting events) of water sites. For instance, for the Athens Olympic Games, the surveillance programme involved a series of inspections and microbiological sample testing in water sites (including water supply systems in hotels and Olympic venues), cooling towers and decorative fountains to ensure that both drinking and recreational water was safe (Mouchtouri et al., 2007; Hadjichristodoulou et al., 2006a; Hadjichristodoulou et al., 2006b). In particular, during the Athens Olympics, a total of 1,086 samples were taken from 385 hotels accommodating athletes and tourists to examine any potential legionella contamination of the water distribution systems. It was found that 20.8% of the hotels studied were positive for legionella; contamination was more likely to be prevalent in hotels that operated seasonally compared to those that operated all year round (Mouchtouri et al., 2007).

One approach whereby public health concerns regarding the transmission of waterborne diseases (as well as other public health risks discussed below) have been typically addressed is by enhancing existing health surveillance systems. For instance, during the 1984 Summer Olympics in Los Angeles, reports from 198 participating facilities including hospitals, private physicians and Olympic sites on potential waterborne diseases (among other types of diseases) were increased three-fold during the event (Weiss et al., 1988).

### **3.4.1.3 Airborne and communicable<sup>4</sup> diseases**

The potential transmission of infectious diseases during mass gatherings and the systems in place to prevent and contain these risks was considered in a number of papers. Lombardo et al. (2008) argue that increases in population density and movement are two main mechanisms whereby mass gatherings facilitate the transmission of diseases. In particular, the increase in population density increases the possibility that individuals will come into contact with others who may carry an infection. Moreover, mass gatherings involve a high level of population

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<sup>4</sup> A contagious disease that can be contracted directly, e.g. by touch, or indirectly, e.g. bodily fluids.

movement (e.g. people travelling to countries hosting major events), which in turn increases the possibility that visitors may import infectious diseases into the local population and/or visitors may get infected and carry the disease back to their home country (Lombardo et al., 2008).

Although mass gatherings can increase the risk of airborne diseases, their occurrence is considered rare. For instance, an early review of communicable diseases in competitive sports carried out between 1966 and 1993 identified only 38 reports of disease outbreaks (Goodman et al., 1994; cited in Enock and Jacobs, 2008). From these 38 reports, 24 disease outbreaks were a result of transmission through contact sports, such as wrestling and rugby (Thackway et al., 2000). Elsewhere, Schenkel et al. (2006) note that the available published surveillance data show that there is no significant increase in disease outbreaks during mass gatherings. However, it has also been argued that the small numbers of communicable diseases may be a result of inadequate health surveillance and/or non-reporting of symptoms (Enock and Jacobs, 2008).

A few papers were identified whereby an outbreak of an infectious disease took place during a major sporting event. For instance, Ehresmann et al. (1995) reported an outbreak of measles during the International Special Olympics in the US in 1991. The disease was transmitted from an athlete to 24 people, 16 of whom had attended the Olympics. The transmission occurred at the opening ceremony in a domed stadium, at the track and field events and the first aid stations (Ehresmann et al., 1995). The transmission of the disease to spectators led the authors to suggest that it occurred through the stadium's ventilation system. Williams et al. (2009) showed that there were increased numbers of norovirus and measles outbreaks during the 2006 football World Cup in Germany. Other examples of infectious diseases identified included a case of meningitis outbreak during a European Youth Olympic Sports festival (Cummiskey et al., 2008), a cluster of meningococcal meningitis at a UK rugby match (Orr et al., 2001), and an outbreak of meningococcal disease during a 1997 international youth football tournament in Belgium (Reintjes et al., 2002). Finally, cases of influenza A and B, among both athletes and non-athletes, were reported during the 2002 Salt Lake City Winter Olympics (Gundlapalli et al., 2006). The influenza outbreak was contained through a combination of viral testing, medical treatment of infected individuals and prophylactic treatment of individuals that came in contact with the infected individuals (Gundlapalli et al., 2006).

Cities hosting major sporting events have considered the potential of a communicable disease outbreak as a high priority public health risk. A number of papers were found that described the public health surveillance systems used during the Olympic Games to ensure the timely detection of potential disease outbreaks. Typically, hosting cities will enhance their existing surveillance systems to enable what has been referred to as '*epidemic intelligence*' (Kaiser and Coulombier, 2006). Epidemic intelligence refers to the activities that relate to the identification, assessment, verification and investigation of potential health risks (including both communicable and non-communicable health hazards) (Kaiser and Coulombier, 2006). It is suggested that several issues should be considered in prioritising the need for epidemic intelligence including number of people expected to attend an event, duration of event, characteristics of people attending (e.g. nationalities, age range), and potential spread of infection to other sites in the community (Kaiser and Coulombier, 2006). Hosting cities of major sporting events will typically enhance their existing surveillance systems by setting up on-site clinics, enhance the frequency of surveillance data reporting, and use systems that will enable the detection of any abnormalities or patterns in the surveillance data (e.g. Weiss et al., 1988; Jorm et al., 2003; Kaiser and Coulombier, 2006; Panagiotakos et al., 2007).

During the 2000 Olympic Games in Sydney, there were a total of 55, 339 emergency department presentations, approximately a quarter of which represented 'Olympic surveillance target conditions', such as vomiting, pneumonia, diarrhea, influenza-like illness,

and illicit drug-related conditions (Jorm et al., 2003). However, no communicable disease outbreaks were reported during the competition period (Jorm et al., 2003). During the 2004 Athens Olympics, a syndromic surveillance system was set up in eight major hospitals and a major healthcare centre, whereby presentations with specific symptoms, such as respiratory infection with fever, bloody diarrhoea, gastroenteritis (without blood) and meningitis, were recorded and analysed using an algorithm called Pulsar. The use of this algorithm enabled the Greek authorities to be alerted promptly regarding potential communicable disease outbreaks (Panagiotakos et al., 2007).

#### **3.4.1.4 Controls**

Drawing on previous major sporting events, enhancements to existing surveillance systems to deal with potential communicable diseases have typically included:

- *Surveillance:* Enhancing existing surveillance systems to detect the emergence of infectious diseases and identify any unusual disease and injury patterns has been the primary means of controlling for infectious diseases (Enock and Jacobs, 2008). The development of an enhanced surveillance system requires a lot of time and resources and needs to be appropriately piloted. For instance, the surveillance system at Sydney Olympics, the Emergency Department Olympic Surveillance System (EDOSS), was piloted at mass gatherings a year prior to the commencement of the games (e.g. Thackway et al., 2000).
- *Surveillance and sources of information:* Collection of surveillance data from different sources: During the Sydney Olympics, surveillance data on potential communicable diseases were reported by hospitals, laboratories, schools and cruise ships (which served as 'floating hotels') (Jorm et al., 2003). In addition, fifteen emergency departments monitored the occurrence of any high priority diseases across the main Olympic venues (Jorm et al., 2003).
- *Data recording and reporting:* Increasing the frequency of data reporting on potentially infectious diseases: For instance, during the 2006 Football World Cup in Germany the frequency of surveillance data was increased from weekly to daily (Schenkel et al., 2006; Williams et al., 2009). In Sydney, surveillance data was collected three times a day, as opposed to previous Olympics where data collection took place 3 times a week (e.g. Jorm et al., 2003; Weiss et al., 1998; cited in Enock and Jacobs, 2008).

Compilation of daily reports on public health risks: In Sydney, Olympic medical facility staff sent health and injury-related information on a daily basis which was examined for any unusual patterns of disease incidents; surveillance reports were sent daily to the health department (with particular focus on communicable diseases as well as food-related illnesses and injuries) (Thackway et al., 2000; Jorm et al., 2003). In addition, during the 2006 Football World Cup in Germany, short versions of reports on infectious diseases were available to the public via the internet (Schenkel et al., 2006).

- *Breadth of data collection:* Screening of both national and international press and working with international partners to collect information on any infectious diseases of public health relevance (e.g. Schenkel et al., 2006). During the 2006 World Cup in Germany, daily telephone conferences held with the European Centre for Disease Prevention and Control to discuss information of international public health relevance (Schenkel et al., 2006). During the Sydney Olympics, information on global trends in infectious diseases was collected from sources such as the World Health Organisation (Thackway et al., 2000). At the Beijing Olympics, there were collaborative efforts between the Chinese Centre for Disease Control and Prevention, the European Centre

for Disease Prevention and Control and other European partners in assessing potential public health risks (e.g. Payne, 2008).

- *Information for health professionals:* Provision of information packs to general practitioners and accident and emergency departments about communicable diseases that are not prevalent in the UK and establishing appropriate mechanisms to allow an immediate reporting of communicable diseases (Enock and Jacobs, 2008). For instance, in Atlanta, physicians and other health care providers were encouraged to report any unusual symptoms directly to the state Division of Public Health (Brennan et al., 1997). Further, a 24-hour a day, 7 days a week telephone hotline was set up during the 1984 Summer Olympics in Los Angeles to facilitate immediate disease reporting (Weiss et al., 1988).
- *Staff training:* Staff training in collecting and analysing surveillance data: For instance, in Sydney, 50 officers were trained to analyse and collect surveillance data and each emergency department had one officer who was available 18hrs a day, 7 days a week (Jerrard et al., 2005; cited in Enock and Jacobs, 2008).
- *Public awareness:* Provision of information packs highlighting the risks of communicable diseases during major sporting events and ways that individuals may protect themselves (e.g. O'Grady and Krause, 1999).
- *Immunization:* Immunization against vaccine-preventable diseases: Staff, volunteers, delegates and visitors should be immunised against vaccine-preventable diseases, such as measles, to prevent transmission (e.g. Shaw et al., 2007; Davis et al., 2008; Heggie, 2009). The importation of diseases by athletes and staff, and not just those diseases that are transmitted through direct contact with blood and bodily fluids, should be considered at the planning stages (Ehresmann et al., 1995).

### **3.4.2 Non-infectious risks**

#### **3.4.2.1 Heat-related illnesses**

Exposure to excessive levels of heat poses a health risk to both athletes and members of the public alike. Warm temperatures and sun exposure were often linked to heat related illness at Olympic events. Illnesses associated with prolonged exposure to heat and the sun include exhaustion/stroke, sunburns and dehydration. Enock and Jacobs (2008) cite surveillance data that suggests that the incidence of heat-related illnesses/conditions ranges from 0.4 to 11.5 cases per 1000 people at temperatures of 30° C (86° F) to 49.4° C (121° F). Factors that increase the risk of heat-related disease mortality include socio-economic status and not taking appropriate preventative measures (Centres for Disease Control and Prevention, 2006; cited in Enock and Jacobs, 2008). Behaviours such as standing in direct sunlight for prolonged periods of time or walking around without adequate sun protection increase the risk of heat-related conditions (Enock and Jacobs, 2008).

Research suggests that conditions that contribute to climatic heat stress (i.e. stress experienced by the body's thermoregulatory system) include: ambient temperature, air humidity, air movement, and radiant heat (from the sun and from nearby warm surfaces) (Burskirk, 1977 cited in Verdaguer-Codina et al., 1995). Cases of heat-related illnesses were observed in several Olympic Games and major sporting events, such as at the beach volleyball venue during the Atlanta Olympic Games, and the equestrian event in the Los Angeles Summer Olympics (Weiss et al., 1988; Brennan, 1997; Milsten et al., 2002; Enock and Jacobs, 2008). In a review of the literature on medical care in mass gatherings, Milsten et

al., (2002) noted instances of heat-related deaths among marathon runners, further adding that minor heat-related illness and heat exhaustion are the most common conditions.

In addition to the health risks mentioned above, exposure to excessive levels of heat may impact negatively on the performance of athletes. During both the Barcelona and the Atlanta Olympic Games in 1992 and 1996 respectively, a number of climatic heat stress measurements were taken to determine the levels of optimum athletic performance, and to assist with the day-to-day running of the games (Verdaguer-Codina et al., 1995; Martin, 1999). For instance, in preparation for the Atlanta Olympic Games, a series of climatic heat stress measurements were taken 4 years prior to the commencement of the games in order to estimate and compare the average heat stress index experienced during specific time periods. This information consequently informed the medical care planning for both athletes and spectators (Martin, 1996). Furthermore, during the Atlanta Olympic Games, climatic heat measurements were used to re-schedule events, where necessary, during more favourable climatic conditions and to make public announcements advising spectators to drink plenty of fluids when the risk of heat-related illnesses was high (Martin, 1999). Finally, surveillance data was used to distinguish between two types of heat-related illness, skin/sunburn and exhaustion/stroke, thus targeting public health awareness messages appropriately during the Atlanta Olympics (Centers for Disease Control and Prevention, 1996; cited in Enock and Jacobs, 2008).

#### **3.4.2.2 Cold and wet weather illness**

Although the literature on the public health risks posed by weather conditions has predominantly focused on exposure to excessive heat, Milsten et al. (2002) acknowledge that risks are also encountered in cool, wet weather, which can increase the incidence of cold-related illness as well as slips from wet surfaces. For instance, hypothermia will be more prevalent in water sport events, in cool, rainy weather conditions, and where alcohol is consumed by participants (Milsten et al., 2002).

#### **3.4.2.3 Controls**

Although the UK climate is much cooler compared to that of other countries that have previously hosted the Olympic Games, a number of measures may be taken to prevent and mitigate the potential risks of developing heat-related illness for both the athletes and the public. Milsten et al. (2002) note that heat-related illnesses are '*one of the most preventable diseases*' (p. 158). Control and mitigation measures may include:

- *Information gathering:* Obtaining climatic heat measurements both prior and during major sporting events can be of value to medical care planning and to the day-to-day running of the events (e.g. in terms of re-scheduling events and/or advising the public), as is the use of different heat-related illness categories (i.e. skin/sunburn and exhaustion/stroke) following Atlanta's example (Peiser and Reilly, 2004; Enock and Jacobs, 2008; Verdaguer-Codina et al., 1995; Martin, 1996).
- *Public awareness:* Increasing public awareness of the symptoms associated with heat-related conditions and the range of preventative behaviours available. This may be part of a broader health promotion programme through the distribution of pamphlets and media public awareness campaigns. In Atlanta, public health education materials, including a wellness brochure, were distributed with the tickets to all visitors (Brennan, 1997; Enock and Jacobs, 2008). Public awareness announcements during major sporting events could encourage individuals to drink plenty of fluids and to seek sun-

protected areas in order to avoid prolonged exposure to the heat (Weiss et al., 1988; Brennan, 1997; Enock and Jacobs, 2008).

- *Hydration and cooling*: Providing ample water fountains and water misters in the most crowded sites in order to help cool spectators and pedestrians (Weiss et al., 1988; Brennan, 1997; Enock and Jacobs, 2008).
- *Active public prevention behaviours and organiser assistance*: Encouraging the promotion of preventative behaviours against heat-related illnesses through supply of items such as sunscreen, hats and fans for pedestrians, and portable shade canopies, water soaked towels and cooled electrolyte drinks for athletes (Brennan, 1997; Enock and Jacobs, 2008).
- *Consideration of athletes*: Scheduling endurance events, such as marathons, to early mornings, where possible (Verdaguer-Codina et al., 1995).
- *Staff rotation*: Rotating security staff and venue employees into cooler areas at frequent time intervals, and minimising as much as possible excessively long duties in hot weather conditions (e.g. Martin 1996, 1999)
- *Plans for cold weather*: Developing a ‘wet weather plan’ to address problems associated with potentially higher incidents of cold-related illnesses and/or slips and falls during cool, rainy weather (Enock and Jacobs, 2008).

### **3.4.3 Respiratory diseases**

A number of papers were found that examined the risk of respiratory diseases from air pollutants, such as sulphur dioxide, and/or aeroallergens, such as pollen during major sporting events. Respiratory diseases are highest among athletes, compared to the general population and especially among those who participate in endurance events, such as cyclists and long distance runners (Li et al., 2008).

Several cases of respiratory diseases have been documented in major sporting events, including the Los Angeles Olympics in 1984 and the Atlanta Olympics in 1996 (e.g. Enock and Jacobs, 2008). During the Athens Olympics, the concentration of aeroallergens (pollen and fungi spores) was examined in three Olympic cities and the data was used to help athletes that suffer from respiratory allergies take the necessary preventative measures to ensure that their performance was unaffected (Gioulekas et al., 2003).

Finally, a small number of papers addressed health-related risks associated with travelling to countries hosting major sporting events and the implications of such risks for health care planning (Davis et al., 2008; Heggie, 2009). For instance, Davis et al. (2008) presented data collected for visitors to China from 1998 to 2007 by the Genosentinel Surveillance Network, which encompasses specialised medical clinics that provide surveillance data on ill travellers. The top five diagnoses among travellers to China were respiratory-related illness (e.g. upper respiratory tract infection, asthma), followed by dermatologic-related conditions (e.g. eczema), and injuries (e.g. sprains, lacerations and contusions) (Davis et al., 2008).

#### **3.4.3.1 Controls**

Measures used at previous Olympic Games to control and mitigate the potential onset of respiratory diseases have included:

- *Intelligence:* Olympic venues should be pre-tested to check for levels of seasonal allergens prior to the commencement of the Games (Enock and Jacobs, 2008).
- *Public/athlete information provision:* Cities organising forthcoming Olympic Games should make aeroallergen information available to athletes and the public; during the 2004 Athens Olympics, it was suggested that daily reports on aeroallergen circulation should be made available through the mass media (Gioulekas, 2003). Team managers and medical officers need to ensure that athletes are aware of the possibility of exposure to aeroallergens (Katelaris et al., 2000).
- *Clinical support and advice:* Thorough clinical examination of athletes suffering from respiratory allergies and recommendation of appropriate prophylactic treatment (Katelaris et al., 2000).
- *Medical preparedness for issues:* Medical preparedness in place to deal with a potential onset of respiratory diseases; during the 2008 Beijing Olympics, 21 medical facilities, including a respiratory specialist, provided medical care for potential asthma attacks and anaphylactic allergic reactions (Li et al, 2008).

### **3.5 ROAD ACCIDENTS**

A small number of papers were identified that dealt with the potential of an increased number of road accidents due to the influx of international visitors attending major sporting events. In a review of the literature leading up to the 2000 Sydney Olympics, Wilks (1999) showed that international visitors are at a higher risk of road traffic accidents compared to local residents. For instance, international visitors are more likely to be admitted to hospital as a result of a motor vehicle crash than any other type of injury. Similarly, Shaw et al (2007) argued that car and motorcycle accidents are the leading cause of injury and death among travellers under the age of 55. Factors that increase the risk of road traffic accidents include driving in unfamiliar surroundings/roads and driving on the opposite side of the road than the one accustomed to (Petridou et al., 1997; cited in Wilks, 1999).

#### **3.5.1 Controls**

Little information was found on the controls in place to prevent injuries from road traffic accidents in cities that have hosted major international sporting events. For instance, suggested measures to improve road safety during the 2004 Athens Olympics included retraining highway patrol officers, and improvements in the secondary road network including lane widening and lane separation in dangerous ‘hot spots’ (Geokas et al., 2001).

Drawing on anecdotal evidence, Wilks (1999) highlighted six areas that could be communicated to individuals visiting cities hosting the Olympic Games. These included:

- Enhanced awareness of driving on opposite side of the road
- Importance of wearing seatbelts
- Limiting the use of alcohol, and
- Avoid driving when tired.

Shaw et al. (2007) advised that travellers should ensure that they have a travel health insurance with specific overseas coverage prior to travelling abroad.

## **3.6 INJURIES**

A few papers were found that contained information on injuries sustained at major sporting events, although the focus was on injuries sustained by athletes rather than members of the public. In particular, sports-related injuries are one of the most common anticipated problems for athletes attending major sporting events. Acute injuries resulting from contact sports, such as wrestling or boxing may be particularly prevalent (e.g. Duda, 1988; Jorm et al., 2003). For instance, Jorm et al. (2003) presented data on emergency department presentations during the surveillance period at the Sydney Olympic Games. During the competition, 31 sports-related injuries were reported among athletes, which involved falls from horses, falls from bicycles and injuries incurred during boxing competitions. Further, a high number of injuries was reported on beaches, in swimming pools and in premises selling alcohol such as bars and pubs (Jorm et al., 2003).

Injuries may also be a common anticipated problem for members of the public, although little information was available on the prevalence of such incidents during major sporting events. For instance, during the 1996 Olympic Games in Atlanta, 30,000 people sought medical care with the most common incident being injury representing 30% of all cases (Brennan et al., 1997). However, no information was given on the types of injuries sustained or prevalence of injury among different groups (e.g. athletes, members of the public). Similarly, Hiltunen et al. (2007) reported that, during the Helsinki 2005 World Championship Games, ambulance calls responded to falls and traumatic injuries, however, no other information was given regarding the nature of the incidents.

### **3.6.1 Controls**

- *Medical preparedness:* The controls in place to deal with injuries sustained during major sporting events form part of a broader medical preparedness. In addition, careful planning may be required for certain events. For instance, it is suggested that part of the planning for water sport events, especially those that involve motorised watercrafts, should ensure that medical response teams with trained personnel and appropriate equipment are available (DHS, 2005).

## **3.7 MUSCULOSKELETAL DISORDERS (MSDs)**

We can gain some idea of the potential for the development of musculo-skeletal disorders (MSDs) from the statistics published in the Official Report of the Sydney Games (2004). In the report it cites that 326 street cleaners manually removed approximately 20 tonnes of rubbish from city streets, which is twice the usual amount. Up to 5000kg of rubbish was removed from the Olympic Sites and 197sq m of city footpaths and 80000 sq m of city roadways were cleaned three times a day, which is equivalent to approximately 1800 football fields. In addition there was a team of 12 anti-graffiti cleaners who were employed around the clock removing approximately 1300 instances of graffiti.

### **3.7.1 Controls**

- *Consideration of designing out manual handling or using lifting aids:* Although there is nothing in the literature from past Games that provides information on controls and mitigation measures for reducing the incidences of MSDs, the London Olympic Delivery Authority has published a Design and Construction, Health, Safety and Environment Standard, which documents best practice with reference to MSDs and includes controls. In this document it suggests that manual handling should be eliminated or reduced as far as is practicable through the design and planning stages. Suppliers have to undertake a suitable and sufficient risk assessment taking into

account regulations, Approved Codes of Practice and industry good practice in situations where manual-handling operations cannot be avoided. Personnel are expected to be briefed and trained on the risks and precautions including methods of safe manual handling.

### **3.8 CROWD SAFETY**

From the literature there appear to be two main issues associated with crowd safety which are:

- Ensuring that the design of the area adequately takes into account crowds and pedestrian movement.
- Having systems in place to manage crowds safely.

Crowds behave in different ways so a crowd in a main stadium is likely to behave differently to the crowds around weightlifting events (Rowe and Ancliffe, 2008) and managing crowds at major sporting events is crucial if their safety is to be protected (Mounsey et al 2007) This is particularly important in areas where pedestrian volumes increase quickly i.e. near transport interchanges, station platforms, stadium exits, bridges, concourses and ticket booths/ticket gates.

Incidents or fatalities involving crowds are well documented. In Hillsborough in 1989 there were 96 fatalities. During the Haj in Mecca in 1990 there were 1426 fatalities whilst in 2000 nine people were killed and twenty-six people injured at the Roskilde rock concert. There can also be incidents involving smaller numbers that still have fatal results as was seen during a rush at the Ikea shop in Saudi Arabia when three people were killed (Rowe and Ancliffe, 2008). The Event Safety Guide (HSE, 1999) outlines the factors that impact on crowd management such as the design of the venue to allow good entry and exit and to allow for crowd movement within the venue; crowd capacity; provision of adequate facilities and clear, effective means of communication with an audience. A review of the Olympic Games in Sydney (Anon, 2001) identified that the biggest safety risks at the event involved the management of crowds including people in wheelchairs or with other mobility difficulties and the transportation of people between different venues. In 2005, the United States Department of Homeland Security drew up a document on special events contingency planning in which it also recognised the issues posed by attendees or crowds. It identified that crowds can make communication slower and more difficult to handle and that they increase the potential number of victims in the event of an incident.

#### **3.8.1 Controls**

- The Event Safety Guide (Lincolnshire County Council, 2009) covers venue and site design along with crowding issues. The Event Safety Guide suggests the following controls should be put in place:
  - *Safety announcements:* Safety announcements should be made before the event starts using PA systems and video screens and provide information about exits, identifying stewards and procedures for evacuation.
  - *Communication between staff:* Avoid separation of security and stewarding duties as communication between the two types of staff is critical for the safe management of crowds.

- *Risk assessment and staff numbers:* Steward numbers should be based on the assessment of risk not a numerical count of spectators.
- *Training and competence:* Stewards should have the appropriate competencies and be trained in fire safety, emergency evacuation and dealing with incidents such as bomb threats.
- *Staff welfare:* Stewards should receive regular rest breaks and should not be sited near loud speakers.
- *Design and planning using computer simulation:* Computer simulation techniques can be used early on in planning to help identify scenarios that compromise the safety and security of Olympic sites (Johnson, 2008). Johnson suggests that the computer simulations be used as training tools to rehearse tactics and standard operating procedures to check for weak links during mass evacuations. Software can be built that takes into account how crowds behave in particular situations given that crowds tend to remain static when alarms are sounded until they have established its credibility. However, it does require time and resources be applied not just at the planning stage but also during the construction of the infrastructure (CL4). Mounsey et al (2007) used pedestrian modelling software to look for areas of critical congestion during the Commonwealth Games in Melbourne in 2006. It identified that games traffic should be banned from certain areas and crowd management plans were put in place at each of the railway stations used by spectators to help control the flow of pedestrian traffic. The case study of Cardiff's handling of pedestrian flow between Cardiff Station and the Millennium Stadium (Rowe and Ancliffe, 2008) indicated that crowd flows needed to be matched to available rail capacity and because there was little distance between the station and the stadium there was little time for people to make decisions. This prompted the design to include stepped queuing options as a way of managing the waiting numbers. The case study also recognised the importance of stewards and their training.

Some of the key messages from this paper included:

- *Design:* Ensuring an integrated approach at the design stage so designing for operation not just to comply with codes.
- *Competence of those involved in the assessment:* Encouraging input from operators and key stakeholders (disability groups, user representative groups).
- *Issues beyond the venue:* Taking into account the areas around the venue including transportation systems.
- *Design in emergency conditions:* Using modelling to test emergency operating conditions.
- *Controlling crowds:* The Department of Homeland Security (2005) drew on the studies by Fruin (1981) for their recommendations for crowd control. Fruin identified crowd throughput as an area that needs to be controlled with easily identifiable stewards and ticket collectors. Doorways and stairwells were also highlighted as areas that needed particular consideration as they needed to be appropriate for the expected numbers of entering and egress. Although escalators and moving walkways are mentioned in the report, there is no discussion of any potential risk nor control measures. Other areas that would need to be controlled include:

- Transport pick-up and drop-off areas.
  - Spectator and official viewing areas.
  - Seated eating areas.
  - Pedestrian thoroughfares.
  - Fire, first aid and medical centres.
  - Competitors and officials marshalling areas.
- *Considerations for the disabled:* The report also suggests that the needs of people with limited mobility and disabilities needs to be considered as well as handling crowds in the event of a mass evacuation and crowd regulation with regimented seating areas or flow barriers. Some of the controls can be designed into the process but it also relies on the competency of the stewards and other ground staff (Fruin, 1981).
  - *Public welfare:* Crowd management also extends to ensuring the comfort and health and safety of spectators and although this links with “Public Health and Safety” discussed in another part of this review it will have a bearing on how crowds are controlled and managed (Peiser & Reilly, 2004; Enock & Jacobs, 2008). The experience at the Barcelona Olympic Games (Verdaguer-Codina, et al. 1995) suggests that climatic heat stress can affect spectators, officials and security personnel as well as the athletes. Some of the precautions can be achieved through education and preparation and include the wearing of a visor or hat, regular intake of water or electrolyte drinks, wearing loose reflective clothing including lightweight uniforms and wearing sunscreen. Safety Guidelines for the Special Olympics (2009) which are directed towards the wellbeing of disabled spectators and competitors suggests that water coolers be sited at each venue and periodically refilled. Staff should receive awareness training to look for the signs of hypothermia and seizures.

### **3.9 EMERGENCY PLANNING AND RESPONSE**

#### **3.9.1 Medical preparedness**

Medical preparedness is a key issue in the management of public health and safety risks and a number of papers were found that examined the impact of major sporting events on the workload of emergency services. The majority of papers reported an increase in emergency incidents during major sporting events (e.g. Deakin et al., 2007), however, some reported no association between attendance at major sporting events and number of emergencies (Cooke et al., 1999). It is suggested that between 0.3% and 1.3% of event attendees will require some form of medical care, irrespective of the type or size of the event and the physical layout of the venue (Leonard et al., 2001; cited in DHS, 2005).

Deakin et al. (2007) looked at the effects of attendance at the 2006 Football World Cup on call volumes and profiles. They found that on the first day of the football match, the call volumes received by the Hampshire Ambulance Service was 50% higher than usual. This is a particularly interesting finding, given that the World Cup was not hosted in the UK in that year. Call profile analysis showed that emergencies related to alcohol use, assault and road traffic accidents. The authors argued that analysis of call volumes and profiles received by emergency departments during major sporting events can aid in resource planning and, consequently, in ensuring that high levels of patient care can be provided (Deakin et al.,

2007). Moddy et al. (2007) examined whether attendance to A&E departments increased as a result of the rugby world cup final held in Australia in 2003. It was found that A&E attendance was increased 6-8 hrs after kick-off (compared to attendance data between 2000 and 2002). Similarly, a 5.9% increase in ambulance calls was observed during the World Championship Games in Helsinki in 2005 compared to the corresponding time period in the five previous years (Hiltunen et al., 2007). In particular, incidents that were attended to during the games included chest pains, dyspnoea, unconsciousness, intoxication, abdominal pains, dehydration, seizures and falls. The most common cause for ambulance calls were traumatic injuries and infections (Hiltunen et al., 2007).

On the other hand, Cooke et al. (1999) found no association between daily attendance figures in emergency departments and attendance at the European Football Championships in 1996. It was hypothesised, however, that the absence of an association could be due to the fact that individuals may have delayed going to A&E until after the sports tournament had ended, a possibility which was not examined in the study (Cooke et al., 1999). Similarly, O'Grady and Krause (1997) found that attendance at the 1997 Ararufa Games, a biannual, international sporting event, did not have an impact on the workload of a local hospital whereby the majority of incidents related to minor illness and/or injury.

### **3.9.2 Controls**

Drawing on the experience of previous Olympic events, medical preparedness has typically included the following:

- *Public health response teams:* Availability of public health response teams on site: In the Olympic Plaza, during the Salt Lake City Olympics, there were five medical teams during opening hours, five on bikes and one on a golf cart (Comeau, 2002). At the Torino 2006 Olympic and Paralympics Winter Games, the medical services team comprised both general and specialist physicians such as nurses, physiotherapists, orthoptists and medical radiology technicians (Massazza et al., 2006). At the 1984 Summer Olympics in Los Angeles, emergency public health response teams consisted of physicians, epidemiologists and appropriate support staff (Weiss et al., 1988).
- *Polyclinics:* Provision of polyclinics for each Olympic village: The services and resources available in each polyclinic will depend on the size of the Olympic village and estimated use, and may include a walk-in primary care clinic, a physical therapy centre and a pharmacy (Duda, 1988). For instance, at the Torino 2006 Olympic and Paralympics Winter Games, each polyclinic included qualified personnel on duty and/or on call, and a 24-hr ambulance service. Helicopters were also available for transporting patients with medical problems that required hospitalisation (Massazza et al., 2006).
- *Co-ordination:* Co-ordination and cooperation between rescue authorities, hospitals and police: During the Salt Lake City Olympic Games in 2002, the fire department provided 2-person bike teams and personnel on golf carts to assist with the increase in emergency medical response (Comeau, 2002). At the 1984 Summer Olympics in Los Angeles, local law enforcement agencies were responsible for the transportation of individuals to hospital through periods of heavy traffic (Weiss et al., 1988).
- *Site layout and access:* Site layout for easy access by emergency vehicles: According to guidance published by the Department of Homeland Security (DHS, 2005) on the management of risks associated with mass gatherings, several traffic management issues need to be considered with regards to emergency medical vehicles (among other important service vehicles). These include:

- Ensuring there is adequate access for emergency medical vehicles and sufficient space to manoeuvre depending on the incident;
  - Provision of roads that can be used only by emergency medical vehicles;
  - Provision of designated pick-up and drop-off points for visitors that will not obstruct emergency medical vehicles, and
  - Consideration of the environmental hazards that may result if access and egress routes are not established for emergency medical services.
- Finally, Yancey et al. (2008) discussed several health and safety issues in light of the forthcoming 2010 Football World Cup in South Africa, and suggested that the following venue characteristics and infrastructure should be considered:
    - Traffic management with clear pedestrian and vehicle routes;
    - Security available on site to minimise potential pedestrian-vehicle contact;
    - Vendor delivery and pick-up time management (e.g. food supplies, equipment etc), and
    - Effective gate management.

### **3.10 VOLUNTEERS, RECRUITING AND TRAINING**

*Volunteer competency:* Volunteers play a key role in ensuring the health and safety of people attending the Olympic Games whether they be spectators or competitors. Since Munich, the majority of risk assessments for Olympic Games cover the potential for security threats and in the event of a mass evacuation the deployment of these personnel and their skill in marshalling crowds to safety will be critical. However, there are a number of issues associated with the selection and recruitment of volunteers that present a potential risk (Comeau, 2002). This is something that the report from the Salt Lake City Winter Olympic games raised when suggesting that had the Venue Safety Operatives not been volunteers they might have been subject to stricter recruitment and selection procedures and therefore be a more skilled body of staff. The report also highlighted the need for key decision makers to be in place before volunteers were recruited so that venue operational safety training could start with the appropriate leadership structures in place. In their view the operations safety programme needed to have been instigated two years prior to the commencement of the Games.

The experience of the 2004 Athens Games was that the majority of accidents were due to poor work practices arising from a lack of orientation and job training, performance pressure and the inexperience that resulted in knowledge and skill based errors (Katsakiori, et al., 2008). However, the sites hosting the Athens Games were manned by between 30 – 150,000 volunteers of which 2,000 were medical and nursing staff, private security and military (Gryllis, 2005; Mavroidi, 2005). There is no evidence to indicate when in relation to the start of the Games, these volunteers were recruited.

Closer to home it should be noted that whilst there is a requirement for security guards at sporting events to be licensed as a way of ensuring they have been trained and vetted to security industry standards, there is no such requirement for volunteers (Home Office, 2006). Although security is not entirely within the scope of this review, the potential risk this poses

to the safe management of crowds is and highlights the need for a robust recruitment, selection and training strategy of this section of the volunteer cadre (Decker, et al., 2005).

The report produced by the Salt Lake City Olympic Committee highlighted that volunteers are a weak link and suggested that other Organising Committees need to be aware of that fact and deal with it accordingly.

### **3.10.1 Controls**

- *Incident reporting and recording:* As with other topics there has been little sharing of good practice until recent Games. Although there is no evidence that the procedures put in place for paid employees were also applied to volunteers at the Sydney Games (Anon, 2001) a number of practices were instigated which may have contributed to Sydney being referred to as the “safest Games ever.” These included all staff being issued with incident report cards at the beginning of each shift and being trained to remember the three “I” – identify, isolate and inform. Boxes were placed around the venue and regularly checked by risk management staff and every rumour circulating about safety problems no matter how trivial was checked and verified. Contractors were also provided with training kits so essentially everyone coming on site was expected to adhere to the safety practices on site.
- *Competence and site orientation:* A review of the incidents that occurred during the Athens Olympics 2004 suggests that not all the lessons from previous Games had been learned. Although Athens structured its operations so that communications could be cascaded down to the lowest possible level and there was a policy for all venue team staff to receive continuous on-the-job training there were a number of serious incidents reported at the Games. Katsakiori et al., (2008) identified the importance of orientation and job training and being aware of the impact of the worker’s inexperience in being able to assimilate and act upon that learning.

A Lincolnshire County Council report (2009) suggests that training and briefing of stewards is central to ensuring event safety. Although volunteers are not paid they should still receive sufficient training and briefings commensurate with their role. It was suggested that good practice might be for the Police to be invited to take part in any briefings but there is no evidence that this would be suitable good practice for large scale sporting events.

At 2000 Sydney Games (Anon, 2001) a strict risk management regime was enforced with 120,000 strong workforce receiving training and instruction including orientation of the site, venue training as well as job specific training.

## **3.11 WORKPLACE VIOLENCE**

Two papers were found that explicitly discussed the prevention of workplace violence during major sporting events such as the Olympics. Bowie (2000) defined workplace violence as: ‘*a perceived or actual verbal, emotional threat or physical attack on an individual’s person or property by another individual, group or organisation*’ (p. 248). Occupational groups that are considered to be particularly at risk of workplace violence include those in public situations (e.g. hospitality staff, health staff, sales personnel), individuals that work in community settings (e.g. taxi and bus drivers), and security staff (Bowie, 2000). Bowie (2000) argues that individuals that are involved in the provision of Olympic-related services, such as enforcement and crowd control, hospitality services and health and welfare services may be most at risk of violence.

It should be mentioned however, that evidence of workplace violence was not found from previous Olympic events. This may be, however, due to the fact that workplace violence may be given less attention during major sporting events compared to other risks, such as public health and safety risks. Indeed, Sivarajasingam et al (2005) note that violent incidents during major sporting events are under-researched. In a review of 106 international rugby and football matches, Sivarajasingam et al. (2005) showed that both match attendance and matches where the national team won were associated with increases in assault injuries resulting in emergency department attendances. In light of these findings, the authors recommended that violence prevention efforts should be enhanced during international games, especially when the national team is expected to win (Sivarajasingam et al., 2005).

### **3.11.1 Controls**

Bowie (2000) proposed a number of measures to identify the hazards that may give rise to workplace violence. In particular, violence audits, workplace inspections, incident investigations and injury and illness records may be used to identify potential workplace hazards. It is further argued that each Olympic-related service, such as hospitality or security, will have its own, individual risk profile that will need to be identified (Bowie, 2000).

A standard hierarchy of controls is proposed as a means of addressing the potential risks of workplace violence. In particular, Bowie (2000) proposes the following controls to manage workplace violence:

- Eliminating the triggers that may give rise to workplace violence, such as not operating a service outside normal working hours.
- Providing safer alternatives such as using more experienced and trained staff to deal with potential violent incidents.
- Implementing safer systems of work, including provision of security screens and alarms.
- Putting in place a number of administrative controls including provision of ongoing staff training, effective incident reporting systems and post-incident management plans.

## **3.12 FIRE SAFETY**

There was very little information pertaining to fire-related risks or characteristics of fire-related incidents during major sporting events. Hume (2001) presented data that showed that during the Sydney Olympics, the fire brigade responded to a total of 144 incidents across the Olympic sites. Of these incidents, 85 related to automatic fire alarms, 6 were structural fires and 17 incidents involved minor fires resulting from rubbish and fireworks used in grassed areas (Hume, 2001).

It is worth noting that one of the major challenges faced by the fire department during the 2002 Salt Lake City Olympics involved access because of the number of temporary structures and crowds present at the Olympic venues (Comeau, 2002), however no information was given as to whether and/or how these challenges were addressed.

### **3.12.1 Controls**

Measures that may be taken to ensure that there is adequate preparedness to deal with potential fire incidents during major sporting events may include:

- *Pre event inspections:* Conducting inspections prior to the commencement of the event to identify and address promptly any underlying problems (DHS, 2005; Hume 2001).

For instance, during the Sydney Olympics, a group of 20 accredited officers carried out daily inspections at Olympic venues to ensure that there were no breaches of installed safety systems (Hume, 2001).

- *Identifying and disposing unexploded fireworks:* Fireworks can be a fire safety hazard (as was evident at the 2000 Sydney Olympics); it is suggested that at events where fireworks are likely to be used, potential unexploded fireworks should be identified and disposed of prior to allowing access to the public in a particular area (DHS, 2005).
- *Monitoring plans:* Monitoring of fire safety and preparedness plans by local fire authorities to ensure that the measures in place meet relevant standards (DHS, 2005).
- *Availability of resources:* Ensuring that there are adequate resources in place to meet a potential increase in fire-related incidents: During the 2002 Salt Lake City Olympics, two separate fire departments were set up; one for the city and one for the Olympics. There was a temporary fire station dedicated to responding to incidents with the Olympic village; and three other stations with a separate rescue engine for Olympic response were also available (Comeau, 2002).

### **3.13 CARBON MONOXIDE AND GAS SAFETY**

A search of the literature reveals no evidence of any incidents nor fatalities related to carbon monoxide and gas safety issues at the Olympic Games or any similar large scale sporting event. However, anecdotally there has been an increase in property prices in the Stratford area as investors seek to buy up properties in advance of the Olympic Games. Similarly in an article published in February 2010, The Sunday Times (2010) reported householders near the main sites are seeking to cash in on the Olympic Games by letting out their properties for the duration of the Games. Given the maturity of the housing stock in and around the Stratford area and the inexperience of landlords coming into this market there may be some potential for carbon monoxide and other gas safety issues to occur.

#### **3.13.1 Controls**

- From March 2010 Newham Borough Council ([www.newham.gov.uk](http://www.newham.gov.uk), 2010) requires all landlords and Managing Agents to hold a licence having demonstrated that amongst other things that any gas installations have the necessary safety certificates.

### **3.14 ELECTRICAL HAZARDS**

Although no incidents related to electrical hazards have been reported in the literature, The Event Safety Guide published by the HSE (HSE, 1999) suggests that there is a potential for electricity to cause death or serious injury to workers, athletes or members of the public due to the temporary nature of some installations. The supply of electricity may also present an issue in that lighting levels need to be maintained at an adequate level to help people evacuate.

#### **3.14.1 Controls**

- The Event Safety Guide suggests that competent electricians should carry out the work on electrical installation and must comply with the Electricity at Work Regulations (1989). It also suggests attention should be given to temporary cabling, the use of generators and any resulting noise nuisance they present to local residents.

## 4 DISCUSSION & CONCLUSIONS

### 4.1 SUMMARY OF FINDINGS

This literature review has highlighted a range of risks that have been associated with previous major sporting events, along with a variety of ways to prevent and mitigate these. The literature was largely descriptive in nature, tended to focus on the ‘during event’ stage, and also had a stronger emphasis on mitigation, rather than prevention. To summarise the findings it is useful to revisit the research questions:

#### 4.1.1 What are the potential risks to health and safety that are, or may arise before, during and after major sporting events?

As previously noted, the literature identified for the review tended to focus on the ‘during event’ stage. Also, the risks identified are all relatively well-known in society, but may not usually coexist at the same magnitude outside of the Olympics. The key risk topics identified in this review were:

- Traditional construction related risks
- Public health and safety risks – infectious diseases:
  - Waterborne diseases
  - Airborne and communicable diseases
- Public health and safety risks – non-infectious diseases:
  - Heat related illness
  - Respiratory illness
- Road accidents
- General injuries to the public
- Musculoskeletal disorders
- Crowd safety
- Emergency planning and response
- Workplace violence
- Fire safety
- Carbon monoxide and gas safety
- Electrical hazards

Lack of training and site orientation for volunteers was also highlighted in a number of articles, which could impact across the risk topics, such as emergency response and crowd safety.

Risk assessments were often applied to identify and assist the process of controlling risks. The literature identifies the importance of involving competent personnel in the risk assessment process. Examples from the articles include involvement from a range of relevant organisational bodies, as well as academics and other sources of information such as literature reviews.

#### 4.1.2 What can HSE or other bodies/organisations do to prevent or mitigate potential/foreseeable risks?

To summarise measures to control risks, the following table highlights the risks identified under research question one. These are then mapped against the measures to control these risks that have been highlighted in the literature. Each risk identified is followed by the number in parenthesis of papers referenced for that area. This format is also followed for the control measures. Some papers cover more than one risk category and some cover multiple controls. Also, Table 4 covers volunteers and the considerations that may help to reduce accidents amongst this group, whilst helping to control and mitigate other risks.

**Table 3: Summary of risks and controls**

Risks identified	Control measures
<ul style="list-style-type: none"> <li>• Traditional construction related risks (20)</li> </ul>	<ul style="list-style-type: none"> <li>• Consideration of safety culture and avoiding a blame culture (4)</li> <li>• Health and safety awareness sessions/training (inc. site orientation) (3)</li> <li>• Risk management teams/departments (3)</li> <li>• Partnership working / leadership /worker engagement (3)</li> <li>• Competent workers (e.g. scaffolders &amp; electrical workers) (3)</li> <li>• Availability and accessibility of PPE (2)</li> <li>• Adherence to regulations - CDM (2007) (2)</li> <li>• Use of risk identification/ assessments/ planning (2)</li> <li>• Adequate maintenance, particularly of temporary structures (1)</li> <li>• Design stage to consider crowd movement (vibration and resonance) (1)</li> <li>• Health and safety monitoring and reporting procedures (1)</li> <li>• Health surveillance, assessment/checks (1)</li> <li>• Reduction of performance pressures where possible (1)</li> <li>• Adequate management of safety for contractors (e.g. safety in contract agreement) (1)</li> <li>• Consideration of hierarchy of controls (1)</li> <li>• Use of flame resistant materials for temporary structures (1)</li> <li>• Adequate supervision, e.g. tagging systems to monitor scaffolding (1)</li> <li>• Ensuring welfare/health facilities are available (1)</li> <li>• Computer modelling – e.g. for fire simulation (1)</li> </ul>
Public health and safety risks – infectious diseases:	

<ul style="list-style-type: none"> <li>○ Waterborne diseases (8)</li> </ul>	<ul style="list-style-type: none"> <li>• Inspections of cooling towers or water supplies (inc. swimming pools) in areas of potential risk (5)</li> <li>• Surveillance programs (prior and during the event), including microbiological testing and inspections of water sites (e.g. decorative fountains &amp; swimming pools) (3)</li> <li>• Microbiological testing of swimming pools and water sources for escherichia coli, staphylococcus coli, staphylococcus aureus, pseudomonas areuginosa and heterotropic plate (3)</li> <li>• Training in standardised inspections (2)</li> <li>• Maintenance of Geographical information system databases of all cooling towers registered with local councils. (1)</li> <li>• Education of facility owners on best management (1)</li> <li>• Consideration that there may be increased risk of legionella at seasonal hotels. (1)</li> <li>• Awareness raising of waterborne risks (1)</li> </ul>
<ul style="list-style-type: none"> <li>○ Airborne and communicable diseases (21)</li> </ul>	<ul style="list-style-type: none"> <li>• Epidemic intelligence (identification, including global health trends), assessment, verification and investigation of potential health risks). (6)</li> <li>• Daily reporting on potentially infectious risks (e.g. up to 3 times a day) (4)</li> <li>• Immunisation where possible/appropriate for staff/volunteers (3)</li> <li>• Increased reporting of potentially infectious diseases from sources such as health care and telephone ‘hotlines’ (2)</li> <li>• Staff training in collecting and analysing surveillance data. (2)</li> <li>• Surveillance systems, which may include on site clinics (may need piloting up to 12 months prior to start of event) (1)</li> <li>• Gathering intelligence from different sources (e.g. cruise ships, schools, hospitals) (1)</li> <li>• Provision of information packs to general practitioners and accident and emergency departments about communicable diseases that are not prevalent in the UK and establishing appropriate mechanisms to allow an immediate reporting of communicable (1)</li> <li>• Information to the public on how to protect themselves (1)</li> </ul>
<p>Public health and safety risks – non-infectious diseases:</p>	
<ul style="list-style-type: none"> <li>• Heat related illness (8)</li> </ul>	<ul style="list-style-type: none"> <li>• Climatic heat measurements (prior to and during Games) (4)</li> <li>• Encouraging safe public behaviours e.g. use of water fountains (particularly in areas likely to be crowded) and sunscreen, hats and fans. Portable shade</li> </ul>

	<ul style="list-style-type: none"> <li>canopies may also be useful (3)</li> <li>Provision of water fountains and water misters (3)</li> <li>Public information/announcements (2)</li> <li>Staff rotation – hot locations to cooler areas (2)</li> <li>Considering a wet weather plan to prevent cold weather illness (1)</li> <li>Scheduling long distance events when the temperature is likely to be lower (e.g. in the morning) to help endurance athletes (1)</li> </ul>
<ul style="list-style-type: none"> <li>Respiratory illness (6)</li> </ul>	<ul style="list-style-type: none"> <li>Public/athlete information on aeroallergens (2)</li> <li>Availability of respiratory specialists &amp; clinical examination (2)</li> <li>Testing of seasonal allergens for intelligence (1)</li> </ul>
<ul style="list-style-type: none"> <li>Road accidents (4)</li> </ul>	<ul style="list-style-type: none"> <li>Improvements to road networks (1)</li> <li>Seatbelt use (1)</li> <li>Avoiding driving when tired (1)</li> <li>Increased awareness of driving on the opposite side of the road for some international visitors (1)</li> <li>Limited consumption of alcohol (1)</li> </ul>
<ul style="list-style-type: none"> <li>General injuries to the public (5)</li> </ul>	<ul style="list-style-type: none"> <li>Medical preparedness (including access to difficult to reach locations, e.g. pools and lakes etc.) (1)</li> </ul>
<ul style="list-style-type: none"> <li>Musculoskeletal disorders (1)</li> </ul>	<ul style="list-style-type: none"> <li>Use of lifting aids (1)</li> <li>Adequate training (1)</li> </ul>
<ul style="list-style-type: none"> <li>Crowd safety (13)</li> </ul>	<ul style="list-style-type: none"> <li>Ensure staff competence (2)</li> <li>Use of modelling to test designs &amp; procedures (2)</li> <li>Consideration of minority groups such as the disabled (2)</li> <li>Design should account for crowd size and movement (1)</li> <li>Systems to manage crowds (1)</li> <li>Try to keep stewards and security collocated to improve communication between these groups (1)</li> <li>Steward numbers based on risk, not crowd size (1)</li> <li>Crowd announcements, use of screens to identify exits (1)</li> <li>Consider steward welfare (breaks etc.) (1)</li> <li>Consider the wider environment such as surrounding transport (1)</li> <li>Staff awareness raising for signs of hypothermia and seizures (1)</li> </ul>
<ul style="list-style-type: none"> <li>Emergency planning and response (12)</li> </ul>	<ul style="list-style-type: none"> <li>Public health response teams at location. (3)</li> <li>Coordination between authorities hospitals and police (2)</li> <li>Design to include site layout consideration - clear access, e.g. medical access not near public drop off</li> </ul>

	<p>(2)</p> <ul style="list-style-type: none"> <li>• Ensure mobility of teams e.g. using bikes, golf carts, helicopters etc. (1)</li> <li>• Walk in clinics on site (1)</li> </ul>
<ul style="list-style-type: none"> <li>• Workplace violence (2)</li> </ul>	<ul style="list-style-type: none"> <li>• Violence audits (1)</li> <li>• Workplace inspections (1)</li> <li>• Incident investigations (1)</li> <li>• Injury and illness records (1)</li> </ul>
<ul style="list-style-type: none"> <li>• Fire safety (3)</li> </ul>	<ul style="list-style-type: none"> <li>• Inspections by accredited officers at sites before event to address underlying problems (2)</li> <li>• Potential unexploded fireworks identified when possible (1)</li> <li>• Local Authority fire safety preparedness plans (1)</li> <li>• Consider additional resource to be brought in e.g. temporary fire stations (1)</li> </ul>
<ul style="list-style-type: none"> <li>• Carbon monoxide and gas safety (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Consideration that there may be an influx of new landlords to the London area, and potentially beyond (researcher observation)</li> </ul>
<ul style="list-style-type: none"> <li>• Electrical hazards (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Work should be completed in line with the Electricity at Work Regulations (1989) (1)</li> </ul>

**Table 4:** Suggestions to improve the impact of volunteers

<b>Worker group</b>	<b>Suggestions to improve impact and reduce accidents</b>
Volunteers (7)	<ul style="list-style-type: none"> <li>• Volunteers contributing to incident reporting, e.g. with incident report cards (1)</li> <li>• Adequate training and competence, for example through job/site orientation and continuous on the job training. Using existing bodies for the training (e.g. the police) was also suggested (3)</li> </ul>

## **4.2 CONCLUSIONS**

The risks identified in this literature review are all already well-known risks, but are likely to apply on a larger scale due to the size of the Olympic Games. Whilst it appears that recording of lessons at major sporting events has increased in more recent times, the type of information gathered is very much descriptive in nature. Whilst this provides useful information for those planning health and safety management at events, it would be desirable to have a stronger evidence base to underpin the effectiveness of measures identified. The literature also appears to have a strong emphasis on the mitigation of health and safety issues. There may be greater potential to remove or reduce risks at source, e.g. design.

As the risks identified are likely to be relatively well known, those that fall under the remit of the Health and Safety Executive (HSE) are therefore likely to be being pursued from a regulatory perspective. Encouraging organisations to utilise worker engagement is a good example of where the HSE are already taking action, communicating the importance of this process to industry. It may be that some of the findings provide some assistance with helping to focus regulatory activity. An example here may be concern around temporary structures and ensuring that maintenance checks are completed regularly by competent personnel within the industry during the event.

Finally, a number of sources covered in the review identified the importance of communication between different bodies as well as gathering information from the public. These articles identified the use of technology such as telephones and the internet. Whilst mobile phones and the internet have been around for some time, advances in technology, such as increased public wireless internet access, faster internet speeds and mobile phone applications may provide greater opportunities to gather and utilise information. For example, mobile internet or texting systems to enable easy reporting of ill health or accidents by members of the public. The wide spread availability of camera phones may also provide opportunities to gather fast and useful intelligence. The opportunity to use novel technology could therefore contribute to a safe Olympic Games in 2012.

## **4.3 RESEARCH LIMITATIONS**

Whilst this literature review has aimed to provide a good understanding of the risks and controls associated with health and safety at major sporting events, there are, however, some limitations. Possibly the main limitation is that the information yielded from articles has largely taken the form of descriptive information. This includes the peer-reviewed articles, which generally described the risk assessment/identification and the controls applied, with no link to evaluation of effectiveness. This may bring the utility of some of the controls and mitigation measures in to question.

## **4.4 RECOMMENDATION**

- While this report will have a great deal of relevance for HSE, it may also provide useful information to other bodies and regulators. It is therefore suggested that wider dissemination of this report occurs, for example to local authorities, the Health Protection Agency and other government departments.

## 5 REFERENCES

- Anderson, A. C. (1996). Outbreak of salmonella food poisoning at Junior World Rowing Championships. *British Journal of Sports Medicine*, 30, 347-348.
- ANON. (2001). Journal of Occupational Health and Safety Australia and New Zealand, 17 , (4), pp328.
- ATHOC. (2004). *Official Report of the XXVII Olympiad (Athens) Volume 1: The Homecoming of the Games - Organisation and Operations*.
- Banwell, K. (2000). Environmental health preparation for the Sydney 2000 Olympic and Paralympic Games. *New South Wales Public Health Bulletin*, 11, 147-148.
- Bowie, V. (2000). Planes, trains and prostitutes: dealing with potential workplace violence encountered by Olympic support services. *Journal of Occupational Health and Safety*, 16 (3), 247-254.
- Brennan, R. J., Keim, M. E., Sharp, T., W., Wetterhall, S. F., Williams, R. J., Baker, E. L., Cantwell, J. D., and Lillibrige, S. R. (1997). Medical and public health services at the 1996 Atlanta Olympic Games. *The Medical Journal of Australia*, 167, 595-598.
- Comeau, E. (2002). The Salt Lake City challenge – 2002 Olympic follow-up. *Fire International*, 197, 10-11.
- Connor, N. (2004). *Simulating pedestrian circulations for Olympic planning*. *Public Transport International*,. 53( 2), 28-29.
- Cooke, M. W., Allan, T. F., and Wilson, S. (1999). A major sporting event does not necessarily mean an increased workload for accident and emergency departments. *British Journal of Sports Medicine*, 33, 333-335.
- Cummiskey, J., Borriore, P., Bachil, N., Ergen E., and Pigozzi, F. (2008). Report of a serious communicable disease at a major sporting event. *The Journal of Sports Medicine and physical fitness*, 48 (2), 125-128.
- Davis, X. M., MacDonald, S., Borwein, S., Freedman, D. O., and Kozarsky, P. E. (2008). Short report: Health risks in travellers to China: The Geosentinel experience and implications for the 2008 Olympics. *American Journal of Tropical Medicine and Hygiene*, 79 (1), 4-8.
- Deakin, C. D., Thompson, F., Gibson, C., and Green, M. (2007). Effects of international football matches on ambulance call profiles and volumes during the 2006 World Cup. *Emergency Medicine Journal*, 24, 405-407.
- Decker, S. H., Greene, J. R., Webb, V., Rojek, J., McDevitt, J., Bynum, T. (2005). Department of Homeland Security (DHS). Special events contingency planning: Job aids manual. Accessed from <http://training.fema.gov/EMIWeb/downloads/is15aSpecialEventsPlanning-JAmanual.pdf>.
- Duda, M. (1988). Striving for safe, healthy and fair Summer Olympics. *The Physician and Sports Medicine*, 16 (9), 147-157.
- Ehresmann, K. R., Hedberg, C. W., Grimm, M. B., Norton, C. A., MacDonald, K. L., and Osterholm, M. T. (1995). An outbreak of measles at an international sporting event with airborne transmission in a domed stadium. *Journal of Infectious Diseases*, 171, 679-683.

- Engineering News Record (17/6/1996). *Engineer Suspended over Olympic Stadium error*. P. 7 pub. McGraw-Hill.
- Engineering News Record. (15/5/1995). *Olympic light towers to get steel bracing*. P.11. pub. McGraw-Hill.
- Enock, K. E. and Jacobs, J. (2008). The Olympic and Paralympic Games 2012: Literature review of the logistical planning and operational challenges for public health. *Public Health*, 122, 1229-1238.
- Florida-James, G., Donaldson, K., Stone, V. (2004). Athens 2004: The pollution climate and athletic performance. *Journal of Sports Science and Medicine*, 22 (10), 967-980.
- Friedman, M. S., Powell, K. E., Hutwagner, L., Leroy, G. M., and Teague, G. W. (2001). Impact of changes in transportation and commuting behaviours during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma. *The Journal of the American Medical Association*, 285 (7), 897-905.
- Geokas, M. C. and Papanicolaou, S. (2001). Bloodshed on the asphalt and why the thing bites back: Traffic safety issues in Greece prior to the 2004 Summer Olympics. *Journal of Traffic Medicine*, 29 (1-2), 6-8.
- Gioulekas, D., Damialis, A., Papakosta, D., Syrigou, A., Mpaka, G., Saxoni, F., and Patakas, D. (2003). 15-year aeroallergen records: Their usefulness in Athens Olympics, 2004. *Allergy*, 58, 933-938.
- Gryllis, C. (2005). *Surveillance During Mass Gatherings*. Paper presented at EPINORTH Seminar. 5-10 September 2005, Tallinn. Estonia.
- Gundlapalli, A. V., Rubin, M. A., Samore, M. H., Lopansri, B., Lahey, T., McGuire, H. L., Withrop, K. L., Dunn, J. J., Willick, S. E., Vosters, R. L., Waeckerle, J. F., Carroll, K. C., Gwaltney, J. M., Hayden, F. G., Elstad, M. R., and Sande, M. A. (2006). Influenza, Winter 2002. *Emerging Infectious Diseases*, 12 (1), 144-146.
- Hadjichristodoulou, C., Goutziana, G., Mouchtouri, V., Kapoula, C., Konstantinidis, A., Velonakis, E., Vatopoulos, A., and Kremastinou, J. (2006a). Evaluation of standardised scored inspections for Legionnaires' disease prevention, during the Athens 2004 Olympics. *Epidemiology and Infection*, 134 (5), 1074-1081.
- Hadjichristodoulou, C., Mouchtouri, V., Soteriades, E. S., Vaitisi, V., Kolonia, V., Vasilogiannacopoulos, A. P., and Kremastinou, J. (2005). Mass gathering preparedness: The experience of the Athens 2004 Olympic and Para-Olympic Games. *Journal of Environmental Health*, 67 (9), 52-57.
- Hadjichristodoulou, C., Mouchtouri, V., Vaitisi, V., Kapoula, C., Vousourelis, A., Kalivitis, I., Chervoni, J., Papastergiou, P., Vasilogiannakopoulos, A., Daniilidis, V. D., and Kremastinou, J. (2006c). Management of environmental health issues for the 2004 Athens Olympic Games: Is enhanced integrated environmental health surveillance needed in everyday routine operation? *BMC Public Health*, 6, 306.
- Hadjichristodoulou, C., Mouchtouri, V., Vousourelis, A., Konstantinidis, A., Petrikos, P., Velonakis, E., Boufa, P., and Kremastinou, J. (2006b). Waterborne diseases prevention: evaluation of inspection scoring system for water sites according to water microbiological tests during the Athens 2004 pre-Olympic and Olympic period. *Journal of Epidemiology and Community Health*, 60, 829-835.

- Heggie, T. W. (2009). Travelling to Canada for the Vancouver 2010 Winter Olympic and Paralympic Games. *Travel Medicine and Infectious Disease*, 7, 207-211.
- Hiltunen, T., Kuisma, M., Määttä, T., Tennilä, A., Hari, T., Bäckman, R., and Väyrynen, T. (2007). Prehospital emergency care and medical preparedness for the 2005 World Championship in Athletics in Helsinki. *Prehospital and Disaster Medicine*, 22 (4), 304-311.
- Home Office. (2006). *Partial Regulatory Impact Assessment on Security Guards at Sports and Other Events and The Private Security Industry Act 2001*. pub. March 2006. ISBN 1-84473-887-6.
- Home Office. (2009). *London 2012- Olympic and Paralympic Safety and Security Strategy*
- HSE. (1989). Memorandum of guidance on the Electricity at Work Regulations 1989. Guidance on Regulations. HSE Books.
- HSE. (1999). The Event Safety Guide: A guide to health, safety and welfare at pop concerts and similar events. HSE Books.
- HSE. (2007). Construction (Design and Management) Regulations 2007. (CDM) Approved Code of Practice. HSE Books
- Hume, B. (2001). Protecting the people's Games – debriefing in post-Olympics Sydney. *Fire International*, 183, 26.
- IWW. (2009). *Olympic dream or workers' nightmare? An inside report on health and safety conditions at the London 2012 Olympics site*. IWW Construction Workers Industrial Union. Newcastle Upon Tyne.
- Jorm, L. R., Thackway, S. V., Churches, T. R., and Hills, M. W. (2003). Watching the Games: public health surveillance for the Sydney 2000 Olympic Games. *Journal of Epidemiology and Community Health*, 57 (2), 102-108.
- Kaiser, R. and Coulombier, D. (2006). Epidemic intelligence during mass gatherings. *Eurosurveillance*, 11 (5). Accessed from <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=3100>.
- Katellaris, C. H., Carrozzi, F. M., Burke, ThV., and Byth, K. A. (2000). A springtime Olympics demands special consideration for allergic athletes. *Journal of Allergy and Clinical Immunology*. 106, 260-266.
- Katsakiori, P., Manatakis, E., Goutsos, S., Athanassiou, G. (2008) Factors Attributed to Fatal Occupational Accidents in a Period of 5 Years Preceding the Athens 2004 Olympic Games. *International Journal of Occupational Safety and Ergonomics (JOSE)*, 4. (3), 285-292.
- Li, J., Lu, Y., Huang, K., Wang, C., Lu, J., Zhang, C., and Zhong, N. (2008). Chinese response to allergy and asthma in Olympic athletes. *Allergy*, 63, 962-968.
- Lincolnshire County Council. (2009). *A Guide for Event Organisers in Lincolnshire Version 6, Issued December 2009*. (Emergency Planning Unit).
- Lombardo, J. S., Sniegowski, C. A., Loschen, W. A., Westercamp, M., Wade, M., Dearth, S., and Zhang, G. (2008). Public health surveillance for mass gatherings. *Johns Hopkins Applied Technical Digest*, 27 (4), 347-355.

- Martin D. E. (1999). Measurement of climatic heat stress at outdoor venues for endurance events at the Atlanta Olympic Games, 1996. *Sports Medicine, Training and Rehabilitation*, 8, 321–346.
- Martin, D. E. (1996). Climatic heat stress studies at the Atlanta 1996 Olympic stadium venue, 1992-1995. *Research in Sports Medicine*, 6 (4), 249-267.
- Massazza, G., Pigozzi, F., Bono, D., Borrione, P., Redivo, L., Bribaudo, C. G., Ghiselli, G., Lazzarone, C., and Schamasch, P. (2006). The medical services for the Torino 2006 Olympic and Paralympics Winter Games: Basic medical and emergency services and anti-doping control. *Medicina Dello Sport*, 59, 113-139.
- Mavroidi, N. (2005). *Epidemiologic Surveillance during Athens 2004 Olympic Games*. Paper presented at EPINORTH Seminar 5-10 September 2005. Tallinn. Estonia.
- Moody, W. E., Hendry, R. G., and Muscatello, D. (2007). Were attendances to accident and emergency departments in England and Australia influenced by the Rugby World Cup Final 2003? *European Journal of Emergency Medicine*, 14, 68-71.
- Mouchtouri, V., Velonakis, E., Tsakalof, A., Kapoula, C., Goutziana, G., Vatopoulos, A., Kremastinou, J., and Hadjichristodoulou, C. (2007). Risk factors for contamination of hotel water distribution systems by Legionella species. *Applied and Environmental Microbiology*, 73 (5), 1489-1492.
- Mounsey, G., McPherson, C., and Langdon, N. (2007). Pedestrian Planning for the 2006 Commonwealth Games Proceedings of the Institution of Civil Engineers – Municipal Engineer 160 Issue ME4 pp.177-182.
- Newham Borough Council. (2010). [www.newham.gov.uk/.../2010/March/](http://www.newham.gov.uk/.../2010/March/) (Accessed March 2010)
- O’Grady, K-A. and Krause, V. (1997). Public hospital utilisation during the 1997 Arafura Games. *Australian and New Zealand Journal of Public Health*, 23 (2), 218-219.
- Official Report of the Olympiad (Sydney). (2004). Vol. 1, Pt3.
- Olympic Delivery Authority. (2008). *Design and construction Health, Safety and Environment Standard*. 3<sup>rd</sup> Edn. July 2008.
- Orr, H., Kaczmarek, E., Sarangi, J., Pankhania, B., and Stuart, J. (2001). Cluster of meningococcal disease in rugby match spectators. *Communicable Disease and Public Health*, 4, 316-318.
- Panagiotakos, D. B., Costarelli, V., and Polychronopoulos, E. (2007). The perspective of syndromic surveillance systems on public health threats: a paradigm of the Athens 2004 Olympic Games. *Journal of the Royal Society for the Promotion of Health*, 127, 111-112.
- Payne, L. (2008). Preparedness activities ahead of the Beijing 2008 Olympic Games – Enhancing EU epidemic intelligence. *Eurosurveillance*, 13 (32). Accessed from <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=18947>.
- Peiser, B., and Reilly, T. (2004). Environmental factors in the summer Olympics in historical perspective. *Journal of Sports Sciences*, 22, 981-1002.
- Reintjes, R., Kistemann, T., Mac Lehosé, L., McKee, M., Gill, N., Weinberg, J., Schaefer, O., Camaroni, I., Fulop, N., and Brand, H. (2002). Detection and response to a meningococcal

disease outbreak following a youth football tournament with teams from four European countries. *International Journal of Hygiene and Environmental Health*, 205 (4), 291-396.

Ren, A., Shi, J., & Shi, W. (2007). Integration of fire simulation and structural analysis for safety evaluation of gymnasiums. With a case study of gymnasium for Olympic Games in 2008. *Automation in Construction*. 16, pp.277-289.

Reynolds, P., & Pavic, A., (2006). Vibration Performance of a Large Cantilever Grandstand during an International Football Match. *Journal of Performance of Constructed Facilities*, 20, (3), 202-212.

Rowe, I., and Ancliffe, S., (2008). *Guidance on designing for crowds – an integrated approach*. London, CIRIA.

Schenkel, K., Williams, C., Eckmanns, T., Poggensee, G., Benzler, J., Josephsen, J., and Krause, G. (2006). Enhanced surveillance of infectious diseases: The 2006 FIFA World Cup experience, Germany. *Eurosurveillance*, 11 (2). Accessed from <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=670>.

Shaw, M. T. M., Leggat, P. A., and Borwein, S. (2007). Travelling to China for the Beijing 2008 Olympic and Paralympic Games. *Travel Medicine and Infectious Disease*, 5, 365-373.

Sivarajasingam, V., Moore, S., and Shepherd, J. P. (2005). Winning, losing and violence. *Injury Prevention*, 11, 69-70.

Special Olympics – Safety Guidelines 2009. [www.sowa.org](http://www.sowa.org). (Accessed 17/3/2010).

Sun, Y., Fang, D., Wang, S., Dai, M., & Lv, X. (2008). Safety Risk Identification and Assessment for Beijing Olympic Venues Construction. *Journal of management in Engineering*, 25, 40-47.

Thackway, S. V., Delpech, V. C., Jorm, L. R., McAnulty, J. M., and Visotina, M. (2000). Monitoring acute diseases during the Sydney 2000 Olympic and Paralympic Games. *The Medical Journal of Australia*, 173, 318-321.

The Sunday Times “Be an Olympic Winner (28/2/2010) [http://property.timesonline.co.uk/tol/life\\_and\\_style/property/buying\\_and\\_selling/article7042904.ece](http://property.timesonline.co.uk/tol/life_and_style/property/buying_and_selling/article7042904.ece). (Accessed 3/3/2010).

Traversi, D., Degan, R., De Marco, R., Gilli, G., Pignata, C., Ponzio, M., Rava, M., Sessarego, F., Villani, S., and Bono, R. (2008). Mutagenic properties of PM2.5 air pollution in the Padana Plain (Italy) before and in the course of XX Winter Olympic Games of ‘Torino 2006’. *Environmental International*, 34, 966-970.

Vancouver 2010 commits to excellence in Olympic and Paralympic Games venue construction safety. ([www.vancouver2010.com/olympic-news/n/news/vancouver-2010-commits-to-](http://www.vancouver2010.com/olympic-news/n/news/vancouver-2010-commits-to-) (Accessed 15/12/2009).

Varano, S., & Manning, P. K. (2005). *Safety and Security at Special Events: The Case of the Salt Lake City Olympic Games*. *Security Journal*, 18 (4), 65-74.

Verdaguer-Codina, J., Martin, D. E., Pujol-Amat, P., Inef, A. R., and Prat, J. A. (1995). Climatic heat stress studies at the Barcelona Olympic Games, 1992. *Sports Medicine, Training and Rehabilitation*, 6, 167-192.

Wang, W., Primbs, S. T., Simonich, S. L. M. (2009). Atmospheric particulate matter pollution during the 2008 Beijing Olympics. *Environmental Science and Technology*, 43 (14), 5314-5320.

Wardell, R., Dever, B., Amell, B., & Ross, G. (1988). *Design of Temporary Spectator Facilities at Outdoor Winter Athletic Events*. Proceedings of the 21<sup>st</sup> Annual Conference of the Human Factors Association of Canada, 14-16 September.

Weiss, B. P., Mascola, L., and Fannin, S. L. (1988). Public health at the 1984 Summer Olympics: The Los Angeles County experience. *American Journal of Public Health*, 78 (6), 686-687.

Wilks, J. (1999). International tourists, motor vehicles, and road safety: A review of the literature leading up to the Sydney 2000 Olympics. *Journal of Travel Medicine*, 6 (2), 115-121.

Williams, C. J., Schenkel, K., Eckmanns, T., Altmann, D., and Krause, G. (2009). FIFA World Cup 2006 in Germany: enhanced surveillance improved timeliness and detection. *Epidemiology and Infection*, 137, 597-605.

[www.constructionnewsportal.com](http://www.constructionnewsportal.com) (13/11/09). *Safetrak electronic system streamlines inspection and decommissioning of scaffolding structures on three Olympic sites*. (Accessed 17/12/2009).

[www.london.2012.com](http://www.london.2012.com). *Health, safety and security/ODA priority themes/London 2012* (Accessed 15/12/2009).

[www.vancouver2010.com](http://www.vancouver2010.com). Legacy of safety accessed via [www.vancouver2010.com/more-2010-information/sustainability](http://www.vancouver2010.com/more-2010-information/sustainability). (Accessed 15/12/2009).

Yancey, A. H., Fuhri, P. D., Pillay, Y., and Greenwald, I. (2008). World Cup 2010 planning: An integration of public health and medical systems. *Public Health*, 122, 1020-1029.

## 6 ANNEXES

### 6.1 ANNEX 1: FOOD SAFETY

Mass gatherings, such as Olympic events amplify the potential of food borne disease outbreaks because of the increased levels of food production and transportation that are required to meet the demands of venues, hotels and food stores (Hadjichristodoulou et al., 2005). Surveillance systems used in previous Olympic Games have consistently given particular attention to food borne diseases (among others, such as infectious disease outbreaks)(e.g. Thackerway et al., 2000).

Some instances of food borne disease were identified during major sporting events. For instance, there was an outbreak of salmonella enteriditis during a Junior World Rowing Championships in Poland in 1995 whereby several athletes and coaches were affected (Anderson, 1996), whilst during the 1992 Barcelona Games, emergency departments reported an increased number of cases with food borne illness (Panella et al., 1995; cited in Thackerway et al., 2000). On the other hand, no food borne diseases were reported during the Athens 2004 Olympics; some isolated cases of gastroenteritis were observed, which, however were not linked to the Olympic Games (Hadjichistodoulou et al., 2005).

#### 6.1.1 Controls

The primary means of controlling the potential occurrence of food borne diseases has involved enhancing food safety monitoring both prior and during the duration of major sporting events. Specific controls include:

- *Food safety inspections:* Prior to the commencement of the 2000 Sydney Olympics, food safety inspections of food premises were augmented to control for the risks of food borne diseases outside the Olympic venues (Thackerway et al., 2000). At the Atlanta Olympic games in 1996, 150 food inspectors were employed to inspect and monitor food vendors. Other general environmental health services, such as sanitation services and solid waste disposal were also enhanced (Brennan et al., 1997). It is suggested that public health inspectors should be on site during the duration of a mass gathering event to monitor public health compliance and should have the power to cease operations for food vendors that are breaching appropriate food safety standards (DHS, 2005).
- *Microbiological testing of food:* In addition to inspections of Olympic venues, food safety teams during the Sydney and Athens Olympics carried out selective sampling and microbiological testing of foods (e.g. Jorm et al, 2003; Hadjichristodoulou et al., 2006c). During the Sydney Olympics, an estimated 7.5 tonnes of food were destroyed because of safety risks (e.g. Jorm et al., 2003).

### 6.2 ANNEX 2: AIR POLLUTION

Air pollutant levels may increase during mass gatherings, such as major sporting events like the Olympics (e.g. Florida-James et al., 2004). In planning major sporting events, a number of measures have been taken to increase the levels of air pollutants, because of their known associations with chronic ill health. For instance, particulate matter 2.5 (PM 2.5) is an air pollutant which is implicated in several chronic adverse health effects, such as the decrease of respiratory functionality and cancer (Traversi et al., 2008). Increases in the concentration levels of this particular air pollutant may result from constructions during the months before the Olympics, urban traffic and other anthropogenic sources. The levels of air pollutant PM2.5 were monitored over a 14 month period as part of the preparation planning for the 2006 Winter Olympics in Torino (Traversi et al., 2008). Similarly, Wang et al. (2009) measured atmospheric particulate matter (i.e. particles with potentially toxic chemicals)

before, during and after the Olympic Games in Beijing. These particles have been linked with respiratory morbidity and mortality. They found that particulate matter concentrations were higher in Beijing compared to those in other Olympic Game cities (e.g. Atlanta, Sydney and Athens). However, concentration levels were lower when compared to the same time period a year earlier (i.e. 2007). It was hypothesised that the observed decrease was a result of measures that had been implemented to improve air quality (Li et al., 2008; Wang et al., 2009).

Cities hosting the Olympic Games have employed a number of effective measures to reduce air pollutants that typically involve, among others, implementing a traffic management plan (see section 3.1.7.1). For instance, the lack of increase in the levels of PM<sub>2.5</sub> during the 2006 Winter Olympics in Torino were attributed to preventative measures adopted prior to the games, which included provisions of free and more regular public transport, and use of underground transport (Traversi et al., 2008). Friedman et al. (2001) examined the impact of traffic changes implemented during the Atlanta Olympics on concomitant changes in air pollution and experienced asthma among children. They compared the 17 days of the Olympic Games to a baseline period (4 weeks before and 4 weeks after the games) and found that traffic reduction measures were associated with a reduction in ozone pollution and asthma events among children.

### **6.2.1 Controls**

Cities that have hosted previous Olympic Games have implemented a number of successful measures to control the emission of air pollutants (e.g. Shaw et al., 2007; Li et al., 2008). During the Atlanta Olympic Games in 1996, the following controls were implemented:

- Development and use of an integrated 24-hr a day public transportation system,
- Addition of 1,000 buses for park-and-ride services,
- Local business use of alternative work hours and telecommuting,
- Closure of the downtown sector to private vehicles.

Prior to the 2008 Beijing Olympics, the Chinese government implemented a number of measures to reduce air pollutants, which included:

- Utilisation of clean energy resources, such as liquefied petroleum and natural gas,
- Using an even-odd number plate system on alternate days to reduce the number of cars on the roads,
- Relocating and/or closing approximately 140 enterprises considered as ‘serious polluters’, and
- Slowing down construction activities as a means of controlling dust pollution.

### 6.3 ANNEX 3: TEMPLATE FOR DATA EXTRACTION

#### Article title

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Reviewer		Reference number	
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#### Ranking for relevance to the Olympics

3	An Olympic event from the last 25 years (or older if issues identified still appear current)
2	A major sporting event involving multiple sports or events with multinational representation in the last 25 years (e.g. Commonwealth games), or Olympic events older than 25 years
1	A major sporting event with international representation for a single sport (e.g. world cup (rugby or football), tour de France)
0*	Other events (e.g. not sport related)

#### Phase of event:

Pre event (design, planning, construction)	
During Event	
Post Event (legacy, removing temporary structures etc)	

#### Group included:

Athletes	
Public	
Duty Holders	
Employees	
Sub contractors	
Regulator	
Other Bodies (please state)	

#### Business sectors covered:

Manufacturing	
Transport	
Construction	
Government	
Security	
Services (please state)	
Communications / media	
Other (please state)	

---

\* i.e. Generally excluded, unless the article appears to provide information key to the aims of the research.

**Hazards<sup>5</sup>/risks<sup>6</sup> identified:** (e.g. work at height, machinery, crowding)

--

Method adopted for hazard/risk identification

--

**Stage that hazards/risks were identified** (proactive or reactive)

--

**Type of harm associated with risks/hazards:** (e.g. fatality, broken bone, fracture, cut, respiratory illness)

--

Is the type of harm:

Health related	
If health related is it, or could it be long latency: Yes / No	
Safety related	
Both	

Mitigation or control measures identified/applied

--

Further mitigation or control measures suggested

---

<sup>5</sup> "...the potential for harm arising from an intrinsic property or disposition of something to cause detriment..."

<sup>6</sup> "...the chance that someone or something that is valued will be adversely affected in a stipulated way by the hazard."

**Resources associated with mitigation & controls (e.g. cost, timescales)**

**Article summary**

**Scientific robustness**

**Article/study type:**

4	Meta analyses, systematic reviews and similar research
3	Peer reviewed journal articles Evidenced based policy documents (if from a credible source)
2	Trade paper with editorial review & other sources such as credible news articles
1	All other sources (e.g. purely anecdotal)

**Comments on the study design**

Strengths

Limitations

## 6.4 ANNEX 4: ARTICLE SUMMARIES

**Author(s): Anderson, A.C. (1996).**

**Title: Outbreak of salmonella food poisoning at Junior World Rowing Championships.**

**Article summary:**

*Paper describes an outbreak of Salmonella enteritidis occurring at the junior world rowing championships at Poznan, Poland in August 1995, which had a significant effect on the performance of several of the largest national teams.*

**Key risks identified:**

*Food poisoning, specifically salmonella enteritidis.*

**Key control measures identified:**

*Health surveillance, treatment with dioralyte rehydration solution, loperamide, cinnarizine, paracetamol, and ciprofloxacin.*

**Author(s): ANON. (2001).**

**Title: NA.**

**Article Summary:**

*Overview of the issues, faced at the Olympics in Sydney.*

**Key Risks Identified:**

*Temporary structures and management of crowds including people in wheelchairs.*

**Key control measures identified:**

*Regular checks of temporary structures.*

*Structured training programme for workers onsite, including volunteers.*

**Author(s): NA**

**Title: ATHOC. (2004). Official Reports of the XXVII Olympiad (Athens) Volume 1: The Homecoming of the Games - Organisations and Operations.**

**Article summary:**

*Lessons learned from experiences of running the Athens games.*

**Key risks identified:**

*Need for health surveillance in swimming pools, lack of training of staff.*

**Key control measures identified:**

*Use of volunteers, regular testing of swimming pools, training and organising of staff.*

**Author(s): Banwell, K. (2000).**

**Title: Environmental health preparation for the Sydney 2000 Olympic and Paralympic Games.**

**Article summary:**

*The paper describes the environmental health planning for the Sydney 2000 Olympics and in particular for minimising the risk of an outbreak of legionnaires disease.*

**Key risks identified:**

*Waterborne diseases and exposure to bacterium Legionella pneumophila.*

**Key control measures identified:**

*Description of strategies to maximise compliance with the cleaning and maintenance provisions for cooling towers which included: maintenance of GIS database of all cooling towers registered with local councils; review of the Legionella Emergency Management Plan; inspection of cooling towers in areas of potential risk; and provision of educational material on best management to building owners and operators.*

**Author(s): Bowie, V. (2000).**

**Title: Planes, trains and prostitutes: dealing with potential workplace violence encountered by Olympic support services.**

***Article summary:***

*The paper argues that Olympic-related services (such as international and national transport services, retail, enforcement and crowd control agencies, hospitality and tourism) may be exposed to 4 different types of violent incidents: internal (violent acts by current or former employees of an organisation), external (violence committed by external intruders who have no relationship with the organisation), service-related (aggressive acts by customers/clients of a service) and organisational (organisations placing employees in dangerous situations or allowing a climate of bullying to develop in the workplace). It is suggested that Olympic events may be at risk of experiencing external violence in particular. Each Olympic service will have its own unique violence profile - several methods are suggested for identifying risks associated with workplace violence.*

***Key risks identified:***

*Violent acts.*

***Key control measures identified:***

*Measures include: safety audits, workplace inspections, hazard reports, injury and illness records, compensation and rehabilitation reports, grievance and OHS complaints, discussion with staff and unions and workplace observations. The standard action hierarchy of elimination, substitution, engineering and administrative controls and use of appropriate PPE is proposed for managing workplace violence.*

**Author(s): Brennan, R. J., Keim, M. E., Sharp, T., W., Wetterhall, S. F., Williams, R. J., Baker, E. L., Cantwell, J. D., and Lillibridge, S. R. (1997).**

**Title: Medical and public health services at the 1996 Atlanta Olympic Games.**

**Article summary:**

*This paper reviews the 1996 Atlanta Olympics hoping to benefit from the experience to plan for the 2000 Sydney Olympic games. The paper finds that excellent health promotional and prevention activities before and during the games resulted in fewer medical and public health problems than anticipated. However, there was room for improvement in the level of communication and cooperation between the many service providers to ensure the most appropriate and efficient response.*

**Key risks identified:**

*Heat related illness, food safety and environmental health, infectious diseases, terrorist attack.*

**Key control measures identified:**

*Monitoring of heat related illnesses at specific venues meant there could be an increase public awareness announcements at these venues, encouraging spectators to drink more fluids to seek shade and to recognise the symptoms of heat related illness.*

*Extensive media public awareness campaign supplemented pamphlets sent to ticket purchasers informing them of preventative measures.*

*Shelter, water consumption, wide brimmed, hats fans, sunscreen, and prevention information provided to pedestrians.*

*Water misters attached to high velocity evaporative fans at most crowded sites to help cool spectators and pedestrians.*

*Guidelines on recognition and management of heat related illness to hospitals.*

*Consequently it was found that heat related illness was less common than anticipated, diagnosed in 10% of patients examined by physicians at Olympic venue clinics and first aid stations, although this could have reflected the cooler than expected weather. About 150 food and drug inspectors were employed to inspect and monitor food vendors who had to comply with strict state health and safety regs and to have an official licence.*

*Active surveillance allowed for spotting unusual presentations and infectious disease outbreaks.*

*Safe sex campaign to limit spread of STDs via posters, pamphlets and buttons.*

*Revising disaster plans, educational programs to address mass casualty incidents, training in bio and chemical exposed patients.*

**Author(s): Comeau, E. (2002).**

**Title: The Salt Lake City challenge - 2002 Olympic follow-up.**

**Article summary:**

*The article gives a retrospective account of the fire protection that was in place during the 2002 Olympics at Salt Lake City. It describes incidents that the fire department dealt with during the games such as the presence of hazardous materials (suspicious packages) as well as the challenges faced such as access because of temporary buildings, structures and crowds. Measures in place to deal with fire incidents as well as potential terrorism incidents included setting up additional, temporary stations dedicated to Olympic-related incidents, assignment of venue commanders for each Olympic venue to co-ordinate local responses to incidents, providing additional staff at the airports. Fire department also assisted with emergency medical response - there were five medical teams (four on bikes and one on a golf cart). Key to the successful operations were working with outside agencies and planning early.*

**Key risks identified:**

*Use of fireworks, suspicious packages/hazardous materials, mass gatherings/demonstrations.*

**Key control measures identified:**

*Set up of 2 separate fire departments during the Olympics: one for the city (Salt Lake City) and one for the Olympic village - the Olympic village temporary fire station was equipped with a rescue engine (staffed with 2 paramedics), ladder truck and a battalion chief. There were 3 other stations located outside the Olympic village perimeter that had a separate engine assigned to them specific for Olympic response. The engines were checked daily by a Department of Defence bomb team. The Fire Department assigned a venue commander (captain) to each of the venues who oversaw the operations of personnel including inspectors, firefighters in the event of fire incident until outside resources responded/senior officers arrived. Provision of two-person bike teams and personnel on golf carts to accommodate the potential increase in emergency medical responses during the events. These were available in the Olympic Plaza during open hours. Put in place new dispatch centre and four additional dispatchers per shift to handle the volume of calls received.*

**Author(s): Connor, N. (2004).**

**Title: Simulating pedestrian circulations for Olympic planning.**

**Article summary:**

*Article details use of pedestrian simulation software to predict crowd movements and help in the design of stadium entrances, walkways, train capacities, and so on. Foresight from the simulations allows crowd management to be planned and queuing systems designed. Congestion problems can be identified and solutions sought. Also enables transport operators to improve on-time running, extend station life, optimise construction costs, increase passenger satisfaction, and improve health and safety.*

**Key risks identified:**

*Public health and safety risks associated with crowding.*

**Key control measures identified:**

*Planning committee used pedestrian simulation to reliably predict how people would move in a given scheme or scenario. This aids in planning effective infrastructure truly capable of coping with peak demands, limits infrastructure costs and tests proposed schemes before investing, mitigates risks, and quantifies differences of proposed schemes, tests and improves operational effectiveness, and aids communication across agencies.*

**Author(s): Cooke, M.W., Allan, T.F., and Wilson, S. (1999).**

**Title: A major sporting event does not necessarily mean an increased workload for accident and emergency departments.**

**Article summary:**

*The paper examined whether the workload for accident and emergency (A&E) departments increased as a result of attendance at the Euro96. Fourteen accident and emergency departments (7 close to the Euro 96 venue and 7 more distant ones) were contacted and requested to provide their daily attendance figures over a 9-week period. They found no significant associations between daily attendance figures in emergency departments and the day of the football match. Although some emergency departments showed increases in attendance figures, these were not related to the football match. It is possible that individuals may have delayed going to A&E until after the sports tournament had ended but this was not examined.*

**Key risks identified:**

*Increases in local population; increases in violent incidents; sports injuries.*

**Key control measures identified:**

*NA*

**Author(s): Cummiskey, J.,Borrione, P., Bachil, N., Ergen E., and Pigozzi, F. (2008).**

**Title: Report of a serious reportable communicable disease at a major sporting event.**

***Article summary:***

*The paper reports on a case of meningitis outbreak during a European Youth Olympic sports festival and how it was contained. The Local Health Authority and National Public Health Authority of the patient's country was informed. The patient was treated at a local hospital and was able to make a full recovery. Prophylactic therapy was given to the patient's inner circle and the outer circles of contacts were under daily surveillance for symptoms. Each participating country was also informed - this was done at the event by informing the Chef of the Missions and writing to the Secretary Generals of each National Olympic Committee attending.*

***Key risks identified:***

*Meningitis.*

***Key control measures identified:***

*Treatment of patient at local hospital; provide inner core contacts (i.e. people who would have been in direct contact with patient) prophylactic drugs. Surveillance of other close contacts for symptoms on a daily basis. Each participating country was also informed - this was done at the event by informing the Chef of the Missions and writing to the Secretary Generals of each National Olympic Committee attending.*

**Author(s): Davis, X. M., MacDonald, S., Borwein, S., Freedman, D.O., and Kozarsky, P.E (2008).**

**Title: Short report: Health risks to travellers to china: The geosentinel experience and implications for the 2008 Beijing Olympics.**

***Article summary:***

*Selected data collected for travellers to China from 1998 to Nov 2007 by the GeoSentinel Surveillance network were used to provide an evidence base for prioritising recommendations for Olympic and other future travellers to China. Respiratory illnesses and injuries were common among patients seen during their travel; acute diarrhoea and dog bites were common among those seen after travel. Tropical and parasitic diseases were rare. Pre-travel consultation for travellers to China should be individualised according to these findings.*

***Key risks identified:***

*Top individual diagnoses among selected main syndrome groups for China travellers seen during travel: respiratory - upper respiratory tract infection, acute bronchitis, allergic rhinitis, asthma, acute otitis media. Dermatologic - eczema, insect sting, non-drug-related allergic rash, skin abscess, superficial skin infection. Injury - sprain/strain, laceration, contusion, fracture, abrasion.*

***Key control measures identified:***

*Health outcomes of travel to China were not 'exotic' compared with travel to the typical tropical countries of Asia but were substantial enough to result in medical encounters for a variety of significant health events. Travellers and health care practitioners should work together to ensure safe and healthy travel to China.*

**Author(s): Deakin, C.D., Thompson, F., Gibson, C., and Green, M. (2007).**

**Title: Effects of international football matches on ambulance call profiles and volumes during the 2006 World Cup.**

***Article summary:***

*Prompt ambulance attendance is aimed at improving patient care, however, unforeseen demand precludes the ability to tailor resources to cope with increased call volumes and can have a marked detrimental effect on performance and hence patient care. Emergency calls were analysed from the first weekend of the 2006 world cup football match by volume and classification. There were distinct peaks before and after match with increases in alcohol related emergencies including collapse unconsciousness assault and road traffic accidents. The mapping showed a significant increase in overall emergency calls and mapping of limited resources to these patterns will allow improved responses to emergency calls.*

***Key risks identified:***

*Alcohol related emergencies including collapse, unconsciousness, assault and road traffic accidents.*

*Patient care is detrimental by unforeseen demand on ambulance service during public events.*

***Key control measures identified:***

*Having established the increased volume of calls resulting from the initial day of the world cup resources were reconfigured to cope with anticipated increased demand on subsequent days.*

**Author(s): Decker, S. H., Greene, J. R., Webb, V., Rojek, J., McDevitt, J., & Bynum, T. (2005).**

**Title: Department of Homeland Security (DHS). Special events contingency planning: Job Aids manual.**

***Article summary:***

*US document - Department of Homeland Security (DHS) and Federal Emergency Management Agency (FEMA). Document provides guidance for the management of risks associated with conducting events that involve mass gatherings of people and assist planners and organisers in making such events safe and successful. Document identifies the elements that should be considered by those responsible for planning and conducting events that attract large numbers of people. Document not geared towards large international events e.g. Olympics, more focused on 'routine' events such as parades, fairs, concerts and air shows.*

***Key risks identified:***

*Spectator management and crowd control, traffic and transportation, public health, medical care, environmental concerns, aircraft, camping, hazardous materials, chemical, biological, radiological, nuclear, explosive, fire safety, communication systems, rumour control, alcohol, drugs, weapons.*

***Key control measures identified:***

*Standardised organisational structures, multi-agency coordination systems, public information systems should be clearly defined and understood, as should all processes, procedures, and systems designed to improve interoperability among jurisdictions and disciplines. Careful consideration should be given to physical layout of the event, spectator management, public safety, public health, and medical care in the planning of large scale events. Pre-events plans reduce response times and better enable agencies to improvise because they have discussed contingencies beforehand. A pre-event plan defines roles and responsibilities in advance and creates ownership of potential problems for agencies that are involved in the process.*

**Author(s): Duda, M. (1988).**

**Title: Striving for safe, healthy and fair summer Olympics.**

**Article summary:**

*The paper describes the medical preparedness of the US medical team to provide support to the 640 US athletes attending the 1988 Olympic Summer Games in Korea. The main risks identified were potential for transmission of infectious diseases, heat and injuries sustained by contact sports.*

**Key risks identified:**

*Heat, contact sports (e.g. wrestling, judo, boxing) and transmission of infectious diseases.*

**Key control measures identified:**

*Ensuring that medical team can adequately deal with any health issues that may arise; having sufficient number of staff for the number of athletes attending event; Olympic organising committee provided a poly clinic, including a walk-in primary care clinic, a 20-bed overnight infirmary for overnight observation, a physical therapy center and a pharmacy. Educating athletes about the potential for infectious diseases during the games.*

**Author(s): Ehresmann, K. R., Hedberg, C. W., Grimm, M. B., Norton, C. A., MacDonald, K. L., and Osterholm, M. T. (1995).**

**Title: An outbreak of measles at an international sporting event with airborne transmission in a domed stadium.**

**Article summary:**

*The paper reports on an outbreak of measles during the International Special Olympics in the US in 1991. The disease was transmitted from an athlete to 24 people, 16 of which had attended the Olympics. The transmission occurred at the opening ceremony in a domed stadium, at the track and field events and the first aid stations. The transmission of the disease to spectators led authors to suggest that it occurred through the stadium's ventilation system. Controls suggested to prevent transmission included adequate immunisation of athletes, visitors etc and consider the importation of diseases by athletes and staff at the planning stages.*

**Key risks identified:**

*Airborne transmission of measles.*

**Key control measures identified:**

*Immunisation.*

**Author(s): Engineering News Record (17/6/1996).**

**Title: Engineer suspended over Olympic stadium error.**

**Article summary:**

*An engineers design error was blamed for a collapse of a tower in the Olympic stadium that killed an ironworker. Although it states that he knew of his error he failed to stop work on the tower or indicate urgency for the needed retrification.*

**Key risks identified:**

*Design error of tower at Olympic stadium in Atlanta.*

**Key control measures identified:**

*NA.*

**Author(s): Engineering News Record. (15/5/1995).**

**Title: Olympic light towers to get steel bracing.**

**Article summary:**

*After one of the tower assemblies collapsed and killed a worker structural work is to be carried out on the other towers.*

**Key risks identified:**

*Under designed towers at the Olympic stadium in Atlanta.*

**Key control measures identified:**

*Bracing to be added.*

**Author(s): Enock, K.E. Jacobs, J. (2008).**

**Title: The Olympic and Paralympic Games 2012: Literature review of the logistical planning and operational challenges for public health.**

**Article summary:**

*Literature review of relevant research pertaining to large sporting events and Olympic games.*

**Key risks identified:**

*Heat-related illnesses, food borne and waterborne illnesses, sexually transmitted diseases, and communicable diseases. Also minor complaints, e.g. headache, fatigue, minor abrasions, lacerations, sunburn and bee stings. Minor trauma, exposure-related or exertion-related illnesses, heat exhaustion, muscle injuries, alcohol abuse, illicit drug usage, dehydration.*

**Key control measures identified:**

*Setting new policies and procedures for management of public health and environmental hazards, e.g. suspension of food service permits, specified numbers of water containers at each venue, defined acceptable standards for accommodation, water quality standards, provision of required number of portable toilets, control of illegal food outlets, food site inspections, inspections of water cooling systems, waste services, sanitation services and solid waste disposal.*

**Author(s): Florida-James, G., Donaldson, K., Stone, V. (2004).**

**Title: Athens 2004: The pollution climate and athletic performance. Journal of Sports Science and Medicine, 22 (10), 967-980.**

**Article summary:**

*Impact of air pollution on athlete's performance.*

**Key risks identified:**

*Air pollution.*

**Key control measures identified:**

*Traffic management.*

**Author(s):** Friedman, M. S., Powell, K. E., Hutwagner, L., Leroy, G. M., and Teague, G. W. (2001).

**Title:** Impact of changes in transportation and commuting behaviours during the 1996 summer Olympic Games in Atlanta on air quality and childhood asthma.

**Article summary:**

*Vehicle exhaust is a major source of ozone and other air pollutants. Although high ground level ozone pollution is associated with transient increases in asthma morbidity the impact of citywide transportation changes on air quality and childhood asthma has not been studied. The alternative transportation strategy implemented during the 1996 summer Olympic games in Atlanta provided such an opportunity. It was found that the efforts to reduce the downtown traffic congestion during the games was associated with a prolonged reduction in ozone pollution and significantly lower rates of childhood asthma events (albeit temporary) decrease in the burden of asthma among Atlanta's children.*

**Key risks identified:**

*Vehicle exhaust is a major source of ozone and other air pollutants.*

**Key control measures identified:**

*Efforts were made to reduce downtown traffic congestion during the Olympic Games resulting in decreased traffic density especially during the critical morning period. This was associated with a prolonged reduction in ozone pollution and significantly lowers rates of childhood asthma events. Development and use of an integrated 24 hour a day public transportation system, the addition of 1000 buses for park and ride services, local business use of alternative work hours and telecommuting, altered downtown delivery schedules and public warnings of potential traffic and air quality problems.*

**Author(s):** Geokas, M. C. and Papanicolaou, S. (2001 ).

**Title:** Bloodshed on Asphalt and why the thing bites back: Traffic safety issues in Greece prior to the 2004 Summer Olympics.

**Article summary:**

*This article recognised that its grim accident and death rate on the roads would need to be tackled before the Olympics as this would bring in a huge influx of athletes and tourists and even one deadly car crush with foreign victims will amount to a big catastrophe for Greece in the eyes of the whole world. It appears that the road network is very different from the UK so these control measures may not apply for the 2012 Olympics.*

**Key risks identified:**

*Inadequate management of vehicle traffic in Greece.*

*Inadequate secondary road network in provinces of Greece.*

**Key control measures identified:**

NA

**Author(s):** Gioulekas, D., Damialis, A., Papakosta, D., Syrigou, A., Mpaka, G., Saxoni, F., and Patakas, D. (2003).

**Title:** 15-year aeroallergen records: Their usefulness in Athens Olympics, 2004.

**Article summary:**

*The paper introduced a methodology for calculating the presence of aeroallergens in 3 Olympic cities and aimed to provide this information to athletes participating in the Athens Olympics in 2004.*

**Key risks identified:**

*Exposure to aeroallergens for athletes with respiratory allergens*

**Key control measures identified:**

NA

**Author(s):** Gryllis, C. (2005).

**Title:** Surveillance during mass gatherings.

**Article summary:**

*Athens 2004 preparations - Olympic games and travel medicine office, Hellenic centre for infectious diseases control. This body designed and implemented an approach to monitor and respond to public health issues during the games. Approach included raising awareness, increasing laboratory resources and reporting for physicians, preparedness plans, management of incidents plans, response coordination including collaboration with other agencies, training events for additional staff and volunteers. Learning includes importance of increased capacity for response, separation of surveillance and response processes, time required to plan and deliver strategy is minimum 2 years, importance of public health infrastructure, importance of admin and logistics support, and contingency planning. Also importance of 'inside the fence' perspective, to be integrated into planning, benefits of public health experts with previous experience, and international advisors. Actions hold long term benefits, however recognised not enough pre-games planning for the post-games assimilation of activities/plans.*

**Key risks identified:**

*All public health issues, e.g. varicella, gastroenteritis, rubella, measles, pertussis, mumps, respiratory infections.*

**Key control measures identified:**

*Implementation of surveillance team, coordination team, coordination centre, standard operating procedures, increased sensitivity concerning response, 4 outbreak investigation teams - rotating schedule, fact sheets for general public and media, protocol/guidelines for single case and outbreak management.*

**Author(s):** Gundlapalli, A. V., Rubin, M. A., Samore, M. H., Lopansri, B., Lahey, T., McGuire, H. L., Withrop, K. L., Dunn, J. J., Willick, S. E., Vosters, R. L., Waeckerle, J. F., Carroll, K. C., Gwaltney, J. M., Hayden, F. G., Elstad, M. R., and Sande, M. A. (2006).

**Title:** Influenza, Winter 2002.

**Article summary:**

*The study was performed at the Olympic village polyclinic during winter Olympics 2002, Salt Lake City. Athletes and non-athletes with upper/lower respiratory symptoms were screened for influenza by various modalities. Viral test results and public health reports of influenza in the local community were reviewed daily. Three distinct clusters were identified during the games. Cluster 1 consisted of 13 law enforcement personnel who worked and lived in close proximity, Cluster 2 consisted of 12 members of a national team who had trained together at a common location before arrival at the Olympic village, Cluster 3 consisted of 8 participants of 1 sport which had 80 participants with common training venues. The surveillance and intervention strategy used in this study may serve as a model for mobilising teams to provide health care to a large assembly of participants. Empirical treatment based on clinical and epidemiological data combined with testing may be a prudent approach to influenza control in large gatherings. Similar approaches may enhance preparedness for public health threats and emerging respiratory pathogens such as avian influenza and agents of bio terrorism.*

**Key risks identified:**

*Influenza A and B.*

**Key control measures identified:**

*Potential clusters of influenza were promptly identified, index patients were treated with oseltamivir and contacts were given oseltamivir prophylaxis.*

**Author(s):** Hadjichristodoulou, C., Goutziana, G., Mouchtouri, V., Kapoula, C., Konstantinidis, A., Velonakis, E., Vatopoulos, A., and Kremastinou, J. (2006a).

**Title:** Evaluation of standardized scored inspections for Legionnaires' disease prevention, during the Athens 2004 Olympics.

**Article summary:**

*This study looked at evaluating the utility of inspection scoring systems in predicting legionoellas proliferation in water systems and in preventing legionnaires disease and it concludes that prevention planning and implementation strategies of policy makers and regulators would include standardized scored inspections of water sites.*

**Key risks identified:**

*Legionella.*

**Key control measures identified:**

*Inspections.*

**Author(s):** Hadjichristodoulou, C., Mouchtouri, V., Vousourelis, A., Konstantinidis, A., Petrikos, P., Velonakis, E., Boufa, P., and Kremastinou, J. (2006b).

**Title:** Waterborne diseases prevention: evaluation of inspection scoring system for water sites according to water microbiological tests during the Athens 2004 pre-Olympic and Olympic period.

**Article summary:**

*The study shows the utility of standardised inspection grading systems in waterborne diseases prevention planning and implementation strategies of policy makers and regulators. The relation between the standardised inspections results of 716 water supply systems and 289 public swimming pools, and microbiological test results of 2358 samples collected during inspections was examined. Future water quality assessment should be based on the implementation of a robust standardised inspection system and reduce the need of microbiological tests.*

**Key risks identified:**

*Microbiological risks in Olympic swimming pools, and water supply systems.*

**Key control measures identified:**

*Inspection grading systems for water site inspections - implemented in two years prior to and during 2004 Olympics. Guidelines for safe operation of swimming pools and standardised water disinfection guidelines were prepared and distributed to the facility owners together with instructions to the public for healthy swimming.*

**Author(s):** Hadjichristodoulou, C., Mouchtouri, V., Vaitis, V., Kapoula, C., Voutsourelis, A., Kalivitis, I., Chervoni, J., Papastergiou, P., Vasilogiannakopoulos, A., Daniilidis, V. D., and Kremastinou, J. (2006c).

**Title:** Management of environmental health issues for the 2004 Athens Olympic Games: Is enhanced integrated environmental health surveillance needed in every day routine operation?

**Article summary:**

*Between January 2003 and September 2004, 196 inspectors conducted 8562 inspections, collected 5024 water samples and recommended 17027 corrective actions. Resources from health inspection agencies. Lessons learned include timely implementation and installation of communication processes, rapid response to unsatisfactory inspection results. Recommend to adopt enhanced health surveillance aimed at public health decision making.*

**Key risks identified:**

*Environmental health risks - food outlets, water supply.*

**Key control measures identified:**

*Centrally managed data from sites, supervised and coordinated prompt corrective actions for sites with unsatisfactory inspection results.*

**Author(s):** Hadjichristodoulou, C., Mouchtouri, V., Soteriades, E. S., Vaitzi, V., Kolonia, V., Vasilogiannacopoulos, A. P., and Kremastinou, J. (2005).

**Title:** Mass gathering preparedness: The experience of the Athens 2004 Olympic and Para-Olympic Games.

**Article summary:**

*The paper describes the approach adopted in order to identify deficiencies in the public health infrastructure and the major public health risks during the Athens Olympic Games. The paper discusses the needs assessment process that was carried out to address deficiencies in the public health infrastructure. This involved on-site visits to several public health agencies to identify personnel, resource and training-related deficiencies. An intense program of environmental health inspections before and especially during the Olympic games was put in place to ensure the safety and sanitation of food, drinking water, waste management etc.*

**Key risks identified:**

*Enhanced production and rushed transportation of large quantities of food and bottled water (to meet increased demand); confines of indoor venues or cruise ships increase airborne transmission of diseases.*

**Key control measures identified:**

*A total of 196 public health inspectors were considered necessary to execute health inspections during the pre-Olympic and Olympic periods. Main inspection issues included: safety and sanitation of food (preparation and service), drinking water, pest control, waste management, toilet sanitation, cooling towers, swimming pools and other water sport venues. Environmental health inspections during the event used as a means of preventing the distribution of contaminated foods. Daily reporting of inspection results allowed the executives to be informed in real time and make decisions at short notice.*

**Author(s): Heggie, T.W. (2009).**

**Title: Travelling to Canada for the Vancouver 2010 Winter Olympic and Paralympic Games.**

***Article summary:***

*Paper reviews health and safety issues for all travellers to Canada for 2010 Vancouver winter Olympic games with a specific focus on pre-travel planning, road and transport safety, natural and environmental hazards, Olympic medical facilities, safety and security, and infectious disease.*

***Key risks identified:***

*Motor vehicle crashes, natural and environmental hazards e.g. avalanche, earthquakes, tsunami, infectious disease, crimes against the person e.g. mugging.*

***Key control measures identified:***

*Numerous strategies recommended, e.g. road safety awareness.*

*Observe all avalanche warning signs posted along roadways, at ski resorts, and at other recreational destinations.*

*Obey all road, trail, and wilderness area closures.*

*Do not attempt to drive through avalanches - not even small ones.*

**Author(s):** Hiltunen, T., Kuisma, M., Määttä, T., Tennilä, A., Hari, T., Bäckman, R., and Väyrynen, T. (2007).

**Title:** Prehospital emergency care and medical preparedness for the 2005 World Championship in athletics in Helsinki.

**Article summary:**

*The paper is an observational study that described the success of medical preparedness during the Helsinki Games; the data collection was prospective and included data from all emergency calls at the sports venues, patient characteristics and causes of emergencies from medical reports provided by on-site first aid. Situations that were attended to during the games included chest pains, dyspnoea, unconsciousness, intoxication, abdominal pains, dehydration, seizures, fall. The most common cause for ambulance calls was traumatic injuries and infections. The success of medical preparedness during the games was based on careful and timely planning, analysis of local risks, good coordination among the different authorities and clear command/reporting structures.*

**Key risks identified:**

*Chemical, biological, radiological or nuclear incidents (CBRN); heat, air humidity, number of spectators attending, duration of event and availability of alcohol.*

**Key control measures identified:**

*Operating protocols in place to deal with the occurrence of special situations that included: bomb threats, illicit drug use, contagious diseases and epidemic situations; planning of medical preparedness 18 months in advance of games; good coordination and cooperation between rescue authorities, hospitals and police (e.g. on-site medical command). Increases in number of ambulance units (1-2) the day preceding the games, day after the games and during walking and marathon races. One extra ambulance added to city's emergency medical services after the closure of the temporary rescue station every night for the duration of the games. 46 professionals worked at any time including people with first-aid backgrounds and health professionals.*

**Author(s): Home Office. (2006).**

**Title: Partial Regulatory Impact Assessment on Security Guards at Sports and Other Events and the Private Security Industry Act 2001.**

***Article summary:***

*Home office document - Regulatory Impact Assessment considering the options available for applying the Private Security Industry Act (PSIA) to security staff at sports and other events, and sets out the Governments views on the options and seeks comments on issues relating to implementation. The PSIA establishes a framework of controls including licensing of all individuals engaging in licensable activity in five industry sectors: vehicle immobilisers (wheel clampers), manned guards, key holders, security consultants, and private investigators.*

***Key risks identified:***

*All security risks, e.g. crime and disorder.*

***Key control measures identified:***

*Effective regulation of the Private Security Industry with reference to the Private security Industry Act 2001 to ensure all security staff are of a certain standard and adhere to requirements of the Act, e.g. licensing of individuals engaged in licensable activities.*

**Author(s): Home Office. (2009).**

**Title: London 2012 - Olympic and Paralympic Safety and Security Strategy.**

**Article summary:**

*Top level home office strategy document detailing various organisations' involvement in the planning, preparation and delivery of the 2012 games. Sets out vision, aim, objectives and accountability of the various bodies, success criteria, planning principles and assumptions, and safety and security programme structure, and strategic governance.*

**Key risks identified:**

*Hazards associated with safety, security, emergency services.*

**Key control measures identified:**

*Protect programme (ID assurance, VIP protection, Site and venue security, Chemical, Biological, Radiological, Nuclear and explosive, Transport security, Border security) Prepare programme (Olympic resilience, Specialist response, Critical Olympic supporting infrastructure) Identify and disrupt programme (Olympic intelligence, Serious and organised crime, volume crime, CCTV, Automatic number plate recognition) Command, control, plan and resource programme (National resource requirement, Meeting demand, Training, Operations logistics infrastructure, National co-ordination, Airwave, Olympic control infrastructure) Engage programme (International relations, Community relationships, Volunteers, Prevent, Industry).*

**Author(s): HSE**

**Title: Memorandum of guidance on the Electricity at Work Regulations 1989, HSE. (1989).**

**Article summary:**

*Regulations relating to electricity in the workplace.*

**Key risks identified:**

*Electrical.*

**Key control measures identified:**

*Comprehensive HSE document covering a variety of controls that are generic (i.e. not specific to the Olympics).*

**Author(s): HSE**

**Title: The Event Safety Guide. A guide to health, safety and welfare at pop concerts and similar events. HSE. (1999).**

**Article summary:**

*Over 200 pages of detailed information on how to host large scale entertainment events, e.g. music events. Lots of useful information for music concert type events, some relevance to Olympics, but not entirely.*

**Key risks identified:**

*Venue and site design, fire safety, crowding, transport, structures, electrical infrastructure e.g. lighting, food and water hygiene, sanitation, waste management, noise and vibration.*

**Key control measures identified:**

*Follow HSW Act 1974, Apply reasonably practicable controls for the various hazards identified, e.g. vehicle access - have designated vehicle routes.*

**Author(s): Hulme, B. (2001).**

**Title: Protecting the people's Games - debriefing in post- Olympics Sydney.**

**Article summary:**

*The paper describes the preparation of the emergency response teams for the Sydney Olympics to potential chemical, biological and radiological incidents, and fires. The success of the response team was due to the use of risk assessments, development of emergency protocols, extensive training and inspections.*

**Key risks identified:**

*Fire, release of potentially dangerous chemical substances.*

**Key control measures identified:**

*Use of risk assessment to develop chemical, biological and radiological capabilities for emergency response teams (e.g. fire brigade, defence forces). Extensive training for all emergency response staff using chemical, biological and radiological exercises; pre-planned protocols to deal with emergencies. Daily inspection of all Olympic venues prior to occupancy by accredited fire safety officers - group of 20 officers carried out daily inspections to ensure that there were no breaches of the safety systems installed.*

**Author(s): IWW. (2009).**

**Title: Olympic dream or workers' nightmare? An inside report on health & safety conditions at the London 2010 Olympic site.**

**Article summary:**

*Whistle blowing report from anonymous authors from IWW construction workers industrial union, critical of current practices on 2012 Olympics construction sites, e.g. PPE not worn, pressure from management, and so on. No substantive evidence base.*

**Key risks identified:**

*Construction health and safety hazards.*

**Key control measures identified:**

*PPE, and safety culture inferred.*

**Author(s): Jorm, L. R., Thackway, S. V., Churches, T. R., and Hills, M. W. (2003).**

**Title: Watching the games: public health surveillance for the Sydney 2000 Olympic Games.**

**Article summary:**

*The paper describes the public health surveillance system used in the Sydney Olympics and how it was developed. The objective of the system was to detect quickly emerging disease outbreaks (see control measures and resources for a description of the surveillance system). The success of the public health surveillance system was attributed to careful planning (3 years in advance of the games), a comprehensive coverage of public health issues and the timely reporting and communication of relevant data (e.g. daily reports highlighting important issues sent to the peak health decision making body for the games). The most acute public health issues that emerged related to injuries and illicit drug-related events. The use of a free text injury description field (in addition to data collected in categorised fields) allowed the identification of emerging issues such as use of specific drugs.*

**Key risks identified:**

*Food borne illnesses, terrorism, measles, rubella, pertussis, meningococcal and viral meningitis, tuberculosis, sexually transmitted diseases, viral haemorrhagic fevers, blood borne pathogens, water borne illness, legionnaires disease, Giardia cysts and Cryptosporidium oocysts, bioterrorism.*

**Key control measures identified:**

*Application of an 'active' public health surveillance to ensure the timely detection of disease outbreaks immediately before, during and after the Olympics. Mitigation measures included: increasing the frequency with which hospitals, labs, schools reported communicable diseases to local public health units to 3 times a day, local; public health units contacted labs daily for information of new diagnoses of 22 high priority diseases. 15 emergency departments were selected as sites to monitor high priority diseases across the main Olympic venues - the health department supplied funds to employ surveillance officers, desktop computers, software, documentation and training. Olympic medical facility staff sent health and injury-related info daily to generate surveillance reports for the health department (with particular focus on food-related illness, communicable diseases and injuries suffered by spectators at Olympic venues). Food safety teams conducted site inspections and carried out selective sampling and microbiological testing of foods. Environmental health teams inspected water cooling systems, water services, sanitation and general safety issues inside the Olympic venues. Data contained in the surveillance reports was also checked for any unusually occurrences of non-specific respiratory and gastrointestinal illness as indication of possible bio terrorism. Prior to the games, training in awareness for chemical, biological and radiological emergencies was given, hospital sites developed mass casualty decontamination facilities and protective equipment as well as pharmaceutical supplies were distributed to major hospitals.*

**Author(s): Kaiser, R. and Coulombier, D. (2006).**

**Title: Epidemic intelligence during mass gatherings. *Eurosurveillance*, 11 (51), Article 3.**

***Article summary:***

*The paper discusses epidemic intelligence during mass gatherings and the issues that should be considered at the planning stage. As part of the medical planning preparations for a mass event, health authorities will enhance their existing surveillance systems to enable earlier warnings of potential public health threats. Epidemic intelligence refers to the activities that relate to the identification, assessment, verification and investigation of potential health threats (including both communicable and non-communicable health hazards). Issues that should be considered in prioritising the need for epidemic intelligence include: number of people expected to attend, duration of event, characteristics of people attending (e.g. nationalities, age range), expected public attention or political importance and potential spread of infection to other sites in the community. The paper recommends several steps that should be taken in planning epidemic intelligence: lit review of previous (similar) events, conducting risk assessment of existing surveillance system to assess the extent to which it can detect and control potential public health threats; the risk assessment should consider: accessibility and types of venues (e.g. indoors/outdoors, size), likely demographics of people attending, environmental factors (e.g. weather) and communicable and non-infectious hazards of concern. Existing surveillance systems may be enhanced in cities hosting mass gatherings, setting up venue specific surveillance systems such as on-site clinics, and setting up systems that will automatically detect any abnormalities in the surveillance data. Planning should also consider whether daily reports on epidemiological data should be disseminated to the public.*

***Key risks identified:***

*High population density.*

***Key control measures identified:***

*Use of epidemic intelligence systems for early detection of potential public health threats.*

**Author: Katelaris, C. H., Carrozzi, F. M., Burke, T.V., and Byth, K. A. (2000).**

**Title: A springtime Olympics demands special consideration for allergic athletes.**

**Article summary:**

*The article highlights the potential for athletes to suffer allergic symptoms triggered by pollen exposure, which may impact detrimentally on their performance. The researchers monitored pollen levels over the period of the Olympic events. It was identified that athletes from aquatic sports were more likely to have symptoms than those from other sports.*

**Key risks identified:**

*Allergic symptoms such as rhinoconjunctivitis and exacerbation of asthma.*

**Key control measures identified:**

*Olympic team managers and medical officers to adequately prepare athletes for the potential exposure to high pollen levels, for example, with medication.*

**Author(s): Katsakiori, P., Manatakis, E., Goutsos, S., Athanassiou, G. (2008).**

**Title: Factors Attributed to Fatal Occupational Accidents in a Period of 5 years Preceding the Athens 2004 Olympic Games.**

**Article summary:**

*Study aimed to determine the factors attributed to occupational fatalities occurring in the region of East Attica, Greece, in all industry types over the 5 year period preceding 2004 Olympics. Questionnaires were completed and analysed using PCA. Results show that more accidents occurred in construction due to large scale civil works. Poor work practices arising from lack of orientation and job training, performance pressure and workers' inexperience associated with knowledge and skill based errors were revealed by questionnaire as the most common factors attributed to occupational fatalities.*

**Key risks identified:**

*Exposure or contact with electric current. Falls from a height. Strikes from falling objects (collapses, slips, etc.). Being caught in between and clamped into or between objects. Exposure or contact with hazardous substances (inhalation, ingestion or absorption of harmful substances). Other injury types.*

**Key control measures identified:**

*The importance of orientation and job training is confirmed. Provision of the right protective equipment and supervision of employees using it would seem to be a sufficiently adequate measure, producing a distinct improvement in the working conditions. It seems essential to reduce performance pressure over the worker. The workers' inexperience is important in any workplace.*

**Author(s): Li, J., Lu, Y., Huang, K., Wang, C., Lu, J., Zhang, C., and Zhong, N. (2008).**

**Title: Chinese response to allergy and asthma in Olympic athletes.**

**Article summary:**

*At least 20% of elite athletes are suspected to suffer from respiratory allergies consequently it is important to monitor the pollen counts and improve air quality otherwise the athletes would be exposed to airborne allergens and pollutants during competitions which could hinder peak performance. Due to the adoption of various control measures, the ambient air TSP and SO<sub>2</sub> levels in Beijing decreased in last decade. However, ambient air NO<sub>x</sub> levels increasing due to an increased number of motor vehicles.*

**Key risks identified:**

*Allergy and asthma in athletes - prevalence of asthma is higher in elite athletes than in the general population.*

**Key control measures identified:**

*The following measures were taken before and during the 2008 Olympic games.*

- 1. Utility of clean energy sources (by the end of 2006, 78% of terminal energy sources consumed in Beijing had been composed of clean energy sources such as natural gas. About 60 000 boilers had been altered to change energy sources from coal to natural gas).*
- 2. Prevention of pollution from motor vehicles (stricter standards limiting level of exhaust fumes discharged by motor vehicles).*
- 3. Industrial pollution control (more than 140 enterprises causing serious air and or water pollution had been closed or relocated from the Beijing area).*
- 4. A forestation (by Year of 2006, 2 years ahead of schedule, the forest coverage in Beijing had reached 51% and the ecosystem been improved considerably).*
- 5. Reinforcement - the control of dust pollution caused by construction sites.*
- 6. During the games, 21 dedicated medical facilities will be providing medical services to athletes and delegations and on site will also be doctors and nurses from these hospitals. Respiratory specialist will be on duty in polyclinic in village. These doctors are well trained to deal with asthma attacks and anaphylactic allergic reactions. Can receive airways challenge or bronchodilator tests in the lab of hospital assigned as a dedicated pulmonary function testing lab for the Olympic Games.*

**Author(s):** Lincolnshire County Council. (2009).

**Title:** A Guide for Event Organisers in Lincolnshire Version 6.

**Article summary:**

*Article details things to consider when planning a public event in Lincolnshire. Aimed more at low risk events such as county fairs.*

**Key risks identified:**

*Fire, food hygiene, traffic management, article focuses on lower risk events, e.g. county fairs.*

**Key control measures identified:**

*Recommended approach for those organising public events are to include: Public liability insurance, risk assessment, evacuation, stewards, training, environmental issues, fire arrangements, communications, temporary structures, barriers and stands.*

**Author(s):** Lombardo, J. S., Sniegowski, C. A., Loschen, W. A., Westercamp, M., Wade, M., Dearth, S., and Zhang, G. (2008).

**Title:** Public health surveillance for mass gatherings.

**Article summary:**

*Mass gatherings represent challenges for public health organisations because of the health risks associated with crowd size, duration of stay and population movement across jurisdictions. Article examines previous disease surveillance practices in planning mass events and describes one approach for sharing health-risk information employed during 2007 Super Bowl.*

**Key risks identified:**

*Infection diseases - 1) population increase with associated increase in the number of diseased persons with closer interpersonal contact than normal, 2) population movement - visitors diseases spread to local population and visitors exposed to local diseases which are carried back.*

*Heat/cold exposure, lightning, crowd size/density (increased exposure to microbes, decreased access to patients, decreased access to water/toilets), crowd mobility, risky behaviour, drugs, alcohol (decreased coordination & judgement, increased violence, physiological effects), crowd mood (team rivalry), infrastructure strain (e.g. poor hygiene practices in temporary facilities), target for terrorism.*

**Key control measures identified:**

*Systems to share disease surveillance information across judicial barriers and health departments (JHU/APL ESSENCE system).*

**Author(s): Martin, D. E. (1996).**

**Title: Measurement of climatic heat stress at outdoor venues for endurance events at the Atlanta Olympic Games, 1996.**

**Article summary:**

*Climatic heat stress measurements were made at 4 sport venues at the 1996 Atlanta Olympic games. The known potentially adverse effects of climatic heat stress on athletic performance coupled with Atlanta's history of abnormally hot humid weather during the games indicated the need for continued documentation. Instrumentation was used to measure temperature and consequently a health stress index calculated. This was then used to advise staff, spectators and athletes at the athletics venue on when the temperatures got high and what control measures to take e.g. removal of jackets or providing drinks. The temperature at the London 2012 Olympics may not require such rigorous testing as the GB climate is a lot cooler than Atlanta.*

**Key risks identified:**

*Climatic heat stress.*

**Key control measures identified:**

*Awareness of Atlanta's typical weather patterns meant that there was re-scheduling - moving the men's marathon to the early morning.*

*Medical staff, stadium admin, public address staff all used the continually updated climatic heat stress info at 10 min intervals throughout the nine days of competition. When climatic heat stress threshold values were established an increased responsiveness to manage effectively the elevated risk for thermal injury e.g. public address making announcements to spectators when HSI exceeded 80.1 F to drink fluids frequently.*

*Officials were permitted removal of uniform jackets when BGT exceeded 90F.*

*Field event competitors were provided with portable shade canopies if sun visible and was addition of water soaked towels in insulated coolers, supplemented supplies of cooled electrolyte drinks when HSI reached 80.6F.*

*Medical staff increased size and alertness of their personnel preparedness for managing athletes arriving at the finish line of competitions involving running and walking.*

**Author(s): Martin, D.E. (1996).**

**Title: Climatic heat stress studies at the Atlanta 1996 Olympic stadium venue, 1992-1995.**

**Article summary:**

*Climatic heat stress measurements were made during 92, 93, 94 and 95 at the Atlanta stadium construction site in order to estimate and compare the average heat stress encountered during specific time periods. In turn this permits consideration of whether the heat stress during one period might be preferable to another for example undertaking a marathon in the early morning versus early evening.*

**Key risks identified:**

*Climatic heat stress.*

**Key control measures identified:**

*NA*

**Author(s): Massazza, G., Pigozzi, F., Bono, D., Borrione, P., Redivo, L., Bribaudo, C. G., Ghiselli, G., Lazzarone, C., and Schamasch, P. (2006).**

**Title: The medical services for the Torino 2006 Olympic and Paralympics Winter Games.**

**Article summary:**

*The paper describes the medical system that was going to be put in place for the 2006 Olympic and Paralympics games in Torino. The majority of the paper was written in the future tense suggesting that the medical plan system was not yet implemented. A risk assessment process is described that will involve the generation of several critical scenarios associated with the games (such as risks due to adverse events, mass movements of individuals/vehicles etc) but hazards are not explicitly discussed.*

**Key risks identified:**

*Not explicitly stated.*

**Key control measures identified:**

*The control measures involved a general description of the medical preparedness that will be in place e.g. setting up polyclinics at every Olympic village, dedicated telephone number to deal with emergencies etc.*

**Author(s): Mavroidi, N. (2005).**

**Title: Epidemiologic Surveillance during Athens 2004 Olympic Games.**

**Article summary:**

*Highlights the need for specific public health planning at Olympic Games due to the large scale of such events, the pressures on infrastructure, the conditions created that favour disease occurrence and transmission as well as the increased public and media interest.*

**Key risks identified:**

*Identifies a range of potential diseases that could be more prevalent during Olympic Games, including gastroenteritis, rubella, Measles, Mumps, respiratory infections, and meningococcal disease.*

**Key control measures identified:**

*The work highlights the importance of communication and the flow of information and data across the varying organisations, e.g. athletic venues, hotels, hospitals and cruise ships by telephone, email and fax. Tools such as priority notifiable disease forms were used. Having frequent reporting was considered important as was training across the various bodies involved to raise awareness was seen to be important. Such bodies included health care and the emergency services.*

**Author(s):** Moody, W. E., Hendry, R. G., and Muscatello, D. (2007).

**Title:** Were attendances to accident and emergency departments in England and Australia influenced by the Rugby World Cup Final 2003?

**Article summary:**

*The study examined whether attendance to A&E departments increased as a result of the rugby world cup final held in Australia in 2003. They obtained A&E attendance data from hospitals in 2 countries (8 local hospitals in West Midlands and 46 hospitals in New South Wales) that spanned 6 hrs before and 12 hrs after kick off. Attendance rates were compared to attendance data between 2000-2002. They found that A&E attendance increased in the West Midlands 6-8 hrs after kick-off (compared to what would be expected from the 2000-2002 data). It was speculated that the increase in A&E attendance could have been due to either alcohol misuse or people delaying seeking treatment until after the end of the match. Authors cite a study by Sivarajasingam et al (2005) who reviewed 106 international rugby and football matches and found an increase in the number of assault victims on the day of the game. These authors also suggested that the increase in incidents was related to alcohol misuse.*

**Key risks identified:**

*Mass gatherings; alcohol consumption.*

**Key control measures identified:**

*NA*

**Author(s):** Mouchtouri, V., Velonakis, E., Tsakalof, A., Kapoula, C., Goutziana, G., Vatopoulos, A., Kremastinou, J., and Hadjichristodoulou, C. (2007).

**Title:** Risk factors for contamination of hotel water distribution systems by Legionella species.

**Article summary:**

*Sample collection and analysis 2003 - 2004 as part of environmental health surveillance programme developed by Olympic planning unit and implemented for Athens 2004. Main thrust of article describes various details of hotel water systems that give rise to legionella, e.g. water temperature, hotel age, boiler age.*

**Key risks identified:**

*Legionella.*

**Key control measures identified:**

*Effective water management process in hotels.*

**Author(s): Mounsey, G., McPherson, C., and Langdon, N. (2007).**

**Title: Pedestrian Planning for the 2006 Commonwealth Games Proceedings of the Institution of Civil Engineers.**

**Article summary:**

*The paper provides an overview of the pedestrian modelling approach taken to identify hazards associated with overcrowding for the Commonwealth Games.*

**Key risks identified:**

*Overcrowding.*

**Key control measures identified:**

*By applying the pedestrian modelling, they identified areas of critical congestion. Measures taken included: banning traffic at certain times to ease pedestrian congestion, putting in place crowd management plans to help control pedestrian flows in railway stations, holding cultural events in locations that were sufficiently separated from the sporting venues to ease congestion.*

**Author(s): Newham Borough Council (2010).**

**Title: NA**

**Article summary:**

*From March 2010 Newham Borough Council requires all landlords and Managing Agents to hold a licence having demonstrated that amongst other things that any gas installations have the necessary safety certificates.*

**Key risks identified:**

*NA*

**Key control measures identified:**

*Safety certificates for gas installations.*

**Author(s): O'Grady, K-A. and Krause, V. (1997).**

**Title: Public hospital utilisation during the 1997 Arafura games.**

***Article summary:***

*Article details usage of public hospitals during Arafura Games. Sporting events are ideal environments for the transmission of infectious diseases. Imported measles, outbreaks of viral meningitis and food borne diseases have occurred..*

***Key risks identified:***

*Minor MSD's, viral illness, respiratory illness, minor dermal injury, minor neurological injury, abdominal injury, vertigo, malaria, urinary tract infection, abdominal pain, gynaecological problem.*

***Key control measures identified:***

*Hospital utilisation. Health information pamphlet designed and given to all athletes and officials, describing how to avoid common communicable diseases and environmental dangers.*

**Author(s): Official report of the Olympiad (2004)**

**Title: NA**

**Article summary:**

*This substantial article provides a summary of organising, delivery and legacy of the Olympics in Sydney during 2000. It covers aspects including:*

- *Bidding for the Games*
- *Preparing the venues*
- *Competing in the Games*
- *Volunteers*
- *Security*
- *The city*
- *Technology*
- *Athletes*
- *The environment*

*The article covers relatively little on health and safety, although it is acknowledged that during construction, health and safety was left to contractors to manage. There was some concern over overcrowding, for example on the rail network. Some strategies to prevent crowding such as turning people away were deemed to have limited affect and not being feasible. During the Games it was also identified that temporary structures inspected on a daily basis. Attempts were also made to improve street lighting for public safety.*

*A link can be made to the potential for other health and safety risks, for example the report cites that 326 street cleaners manually removed approximately 20 tonnes of rubbish from city streets, which is twice the usual amount. Up to 5000kg of rubbish was removed from the Olympic Sites and 197sq m of city footpaths and 80000 sq m of city roadways were cleaned three times a day, which is equivalent to approximately 1800 football fields. In addition there was a team of 12 anti-graffiti cleaners who were employed around the clock removing approximately 1300 instances of graffiti. Such increases in workloads could add to the likelihood of workers developing musculoskeletal disorders.*

*The article highlights that 46,967 volunteers were recruited to assist during the Games, with 4% of these not turning up to during the event, indicating some degree of attrition. Also, 500 'pioneer volunteers' assisted during the lead up to the event, helping with aspects relating to education and awareness raising. In addition to this a further 500 skilled university students assisted with interviewing volunteers. Training for volunteers included orientation training, job specific training and venue training. Some also received event leadership training.*

**Key risks identified:**

*Construction activities (although this was left to be managed by contractors), crowding, temporary structures, and lighting (lack of).*

**Key control measures identified:**

*Improved street lighting. Keeping health and safety responsibility for construction with contractors.*

**Author(s): Olympic Delivery Authority. (2008).**

**Title: Design and construction Health, Safety and Environment standard. 3rd edition.**

**Article summary:**

*Detailed Standards document outlining management of design and construction arrangements, pre-qualification and tendering guidance, design, construction site risk management, construction site management of HS&E, transport, and a number of detailed appendices containing specific approach to a comprehensive range of hazards and risks.*

**Key risks identified:**

*Health, safety and environment hazards involved with construction of the sites in preparation for 2012 Olympics. Design risks, management of construction phase H&S hazards and risks, environmental hazards and risks, work methods, plant and equipment, fire, welfare facilities, occupational health provision, alcohol and drugs.*

**Key control measures identified:**

*Policies and procedures tightly specified for all construction related activities as per CDM regulations.*

**Author(s): Orr, H., Kaczmarek, E., Sarangi, J., Pankhania, B., and Stuart, J. (2001).**

**Title: Cluster of meningococcal disease in rugby match spectators.**

**Article summary:**

*The article highlights a rugby match where four adults acquired meningococcal disease several days after the match. Two of the adults died. The transmission was unknown, but thought to have originated from an asymptomatic individual at the event.*

**Key risks identified:**

*Potential to contract meningococcal disease at sporting events.*

**Key control measures identified:**

*NA.*

**Author(s): Panagiotakos, D. B., Costarelli, V., and Polychronopoulos, E. (2007).**

**Title: The perspective of syndromic surveillance systems on public health threats: a paradigm of the Athens 2004 Olympic games.**

**Article summary:**

*The paper describes the benefits of using a syndromic surveillance system whereby with the use of an algorithm called PULSAR the public health authorities could detect early any potential health threats to the community. However, these systems are prone to 'false positives' and it is not yet known whether they are better classical clinical/epidemiological approaches.*

**Key risks identified:**

*Mass gathering; overcrowding.*

**Key control measures identified:**

*Syndromic surveillance system set up to alert for any communicable disease outbreaks early. All cases with suspected syndromes that presented to the emergency departments were recorded and analysed using an algorithm called PULSAR. Based on this algorithm, the public health authorities were informed on a daily basis about potential threats for the people that were involved in the Olympics as well as the general public.*

**Author(s): Payne, L. (2008).**

**Title: Preparedness activities ahead of the Beijing 2008 Olympic Games – Enhancing EU epidemic intelligence.**

**Article summary:**

*The paper highlights the increased public health risks due to the mass gatherings associated with Olympic events, due to factors such as large scale international mobility.*

**Key risks identified:**

*Risks during the Beijing Olympics included respiratory disease, diarrhoea, seasonal influenza, malaria, sexually transmitted infections and animal bites, which could lead to rabies. It was also recognised that there may be increased incidents related to heat and pollution as well as increased number of accidents, e.g. road traffic accidents.*

**Key control measures identified:**

*It is highlighted that rapid detection, assessment, response and communication are key. Daily epidemic intelligence was raised as important in order to achieve this.*

**Author(s): Peiser, B., and Reilly, T. (2004).**

**Title: Environmental factors in the summer Olympics in historical perspective.**

**Article summary:**

*High air temperatures and humidity are important factors affecting performance of Olympic endurance athletes. Sky cover and presence or absence of light precipitation impact on marathon performances. Analysis of average monthly temperatures in host cities has become commonplace - organisers, coaches, and sports scientists use this data to gain probabilistic view of weather conditions. Daily temperatures and weather conditions are unpredictable more than one week in advance, particularly in temperate zones.*

**Key risks identified:**

*The physical environment influences outdoor sports in many ways. Climatic weather conditions during competition, varied altitudes and slopes, levels of air pollution, ferocity of radiant heat, urban heat islands, other unique topographical features.*

**Key control measures identified:**

*Physiological adaptations to training, advanced acclimatisation methods, nutritional considerations, improved race conditions.*

**Author(s): Reintjes, R., Kistemann, T., Mac Lehosé, L., McKee, M., Gill, N., Weinberg, J., Schaefer, O., Camaroni, I., Fulop, N., and Brand, H. (2002).**

**Title: Detection and response to a meningococcal disease outbreak following a youth football tournament with teams from four European countries.**

**Article summary:**

*Paper describes an outbreak of meningococcal disease at an international youth football tournament. Control measures varied in each of the 4 countries involved, with the outbreak illustrating deficiencies in management of international outbreaks but also demonstrated benefits of international co-operation.*

**Key risks identified:**

*Meningococcal disease caused by neisseria meningitis.*

**Key control measures identified:**

*Health surveillance and chemoprophylaxis.*

**Author(s): Ren, A., Shi, J., & Shi, W. (2007).**

**Title: Integration of fire simulation and structural analysis for safety evaluation of gymnasiums - with a case study of gymnasium for Olympic games in 2008.**

**Article summary:**

*The article goes into a lot of depth about the model for structural analysis.*

**Key risks identified:**

*Fire in gymnasiums.*

**Key control measures identified:**

*Apply advanced computational simulation software e.g. fire dynamics simulation for the safety evaluation of gymnasiums, however, easily damaged structural components that may highly lead to the structural collapse of their corresponding gyms cannot be predicted by these software tools alone, some structural analysis software can be contributed to the judgement such as ANSYS.*

**Author(s): Reynolds, P., & Pavic, A., (2006).**

**Title: Vibration Performance of a Large Cantilever Grandstand during an International Football Match.**

**Article summary:**

*Paper presented the shaker modal testing and in-service monitoring applied to East Stand at Elland Road. Several modes of vibration were estimated, and considered appropriate for determination of modal properties of seating decks in stadia.*

**Key risks identified:**

*Vibration problems in stadia are becoming more common due to increased structural slenderness and livelier dynamic crowd excitation. Modern stadia are typically lighter and more slender than in the past, as a result of improved construction technologies combined with architectural demands for increased all-seated capacities whilst retaining clear sightlines. There is a tendency for crowds to be livelier than was previously the case. There is an increased use of stadia as venues for pop concerts, where the presence of a musical beat serves to synchronise crowd activity, resulting in more onerous dynamic loading conditions.*

**Key control measures identified:**

*Designers should give adequate consideration of vibrations and resonances during design and construction of stadia.*

**Author(s): Rowe, I., and Ancliffe, S., (2008).**

**Title: Guidance on designing for crowds - an integrated approach.**

**Article summary:**

*Article covering considerations for design and construction of large sporting infrastructure for crowds. Design should always consider the different types of event and operating modes, required layout for different events, operational accommodation requirements for different events, staffing and security requirements for different events, defined operating conditions and how environment is managed, numbers and profiles of crowds, crowd movement targets and standards, key visitor experience standards, policy on inclusive design and accommodating disabilities.*

**Key risks identified:**

*Risks associated with crowds, e.g. crushing.*

**Key control measures identified:**

*Effective design and construction for crowds, considering design standards and operational requirements. Considering floor surfaces, stairs, obstructions, signage, gates and barriers, CCTV, gradients, seating, and space requirements.*

**Author(s): Schenkel, K., Williams, C., Eckmanns, T., Poggensee, G., Benzler, J., Josephsen, J., and Krause, G. (2006).**

**Title:Enhanced surveillance of infectious diseases: The 2006 Fifa World Cup experience.**

**Article summary:**

*The paper describes the health surveillance system employed in the 2006 World Cup in Germany and describes the controls that were used in response to disease outbreaks during the event. The surveillance system involved the transmission of info regarding potential infectious disease cases daily within the 12 World Cup Cities as well as neighbouring cities; the electronic notification system incorporated disease notifications of non-residents of Germany, which is information that was not routinely reported; information on outbreaks or any type of public health relevant event was sent in a standardised, free text written report and relevance to the World Cup was based on the subjective judgment of local health departments; international and German press (both lay and expert sources) were screened daily for any infectious diseases of public health relevance; regular telephone conferences were held between World Cup surveillance stakeholders and local and state health departments as a tool of quality management; daily telephone conferences held with the European Centre for Disease Prevention and Control to discuss information of international public health relevance. Daily reports on the status of infectious disease epidemiology were produced and distributed to local and state health departments, the German Ministry of Health and the National Information and Cooperation Centre (the national security info hub for the World Cup) - a short version was also published on a public webpage.*

**Key risks identified:**

*Norovirus.*

**Key control measures identified:**

*In response to the norovirus outbreak, hygiene precautions were implemented, such as disinfecting surfaces and providing disinfection liquids in sanitary areas; multi-lingual information leaflets giving hygiene advice were also distributed.*

**Author(s): Shaw, M. T. M., Leggat, P. A., and Borwein, S. (2007).**

**Title: Travelling to China for the Beijing 2008 Olympic and Paralympic Games.**

**Article summary:**

*Document details a number of possible medical conditions potentially available in Beijing and urges caution with food hygiene. Road safety also highlighted as a common cause of injury/fatality.*

**Key risks identified:**

*Illness and injury relating to travel to the Olympic Games. Personal health issues (e.g. dental, sexual), coping with acclimatisation and jetlag, coping with culture shock and managing personal stresses due to the altered environment, immunisations, jetlag, diet, medical issues, dietary advice. Also air pollution, malaria, food and waterborne diseases, hepatitis, influenza, Japanese encephalitis, meningitis, measles and rubella, rabies, tetanus, yellow fever, HIV, dengue fever, helminthic diseases, tuberculosis and other less common diseases*

**Key control measures identified:**

*Food hygiene awareness - cook it, boil it, peel it, or avoid it.*

**Author(s): Sivarajasingam, V., Moore, S., and Shepherd, J. P. (2005).**

**Title: Winning, losing and violence.**

**Article summary:**

*The paper reviews international football and rugby matches and examines associations with violence and assault injuries.*

**Key risks identified:**

*Violence.*

**Key control measures identified:**

*NA*

**Author(s): NA**

**Title: Special Olympics – Safety Guidelines 2009.**

**Article summary:**

*Directed towards the wellbeing of disabled spectators and competitors.*

**Key risks identified:**

*Heat related illness.*

**Key control measures identified:**

*Suggests that water coolers be sited at each venue and periodically refilled. Staff should receive awareness training to look for the signs of hypothermia and seizures.*

**Author(s): Sun, Y., Fang, D., Wang, S., Dai, M., & Lv, X. (2008).**

**Title: Safety Risk Identification and Assessment for Beijing Olympic Venues Construction.**

**Article summary:**

*The paper investigated the risk factors associated with the construction of the Olympic venues in Beijing. The risk factors were identified by conducting a literature review and consulting experts from government agencies, the construction industry and academia. The risks were prioritised (based on experts' perceptions) and a risk assessment form developed. This was used to assess the risk profile of two Olympic venues.*

**Key risks identified:**

*Construction industry incidents that may lead to injury or fatality.*

**Key control measures identified:**

*Identification of a total of 25 critical risks for the safe construction of the Olympic venues. These mainly involved contractors and sub-contractors and included lack of emergency response plans, unsafe behaviours, ignoring safety under schedule pressures, inadequate implementation of measures on site safety, inadequate PPE and supervision.*

**Author(s):** Thackway, S. V., Delpech, V. C., Jorm, L. R., McAnulty, J. M., and Visotina, M. (2000).

**Title:** Monitoring acute diseases during the Sydney 2000 Olympic and Paralympic games.

**Article summary:**

*The paper describes public health issues associated with mass gatherings and discusses how Sydney's existing surveillance system was enhanced to cope with these added challenges prior to the commencement of the games. Public health preparations and surveillance for the Sydney Olympics was based on the experience of previous Olympic games particularly Atlanta. The surveillance system paid particular attention to injuries, foodborne diseases, conditions spread via the respiratory route and the importance of early detection of unusual disease clusters/patterns.*

**Key risks identified:**

*Mass gatherings in closed environments and controlled ventilation systems; increased international travel; airborne, waterborne and foodborne disease outbreaks.*

**Key control measures identified:**

*Team of public health experts examining food safety, environmental inspection and cruise ship trend data to identify unusual patterns of disease incidence; GPs also playing important role in the early detection of any unusual patterns of disease; use of outbreak management plants in the event of small disease clusters/unusual patterns of injury; public health investigation teams on standby in the event of a major public health incident.*

**Author(s):** The Sunday Times (2010).

**Title:** 'Be an Olympic Winner (28/2/2010).

**Article summary:**

*The article highlights the growing interest for residents in London in rental in the London area for the period of the Olympics, potentially bringing a large increase of inexperienced landlords to the market for a short period of time. It is noted that areas of particular interest will be Canary Wharf; Wapping and Shoreditch, in the east; Islington and King's Cross, in the north; and anywhere central on the Jubilee or Central lines.*

**Key risks identified:**

NA

**Key control measures identified:**

NA

**Author(s):** Traversi, D., Degan, R., De Marco, R., Gilli, G., Pignata, C., Ponzio, M., Rava, M., Sessarego, F., Villani, S., and Bono, R. (2008).

**Title:** Mutagenic properties of PM2.5 air pollution in the Padana Plain (Italy) before and in the course of XX Winter Olympic Games of Torino 2006.

**Article summary:**

*PM2.5 is one of the most important aspects of environmental health. This air pollutant is breathable and it is implicated in several chronic adverse health effects such as the decrease of respiratory functionality and cancer. In this study PM2.5 air pollution was daily monitored covering the Olympic games to ascertain whether the role of the Olympic games is an environmental factor. Results showed that the Olympic games had not a great impact on the PM2.5 pollution - less than expected. It is suggested that several preventative measures adopted such as free and more frequent public transports, activation of underground transports, and modification of the viability probably limited the increment in air.*

**Key risks identified:**

*Particulate matter 2.5 is an air pollutant which is breathable and it is implicated in several chronic adverse health effects such as the decrease of respiratory functionality and cancer. Increase in the number can be brought about by constructions during the months before the Olympics, urban traffic and other anthropogenic sources.*

**Key control measures identified:**

*Free and more frequent public transports, activation of underground transports.*

**Author(s):** NA

**Title:** Vancouver 2010 commits to excellence in Olympic and Paralympic Games venue construction safety.

**Article summary:**

*VANOC (Vancouver organising committee for the 2010 Olympic and Paralympics winter games) announces partnership with WorkSafeBC (workers' compensation board) to strive to achieve high standards in H&S for construction workers. Focus on developing a safety culture and minimise accidents and ill health.*

**Key risks identified:**

*Health and safety hazards during construction, ill health, business losses and environmental harm due to unplanned events.*

**Key control measures identified:**

*Develop organisational culture of safety first.*

**Author(s):** Varano, S., & manning, P. K. (2005).

**Title:** Safety and Security at Special Events: The case of the Salt Lake City Olympic Games.

**Article summary:**

*Key findings: Centralisation of security likely to be a consistent feature of future Olympics - helped to establish a better pattern of communication and decision-making than had been observed in Atlanta. Communication is the backbone of security, therefore common technology platforms and appropriate training are essential. Recommendations and conclusions - communication must be seen as the central dynamic of security efforts. Building teamwork by planning and training exercises. Adopting a theatre perspective for the event. Co-location of security with Olympic committee. Awareness of cultural aspects of the different security networks and organisations involved. Effective processing of security information. Efforts to establish relationships and understandings in short-lived temporary organisations. Feedback to planners and managers is critical. Public and private sectors must be involved in planning. Management must provide clear and unambiguous directions. Mock exercises that identify gaps and build relationships are key.*

**Key risks identified:**

*Social or political protest, terrorism, local violence.*

**Key control measures identified:**

*Security planning for the games spanned 7 years. Temporary organisations to oversee Games, must overcome tendency to devalue information received from outside own organisation - illustrates critical importance of cultural side of building temporary organisations. Inclusion of fire, emergency, and public health, reinforce theatre concept, use appropriate common platforms for technology, sufficient training for all involved, NSSE designation, visibility of uniforms - different colours had positive effects.*

**Author(s):** Verdaguer-Codina, J., Martin, D. E., Pujol-Amat, P., Inef, A. R., and Prat, J. A. (1995).

**Title:** Climatic heat stress studies at the Barcelona Olympic Games, 1992.

**Article summary:**

*Four environmental conditions contribute to climatic heat stress: ambient temperature, air humidity, air movement, and radiant heat from the sun and nearby warm surfaces. Researchers carried out extensive HIS monitoring of athletes competing in the events most likely to result in heat stress, e.g. marathon. Findings suggest the optimum conditions for timing such events, and suggest training of all involved to recognise heat stress and other advice for public, e.g. wear a hat.*

**Key risks identified:**

*Heat stress.*

**Key control measures identified:**

*Athletes, coaches, spectators, media, officials, and security personnel - be knowledgeable about climate heat stress and how to accommodate it. Athletes understand how they adapt to climatic heat stress during training. Officials and security personnel both are accustomed to heat stress exposure and not be scheduled for excessively long duty in the heat. Spectators, particularly those accustomed to an indoor lifestyle, understand how to cope with prolonged heat exposure when viewing competitions.*

**Author(s):** Wang, W., Primbs, S.T., & Simonich, S.L.M. (2009).

**Title:** Atmospheric particulate matter pollution during the 2008 Beijing Olympics.

**Article summary:**

*Highlights issues of pollution and that Beijing is a high polluting city. Covers control measures and the impact of these as well as impact from other variables such as the weather. Explains that coarse and fine particles which have potentially toxic chemicals sorbed to them. Fine particles seen as more harmful due to ability to be deposited more deeply in the lungs. Fine particles linked to respiratory morbidity and mortality e.g. cardiorespiratory disease. Fatalities associated with the harmful effects outlined.*

**Key risks identified:**

*Pollution from vehicle emissions, manufacturing and construction.*

**Key control measures identified:**

*Road traffic halved by odd/even licence plate 'bans'. Pollution emitting factories closed and slowing down of construction activities in and around Beijing.*

**Author(s) Wardell, R., Dever, B., Amell, B., & Ross, G. (1988).**

**Title: Design of Temporary Spectator Facilities at Outdoor Winter Athletic Events.**

**Article summary:**

*Paper reports preliminary findings from a study of spectator behaviour and facility design during the 1988 winter Olympics, which provided a unique opportunity because of the large crowds and the variety of venues. Data were collected at three venues and ten events. Results presented in the paper relate only to the ski jump bowl event. Results show that some of the stairs exceeded recommended dimensions for riser height and tread depth, therefore represented a potential safety hazard. Faster descent was associated with greater riser height, but the presence of handrails did not influence speed of vertical movement. Temporary bleachers at the stadium were found to more efficient at vertical movement of spectators than permanent stands under certain conditions.*

**Key risks identified:**

*Crowding, crushing, reduced positive spectator experience impacting on enjoyment of the event. A key determinant of spectator experience is the design of the physical facilities - the provisions for ingress, egress, standing, sitting, and moving around the site.*

**Key control measures identified:**

*Design of seating and standing with reference to approved design standards.*

**Author(s): Weiss, B. P., Mascola, L., and Fannin, S. L. (1988).**

**Title: Public Health at the 1984 Summer Olympics: The Los Angeles County experience**

**Article summary:**

*The paper describes the preparations, strategies and surveillance system that was developed for the 1984 Summer Olympics in Los Angeles. Public health concerns included safety and sanitation of food, drinking water, housing, waste disposal, diseases that could be transmitted through the use of swimming pools and other water sports venues as well as poisoning of water supplies (bio terrorism). These concerns were addressed and controlled through the enhancement of the County's active surveillance system - for instance, reports were collected by telephone 3 times a day from 198 participating facilities including hospitals, prepaid health plans, private physicians and Olympic sites. A telephone hotline and emergency public health response teams were also established as well as arrangements made with local law enforcement agencies for the transportation of individuals through the County during heavy traffic. The most frequently reported health problem was heat-related illnesses. Overall, fewer illnesses were reported during the Olympics compared to the same period for the three preceding years.*

**Key risks identified:**

*Public health issues of concern included: excessive exposure to the sun, safety and sanitation of food, drinking water, housing, waste disposal, swimming pools and other water-sports venues and potential poisoning of water (bio terrorism).*

**Key control measures identified:**

*Disease surveillance and control was carried out by a central disease control unit - reports were collected 3 times a day from 198 participating facilities, including hospitals, private physicians and Olympic sites. A telephone hotline was also established to facilitate immediate reporting of diseases. The hotline was available 24 hrs a day, 7 days a week and the number was published six weeks prior to the start of the games in the Health Department's newsletter for use by the medical community. Emergency public health response teams were established that consisted of a physician, an epidemiologist and appropriate support staff. Fourteen medical epidemiologists were located at Olympic venues and hospitals to facilitate local active surveillance. Health surveillance data were collected prior to the opening of the games and for the whole duration of the Olympic events. Other measures included: provision of amble water fountains, provision of well-marked first aid stations for spectators and training for Olympic staff to inform them of public health concerns.*

**Author(s): Wilks, J. (1999).**

**Title: International tourists, motor vehicles and road safety: A review of the literature leading up to the Sydney 2000 Olympics.**

***Article summary:***

*Article reviews papers on road safety, highlighting a number of key factors linked to accidents. Paper calls for further research to better inform the Olympic committee on policies and procedures with respect to short-term visitor driving risks and controls.*

***Key risks identified:***

*In order to provide the best possible experience for up to 1.5 million visitors, it is essential that potential causes of travel-related illness and/or injury are anticipated.*

***Key control measures identified:***

*The leading six issues for medical practitioners to include in advice for patients travelling to Australia are: Be conscious of driving on the left-hand side of the road, Always wear a seatbelt, Don't drink alcohol and drive, Don't exceed the local speed limits, Don't drive if you're tired, Be aware of the distances involved when planning each day of travel.*

**Author(s): Williams, C. J., Schenkel, K., Eckmanns, T., Altmann, D., and Krause, G. (2009).**

**Title: FIFA World Cup 2006 in Germany: enhanced surveillance improved timeliness and detection.**

**Article summary:**

*Enhanced surveillance for infectious disease events with accelerated routine reporting and daily supplementary reports was undertaken during the 2006 FIFA World cup in Germany. The surveillance outputs reporting intervals and detection of world cup relevant events for the enhanced system were evaluated. Detection of world cup relevant events was 44% in the routine system and 77% in supplementary reports. Daily reporting improved timeliness and supplementary reporting improved relevant event detection. Enhancing existing systems without the addition of syndromic surveillance can be an effective approach to mass event surveillance.*

**Key risks identified:**

*At any event where people gather, there is the potential for both non-infectious health hazards including injury, exacerbations of pre-existing disease and heat related illness and infectious disease events. Infectious disease transmission may be promoted by an increase in population density, importation of unusually pathogens, strains on infrastructure, and changes in services or behaviour. Large events are also potential targets for bio terrorism. However despite the existence the results of this study suggest that mass events do not increase the burden of infectious disease in either the host or visitor population however it is likely to continue as a reassurance for government authorities and the public especially in light of the possibility of bio terrorism attacks during such high profile events.*

**Key control measures identified:**

*The electronic reporting system for infectious diseases, SurvNet already in Germany was strengthened and augmented. There were 4 main enhancements to infectious disease surveillance during the FIFA 2006 world cup*

- 1. Accelerated transmission of notifiable disease case data from weekly to daily*
- 2. Marking cases of relevance to the FIFA world cup in routine notifications*
- 3. Daily supplementary reports from all cities hosting matches and*
- 4. The national enhanced surveillance operations centre staffed Monday to sat in the national epidemiology centre, which collected analysed and reported on daily surveillance inputs.*

*Daily supplementary reports were reported briefly on a daily basis and were intended as a supplementary instrument to promptly capture events that would not fulfil the case definition of the routine reporting system. Communication with local and state health departments facilitated by teleconferences, email telephone and pre workload cup training sessions.*

*Commercial text search for 14 infection related keywords of 25 German newspapers to screen for relevant press reports.*

**Author(s): NA**

**Title: Safetrak electronic system streamlines inspection and decommissioning of scaffolding structures on three Olympics sites.**

**Article summary:**

*Construction news article - Olympics contractor implements electronic scaffolding inspection and reporting system. Article suggests system will improve scaffolding inspection and reporting process.*

**Key risks identified:**

*Risks associated with scaffolding safety.*

**Key control measures identified:**

*Scaftag system - electronic system for inspection of scaffolding, scaffolding register.*

**Author(s): Yancey, A. H., Fuhri, P. D., Pillay, Y., and Greenwald, I. (2008).**

**Title: World Cup 2010 Planning: An integration of public health and medical systems.**

**Article summary:**

*Summarises a wealth of information relating to public health provision for 2010 world cup. Article summarised infrastructure requirements, resources, planning, quality management.*

**Key risks identified:**

*All public health issues, e.g. illness from water supply, food hygiene, alcohol.*

**Key control measures identified:**

*Intra-venue population preventative health considerations: Potable water supply and access (sufficient quantity and adequate quality, correct positioning of taps), Toilet facilities - adequacy and access (sufficient quantity and adequate quality, correct positioning of taps), Food integrity inspection plans (hygienic preparation, waste management), Public address system capability (quality of equipment, training of users), Access to alcohol (service on premises vs. none, time period limitations on sale vs. none, use of plastic containers), Traffic ingress and egress routes (spectator pedestrian route mapping, vehicle route mapping, security availability to minimise spectator-vehicle contact, vendor delivery and removal times, gate management).*

# A literature review of the health and safety risks associated with major sporting events

Learning lessons for the London 2012 Olympic and Paralympic games

This work was commissioned by the Health and Safety Executive (HSE) to provide an understanding of the potential hazards and risks associated with hosting the Olympic Games in Great Britain in 2012, as well as potential control measures that could be applied to these. The literature search yielded 384 papers, of which 80 met the inclusion criteria. These papers were then reviewed by the research team and summarised by emergent topics. The topics included: construction, public health and safety risks, road accidents, injuries, musculoskeletal disorders (MSDs), crowd safety, emergency planning and response, volunteers, workplace violence, fire safety, electrical hazards and carbon monoxide/gas safety.

Each of the topics is summarised by the risks identified from previous Olympic events and major sporting events, followed by controls that were applied or identified as potentially useful. The controls often provided practical ways to reduce risks, or to mitigate negative outcomes.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.