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Sports Injury and Illness Epidemiology: Great Britain Olympic Team (TeamGB) surveillance during the Sochi 2014 Winter Olympic Games

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ABSTRACT

Background Sports injury and illness surveillance is the first step in injury and illness prevention, and is important for the protection of both athlete health and performance in major competitions.

Aim To identify the prevalence, severity nature and causes of athlete injuries and illnesses in the Great Britain Olympic Team (TeamGB) during the Sochi 2014 Winter Olympic Games.

Methods The observational prospective cohort study followed the Great Britain Injury/Illness Performance Project surveillance methodology and obtained information on injuries and illnesses that occurred during the Games between 30 January and 23 February 2014 in TeamGB athletes (n=56).

Results Among the 56 TeamGB athletes, there were 27 injuries and 11 illnesses during the Olympic Games period. This equated to 39% sustaining at least one injury and 18% at least one illness, with an incidence of 48.2 injuries and 19.6 illnesses per 100 athletes, respectively. Of all injuries and illnesses, 9% and 7%, respectively, resulted in time loss. The risk of sustaining an injury was highest for freestyle skiing, skeleton and snowboarding; and lowest for curling, biathlon and Alpine skiing (with no reported injuries); with the lower limb being the most commonly injured location. Respiratory system illnesses were most frequently reported overall, and older female athletes were the ones most affected by illness.

Conclusions The risk of injury was double the risk of illness for TeamGB athletes. Overall, the rate of time-loss issues was low. Methodological considerations are important when interpreting data, and prevention strategies should focus on those issues causing the greatest risk, in terms of prevalence and severity, to athlete health and performance.

If it is possible to reduce the absolute number of athlete injury and illness events, and minimise the severity and impact of injuries and illnesses when they do occur, some of the detrimental effects to athlete health and of performance restriction and time loss to training and competition will be reduced. This in turn should ultimately impact on athlete performance, not just in a given sport, but for a whole multisport national team.

As the first step in injury and illness prevention, it is important to reliably and accurately establish the nature of injury and illness in a given population. Together they can quantify the overall risk of injury and illness to athletes providing information to allow prevention initiatives to be correctly prioritised.¹⁹ Therefore, the aim of the present study was to identify the prevalence, severity, nature and causes of athlete injury and illness for the Great Britain Olympic Team (TeamGB) during the Sochi 2014 Winter Olympic Games.

METHODS

The study was an observational prospective cohort design that used a questionnaire-based data collection procedure, following the Great Britain Injury/Illness Performance Project (IIPP) methodology,¹⁸ and using the Sport Medicine Diagnostic Coding System for injury-specific and illness-specific diagnoses.²⁰

TeamGB medical and physiotherapy practitioners recorded all details of athlete injuries and illnesses, including location, system, type, causes and severity, whenever a recordable event occurred. The study was introduced to practitioners by the Chief Medical Officer 2 months prior to the start of the Sochi 2014 Winter Olympic Games. All practitioners involved (two doctors and seven physiotherapists) had prior experience of the IIPP data collection methods,¹⁸ and were provided additional advice and support during the Olympic Games. Each practitioner on arrival into the Sochi 2014 Olympic Games athlete village(s) was provided with a TeamGB IIPP report pack containing an instructional guideline booklet, a list of athlete audit codes and an individual injury/illness report form booklet. Standardised medical report forms were used, with one individual injury/illness report form completed per issue as and when an athlete injury or illness occurred while they were in Olympic competition and training venues, or in the athlete Olympic village(s). Completed individual injury/illness report forms were collected during the Olympic Games, and outstanding forms returned in prepaid reply envelopes, after the Games were complete and practitioners had

INTRODUCTION

Recent work by the IOC has focused on the occurrence of injury and illness in multisports during the Summer and Winter Olympic Games.¹⁻⁴ Injury and illness prevention and the protection of the athlete's health are key mandates for the IOC.⁵⁻⁶ Recognition of the importance of injury and illness surveillance work is growing with international governing bodies for football (FIFA), rugby (International Rugby Board), athletics (International Association of Athletics Federations) and swimming (Fédération Internationale de Natation), and paralympic sport (International Paralympic Committee) also regularly conducting injury and illness epidemiological projects.⁷⁻¹² While the majority of studies seek to identify injury and illness rates by sport at major events, few do so by national participation.¹³⁻¹⁸



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returned to the UK. In addition, the Sochi 2014 Winter Olympic Games official Atos computer medical records system was accessed by the author DP-G to cross-reference data and identify TeamGB athlete injuries and illnesses seen in the polyclinic and medical venues by medical staff of the Sochi 2014 Organising Committee. Where there were duplicates, TeamGB IPP data were retained as the primary source of information, but with any missing TeamGB data fields populated from Atos where available. TeamGB data were returned each time an issue occurred, and returns did not miss any of the Atos entries. Hence, TeamGB data were judged to equate a reporting accuracy of 100%.

The study involved 56 athletes (males: $n=33$; females: $n=23$) from 13 sports, Alpine skiing ($n=2$), biathlon ($n=2$), bobsleigh ($n=10$), cross-country skiing ($n=4$), curling ($n=10$), figure skating ($n=6$), freestyle skiing (halfpipe and slopestyle combined; $n=6$), short-track speed skating ($n=5$), skeleton ($n=4$) and snowboarding (halfpipe, slopestyle and snowboard cross combined; $n=7$). Mean age was 26.9 years, 4.9 SD (male: 27.7 years, 5.4 SD; female: 25.7 years, 4.0 SD). Data collection occurred during the Olympic Games period, starting on the first day TeamGB athletes started to arrive into the Sochi athlete village(s) (30 January 2014), and finishing on the final day of the Games, 23 February 2014.

Definition of injury and illness

An injury/illness was defined as any physical symptom that required medical attention, or prevented an athlete from taking full part in training and competition.¹⁸ These included all injuries and illnesses that (A) received medical attention, or caused performance restriction or time loss to the athlete training/competition and (B) were newly incurred during the Games. Pre-existing injuries/illnesses on arrival into the Games were not reported. Injuries only included those occurring during training or competition. Recurrent injuries/illnesses were reported and were defined as occurring at the same site and of the same type, within 3 months of the previous injury/illness, with the athlete having returned to full participation after the previous event. Home (athlete accommodation) or other accidents were not included. Illnesses were not defined as occurring in training or competition.

Injury/Illness classification

Time-loss was defined as an injury/illness that prevented an athlete's participation in 'any' training or competition. Performance restriction was defined as an injury/illness where training and/or competition participation continued but the volume and/or intensity were restricted as a result of the injury or illness (eg, through pain and/or loss of function). Medical attention (only) was defined as an injury/illness that required medical attention but did not cause time loss or performance restriction. Severity data were reported in days for both time loss and performance restriction.

Data analysis

Athlete injury and illness data were broken down by sport where appropriate, but not by individual discipline for freestyle skiing and snowboarding, due to limited data numbers. Descriptive data were presented as frequencies (numbers) and prevalence (% equating to the number of athletes affected relative to the total squad size, or within a specific sport), and mean values and SD where appropriate. Incidence values, as injuries or illnesses per 100 athletes, and relative risk ((RR) with 95% CIs) were also reported. Significant differences in values for continuous variables were analysed using t tests for independent

groups, and prevalence rates using two-tailed Z tests.²¹ Significance was accepted at $p \leq 0.05$ (equal variances assumed) and exact p values are reported throughout.

Ethical approval for the study was obtained from the UK Sport (London) ethics advisory board.

RESULTS

Number and severity of injuries and illnesses

There were 56 TeamGB athletes competing in 13 of 22 Winter Olympic Sports during the Sochi 2014 Winter Olympic Games. Overall, there were 27 injuries and 11 illnesses recorded within TeamGB. Of all injuries, 21 were classified as causing medical attention (only), 4 causing performance restriction and 2 complete time loss (table 1). In total, there were 44 performance-restricted/time-loss days of training/competition because of injuries, with a mean severity of 3.3 days restricted activity per athlete performance-restriction injury and 15.5 full days lost per athlete time-loss injury. For athlete illnesses, 2 out of 11 were impactful (causing performance restriction or time loss), with just 3 performance-restriction/time-loss days due to athlete illness within TeamGB.

Rate of injuries and illnesses

The prevalence of injuries within TeamGB during the Sochi 2014 Winter Olympic Games was higher compared with that of illness (38% of squad vs 18%; $p=0.031$; table 2). This equated to an incidence of 48.2 injuries and 19.6 illnesses per 100 athletes, respectively. The majority of injuries (93%) occurred in training. Prevalence rates varied by sport, with freestyle skiing, skeleton and snowboarding having the highest injury prevalence, and Alpine skiing followed by skeleton and cross-country having the highest illness prevalence.

The prevalence of injury was similar between male and female TeamGB athletes, with 44% of female athletes injured (13 injuries in 10 athletes) compared with 36% of male athletes (14 injuries in 12 athletes; RR 1.22 (95% CI 0.79 to 1.88)). There were more illnesses sustained by female athletes (8 illnesses in 7 athletes) compared with male athletes (3 illnesses in 3 athletes), equating to 30% vs 9% of female and male TeamGB athletes affected, respectively, although this was not significant (RR 3.33 (95% CI 1.58 to 7.01); $p=0.075$). Female athletes who sustained illnesses during the Games were significantly older than their non-ill female counterparts (ill: 28.4 years, 3.7 SD; non-ill: 24.5 years, 3.6 SD; $p=0.026$).

Nature of injury

By individual anatomical location, injuries to the thigh (19% of all injuries), followed by those to the knee and lumbar spine (15% each), were most common (figure 1), with sprain (injury of joint/ligaments; 30%) followed by contusion (19%) being the most common types of injury within TeamGB. Contact with a static object and recurrence were the events most commonly

Table 1 Number (and percentage) and severity mean days, by injury and illness status within the Great Britain Olympic Team

	Injury	Severity	Illness	Severity
Medical attention	21 (78)		9 (82)	
Performance restriction	4 (15)	3.3	1 (9)	1
Time loss	2 (7)	15.5	1 (9)	2
Total	27 (100)		11 (100)	

Table 2 Number and prevalence (percentage) of injuries and illnesses, by sport within the Great Britain Olympic Team

Olympic Sport	Athletes per sport	Injuries (t/c)	Athletes injured	Injury prevalence	Illnesses	Athletes ill	Illness prevalence
Alpine skiing	2	0		0	1	1	50
Biathlon	2	0		0			0
Bobsleigh	10	5 (5/0)	4	40	2	2	20
Cross-country	4	2 (2/0)	1	25	1	1	25
Curling	10	0		0	1	1	10
Figure skating	6	2 (1/1)	2	33	1	1	17
Freestyle skiing	6	7 (7/0)	6	100	1	1	17
Short track	5	1 (0/1)	1	20	1	1	20
Skeleton	4	3 (3/0)	3	75	2	1	25
Snowboarding	7	7 (7/0)	5	71	1	1	14
Total	56	27 (25/2)	22	39	11	10	18

c, Competition; t, training.

associated with injury (33% of all injuries each), followed by overuse (gradual/sudden onset; 26%).

Nature of illness

Respiratory illness was the most common athlete illness within TeamGB during the Olympic Games, causing 45% of all illnesses. This was followed by gastrointestinal illness (18%). The most common cause of athlete illness was infection (64%), with pain (36%) and cough (27%) being the most commonly reported symptoms.

DISCUSSION

This study determined the prevalence, severity, nature and causes of injuries and illnesses in TeamGB athletes during the Sochi 2014 Winter Olympic Games. The main findings are that (1) the prevalence of athlete injury was approximately double that of athlete illness; (2) the lower limb was the most commonly injured body region (46% of all injuries) and (3) respiratory system athlete illness was the most common illness.

The rates of injury and illness in the present study (39% and 18% of TeamGB, respectively) were much higher compared with those in previous studies completed by the IOC at both the Summer and Winter Olympic Games in London 2012 and Vancouver 2010 (injury 11% and illness 7% at both Games).^{3 4} The most likely reasons for this are the size of the study cohort, where small changes in the injury or illness numbers can influence prevalence rates to a larger degree, the slightly longer 25 days data collection period (for TeamGB, this included starting 8 days prior to the official opening

ceremony) and more sensitive methods of data recording. For example, a small athlete cohort coupled with nine medical and physiotherapy practitioners (equals 6 athletes per practitioner), covering only 13 of the 22 Olympic sport competition and training venues, would likely enable practitioners to have greater awareness of issues as they occurred. Also, data collection forms including all medical-attention, performance-restriction and time-loss athlete injuries and illnesses would lead to greater reporting of not just acute traumatic injuries and illnesses but also overuse/chronic issues,^{18 22} enabling capture of less 'serious' injuries and illnesses, that is, those requiring medical attention only and/or performance restriction, whereby they may often be traditionally missed in reporting in favour of the more obvious severe injuries/illnesses. The current data support this theory, where although the overall rates of injury and illness were high, the majority of these were medical attention/performance restriction, with only 7% of all injuries and 9% of all illnesses resulting in the time loss definition. In contrast, 23% of injuries (with authors suggesting this was an underestimation) and 35% of illnesses were reported to result in time loss at the Vancouver 2010 Winter Olympic Games.³ Limitations to time-loss methodologies have been recognised for several years, and it is known that athletes will continue to train and compete, even at high levels, while experiencing restrictions in their performance as a result of injury and illness. The emergence of a number of recent studies has started to address and propose solutions to this problem.^{18 22 23} Hence, the current IIPP methods' inclusion of a performance-restriction classification provides an important additional layer of information, and better characterisation of injury and illness risk factors, potentially negating an overestimation of the true number of impactful time-loss events, and underestimation of the true impact of some previously (incorrectly) classified medical-attention issues.

Upper respiratory illness (URI) was the most common type of illness with TeamGB, the same as reported in previous Winter Olympic Games studies.^{3 17} Elite athletes are more susceptible to URI than their recreational counterparts,²⁴ and environmental factors such as cold dry air inhalation outside, particularly at the high altitude venues, regular changes in temperature extremes going from inside athlete accommodation and other living quarters to outside, coupled with high respiratory air flow rates during high-intensity exercise, and the stress and intensity of Olympic competition are just some of the factors cited to contribute to this prevalence of URI.²⁴⁻²⁶ With the relative warmth of the sea-level venues at the Sochi Winter Olympic

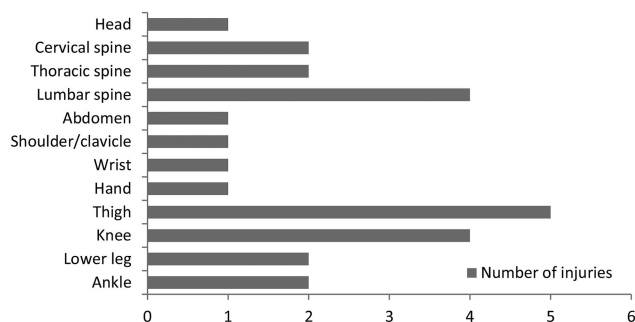


Figure 1 Number of injuries by location, within the Great Britain Olympic Team. Note: one injury location unknown.

Games, and 8 of 11 illnesses occurring in athletes from the mountain village venues (ie, skiing, snowboarding and sliding events), this adds weight to the theories proposed. By gender, the rate of female athlete illness in the present study was higher than for their male counterparts. In addition, it appeared that older female athletes may be at greater risk of illness. These findings are in agreement with the results reported from the Vancouver Olympic Games, where female athlete illness rates were also higher than those in male athletes, and with ill female athletes being significantly older than their healthy counterparts. Further analysis on the causation of this phenomenon, and whether it is solely an issue for Winter sports, could help our understanding and begin to unpick this issue. Prior to the Games, TeamGB athletes and support staff received illness awareness information, which included updates on hand-washing techniques, use of antimicrobial hand foam bottles and prophylactic nasal gels. This formed a small part of the overall TeamGB Games preparation work delivered to the athletes. Continued work focusing on athletes participating in events in colder and higher altitude venues, and on older female athletes, in particular those with a previous history of repeated upper respiratory tract illness, may be of benefit.

In the present study, just over half of all TeamGB injuries occurred in snowboarding and freestyle skiing. Relative to competing athletes, overall freestyle skiing followed by skeleton and snowboarding presented the greatest risk for injury, and Alpine skiing, biathlon and curling having the lowest risk, with no injuries reported in these sports. However, data numbers were very low when broken down by sport and results should be interpreted with some caution. Owing to limited injury/illness numbers, some sports remained grouped, that is, snowboarding and freestyle skiing, encompassing all disciplines. Overall, the current study data were broadly consistent with previously reported findings by Engebretsen *et al*³ where freestyle skiing and snowboarding presented the greatest injury risk, and biathlon and curling the lowest. The location and type of all injuries were also similar to that reported previously from Vancouver, with joint (ligament) sprains and contusions most common, and lower limb injuries predominant, across TeamGB.

Contact with a static object was equally the most common cause of injury alongside recurrent injury within TeamGB. Although relatively common, the severity of recurrent injury was very low, with all resulting in medical attention only. This suggests that athletes were seeking maintenance type treatment for recurring index injuries. While they were not by definition impactful, this does suggest that full and complete rehabilitation of these injuries before returning to training and competition had not been completed, and that athletes were affected in a way that caused them to seek treatment. At the highest level of competition, such as the Olympic Games, where winning margins are small, these may have subtly affected athletes to a greater or lesser degree. Hence, return-to-play decisions should be reviewed by medical staff,²⁷ including the pressure from athletes themselves and/or coaches to return early from injury or illness in the run-up to important events such as the Olympic Games. In contrast to recurrent injury severity, almost half of all contact static object injuries were impactful, resulting in a total of 38 performance-restriction/time-loss days. With 78% of all reported contact with static object injuries (ie, with the ground) occurring in snowboarding and freestyle skiing, this indicates that falls were the predominant cause of the higher risk of injuries observed in these sports at the Sochi 2014

Winter Olympic Games. The most severe of these occurred in freestyle skiing with 33 performance-restriction/time-loss days resulting, with one training related injury forcing an athlete to withdraw completely just prior to competition. Although data numbers are low in the current study, these results are in agreement with previous findings by Flørenes *et al*,²⁸ where the authors reported a high injury rate, especially for severe injuries in World Cup freestyle skiers.

Snow sports such as snowboarding and freestyle skiing are sports that can be affected by adverse weather and snow conditions, and these were reported to be an issue during the Sochi 2014 Winter Olympic Games, with warm weather contributing to soft snow conditions, and reports of more athletes falling during jumps and landing, as a result.²⁹ Standardised guidelines on the quality of snow, and other variables such as the height and technicality of jumps within snowboarding and freestyle skiing in particular, may need to first be implemented during regular season competitions, and then also during the Olympic Games, to try to alleviate the number of fall-related contact injuries in these sports especially.

The main strengths of the present study were the detailed and sensitive data collection methods used, and where reporting accuracy was high given the practitioner to athlete ratio and smaller number of TeamGB athlete events. This also poses a limitation of the work, where high athlete to practitioner ratios would be less likely to occur for many other National Olympic Committee (NOC) delegations, particularly for larger countries. For these larger delegations with more athletes, competing in all 22 sporting events being more disparate across various competition and training venues, it might be more challenging to have knowledge of all medical issues as they arise, and to discern between the more sensitive levels of injury/illness classification. Other strengths include the prospective nature of data collection in one of the most unique sporting competitive environments, the Olympic Games, which provides a valuable insight into the issues suffered by high performance athletes at the pinnacle competitive event of their sporting careers. While the rate of injury and illness was established during the Olympic Games period, it was not logistically possible to record the amount of time dedicated to training and competition for TeamGB athletes. It is known that greater exposure to the environment of risk can increase the absolute number of injury and illness episodes. Hence, in order to determine the true risk of injuries (in particular), inclusion of an exposure time component, that is, the amount of time spent in training and competition, would help to identify more accurate indices of the rate and therefore risk of injury by sport.

CONCLUSIONS

During the Sochi 2014 Winter Olympic Games, 39% and 18% of TeamGB athletes were injured or ill, respectively. The majority of issues resulted in medical attention only, and there were differences in injury and illness rates by sport, and also by gender. It is recognised that methodological considerations can play a part in the results observed, and it is important that these are understood when interpreting the findings. With a better understanding of the aetiology of injuries and illnesses during major sporting events such as the Olympic Games, prevention initiatives and medical resources for future TeamGB delegations may be better targeted to help reduce the impact of injury and illness on competing athletes.

What are the new findings?

- ▶ Prevalence and severity of injuries and illnesses were recorded for the Great Britain Olympic Team during the Sochi 2014 Winter Olympic Games.
- ▶ Prevalence rates were higher than reported during the previous Winter and Summer Olympic Games studies.
- ▶ The majority of injuries and illnesses were of minimal severity requiring only medical attention.

How might it impact on clinical practice in the near future?

- ▶ Illness prevention strategies may be more specifically targeted around older female athletes.
- ▶ Medical and physiotherapy provision may focus more on specific high-risk sports during the Winter Olympic Games.

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