The incidence and patterns of illness at the Sochi 2014 Winter Paralympic Games: a prospective cohort study of 6564 athlete days

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Abstract

Objective To describe the epidemiology of illness at the Sochi 2014 Winter Paralympic Games.

Methods A total of 547 athletes from 45 countries were monitored daily for 12 days over the Sochi 2014 Winter Paralympic Games (6564 athlete days). Illness data were obtained daily from teams without their own medical support (13 teams, 37 athletes) and teams with their own medical support (32 teams, 510 athletes) through electronic data capturing systems.

Results The total number of illnesses reported was 123, with an illness incidence rate (IR) of 18.7 per 1000 athlete days (95% CI 15.1% to 23.2%). The highest IR was reported for wheelchair curling (IR of 20.0 (95% CI 10.1% to 39.6%)). Illnesses in the respiratory system (IR of 5.6 (95% CI 3.8% to 8.0%)), eye and adnexa (IR of 2.7 (95% CI 1.7% to 4.4%)) and digestive system (IR of 2.4 (95% CI 1.4% to 4.2%)) were the most common. Older athletes (35–63 years) had a significantly higher IR than younger athletes (14–25 years, p=0.049).

Conclusions The results of this study indicate that Paralympic athletes report higher illness incidence rates compared to Olympic athletes at similar competitions. The highest rates of illness were reported for the respiratory and digestive systems, eye and adnexa, respectively. Thus, the results of this study form a basis for the identification of physiological systems at higher risk of illness, which can in turn inform illness prevention and management programmes with eventual policy change to promote athlete safety in future editions of the Winter Paralympic Games.

Introduction

Illness has rarely been studied in major sporting events in athletes with impairment. Reference to illness in early studies of injury in Paralympic athletes suffered from the use of a generic illness definition.[1–5] There was also inconsistency in the definition of illness across studies.

Illness was reported during precompetition and competition periods of the London 2012 Summer Paralympic Games.[6] The illness incidence rate (IR) was 13.2 illnesses per 1000 athlete days in a cohort of 3565 athletes. The highest IR was in the respiratory system (IR 3.6 (95% CI)), followed by the skin (IR 2.40 (95% CI)), digestive (IR 1.90 (95% CI)), nervous (IR 1.26 (95% CI)) and genitourinary (IR 1.12 (95% CI)) systems. The IR was highest in the sports of equestrianism (IR 20.7 (95% CI)), powerlifting (IR 15.8 (95% CI)) and athletics (IR 15.4 (95% CI)). Age and sex were not independent predictors of illness. The overall illness IR as well as proportion of athletes with an illness was higher compared to data from studies conducted in similar able-bodied athlete populations.[7–9] This study concluded that a population of athletes with impairment might be at higher risk of developing illness by nature of their underlying impairment.[10,11]

The International Paralympic Committee (IPC) adopted a Medical Code in 2011 which 'encourages all stakeholders to ensure that sport is practiced in a manner that protects the health of the athlete and minimises the chance of injury and illness…'.[12] To do so, the IPC Medical Committee has implemented a long-term prospective illness surveillance project to characterise the risk factors for illness at major events, at the start of the London 2012 Paralympic Games. No such study has ever been conducted in a Paralympic Winter sports environment.

The aim of our study was to document illness at the Sochi 2014 Winter Paralympic Games, using the same web-based injury and illness surveillance system (WEB-IISS) as was used at the 2012 London Paralympic Games.[13] Overall illness incidence rate, illness IR per sport, type of illness and physiological systems affected by the illness were investigated for the 12 days of the Games period.

Methods

This study was a component of a larger ongoing epidemiological study of both Summer and Winter Paralympic Games. This prospective component of the epidemiology of illness was conducted during the 3-day precompetition period and 9-day competition period of the Sochi 2014 Winter Paralympic Games. For the purpose of this study, the precompetition period and competition period were combined and analysed as one 12-day Games period.

Participants

This study was conducted through the IPC Medical Committee. Before research activities were conducted, ethical approval for this study was granted by both the University of Brighton (FREGC/ES/12/11) and the University of Cape Town (HREC/REF 436/2012) Research Ethics Committees. Informed consent was obtained from all athletes for the use of de-identified medical data gathered during the Games.

We used the web-based injury and illness surveillance system (WEB-IISS) which was successfully implemented at the London 2012 Paralympic Games. The WEB-IISS was used for data collection by teams with their own medical support staff. For athletes who did not have accompanying medical staff, illness data were captured via the ATOS information system (Bezons, France) supplied to the medical staff employed by the Sochi Organising Committees of the Olympic and Paralympic Games (SOCOG). Complete details of data sources, data collection methodology, data input and analysis can be found in the previous literature.[13] Specific fields were adapted within the WEB-IISS with regard to Winter sports, which included certain aspects of each athlete's classification within the sports they competed in (lower limb impairment, minimally impaired, sitting class, standing class and visual impairment) as well as the factors contributing to illness.

In brief, introductory information about the study was sent via email to all National Paralympic Committees (NPC) and Chief Medical Officers (CMO) of the teams participating at the Sochi 2014 Winter Paralympic Games. Detailed information regarding the study was provided to the team physicians of all delegations, as well as medical members of the Paralympic Village polyclinic (for countries who did not have their own medical staff), at the precompetition medical briefing on day 2 of the precompetition period. Participation and compliance from teams with medical staff were incentivised by the provision of a data entry tablet to each participating country that had more than 10 athletes competing at the Games. The remainder of the countries with accompanying medical staff reported their data via laptop computers. The data of athletes who did not have accompanying medical staff were captured via the ATOS data capturing system supplied to the polyclinic doctors of the SOCOG.

Definition of illness

A general definition accepted for reporting illness was defined as any athlete requiring medical attention, regardless of the consequences with respect to absence from competition or training. A medical illness was specifically defined as ‘any newly acquired illness as well as exacerbations of pre-existing illness that occurred during training and/or competition or during or immediately before the Sochi 2014 Winter Paralympic Games’.[13]

Calculation of athlete days

Teams without their own medical support

The exposure data in terms of athlete days for countries without their own medical support were made on the assumption that the total number of athletes, as published in the IPC athlete database, was static for the duration of the Games. The total athlete days were calculated as follows: total term days (precompetition and competition 12-day period)×daily team size (for each day).

Teams with their own medical support

The CMO of each team was requested to capture their daily team size (number of athletes that were under the care of the medical team) and register any new illness. An analysis of the data of teams with their own medical support (WEB-IISS) showed that there was a negligible variance (approximately 0.5%) between the reported number of athletes in each delegation and the total number of athletes, as published in the IPC athlete database. Therefore, total

athlete days for each country were also calculated as described for teams without their own medical support.

Calculation of illness IR and illness proportion

The illness IR was calculated as illnesses per 1000 athlete days. The number of athlete days was reported separately by sporting categories, age group and sex. The IR per 1000 athlete days was reported for all illnesses, as well as illnesses in different sports and physiological systems. The illness proportion refers to the percentage of athletes reporting an illness during the study period and was calculated as the number of athletes with an illness over the total number of athletes competing in the relevant subgroup.

Statistical analysis of the data

Data were in the form of counts (ie, the number of illnesses each athlete reported). Athletes could participate in more than one sport and/or more than one event. Some athletes incurred multiple illnesses during the 12 days; thus, the outcome variable was the number of illnesses reported by each athlete. Standard descriptive statistical analyses were reported, including the number of athletes participating in the various sports (combining alpine skiing with snowboarding and cross-country skiing with biathlon) by age (14–25, 26–34 and 35–63 years) and sex (male or female), number of reported illnesses, as well as the number and proportion of athletes with an illness. Generalised linear Poisson regression modelling was used to model the number of reported illnesses overall, as well as the number of illnesses for physiological systems affected by the illness and were corrected for overdispersion and including the independent variables of interest. Results were reported as illness IR per 1000 athlete days (including 95% CIs). Results for overall illness rates were reported by sex, age group and type of sport.

Results

Participants

All countries chose to participate in the study. During the Games period, a total of 45 NPCs, representing 547 athletes over 6564 athlete days, were monitored. Teams with their own medical support staff comprised a total of 6096 athlete days (32 countries, 508 athletes), while teams without medical support staff comprised a total of 468 athlete days (13 countries, 39 athletes).

There were 418 (76%) male and 129 (24%) female athletes in the study. The mean (+ SD) age of all athletes in this study was 31.2±9.5 years (minimum=14 years and maximum=63 years). The total number of athletes, as well as sex and age distribution in each sport, is presented in table 1.

Table 1. Number of athletes participating in each sport (all athletes, males and females, age groups)

Sport	All athletes	Males	Females	Age 14–25 years	Age 26–34 years	Age 35–63 years
All	547	418	129	172	198	177
Alpine skiing/snowboarding	219	163	56	75	88	56
Cross-country Skiing/biathlon	149	95	54	60	49	40
Ice sledge hockey	129	129	0	34	53	42
Wheelchair curling	50	31	19	3	8	39

Incidence of illness by sport

Table 2 presents the total number of illnesses as well as illnesses reported in four categories of sports during the combined precompetition and competition periods. The total number of illnesses recorded in all sports was 123 illnesses in 95 athletes (17.4% of all athletes), with an IR of 18.7 per 1000 athlete days (95% CI 15.1% to 23.2%). The incidence of illness was similar across all four sporting categories. The combined sports of alpine skiing/snowboarding contained the highest total number of illnesses (51 illnesses in 41 athletes); however, the highest IR of 20.0 per 1000 athlete days was reported in wheelchair curling (95% CI 10.1% to 39.6%). An IR of 19.4 was reported in the alpine skiing/snowboarding sports as well as ice sledge hockey (95% CI 13.9% to 27.0% for alpine skiing/snowboarding; 95% CI 12.6% to 29.9% for ice sledge hockey), while an IR of 16.8 (95% CI 10.9% to 25.9%) was reported in the Nordic events of cross-country skiing/biathlon.

Table 2. Incidence of illness by sport (total number of illnesses, number of athletes with an illness, total number of athletes competing, total number of athlete days, proportion of athletes with an illness, illness incidence rates per athlete days)

Sport	Total number of illnesses	Number of athletes with an illness	Total number of athletes competing	Total number of athlete days	Proportion of athletes with an illness	Illness incidence rate illnesses/1000 athlete days (95% CI)
All	123	95	547	6564	17.4	18.7 (15.1 to 23.2)
Alpine skiing/snowboarding	51	41	219	2628	18.7	19.4 (13.9 to 27.0)
Cross-country skiing/biathlon	30	24	149	1788	16.1	16.8 (10.9 to 25.9)
Ice sledge hockey	30	18	129	1548	14.0	19.4 (12.6 to 29.9)
Wheelchair curling	12	12	50	600	24.0	20.0 (10.1 to 39.6)

Incidence of illness by sex and age group

Table 3 depicts the incidence of illness by sex and age groups. The older category of athletes above 35 years had a higher IR of illness compared to the younger athletes below 25 years (IR of 22.6 (95% CI 16.0% to 31.9%) vs 12.6 (95% CI 7.9% to 20.1%) p=0.049), with no significant difference reported in IR by sex.

Table 3.Incidence of illnesses by sex and age group (total number of illnesses, number of athletes with an illness, total number of athletes competing, total number of athlete days, proportion of athletes with an illness, illness incidence rates per athlete days)

Sex/age group	Total number of illnesses	Number of athletes with an illness	Total number of athletes competing	Total number of athlete days	Proportion of athletes with an illness	Illness incidence rate illnesses/1000 athlete days (95% CI)
All	123	95	547	6564	17.4	18.7 (15.1 to 23.2)
Female	28	24	129	1548	18.6	18.1 (11.6 to 28.3)
Male	95	71	418	5016	17.0	18.9 (14.9 to 24.2)
Age 14–25 years	26	19	172	2064	11.0	12.6 (7.9 to 20.1)*
Age 26–34 years	49	35	198	2376	17.7	20.6 (14.7 to 29.0)
Age 35–63 years	48	41	177	2124	23.2	22.6 (16.0 to 31.9)

*Significantly lower compared to age group 35–63 years (p=0.049).

Incidence of illness for each physiological system

Table 4 shows the physiological systems affected by illness. The most affected system was the respiratory system, with 37 illnesses in 30 athletes and an IR of 5.6 (95% CI 3.8% to 8.0%). The second most commonly affected system was the eye and adnexa (surrounding tissues) with 18 recorded illnesses and an IR of 2.7 (95% CI 1.7% to 4.4%). An IR of 2.4 was recorded for both the digestive system and the skin and subcutaneous system (95% CI 1.4% to 4.2% for digestive; 95% CI 1.3% to 4.6% for skin and subcutaneous).

Table 4. Incidence of illness in each physiological system (total number of illnesses, number of athletes with an illness, proportion of athletes with an illness, illness incidence rates per 1000 athlete days)

Physiological system	Total number of illnesses	Number of athletes with an illness	Proportion of athletes with an illness	Illness incidence rate illnesses/1000 athlete days (95% CI)
All	123	95	17.4	18.7 (15.1 to 23.2)
Respiratory	37	30	5.5	5.6 (3.8 to 8.0)
Eye and adnexa	18	17	3.1	2.7 (1.7 to 4.4)
Digestive system	16	14	2.6	2.4 (1.4 to 4.2)
Skin and subcutaneous	16	13	2.4	2.4 (1.3 to 4.6)
Genitourinary	8	8	1.5	1.2 (0.6 to 2.4)
Mental and brain	8	8	1.5	1.2 (0.6 to 2.4)

The main physiological system affected by illness in each sport category

In the alpine skiing/snowboarding category, 11 of the reported illnesses (22%) were digestive illnesses (IR of 4.2 (95% CI 2.2% to 7.8%)). In ice sledge hockey, 10 reported illnesses (33%) were respiratory illnesses (IR of 6.5 (95% CI 3.2% to 13.24%)). For wheelchair curling, 5 of the reported illnesses (42%) were in the eye and adnexa system (IR of 8.3 (95%

Table 5: Physiological systems affected by illness, associated presenting symptoms and percentage of a total of 88 symptoms of illness reported on the WEB-IISS system

Physiological system affected by illness	Presenting symptoms	Total number of illnesses captured by WED-IISS system	Percentage of total illnesses captured by WEB-IISS system
Respiratory	Sore throat	11	12.5%
	Blocked nose (congestion)	10	11.4%
	Cough	3	3.4%
	Headache/sinus pain	1	1.1%
	Hoarseness	1	1.1%
	Rhinorrhea	1	1.1%
	Chest pain	1	1.1%
	Dyspnoea	1	1.1%
Eye and adnexa	Congiuntivitis	1	1.1%
Digestive	Diarrhoea	6	6.8%
	Abdominal Pain/cramps	5	5.7%
	Dyspepsia	2	2.3%
	Nausea	1	1.1%
	Vomiting	1	1.1%
Skin and subcutaneous	Skin break down	6	6.8%
	Stump/prosthesis symptoms	4	4.5%
	Skin rash	2	2.3%
	Blister	1	1.1%
	Pruritis (itchiness)	1	1.1%
Genitourinary	Bladder symptoms	2	2.3%
	Dysuria	2	2.3%
Mental and brain	Insomnia	8	9.1%
	Headache	2	2.3%
	Dizziness	1	1.1%
Other	Pain (not related to injury)	9	10.2%
	Anaphylaxis	1	1.1%
	Other (unspecified)	4	4.5%

CI 3.3% to 21.2%)). In cross-country skiing/biathlon, 16 of the total number of illnesses reported (53%) were respiratory illnesses (IR of 8.9 (95% CI of 5.1% to 15.8%)).

Symptomatology of illness

The diagnosis and frequency of symptoms of the 123 illnesses reported during the Games period are described in Table 5. The most common symptom of illness was sore throat, followed by nasal congestion and pain.

Time loss as a result of illness

Of the illnesses reported during the Games period, 21% of athletes reporting an illness required one or more days of exclusion from training or competition, while 79% of athletes reporting an illness required no time loss from training or competition.

Discussion

This study aimed to document the incidence of illness at the Sochi 2014 Winter Paralympic Games in four combined categories of sports. Similar to the study investigating the incidence of injury at the Sochi 2014 Winter Paralympic Games, this study was the first to document illnesses per 1000 athlete days at an international Winter Games. Thus, this study has provided the first reliable baseline data for the incidence of illness at such a competition. There has been limited previous research that has reported illness as a minor variable in papers focused predominantly on injury incidence at international sporting events. However, these studies were also limited by generic definitions of illness and less reliable data collection systems, often relying on athlete self-report and cross-sectional survey data.[1–5]

Higher incidence of illness in Paralympic athletes in a Winter Games setting

The first important finding of this study was the number of illnesses reported by athletes during the Games period. A total of 123 illnesses were documented in 547 athletes, representing 17.4% of the total number of athletes attending the Games (IR of 18.7 per 1000 athlete days (95% CI 15.1% to 23.2%). A study investigating able-bodied athletes at the Sochi 2014 Winter Olympic Games reported 249 illnesses in 2780 athletes, representing 8% of all athletes participating in the study.[14] The incidence of illness recorded during their study was similar to that reported at both the London 2012 Olympic Games and Vancouver 2010 Winter Olympic Games (8% at the Sochi Games vs 7% at both the London and Vancouver Games).[9,15] This difference between Paralympic and Olympic athletes was also observed at the London 2012 Games, where Paralympic athletes reported twice the rate of illnesses, compared to their able-bodied counterparts (7% at Olympic Games vs 14.2% at Paralympic Games).[6,15]

The IR reported in this study (IR of 18.7 (95% CI 15.1% to 23.2%)) in a Winter Games setting was also higher than that recorded in the 2012 London Summer Paralympic Games, where 501 illnesses were recorded in 365 athletes (14.2% of all athletes, IR of 13.2 (95% CI 12.2% to 14.2%)). Thus, the findings of this study provide the first evidence for the difference in illness incidence and proportion between Olympic and Paralympic athletes at international Winter sporting events, as well as a difference in illness incidence between Winter and Summer sporting settings in Paralympic athletes. The possible reasons for the

high illness incidence in Paralympic athletes compared to Olympic athletes require further investigation. However, the effect of impairment on immune function and higher risk for infection in Paralympic athletes may contribute to rates reported in this study.[16] Additional factors may include an increased risk of genitourinary infection due to neurogenic bladder and self-catheterisation or use of an indwelling catheter;[17] reduced pulmonary function in athletes with higher level neurologic injury such as quadriplegia or quadriparetic cerebral palsy;[18] or the increased age of athletes with impairment competing at the Games.[19]

Incidences and ratios of illness between four sporting categories

The second important finding of this study was the similar incidence of illness across the four categories of sports. The highest IR was recorded in wheelchair curling (IR of 20.0 (95% CI 10.1% to 39.6%)), while the same IR was reported for two additional sporting categories (alpine skiing/snowboarding and ice sledge hockey; IR of 19.4 (95% CI 13.9% to 27.0% and 95% CI 12.6% to 29.9%, respectively). Interestingly, the ratio of illnesses per athlete was 1.7 for ice sledge hockey and 1.2 for alpine skiing/snowboarding, despite the same IR, providing insight into the actual rate of illnesses in these athletes. The ratio in wheelchair curling was 1.0 (12 illnesses in 12 athletes), which highlights that the high IR of wheelchair curling is most likely a result of low numbers and a somewhat hindered statistical analysis, as opposed to a high number of illnesses in that sport. In the future, comparison of sport-specific data longitudinally across several Winter Paralympic Games will be helpful in increasing statistical power, thus enabling more specific comparisons between sports.

Three most commonly affected physiological systems

The third important finding of this study was the distribution of illnesses in various physiological systems. The highest IR was reported in the respiratory system (IR of 5.6 (95% CI 3.8% to 8.0%)), followed by the eye and adnexa (IR of 2.7 (95% CI 1.7% to 4.4%)) and the digestive system (IR of 2.4 (95% CI 1.4% to 4.2%)). Illness in the respiratory system has been reported to be consistently higher than illnesses affecting other systems in Summer and Winter Games settings, as well as both able-bodied athletes and athletes with impairment.[6,9,14,15] The finding in this study of relatively high rates of illness in the eye and adnexa represents a novel contribution to the literature. Interestingly, a higher number of respiratory illnesses were reported in outdoor endurance events, while a higher incidence of illnesses in the eye and adnexa system was documented in indoor curling events. This difference in the pattern of illness in physiological systems between the sports is a novel finding and, similar to the findings of the previous paragraph, requires additional research in future longitudinal studies.

Higher incidence of illness in older athletes

Finally, there was a significant yet marginally lower IR of illness for athletes in the 14–25 years age category, compared to the other two age categories (table 3 (95% CI) p=0.049), indicating that older athletes are possibly more susceptible to illness than younger athletes. As mentioned in the introduction of this paper, this may be due to immune function changes as a result of increased age.[19] The relationship between age, illness and impairment needs to be further explored in future studies.

Limitations of the study

There were a number of limitations of this study. First, the definition of illness used in this study is broad and might include the reporting of seemingly trivial symptomatology and also severe life-threatening illness. Future studies should address this limitation. Second, while diverse ocular conditions including conjunctivitis and keratitis were listed as specific diagnoses in some of the illnesses, the final diagnoses were not available for the majority of cases recorded and this constitutes a limitation of this study. It is, however, possible that the adverse weather and resultant bad snow conditions, including ultraviolet damage (sun burn and glare), might have contributed to the high incidence of eye and adnexa illnesses reported in the Sochi Winter Games setting.[20] Furthermore, there is a common link between allergic upper respiratory tract infection and rhinoconjunctivitis observed in able-bodied athletes, which may have occurred in this study.[21] Further detailed investigation is thus required and is planned for future studies at the next edition of the Winter Paralympic Games. Another limitation of this study was that two electronic sources were used for data collection. It is suggested that this is addressed in future studies of the epidemiology of illness at the Paralympic Games. Furthermore, the relatively small total number of illnesses and athletes reporting illness does not allow for complex multivariate analysis in this study. Future longitudinal studies with larger sample sizes might be helpful in the identification and discussion of risk factors for illnesses in a Winter Paralympic Games setting.

CONCLUSION

In summary, the incidence of illnesses reported at the Sochi 2014 Winter Paralympic Games was higher than that reported at the London 2012 Summer Paralympic Games and the Sochi 2014 Winter Olympic Games. This study also revealed similar incidences of illness reported in all sporting categories, although a slightly higher IR was reported in wheelchair curling. Additionally, different illness patterns were observed in different sports. The highest rates of illness were reported for the respiratory and digestive systems, eye and adnexa, respectively. Further research is required on the factors associated with eye and adnexa illness at Winter Paralympic sporting events.

What are the findings?

- This was the first study to document incidence of illness at a Winter Paralympic Games per 1000 athlete days.
- There was a higher incidence of illness at the Sochi 2014 Winter Paralympic Games, compared to the 2012 London Summer Paralympic Games and Sochi 2014 Winter Olympic Games.
- There was a similar incidence of illness in all sporting categories.
- Illnesses in the respiratory system, eye and adnexa and digestive system were most common.

How might it impact on clinical practice in the future?

- The information in the present study can be used by organisations, coaches and athletes to identify physiological systems at risk for illness in a Winter Games setting for athletes with impairment.
- The identification of areas of risk provides the basis for illness prevention programmes at the athlete level, as well as the organisational level.

- This study has provided a repeatable methodology for the capture and analysis of the incidence of illness in athletes with impairment in a Winter Paralympic Games setting, providing the basis for future studies at upcoming Paralympic Games.

Acknowledgments

This study was approved and supported by the IPC. The authors would like to acknowledge and express their gratitude for the hard work of Cris Gomes, Oriol Martinez and Norma-Angelica Patino Marques, as well as the support of Sochi Medical Services led by Dr Alexey Pleskov and all participating NPC Chief Medical Officers. Furthermore, the authors would like to thank Samsung for their generous donation of Samsung tablets for the collection of data in the study.

Footnotes

- Correction notice This paper has been amended since it was published Online First. The acknowledgements has been changed. The authors inadvertently credited Acer when it was Samsung who donated the tablets for collection of data in the study.
- Twitter Follow Wayne Derman at @ISEM_SU
- Funding IOC Research Centre (South Africa) Grant, IPC Research Grant.
- Competing interests None declared.
- Ethics approval University of Brighton (FREGC/ES/12/11); University of Cape Town (HREC/REF 436/2012).
- Provenance and peer review Not commissioned; externally peer reviewed.

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