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Sport injuries and illnesses during the 1st Winter Youth Olympic Games 2012 in Innsbruck/Austria

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Abstract

Background: Data on the injury and illness risk among young elite athletes are of utmost importance because injuries and illnesses can counter the beneficial effects of sports participation at a young age if children or adolescents are unable to continue to participate because of residual effects of injury or chronic illness.

Objective: To analyse the frequencies and characteristics of injuries and illnesses during the 2012 Innsbruck Winter Youth Olympic Games (IYOG).

Methods: We employed the IOC injury surveillance system for multisport events, which was updated for the Winter Olympic Games in Vancouver 2010. All National Olympic Committees (NOC) were asked to report the daily occurrence (or non-occurrence) of newly sustained injuries and illnesses on a standardised reporting form. In addition, information on athletes treated for injuries and illnesses by the Local Organizing Committee medical services was retrieved from the medical centre at the Youth Olympic Village and from the University hospital in Innsbruck.

Results: Among the 1021 registered athletes (45% females, 55% males) from 69 NOCs, a total of 111 injuries and 86 illnesses during the IYOG were reported, resulting in an incidence of 108.7 injuries and 84.2 illnesses per 1000 registered athletes, respectively. Injury frequency was highest in skiing in the halfpipe (44%) and snowboarding (halfpipe & slope style: 35%), followed by ski cross (17%), ice hockey (15%), alpine skiing (14%), and figure skating (12%), taking into account the respective number of participating athletes. Knee, pelvis, head, lower back and shoulders were the most common injury locations. About 60% of injuries occurred in competition and about 40% in training, respectively. In total, 32% of the injuries resulted in an absence of training or competition. With regard to illnesses, 11% of females and 6% of males suffered from an illness (RR= 1.84 (95% CI: 1.21-2.78), p = 0.003). The respiratory system was affected most often (61%).

Conclusion: Eleven percent of the athletes suffered from an injury and 9% from illnesses during the IYOG. The presented data constitute the basis for future analyses of injury

mechanisms and associated risk factors in Olympic Winter sports are essential to implement effective preventive strategies for young elite winter sport athletes.

Introduction

There is ample evidence that sport participation in children and adolescents is beneficial from a public health perspective [1-3] although negative side effects on direct and indirect costs and returns to sports arise from injuries during sport participation.[4,5] The Youth Olympic Games for athletes aged 14-18 years with its cultural and educational emphasis is one approach of the International Olympic Committee (IOC) to showcase high-level sports as a catalyst improving the health of the youth.[5] While about 3500 athletes from more than 200 National Olympic Committees (NOCs) participated in the first Summer Youth Olympic Games held in Singapore in August 2010, about 1000 athletes from 70 NOCs participated in the first Winter Youth Olympic Games in Innsbruck/Austria in January 2012.

To protect health of its athletes, the IOC initiated and developed in cooperation with the International Olympic Sports Federations and the NOCs the injury and illness surveillance system in the 2008 Beijing and in the 2010 Vancouver Olympics which will be further developed in the 2012 London and 2014 Sochii Olympics.[6] With these systematic injury registrations, high risk sports will be identified, including their most common and most severe injuries to ensure new knowledge on injury trends over time to form the basis for further research on injury risk factors and injury mechanisms and finally to develop injury prevention programmes.[5] However, as injury risk and patterns of young elite athletes may vary from their older professional counterparts, injury surveillance of young elite athletes is needed to gain knowledge about the injury risk among this highly competitive population.[7] With regard to epidemiological data among young elite athletes competing in the 26 sports that were programmed for the first Summer Youth Olympic Games in Singapore, Steffen & Engebretsen [7] identified a total of 13 studies presenting data on injury risk of youth and adolescent elite athletes. However, these studies, mainly on injuries in soccer, represented

only one fifth of all sports included in the Youth Olympic Games in Singapore.[7] In winter sports, even fewer data on injury risk are published on this age group.[5,7] Also illnesses and health related factors have to be considered among winter sports athletes who train and compete most time of the year under cold air exposure. [8,9] At the Vancouver Olympics, the respiratory system was most affected with 63% of all illnesses.[8]

While there are recent data concerning injuries and illnesses from the traditional Winter Olympic Games in Vancouver 2010 [8,9] and from FIS World Cups,[10-12] there is a lack in the knowledge on injury risk and illness occurrence in young elite winter sport athletes.[7] Thus, the aim of the present study was to evaluate the incidence and frequencies of injury and illnesses occurring during the 1st Winter Youth Olympic Games in Innsbruck 2012.

Methods

After obtaining the approvals from the Institutional Review Board and from the ethic committee of the University of Innsbruck, the same methods of the IOC injury and illness surveillance used during the Olympic Winter Games 2010 in Vancouver/Canada [8] were used in the present study. About 4 weeks before the 2012 Innsbruck Winter Youth Olympic Games (IYOG), the NOCs were informed about the study and were invited to participate in the Innsbruck injury and illness surveillance study. The medical representatives and the Chefs de Mission of all NOCs received a booklet with detailed information about the study, including the injury and illness forms to be filled out. In addition, one day before the opening of the Games, NOCs physicians, physiotherapists and the medical representatives of the Winter Olympic International Sports Federations were invited to a meeting covering the details of this study. The NOCs, usually represented by the head physician, were asked to report the daily occurrence (or non-occurrence) of newly sustained injuries and illnesses on a standardised report form. In cases where a NOC had no physician, the team physiotherapist conducted the reporting. If a NOC had no medical person at all, the Chef de Mission was interviewed daily about the occurrence of injuries and illnesses and this information was

checked with data from the medical centres. Information on athletes treated for injuries and illnesses by the Local Organizing Committee medical services was retrieved from the medical centre at the Youth Olympic Village and from the University Hospital in Innsbruck. To prevent double registrations, the athlete's accreditation number was manually checked in all data sources and information from the NOC physician was preferred over the venue or clinic physician's report.

Definition of injury and illness

According to the methods of the IOC injury and illness surveillance an athlete was defined as injured or ill if they received medical attention regardless of the consequences with respect to absence from competition or training.[8] An injury should be reported if it fulfilled the following criteria:[8] (1) musculoskeletal complaint or concussion, (2) newly incurred injuries or reinjuries, (3) incurred in training or competition and (4) incurred during the 1st Winter Youth Olympic Games (13-22 January 2012). An illness was defined as any physical complaint (not related to injury) newly incurred during the games that received medical attention. Chronic pre-existing illnesses were not included unless there was an exacerbation requiring medical attention.

In cases where multiple body parts were injured during the same incident, multiple types of injuries occurred in the same body part, or different body parts were affected by illnesses, only the most severe injury/illness was registered, however, with several diagnoses.[8]

Injury and illness report form

The report form was identical to the one used during the 2010 Vancouver Olympic Games, requiring the following information:[8] athlete's accreditation number, sport discipline/event, date, time, competition/training, injured body part, injury type, cause and estimated time loss. The illness part was located on the same page directly below the injury part including athlete's accreditation number, sport discipline/event, date of occurrence, diagnosis, affected system, main symptom(s) and cause of illness, as well as an estimate of time loss.[8]

Detailed instructions on how to fill out the form correctly were given in the booklet with examples for injuries and illnesses. According to the Vancouver study [8] injury and illness report forms were distributed to all NOCs in the following languages of choice: Chinese, English, French, German, Russian and Spanish.

Confidentiality

All information was treated strictly confidentially. The accreditation numbers were only used to avoid duplicate reporting from NOC physicians and the medical centres and to provide information on age, gender, sport and national federation of the athletes from the IOC database of registered athletes. In addition, after the Olympic Games the injury and illness reports were made anonymous.

Data analysis

All data were statistically analysed using SPSS (SPSS for Windows, versions 18.0, SPSS, Chicago, Illinois). Descriptive data were generally presented for variables as frequencies and proportions as well as mean values with standard deviations (SD). The incidence of injuries and illnesses was calculated as the number of injuries/illnesses per 1000 registered athletes referring to an exposure of the ten days of the Winter Youth Olympic Games. Frequencies of injuries/illnesses in different sports were calculated in relation to the number of registered athletes of the different winter sport disciplines. To compare the number of injuries and illnesses between female and male athletes, a rate ratio (RR) with corresponding 95% confidence interval (95% CI) was calculated. All P-values were two-tailed and values ≤ 0.05 were considered to indicate statistical significance.

Results

Incidence of injuries

Among the 1021 registered athletes (45% females, 55% males) with a mean age of 16.6 ± 0.9 years, a total of 111 injuries during the IYOG were reported, resulting in an incidence of 108.7 injuries per 1000 athletes. While most injured athletes suffered from 1 injury, a total of 8 athletes sustained two injuries. With regard to gender, 9.8% of females and 11.7% of males suffered from at least 1 injury (RR = 1.20 (95% CI: 0.58-1.19), p = 0.314), respectively, resulting in an incidence of 97.6 (95% CI: 70.5-124.7) injuries per 1000 female athletes and 117.3 (95% CI: 90.5-144.1) injuries per 1000 male athletes, respectively. When comparing the frequency of injury in athletes aged 14-15 years and ≥17 years, no significant differences were found (5.4 vs. 3.8%, p = 0.634).

Frequency of injury in different sports

In relation to the number of registered athletes, the frequency of injury was highest in halfpipe skiing (44%), halfpipe snowboarding and slope style (35%), ski cross (17%), ice hockey (15%), alpine skiing (14%), and figure skating (12%) (table 1). Frequencies of injury in all other sports were below 10% (table 1).

Injury location and type

The most affected injury location was the knee (14%) and pelvis (11%), followed by head (10%) and shoulder (9%) (table 2). More than 70% of knee injuries occurred among athletes from alpine skiing and snowboarding. Contusion (39%), ligament sprains (18%) and muscular strains (10%) were the most common injury types (table 2).

Injury mechanism, circumstances and severity of injury

The most common reported injury cause was a non-contact trauma (34%), followed by a contact with a stagnant object (16%) and contact with another athlete (13%). Stratified by sport, 72% of the injuries resulting from contact with a stagnant object and 68% of the non-contact injuries were sustained by alpine skiing and snowboarding athletes, respectively, while 86% of the contact injuries with another athlete occurred in ice hockey. In total, 41% of

injuries occurred in training and 59% of injuries occurred in competition, respectively. However, in ski cross, halfpipe skiing, bob, biathlon, nordic combined, figure skating and speed skating 60% and more of injuries occurred during training (table. 4).

Of the 111 injuries, 35 (32%) were expected to result in time-loss for the athlete (table 4). Of these, 9 (26%) had an estimated absence from training or competition of more than one week. The injuries included one fracture (ribs), one concussion (head), one ligamentous rupture (knee), one nerve injury (wrist), one dislocation (lumbar spine), two sprains (shoulder, knee) and two contusions (knee, pelvis).

Incidence and distribution of illnesses

In total, 86 illnesses during the IYOG were reported, resulting in an incidence of 84.2 illnesses per 1000 athletes. With regard to gender, 11% of females and 6% of males suffered from an illness (RR= 1.84 (95% CI: 1.21-2.78), p = 0.003), respectively, resulting in an incidence of 112.8 (95% CI: 83.9-141.7) illnesses per 1000 female athletes and 61.4 (41.4-81.4) illnesses per 1000 male athletes, respectively. Illnesses were reported from a variety of sports. In ice hockey, cross country, bob, luge, and skeleton, every 10th athlete suffered from at least one illness (table 1).

Affected system, symptom, cause and severity of illness

In total, the respiratory system was affected by 52 (61%) illnesses, mostly observed in Nordic skiing (n = 17), ice hockey (n = 11), alpine skiing and snowboarding (n = 10) and ice track sports (n = 9) (table 3). As a consequence, the illness cause was most often classified as an infection (n = 43, 50%). The most commonly reported symptoms were pain (n = 38, 44%) and fewer (n = 9, 11%). A total of 25 (29%) illnesses were caused by exercise-induced or environmental factors (table 3). About 30% (n = 26 of 86) of illnesses were expected to result in absence from further training or competition. Of those, two illnesses were expected to result in an estimated time loss of 10-14 days (varicella, tonsillitis).

Discussion

The aim of this study was to evaluate the risk of injury and illnesses occurring during the 1st Winter Youth Olympic Games in Innsbruck 2012. The principal findings were that 11% and 9% of the athletes suffered from an injury or an illness, respectively. The frequencies of injuries and illnesses varied between different sports.

Incidence and distribution, type and cause of injuries

This study is the first surveillance of injury and illness of athletes involving athletes of the Winter Youth Olympic Games. Therefore, this is the first time that the incidence of injury and illness of young elite athletes participating in the Winter Youth Olympic Games 2012 can be compared with the incidence of injury and illness of adult athletes participating in the 2010 Vancouver Olympic Games. However, when comparing incidence and frequencies of injuries and illnesses of these two Olympic Winter Games the different duration of Games (Vancouver Games lasted 7 days longer) and partly different sport disciplines have to be considered. The incidence of injury and illness during the Innsbruck YOG (IYOG) was very similar to the Vancouver Olympic Games, where 11% of the athletes incurred an injury and 7% of the athletes an illness.[8]

While the frequency of injury in the 2010 Vancouver Olympic Games was highest for snowboard cross followed by bobsleigh, ice hockey, short track, alpine, and freestyle with about 15-35% of registered athletes,[8] injuries in IYOG were found predominantly in halfpipe skiing (44%), halfpipe & slope style snowboarding (35%), ski cross (17%), ice hockey (15%), alpine skiing (14%), and figure skating (12%). Surprisingly, and in contrast to in the Vancouver Olympic Games, the frequency of injury in the halfpipe disciplines was more than twofold compared with the frequencies of injury in e.g. ski cross, ice hockey, alpine skiing, and figure skating.[8] In a study on elite snowboarders, Torjussen and Bahr [13] reported a 4-8 higher injury risk in big air and halfpipe disciplines than in snowboard slalom and giant slalom disciplines. In the big air and halfpipe disciplines the height and rotations of jumps are rewarded, and there is a trend that the construction and dimension of the halfpipes

increasingly enable skiers and snowboarders to do high jumps.[13] The IYOG halfpipe with its up to seven metres high walls, was comparable to the halfpipe of the 2010 Vancouver Olympic Games. Due to the high frequency of injury among young elite skiers and snowboarders in the halfpipe during IYOG we highly recommend that the dimensions of the halfpipe should be more adequately adapted to the age, musculoskeletal development and skill level of young elite athletes in future YOGs. The final responsibility of dimension regulation of the halfpipe rests with the experts of the International Ski Federation (FIS).

In accordance with the 2010 Vancouver Olympic Games results,[8] the frequencies of injury was low for athletes in the Nordic skiing disciplines (cross-country skiing, biathlon, ski jumping, Nordic combined). Also, ice track sports (bob, luge, skeleton) during IYOG showed relatively low frequencies of injury of about 4-8%. This might be somewhat surprising when taking into account the icy surface and high speed of ice track athletes. However, during the 2010 Vancouver Olympic Games the injury risk for luge and skeleton athletes was also reported to be low while injury risk during bob sleigh was relatively high with about 20%.[8]

Similar to the 2010 Vancouver Olympic Games,[8] the most affected injury location during IYOG was the knee, with a frequency of 14%. In total, 11 out of 15 (73%) knee injuries occurred among athletes from alpine skiing and snowboarding. This corresponds to data from Westin et al. [14], who after having followed students at Swedish Ski High schools during 5 years could report that 41% of injuries involved the knee joint, with most of them being classified as severe injuries. Similarly, Flørenes et al. [12] showed the knee was the most injured body region in World Cup athletes, with incidences of 36% in alpine skiing, 29% in freestyle skiing, and 19% in snowboarding.

During IYOG, head injuries accounted for 10% similar to the 2010 Vancouver Olympic Games result.[8] Head injuries occurred mainly in alpine skiing and snowboarding, ice hockey and ice track sports where helmet use is compulsory. However, due to the high speed and related impact in these sports, helmets can only diminish head injuries but not prevent them all. Injuries affecting the pelvis (11%) and shoulder (9%) were more common during IYOG compared with the 2010 Vancouver Olympic Games (2% pelvis and 5%

shoulder injuries).[8] Mainly IYOG athletes participating in alpine skiing and snowboarding, ice hockey and skating suffered from injuries of the pelvis and shoulders, which is very likely due to falls on hard and icy surfaces.

In about 50% of injuries during IYOG, a contusion or a strain was diagnosed, which is about 10% more in comparison to the 2010 Vancouver Olympic Games.[8] In accordance with the 2010 Vancouver Olympic Games,[8] sprains, concussions and fractures were diagnosed in about 18%, 7%, and 5% of the IYOG athletes, respectively. As head and knee injuries often result in long absence from training and competition, the prevention of concussions and severe knee ligament sprains, including injuries of the anterior cruciate ligament, is important.[8] Time-loss injuries accounted for about 32% during IYOG and 35% during 2010 Vancouver Olympic Games, respectively. In contrast to the 2010 Vancouver Olympic Games, where 54% of injuries occurred during official training sessions,[8] most injuries during IYOG occurred during competition with about 57%. One reason might be that training conditions were less competition-specific during the IYOG compared to the Vancouver Olympic Games. Gradual increases in training intensity to the competition level could potentially help to reduce the subsequent injury risk during competition. On the other hand, there is still a high frequency (43%) of injuries during training sessions. Therefore, the Winter Olympic International Sports Federations should proof and maybe adapt their qualification criteria for athletes participating in YOG.

Another potential problem for youth elite athletes might be the time and competition schedule of the YOG. For example, in alpine skiing, where athletes often compete in more than one discipline, six races were held in eight days during IYOG. To minimize the potential occurrence of physical and mental fatigue and related injuries in the young athletes these facts should be taken into consideration in future YOGs. According to Capranica & Millard-Stafford,[15] more examination of stress-related psycho-biological responses of young elite athletes to competition is needed to establish the recovery interval needed between events during championships as YOG. In addition, Kristiansen and Roberts [16] reported that young elite athletes competing in the European Youth Olympic festival 2007 in Belgrad/Serbia

experienced competitive stressors because of the size and importance of the competition, and additional organizational stressors (e.g., housing, lining up for food, and transportation to competition venues). These stressors are associated with injury risk in athletes [17] and should therefore be considered by the local Organization Committee and the NOCs in planning and preparation for future YOGs.

Our data indicate that age (biological maturity) status did not significantly affect the injury risk during the IYOG when comparing athletes aged 14-15 years and ≥17 years. This is in line with observations reported in French elite youth football players.[18] However, it has to be highlighted that injuries in the young population may affect developing musculoskeletal structures potentially resulting in long-term damage.[19] This further emphasizes the importance of injury prevention in the immature athlete. Most youth sports are classified on the basis of chronological age to guarantee equal changes within each of the different age groups.[20] However, as the standing of youth competitions has increased to the stage at which there may be considerable rewards, individual fame or national prestige associated with winning, the problem of over- and underaging seems to grow in recent years in some sports.[20] However, we do not have any indications that over- or underaging was a problem in the IYOG.

Incidence and distribution, type and cause of illnesses

The illness incidence in Innsbruck was 84.2 illnesses per 1000 athletes, which is somewhat higher compared to the illnesses incidence in Vancouver with 72.1 illnesses per 1000 adult athletes. Similar to the 2010 Vancouver Olympic Games,[8] the respiratory system was the predominant illness location (61%) during IYOG and about 50% of these were caused by infections. This may be related to the inhalation of large volumes of cold air during exercise and competition in certain winter sports athletes [21], and strenuous physical exertion can diminish the defence and thus enhance susceptibility to respiratory infections. Prevention of exposure is the most important prophylactic measure and this should be carefully considered by athletes and coaches.[22] This is supported by data from the Norwegian Olympic team ,

who due to special illness prevention strategies before and during Olympic Games, successfully reduced the prevalence of illnesses from the 2006 Turin Olympic Winter Games to the 2010 Games in Vancouver. They also found a low prevalence of illnesses compared with other nations in the 2010 Games.[9] Finally, as our result suggest that female athletes have a 1.8 higher risk to sustain an illness, gender-specific strategies to prevent illnesses during YOG should be implemented in future. Since it has been shown that female adolescents are more susceptible to respiratory infections than their male counterparts, prevention of exposure becomes especially important for young female athletes.[23]

Data-collection procedures

In this study, an optimal compliance of 100% was achieved. That means our team received all the requested information about the occurrence or non-occurrence of injuries and illnesses in the NOCs. In comparison, the compliance rate in the 2010 Games in Vancouver was 82% for NOCs with more than 10 registered athletes (represented 94.2% of all athletes).[8] A main reason for the perfect compliance in this study was the fact that there was only one Olympic Village in Innsbruck, which in all athletes and coaches resided together during the entire YOG. If some reports were lacking, our study nurse personally contacted the NOCs to get the information.

Practical implications and further research

The protection of the athletes' health is a clearly articulated goal of the International Olympic Committee, and the surveillance of injuries and illnesses during the Olympic and Youth Olympic Games have been implemented to develop preventive measures.[24] According to the six-stage Translating Research into Injury Prevention Practice (TRIPP) model of Finch,[25] analysing injury and illness risk in a specific sport population is the first step in the development of effective preventive strategies. The next step is to identify the most common injury mechanisms and risk factors of any sports discipline.[25] Information on joint kinematics can nowadays be obtained from uncalibrated injury video recordings.[26] In

addition, slope, snow, weather conditions, and the athlete's speed or protective equipment are important risk factors which should be considered when describing injury mechanisms.[27-29] Based on the experiences from the Innsbruck Olympics, where the highest frequency of injury was found among athletes competing in the halfpipe, preventive measures need to focus on creating safe sports arenas considering age, musculoskeletal development, and skill level of young elite athletes. Regarding illnesses among winter sport athletes, preventive measures [9, 30] should already implemented in advance to multisport events.[9] Also, the fact that elite athletes show a 2-3 fold increased risk of illness when traveling to international multi-sport events > 5 time zone differences should be taken into account.[31]

Conclusion

This is the first study evaluating the incidence and frequencies of injuries and illnesses of young elite athletes in several sports, organised in the Winter Youth Olympic Games. Eleven percent of the athletes suffered from an injury and 9% from an illness during the IYOG. The frequencies of injuries and illnesses varied substantially between sports with the highest frequency of injury in halfpipe skiing and the highest frequency of illness in ice hockey and cross country skiing. In the future, analyses of injury mechanisms and associated risk factors in Olympic Winter sports will be essential to implement effective preventive strategies for young elite winter sport athletes.

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Competing interests: None

What are the new findings?

- During the first Winter Youth Olympic Games2012 in Innsbruck/Austria, an incidence of 108.7 injuries and 84.2 illnesses per 1000 registered athletes was found, respectively.
- The risk of sustaining an injury was highest for skiing in the halfpipe (44%) and snowboarding (halfpipe & slope style: 35%), followed by ski cross (17%), ice hockey (15%), alpine skiing (14%), and figure skating (12%).
- Knee, pelvis, head, lower back and shoulders were the most common injury locations.
- Female athletes had a higher risk to suffer from an illness (RR= 1.84 (95% CI: 1.21-2.78), p = 0.003) compared to male athletes.
- The respiratory system was affected most often (61%).

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

- The presented data constituting the basis for future analyses of injury mechanisms and associated risk factors as well as evaluating causes for illnesses in Olympic Winter sports are essential to implement effective preventive strategies for young elite winter sport athletes.

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Table 1: Number (n) and proportions (%) of injuries and illnesses in different sports

	Registered athletes*			Injuries			Illnesses		
	Female n	Male n	Total n	Female n (%)	Male n (%)	Total n (%)	Female n (%)	Male n (%)	Total n (%)
Alpine skiing									
Alpine	56	64	120	9 (16)	8 (13)	17 (14)	4 (7)	4 (6)	8 (7)
Ski cross	12	17	29	1 (8)	4 (24)	5 (17)	-	1 (6)	1 (3)
Halfpipe	10	13	23	4 (40)	6 (46)	10 (44)	-	-	-
Curling	32	32	64	1 (3)	1 (3)	2 (3)	-	2 (6)	2 (3)
Ice hockey									
Tournament	85	85	170	5 (6)	20 (24)	25 (15)	13 (15)	11 (13)	24 (14)
Skills Challenge	14	15	29	-	1 (7)	1 (3)	2 (14)	1 (7)	3 (10)
Ice track sports									
Bob	16	20	36	1 (6)	2 (10)	3 (8)	2 (13)	2 (10)	4 (11)
Luge	24	46	70	1 (4)	2 (4)	4 (6)	6 (25)	1 (2)	7 (10)
Skeleton	14	14	28	1 (7)	-	1 (4)	-	3 (21)	3 (11)
Nordic skiing									
Biathlon	49	50	99	1 (2)	-	1 (1)	8 (16)	-	8 (8)
Cross country	40	50	90	-	5 (10)	5 (6)	10 (25)	3 (6)	13 (14)
Ski jumping	14	23	37	-	-	-	-	1(4)	1 (3)
Nordic combined	-	17	17	-	1 (6)	1 (6)	-	1(6)	1 (6)
Skating									
Figure (Single, Pair, Ice dance)	33	33	66	6 (18)	2 (6)	8 (12)	-	1 (3)	1 (2)
Short track	15	16	31	2 (13)	-	2 (7)	1 (7)	1 (6)	2 (7)
Speed	28	28	56	5 (18)	-	5 (9)	3 (11)	1 (4)	4 (7)
Snowboard									

Halfpipe & Slopestyle	19	31	50	8 (28)	13 (42)	21 (35)	3 (10)	1 (3)	4 (7)
Total	461	554	1015	45	65#	111 (11)	52 (11)	34 (6)	86 (9)

* Information is missing for 6 athletes.
# Information is missing for 1 gender.

Table 2: Number (n) and proportions (%) of injuries , locations, types and causes separated for alpine skiing and snowboarding (alpine, ski cross, ski & snowboard halfpipe, snowboard slopestyle), curling, ice hockey (tournament, skills challenge), ice track sports (bob, luge, skeleton), Nordic skiing (biathlon, cross country, ski jumping, nordic combined)

	Alpine skiing & snowboarding n = 222	Curling n = 64	Ice hockey n = 199	Ice track sports n = 134	Nordic skiing n = 243	Skating n = 153	All* n = 1015
INJURIES: n (%)	55 (24.8)	2 (3.1)	26 (13.1)	8 (6.0)	6 (2.5)	14 (9.2)	111(10.9)
Injury location#							
Face (including eye, ear, nose)	-	-	1	-	-	1	2 (1.8)
Head	7	-	2	2	-	-	11 (9.9)
Neck/cervical spine		-	1	-	-	-	1 (0.9)
Thoracic spine/upper back	4	-	1	1	-	-	6 (5.4)
Sternum/ribs	-	-	1	-	1	1	3 (2.7)
Lumbar spine/lower back	9		-	1	1	-	11 (9.9)
Abdomen	-	-	-	-	-	-	-
Pelvis/sacrum/buttock	5	-	4	-	-	3	12 (10.8)
Shoulder/clavicle	3	1	3	1	1	1	10 (9.0)
Upper arm	-	-	-	-	-	-	-
Elbow	1	-	1	-	-	-	2 (1.8)
Forearm	1	-	2	-	-	-	3 (2.7)
Wrist	1	-	-	-	-	1	2 (1.8)
Hand	3	-	1	-	-	-	4 (3.6)
Finger	-	-	1	-	2	-	3 (2.7)
Thumb	1	-	-	-	-	-	1 (0.9)
Hip	-	-	1	-	-	1	2 (1.8)
Groin	2	-	-	-	-	-	2 (1.8)
Thigh	2	-	2	-	-	-	4 (3.6)
Knee	11	-	-	1	-	3	15 (13.5)
Lower leg	4	-	-	1	1	1	7 (6.3)
Achilles tendon	-	-	-	-	-	-	-
Ankle	1	-	-	1	-	1	3 (2.7)

Foot/toe	-	1	4	-	-	1	6 (5.4)
Injury type#							
Concussion	5	-	2	1	-	-	8 (7.2)
Fracture (trauma, stress, other bone injuries)	2	-	1	-	2	-	5 (4.5)
Sprain (dislocation, subluxation, ligamentous rupture)	12	-	4	1	1	2	20 (18.1)
Strain (muscle rupture, tear, tendon rupture)	8	-	1	1	-	1	11 (9.9)
Meniscus, cartilage	-	-	-	-	-	-	-
Contusion,/ haematoma, bruise	22	-	14	-	1	6	43 (38.7)
Tendinosis, tendinopathy	1	-	-	1	-	-	2 (1.8)
Arthritis, synovitis, brusitis	-	1	-	-	-	1	2 (1.8)
Impingement	1	-	-	-	-	-	1 (0.9)
Laceration, abrasion, skin lesion	-	-	2	-	-	-	2 (1.8)
Dental injury, broken tooth	-	-	1	-	-	-	1 (0.9)
Muscle cramps, spasm	2	1	1	1	2	1	8 (7.2)
Other (incl. nerve, spinal cord, fasciitis)	2	-	-	2	-	3	7 (6.3)
Injury cause#							
Overuse (gradual onset)	2	-	-	1	1	1	5 (4.5)
Overuse (sudden onset)	7	1	1	2	1	1	13 (11.7)
Non-contact trauma	26	-	2	1	1	8	38 (34.2)
Recurrence of previous injury	-	-	-	-	-	1	1 (0.9)
Contact with another athlete	1	-	12	-	-	1	14 (12.6)
Contact with moving object	1	-	5	1	-	-	7 (6.3)
Contact with stagnant object	13	-	1	1	2	1	18 (16.2)
Violation of rules	-	-	3	-	-	-	3 (2.7)
Field of play condition	-	-	-	-	-	-	-

Weather condition	2	-	-	-	-	-	2 (1.8)
Equipment failure	-	-	1	-	-	-	1 (0.9)
Other	3	1	1	1	1	1	8 (7.2)

* Information is missing for 6 athletes; # Information is missing for 1 injury.

Table 3: Number (n) and proportions (%) of illnesses, affected systems, symptoms and causes separated for alpine skiing and snowboarding (alpine, ski cross, ski & snowboard halfpipe, snowboard slopestyle), curling, ice hockey (tournament, skills challenge), ice track sports (bob, luge, skeleton), Nordic skiing (biathlon, cross country, ski jumping, nordic combined)

	Alpine skiing & snowboarding n = 222	Curling n = 64	Ice hockey n = 199	Ice track sports n = 134	Nordic skiing n = 243	Skating n = 153	All* n = 1015
ILLNESSES	13 (5.9)	2 (3.1)	28 (14.1)	13 (9.7)	23 (9.5)	7 (4.6)	86 (8.5)
Illness affected system							
Gastrointestinal	1	1	5	-	1	-	8 (9.3)
Respiratory	10	-	11	9	17	5	52 (60.5)
Allergic, immunological	-	-	1	-	1	-	2 (2.3)
Metabolic, endocrinological	-	-	4	-	-	-	4 (4.7)
Dermatologic	-	-	5	2	-	-	7 (8.1)
Other (incl. urogenital, gynaecological, cardiovascular, neurological, psychiatric, musculoskeletal, dental)	2	1	2	2	4	2	13 (15.11)
Illness symptoms							
Fewer	1	-	1	4	2	1	9 (10.5)
Pain	6	1	9	4	14	4	38 (44.2)
Diarrhoea, vomiting	-	1	3	-	-	-	4 (4.7)
Dyspnoea, cough	2	-	3	1	-	1	7 (8.1)
Other (incl. dehydration, anaphylaxis, lethargy, dizziness)	4	-	12	4	7	1	28 (25.2)
Illness cause							
infection	9	2	11	9	9	3	43 (50.0)
environmental	2	-	2	1	4	2	11 (12.8)
exercise-induced	1	-	6	-	7	-	14 (16.3)
Other (incl. pre-existing,	1	-	9	3	3	2	18 (20.9)

drug)

* Information is missing for 6 athletes.

Table 4: Number and proportions of severity and circumstances of injuries in different sports

	Severity	Circumstances	
	Time loss n (%)	Training n (%)	Competition n (%)
Alpine skiing			
Alpine	6 (35.3)	6 (35.3)	11 (64.7)
Ski cross	-	5 (100.0)	-
Halfpipe	1 (10.0)	6 (60.0)	4 (40.0)
Curling	-	1 (50.0)	1 (50.0)
Ice hockey			
Tournament	8 (31.8)	-	25 (100.0)
Skills Challenge	-	-	1 (100.0)
Ice track sports			
Bob	1 (33.3)	3 (100.0)	-
Luge	-	2 (50.0)	2 (50.0)
Skeleton	-	1 (100.0)	-
Nordic skiing			
Biathlon	-	1 (100.0)	-
Cross country	-	2 (40.0)	3 (60.0)
Ski jumping	-	-	-
Nordic combined	1 (100.0)	1 (100.0)	-
Skating			
Figure (Single, Pair, Ice dance)	2 (25.0)	5 (62.5)	3 (37.5)
Short track	1 (50.0)	1 (50.0)	1 (50.0)
Speed#	4 (100.0)	3 (60.0)	2 (40.0)
Snowboard			
Halfpipe & Slopestyle	11 (52.4)	9 (42.5)	12 (57.1)

Total	35 (31.5)	46 (41.4)	65 (58.6)

Information is missing for 1 injury severity