

Injuries among Disabled Athletes during the 2002 Winter Paralympic Games

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ABSTRACT

WEBBORN, N., S. WILLICK, and J. C. REESER. Injuries among Disabled Athletes during the 2002 Winter Paralympic Games. *Med. Sci. Sports Exerc.*, Vol. 38, No. 5, pp. 811–815, 2006. **Purpose:** This prospective injury surveillance study was conducted to better understand the types of and risk factors for injuries sustained by athletes with disabilities competing in adapted winter sports at the elite level. **Methods:** Detailed information was collected on all injuries evaluated by polyclinic or venue medical personnel during the operational 20-d period of the 2002 Winter Paralympics. **Results:** A total of 39 injuries involving 9% of the Paralympic athletes were recorded in the injury registry. Most of these injuries were of acute, traumatic onset and involved the disciplines of alpine skiing and sledge hockey. Sprains (32%), fractures (21%), and strains and lacerations (14% each) represented the most common diagnoses. Of the recorded injuries, eight (21%) resulted in time lost from training or competition. **Conclusions:** The injury patterns observed among winter Paralympians in this study are not appreciably different from able-bodied athletes competing in similar disciplines, although in many instances the risk factors for sport-specific injury appear to be unique to disabled or adapted competition. Our preliminary observations suggest that several of the more severe injuries were potentially preventable. Ongoing data collection by the International Paralympic Committee should enable feasible injury prevention strategies to be designed and implemented. **Key Words:** INJURY PATTERNS, ADAPTED WINTER SPORT, INJURY PREVENTION, INJURY SURVEILLANCE

The fact that injuries represent an unfortunate and seemingly unavoidable consequence of sports participation is no less true for athletes with disabilities than for able-bodied athletes. Yet, despite the growing awareness and popularity of sports for the disabled, a relative paucity exists of published research devoted to understanding the injury patterns and risk factors for injury among elite disabled athletes. Although the sports medicine literature is replete with studies contributing to our understanding of the risk factors for various types of injury in the 35 different Olympic disciplines, comparatively few studies exist that focus on the risk of injury among disabled athletes competing in the 24 Paralympic events. A search of the PubMed, OVID, and SPORTDiscus databases using the keyword “Olympic” identified several thousand references. A search using the keyword “Paralympic” identified fewer than 100 references in each database. When further coupled with the terms “injury” and “winter,” the

search returned only a few citations from each database. Substituting “disabled sport” for “Paralympic” failed to identify substantially more peer-reviewed articles addressing the epidemiology of injuries in elite adapted winter sports.

During the 2002 Winter Paralympic Games, competitions were held in three sporting disciplines: alpine skiing, Nordic skiing, and sledge hockey. The first two disciplines can be contested either by athletes with a visual disability or by athletes with a variety of physical disabilities, including spinal cord injury, amputation, and cerebral palsy. Sledge hockey is a variant of ice hockey played by athletes with neuromusculoskeletal (but not visual) impairment in a seated position on sledges propelled with the aid of sticks that are also used to strike the puck. No previous data are available on sledge hockey injuries. Although some types of injuries might be considered predictable based on the sporting discipline, equipment modifications (e.g., sledges) that are required to adapt the sport for Paralympic competition may expose these elite athletes to mechanisms of injury that are unique to disabled sports.

Although the few studies that have been published comparing sports participation by both able-bodied and disabled individuals suggest that athletes with disabilities do not have a significantly greater overall risk of injury than their able-bodied counterparts, the functional consequences of injury to an athlete with an underlying physical impairment can be considerably greater than for an able-bodied athlete. For example, a comparatively “routine” shoulder overuse injury that might be a mere “nuisance” for an able-bodied athlete may compromise the

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ability of a C6 tetraplegic athlete to remain independently mobile, to say nothing of dramatically interfering with his or her participation in sports. The Medical Commission of the International Paralympic Committee (IPC), recognizing the potentially devastating effect of injuries on elite, disabled athletes, therefore, decided to embark on a long-term prospective injury surveillance project designed to better characterize the risk factors for injury associated with the Paralympic disciplines.

The first step in the implementation of this project was the development of a musculoskeletal injury database, followed by a trial phase of data collection during the 2002 Salt Lake Winter Paralympic Games. The long-term goals of this project are to identify sport-specific injury patterns and trends over time, identify common injury mechanisms and risk factors for injury, and identify strategies for effective injury prevention. This article describes the process and outcome of the IPC Medical Commission's initial attempt to create and implement a system for comprehensive collection and analysis of athletic injuries occurring during the 2002 Salt Lake Paralympic Winter Games.

METHODS

The protocol was approved by the IPC Medical Commission and all injured athletes who were recruited into the study gave written consent for their medical information to be used for research purposes. The information was stored confidentially on a personal computer.

The principal goal of this study was to catalog and describe every athletic injury that occurred during the operational period of the Salt Lake 2002 Paralympic Games. This period was defined by the opening of the Paralympic Village on March 1, 2002 through its closing on March 19, 2002. During this span of 20 d, the authors collected detailed information on all injuries presenting to either the centrally located polyclinic or to any of the venue medical outposts. In addition, two of the authors (NW and SW) endeavored to contact the team physicians and other medical personnel from all 40 delegations present at the games in an effort to secure their participation in this undertaking. Data collection instruments requesting information on diagnosis, injury mechanism, and disposition were available at all venues and at the polyclinic. Attempts were also made to distribute forms to delegation medical personnel so that data on injuries that may not have been evaluated by venue or polyclinic physicians might also be captured in the database. Each day during the games, either of two authors (SW or NW) scanned the entire list of medical encounters generated by the Salt Lake Organizing Committee (SLOC) Medical Services, looking for athletic injuries that might have been reported. If a questionnaire for the reported injury had not yet been completed, attempts were made to collect as much information as possible about the injury, either by contacting the athlete or a team official directly, or by gathering other information that had been entered into the SLOC Medical Services computerized data system. The injury

registry was furthermore cross-referenced against the list of athletes who had undergone diagnostic imaging to ensure that all athletes with serious injuries were captured within the database. This multilayered system of vigilant injury surveillance allowed us to record information on all athlete injuries that came to the attention of SLOC Medical Services. Subsequently, the data on the 39 different injuries were entered into a Microsoft Access database developed by one of the authors (NW), and an Orchard Injury Code (10) was assigned to each diagnosis.

RESULTS

A total of 416 athletes from 40 countries competed in the 2002 Salt Lake Paralympics. Of these, 328 (79%) were men, whereas 88 (1%) were women. A total of 194 athletes (47% of the total participants), both men and women, competed in alpine skiing, and 134 athletes (32%) competed in Nordic skiing. Eighty-eight males (21%) competed in sledge hockey. Data were obtained on 39 injuries involving 39 athletes from 20 different countries. Of the injuries identified, data on 36 were recorded at the time of presentation using an injury survey instrument, whereas data on the other 3 were obtained retrospectively using information recorded in the SLOC Medical Services database. The average age of the injured Paralympians was 33 yr, with a range of 17–58 yr. Of the injured athletes, 79% were men. The overall and sport-specific injury rates did not differ significantly by gender (Table 1).

Alpine skiers were the most frequently injured athletes, suffering 24 injuries (62% of the total number of injuries). Sledge hockey players ranked second in total number of injuries, sustaining 12 of the 39 injuries (31%), whereas Nordic skiers sustained the fewest number with only 3 (8%) injuries (Table 2). We were unable, however, to collect accurate exposure data and, therefore, our ability to calculate rates of injury incidence is somewhat limited. Participants in sledge hockey had the highest rate of injury per 100 athletes (14%) with alpine skiing (12%) and Nordic skiing (2%) ranking second and third, respectively (Table 2).

Of the 36 injuries for which onset data were available, 30 (77%) were acute traumatic injuries and 6 (15%) were subacute or chronic overuse injuries (Table 2). The percentage of acute traumatic injuries is similar to that seen during the Salt Lake 2002 Winter Olympics, during which 80% of all athletic injuries were the result of acute trauma (M. Elstad, unpublished Salt Lake City 2002 Game Polyclinic report). Sprains (32%), fractures (21%), and strains and lacerations (14% each) represented the most common diagnoses. Five of the six overuse conditions

TABLE 1. Analysis of Paralympic injury patterns by discipline and by gender (overall injury rates appear in parentheses).

	Men	Women	Overall
Alpine skiing	17 (9%)	7 (13%)	24 (12%)
Nordic skiing	2 (1%)	1 (3%)	3 (2%)
Sledge hockey	12 (14%)	NA	12 (14%)
TOTALS	31 (9%)	8 (9%)	39 (9%)

TABLE 2. Analysis of injury mechanism, by Paralympic discipline (the percentage of the total number of recorded injuries appears in parentheses).

	Traumatic	Overuse	Unknown	Total
Alpine skiing	19 (49%)	2 (5%)	3 (8%)	24 (62%)
Nordic skiing	1 (3%)	2 (5%)	3 (8%)	3 (8%)
Sledge hockey	10 (26%)	2 (5%)	12 (31%)	12 (31%)
TOTALS	30 (77%)	6 (15%)	3 (8%)	39

involved the upper limb, and none resulted in time lost from competition or training. All Nordic skiing injuries involved the upper limb, whereas among the alpine skiers who were injured, 33% sustained injuries to the upper limb and 38% sustained lower limb injuries. Sledge hockey injuries more commonly affected the upper limbs (50%) than the lower limbs (33%).

Of the 30 traumatic injuries, 8 resulted in time lost from training or competition (Table 3). The competition status of six other injured athletes was not recorded, but two of these six had intraarticular knee pathology that would have made competition extremely difficult, if not impossible. Thus, at least 27% of the traumatic injuries were severe enough to affect the athlete's ability to participate and, in fact, seven of the athletes who sustained time-loss injuries were unable to compete further in the games. These injuries included two torn anterior cruciate ligaments, two distal radius fractures, and a concussion, all among alpine skiers. One alpine skier also sustained a complete tear of the ulnar collateral ligament of the elbow and a near complete avulsion of the forearm flexor muscles from their origin at the medial epicondyle of the humerus. Although this athlete was unable to finish her competition that day, she resumed competition later in the games using a lockable, hinged, metal elbow brace.

Most recorded injuries (30/39, 77%) were new, with half occurring during competition (39%) and half during sport-specific training (39%). Most (75%) of time-loss injuries occurred during competition. Seven injuries (18%) (five of them overuse in character) were felt to be preexisting but sport-related, and were included in the study because the athlete sought treatment for the condition during the Paralympics (Table 3).

In 7 of the 39 cases (18%), the athlete's equipment was felt to have played a role in the injury. One alpine skier who sustained a complete rupture of her anterior cruciate ligament felt that the injury resulted from the failure of her alpine binding to release. Two athletes were struck by sledge hockey sticks. Four sledge hockey players were involved in collisions that resulted in lower limb injuries. One of these four was an athlete with asymmetric paraparesis who sustained a severe fracture of the distal

femur and proximal tibia of his more functional lower limb (i.e., the limb on which he bore most of his weight when ambulating). Of the two athletes who were struck by a sledge hockey stick, one suffered a leg laceration. The other athlete sustained three rib fractures from the blow and had to withdraw from all competition. Two alpine skiers sustained injuries whose mechanism implicated involvement of their outrigger skis.

DISCUSSION

The literature characterizing the distribution of injuries (by anatomic location, type, and mechanism, commonly referred to as the injury pattern) sustained by disabled athletes competing in the winter Paralympic disciplines is limited in size and scope. Only a handful of studies have attempted to document and critically examine the types of injuries for which elite athletes with disabilities are at risk when participating in winter sports (5,9,12). Using a retrospective survey instrument administered to 68 athletes, Ferrara et al. (5) documented the injuries that occurred during the National Handicapped Sports and the United States Association for Blind Athletes 1989 Winter National Games. More recently, injuries sustained by members of the German Nordic skiing team competing in the 1992 Albertville Winter Paralympics were catalogued by Schmid et al. (12). Laskowski and Murtaugh (9) described the injury history of a cohort of disabled snow skiers, but winter sports were not included in Ferrara and Buckely's (4) 3-yr prospective registry of injuries among athletes with disabilities.

Far more numerous are the articles that examine aspects of injury to wheelchair athletes (1,2,6,7,14), but, by default, these focus primarily on sporting disciplines contested during the Summer Paralympic Games, because the only Winter Paralympic sport whose athletes rely on wheelchairs is the discipline of wheelchair curling (which will debut at the 2006 Torino Paralympics. Ferrara and Peterson (7) characterized the injury patterns among elite disabled athletes in their 2000 review, classifying 19 of the 20 summer Paralympic disciplines as either "low risk" or "high risk" for time-loss injury. These authors, however, omitted a similar classification of the winter disciplines, perhaps because of the relative lack of quality research in this area.

The long-term goal of this IPC project is to better understand the injury patterns and risk factors for injury among the Paralympic disciplines, so that effective injury prevention programs can be designed and implemented. As a first step toward this goal, we attempted to prospectively catalog the injuries occurring during the 2002 Salt Lake Winter Paralympic Games. For this study, we have chosen to report both time-loss injuries and less severe injuries for which medical attention was sought. Although the varying definitions of injury used in the sports injury epidemiology literature admittedly make it difficult to compare studies, given the goals of the investigation we felt it important to describe all sport-related conditions that might conceivably

TABLE 3. Analysis of Paralympic injuries, by activity at time of onset. The numbers in parentheses represent the number of time loss injuries.

	Training	Competition	Preexisting	Unknown
Alpine skiing	11 (2)	7 (4)	4	2
Nordic skiing	1		2	
Sledge hockey	3	8 (2)	1	
TOTALS	15 (2)	15 (6)	7	2

affect the performance or functional capacity of the winter Paralympic athlete.

Our data indicate that nearly 10% of the athletes competing during the 2002 Salt Lake Winter Paralympic Games suffered some form of injury for which they sought treatment from polyclinic or venue medical personnel. In all likelihood, the true injury rate was probably somewhat higher than the calculated 9% because it is extremely doubtful that all injuries came to our attention. It is likely, for example, that some athletes chose not to seek treatment of any kind for minor injuries, and it is also virtually certain that some injured athletes belonging to delegations that supplied their own medical personnel were treated without notification of, or intervention by, the polyclinic or venue medical staff. Any injury that required imaging or for which the athlete was hospitalized was captured, however, by the data collection process we employed.

Our data suggest that Paralympic winter competition is inherently dangerous, particularly alpine skiing and sledge hockey. This data collection project establishes an overall injury rate in excess of 1 of 10 athletes competing in these disciplines. We were unable, however, to track the number of athlete exposures to permit a more refined calculation of the sport-specific injury rates. Of all recorded injuries during the 2002 Winter Paralympics, 77% were caused by an acute traumatic event. This is similar to the proportion of acute traumatic injuries seen during the Salt Lake 2002 Winter Olympics and roughly opposite to the proportion of acute versus overuse injuries calculated during the Sydney 2000 Summer Olympics (K. Crichton, unpublished Sydney 2000 Games Polyclinic report). As was observed during the Salt Lake Olympic Games (11), the greatest number of injuries occurred among alpine skiers. The injury rate among sledge hockey participants, however, was slightly (nonsignificantly) higher than among Paralympic alpine skiers (14 vs 12%, respectively). The injury rate was far lower in Nordic skiing (3%), which was the only discipline that did not precipitate a time-loss injury during the 2002 Winter Paralympics. Less than half of the recorded injuries in Nordic skiers were the result of acute trauma. This contrasts with alpine skiing and sledge hockey, in which 79 and 83% of injuries, respectively, were caused by acute trauma. These were predictable observations based on the

nature of the sports. In general, the patterns of injury seen are comparable to those reported in the literature for athletes competing in the able-bodied versions of these sports (3,8,13). A more precise comparison between sports and across studies is not feasible, however, because of the varying definition(s) of injury employed and the different ways in which injury rates were calculated and reported.

Based on our preliminary observations, risk factors for injury appear to exist that are unique to the adapted winter Paralympic disciplines. In that regard, we believe that several of the more severe recorded injuries may have been preventable. Two time-loss injuries sustained by alpine skiers may have been related to the use of outrigger skis (Fig. 1), although the athletes themselves did not cite the outriggers as contributing to the mechanism of injury. At this point, our limited data do not permit rigorous statistical analysis of potential risk factors. If future studies raise further suspicion that outriggers contribute to an increased risk of injury, it would be worthwhile to carefully scrutinize their design to see if improvements can be made. It may be that reinforcement within the glove or incorporation of a failure mechanism in the outrigger that activates when a certain load is exceeded may help to reduce the relative high incidence of wrist fractures we observed. In addition, we suspect that all the sledge hockey injuries involving the lower limbs (4/12, 33%) potentially could have been prevented had the athletes been required to use protective clothing over their legs, or if the design of the sledge had incorporated a protective shell (Fig. 2). As with any preventive intervention, any proposed modifications must be acceptable to the athletes, cause little to no interference with performance, and not be cost-prohibitive.

RECOMMENDATIONS

We feel that ongoing surveillance of injuries among elite athletes with disabilities is essential to identifying potentially preventable causes of injury. Such Paralympic surveillance efforts demand careful preparation, early planning, and the cooperation of the host organizing committee. The most important elements enabling collection of information on as many injuries as was possible in this study were (a) educating polyclinic, venue, and team

FIGURE 1—Landing heavily on an outrigger represents a potential source of injury in Paralympic alpine skiing.

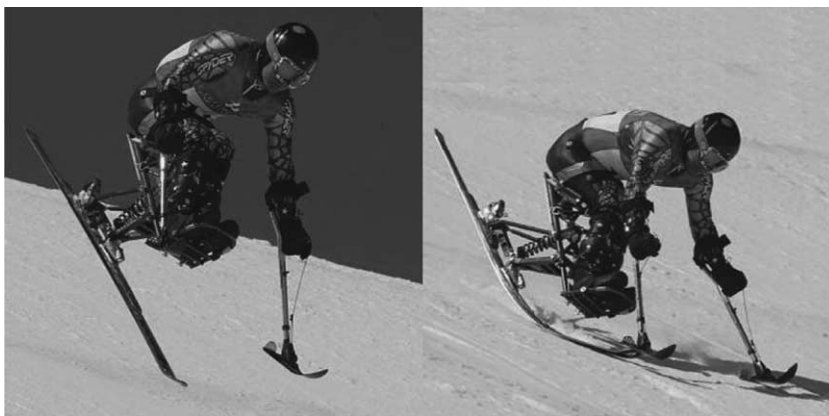


FIGURE 2—Unprotected legs represent a risk factor for injury in sledge hockey.



medical personnel about the study; (b) daily reviewing the list of all medical encounters that were generated by SLOC Medical Services; and (c) cross-checking the clinical diagnosis with diagnostic imaging when performed.

The IPC Medical Commission plans to conduct further studies through its sports science and education subcommittee at future Paralympic Games. Resources need to be made available for personnel involved in data collection, entry, and analysis, particularly as the Paralympics grow in size. Integration of the same data collection system at both Olympic and Paralympic Games has been discussed with the International Olympic Committee, and would facilitate comparison of the injury patterns common to elite able-bodied and disabled athletes. Further improvements to the system of data collection could include the development of sport-specific questionnaires and (perhaps most importantly) accurate measurement of athlete exposures in all disciplines contested. Ideally, computer-generated medical encounter

forms would be printed, based on the athlete's sport. In the future, consideration should be made for analyzing medical conditions (e.g., occurrence of skin breakdown and upper respiratory symptoms), in addition to musculoskeletal injuries. This project has the potential to help devise meaningful injury prevention programs. For that objective to be realized, the information obtained must be shared with the technical and medical committees of the relevant sports federations, in addition to the athletes themselves, so that all involved are better informed regarding the risks inherent in adapted sports and so that their collective experience can be brought to bear on the development, testing, and implementation of injury prevention strategies.

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