

## Descriptive Epidemiology of Paralympic Sports Injuries

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**Abstract:** Paralympic sports have seen an exponential increase in participation since 16 patients took part in the first Stoke Mandeville Games on the opening day of the 1948 London Olympic Games. More than 4,000 athletes took part in the London 2012 Paralympic Games. Few sporting events have seen such rapid evolution. This rapid pace of change also has meant challenges for understanding the injury risks of participation, not only because of the variety of sports, impairment types, the evolution of adapted equipment but also because of the inclusion of additional impairment types and development of new sports over time. Early studies were limited in scope but patterns of injuries are slowly emerging within Winter and Summer Paralympic sports. The IPC's London 2012 study is the largest to date with a prospective cohort study involving 49,910 athlete-days. The results identified large differences across sports and highlighted the need for longitudinal sport specific studies rather than solely games-time studies. This will require collaboration with international sports federations to examine injury patterns and risk factors for injury in this population to appropriately inform injury prevention strategies. Further studies will also need to address the impact of sporting participation, injury, and future health.

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### INTRODUCTION

Paralympic sports have seen an exponential increase in participation since 16 patients took part in the first Stoke Mandeville Games on the opening day of the 1948 London Olympic Games. More than 4000 athletes took part in the London 2012 Paralympic Games to packed audiences and worldwide television coverage. Few sporting events have seen such a rapid evolution. This rapid pace of change also has meant challenges for understanding the injury risks of participation because of inclusion of additional impairment types and development of new sports. In 1960, the International Stoke Mandeville Games were held in Rome and since that time, the Games have been held in the country selected for the Olympic Games where possible, save for financial or political reasons. In 1976, in Toronto, the Games included visually impaired and amputee athletes for the first time, and the Games were known as the Olympiad for the Physically Disabled. In 1980, in Arnhem, athletes with physical disabilities not fitting into the historical disability groups (*Les Autres*; fr. "the others") or with cerebral palsy also were included. The International Paralympic Committee (IPC) was founded in 1989, and since 1994 the management of the Paralympic Games has been administered by the IPC. Although athletes with intellectual disabilities have participated in some Paralympic Games, they are not included in this review.

The data for this review were primarily published articles and reports from a literature search of PubMed and SPORTDiscus; however, information from Congress proceedings and both published and unpublished articles known to the authors but not identified through these database sources also were evaluated. English-language articles were used primarily, but some German texts were incorporated where translation could be performed. Search terms involved permutations and combinations of Paralympic, injury, cerebral palsy, visually impaired, wheelchair, disability, and sport.

A variety of methodologic limitations, which confound the interpretability of the findings, were evident in the literature, particularly in earlier studies. Factors included a lack of standard definitions for reportable injury and injury details, short study timeframes,

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poor or absent exposure data, use of self-report surveys that did not include a confirmed medical diagnosis, and small sample sizes. In addition, the unique grouping of sports by disability makes obtaining a clear picture of injury risk and risk factors in Paralympic sport complicated. For example, when investigating the risk of injury related to a particular sport, of the 27 Paralympic sports (22 summer [planned in year 2016] and 5 winter), some are participated in by athletes with different impairments (athletics: spinal cord injured, visually impaired, amputee, and cerebral palsy), some are unique to particular disability categories (goalball: visually impaired; wheelchair rugby: athletes with impairment in all 4 limbs), some are modified by rules (judo) or equipment (sit-ski; sledge hockey) for particular classes of athletes, and some involve multiple categories of disability on the same team (basketball).

Caution also may be required interpreting studies if the investigation is focused on the risks related to a particular class of disability across different sports. For example, a lower limb amputee athlete may compete with a prosthesis for track athletics or cycling, without a prosthesis for swimming or high jump, or in a wheelchair for sports such as basketball and tennis. Athletes with cerebral palsy may be ambulant or wheelchair users depending upon the degree of disability. Some more recent studies have used a combination of impairment and sport specificity to limit these confounders but so far have relatively few athlete numbers, and the results need to be treated with some caution [1-3].

Changes in professionalism and level of participation in disability sport impose a further difficulty in interpreting the available data. In the 1970s and 1980s, it was not uncommon for individual athletes to participate in multiple sports, even at the Paralympic Games. In a survey of 128 athletes with disabilities, Curtis and Dillon [4] found 79% were competing in track athletics, 71% in wheelchair basketball, 57% in road racing, and 60% in field events in athletics. This occurrence would be rare in elite disability sports now. Technology in the form of lightweight, high tensile-strength materials and improved designs for wheelchairs and prostheses for different populations of Paralympic athletes have changed performance parameters and injury risk characteristics during the past 2 decades. In addition, training protocols and access to specialized trainers, coaches, and medical personnel have changed during the past few decades. As such, comparisons between injury patterns seen 20-30 years ago and those seen currently may not be appropriate. In addition, findings from older research articles in this area may not reflect the current position in elite Paralympic sport.

Thus, a broad overview of injury patterns in Paralympic sports potentially loses sight of risk and risk factor relationships in specific sport/disability interactions, and the small numbers in any particular combination renders analyses and conclusions unstable. In an attempt to address some of these issues, the IPC's Injury Surveillance System

(ISS) was implemented during the 2002 Salt Lake City Winter Paralympic Games and has continued at all subsequent Winter Paralympic Games. The first summer games injury and illness survey was during the London 2012 Paralympic games and was the first study to report on sport-specific injury incidence rates considering exposure to risk.

## WHO IS AFFECTED BY INJURY?

A comparison of injury rates (IRs) reported in prospective and retrospective research is summarized in Table 1 [5-17]. As noted previously, some studies involved multiple disability groups and some covered only individual disability groups; sports surveyed ranged from the full complement of summer Paralympic sports to individual sports. Few studies reported incidence rates because of the omission of exposure data. Interpretability of the results often is challenging in the absence of a reportable injury definition or by the variation of the definition between studies. Invariably, the definition will influence both the data collected and the risk assessment of the sports studied. For example, several retrospective questionnaire studies included minor soft-tissue injuries (eg, blisters or abrasions for which no medical attention was sought) whereas other research, which was based on the organizing committee's medical services at Paralympic Games, did not include minor soft-tissue injuries.

## Summer Sports

The first study to attempt to quantify exposure data was a 2-year prospective study by Ferrara et al [8] of 319 multidisability athletes in summer Paralympic sports. An overall IR of 9.3 injuries/1000 participation hours was reported; however, no sport-specific details were provided, and self-reported symptoms have inherent limitations. The London 2012 injury survey<sup>13</sup> captured data from 3565 athletes (84% compliance by athletes) from 160 delegations (98% compliance by delegation) during training and competition in the 20 summer sports. A total of 49,910 athlete-days were monitored during which a total of 633 injuries in 539 athletes were documented. The overall injury incidence rate was 12.7 injuries/1000 athlete days (95% confidence interval [95% CI] 11.7-13.7). The overall incidence proportion was 17.8 injuries/100 athletes (95% CI 16.5-19.0); however, there were marked variations by sport, with the greatest injury rates in Football 5-a-side (IR 22.4 injuries/1000 athlete-days), Goalball (IR 19.5 injuries/1000 athlete-days), Powerlifting (IR 19.3 injuries/1000 athlete-days), wheelchair fencing (IR 18.0 injuries/1000 athlete-days), and wheelchair rugby (IR 16.3 injuries/1000 athlete-days). Sports with the lowest IRs included sailing (IR 4.1 injuries/1000 athlete-days), rowing (IR 3.9 injuries/1000 athlete-days), and shooting (IR 2.2 injuries/1000 athlete-days).

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