The risk of injuries in Paralympic Athletics differs by impairment and event discipline: A prospective cohort study at the London 2012 Paralympic Games

ABSTRACT:

Background: The injury incidence rates and factors associated with injury in the sport of Paralympic athletics (track and field) have not been comprehensively and prospectively studied.

Purpose: To determine injury incidence rates, characteristics of injury, and associated factors in the sport of athletics at the London 2012 Paralympic Games.

Study Design: Prospective, cohort study

Methods: Nine hundred seventy-seven athletes competing in the sport of athletics were followed over a total 10-day competition period of the Games. Daily injury data was obtained via two databases: 1) a custom built, web-based injury and illness surveillance system (WEB-IISS), populated by team medical personnel, and 2) the organizing committee database, populated by medical providers in the medical stations operated by the Organizing Committee. Athlete impairment category and event discipline were obtained via the International Paralympic Committee athlete database. Injury incidence rates (injuries per 1000 athlete-days) by impairment type, event discipline, sex, and age were examined.

Results: The overall injury incidence rate was 22.1 injuries per 1000 athlete-days (95% CI;19.5 - 24.7). In track disciplines, ambulant athletes with cerebral palsy experienced a lower incidence of injury (IR=10.2, 95% CI; 4.2 - 16.2) when compared to ambulant athletes from other impairment categories. Athletes in seated throws experienced a higher incidence of injury (IR=23.7, 95% CI; 17.5 – 30.0), when compared to athletes in wheelchair racing (IR=10.6, 95% CI; 5.5 - 15.6). In both track and field disciplines, the majority of injuries did not result in time-loss from competition or training. Ambulant athletes experienced the greatest incidence of injuries to the thigh (16.4% of all injuries, IR=4.0), observed predominantly in track athletes.

Wheelchair or seated athletes experienced the greatest incidence of injuries to the shoulder/clavicle (19.3% of all injuries, IR=3.4), observed predominantly in field athletes.

Conclusion: This is the first prospective cohort study examining injury incidence rate and associated factors in the sport of athletics at the Paralympic Games. Injury patterns are specific to the event discipline and athlete impairment type. The majority of injuries occur to the thigh (ambulant athletes) or shoulder/clavicle (wheelchair or seated athletes), and are not time-loss.

What is known about the subject:

- There have been few prior publications detailing the types and rates of injuries in the sport of Paralympic athletics. Athletics is the largest sport on the Paralympic program, and was shown to have the 6th highest injury incidence rate of all Paralympic sports at the London 2012 Paralympic Games.[21]

What this study adds to existing knowledge:

- Injury incidence rates in the London 2012 Paralympic Games were similar when comparing track versus field disciplines in Paralympic athletics. Ambulant athletes with cerebral palsy experienced a lower incidence of injury in track disciplines when compared to other ambulant athletes. Wheelchair/seated athletes competing in seated throws (field) experienced a higher incidence of injury than those competing in wheelchair racing (track). For both ambulant and wheelchair/seated athletes, the majority of injuries occurred in competition and did not result in time-loss from competition or training.
- Sport medicine clinicians caring for athletes in Paralympic athletics should anticipate an injury pattern that is impairment and discipline specific, with wheelchair/seated athletes experiencing predominantly injuries to the shoulder/clavicle, and ambulatory athletes experiencing injuries to the thigh and lower extremity.
- This data can be utilized to form the basis for planning prevention strategies to reduce the risk of injury, which will vary amongst different profiles of Paralympic athletes.

INTRODUCTION:

In recent years, injury surveillance in the sport of athletics (track and field) has grown to become an important area of research in sports medicine and injury prevention[6,9,19,22]. The reason for this is twofold. First, physicians responsible for the care of athletes at major international competitions benefit from an increased awareness of the incidence and types of injuries that their athletes might sustain. Second, through the identification of risk factors associated with common injuries, prevention strategies may be developed and monitored for effectiveness over time[23].

The sport of athletics involves the largest and most diverse number of athletes participating at the Paralympic Games. At the London 2012 Paralympic Games, 26% of the total 4302 athletes competed in athletics. As defined by International Paralympic Committee (IPC) rules[11], Paralympic athletics is inclusive of both track and field events, catering to a number of different impairment categories. This includes athletes with amputation, spinal cord injury, cerebral palsy, visual impairment, and intellectual impairment, among others.

Several large injury surveillance studies with focus on the sport of athletics have been carried out in major international and national competitions[1,2,3,10,12,22] with increasing focus on the benefits of injury prevention programs. In studies carried out at the International Association of Athletics Federations (IAAF) World Athletics Championships in 2007, 2009, and 2011, the injury incidence proportion ranged from 97.0 to 153.4 injuries per 1000 registered athletes[1,2,3]. At the London 2012 Paralympic Games, the first comprehensive injury and illness surveillance study was conducted with a focus on athletes in Paralympic summer sports[8]. When taking into account all sports, this revealed an overall injury incidence rate (IR) of 12.7 injuries per 1000 athlete-days. Athletics (track and field) was shown to have the 6th highest injury IR[21]. Prior studies focused on injury in the sport of Paralympic athletics have been limited by small sample sizes,

limited athlete exposure data, and the predominant use of retrospective or cross-sectional surveys with data reflecting athletes' self-report of injury, thus being subject to recall bias[5,7,15,16,18,20].

The aim of the study therefore was to report further detail regarding the injury incidence rate and characteristics of injury in the sport of athletics at the London 2012 Paralympic Games. Additionally, we sought to determine if potential risk factors such as sex, age, discipline (for example track versus field, sprint versus distance) and impairment category were associated with increased rates of injury within this cohort.

MATERIALS AND METHODS:

This cohort study was completed as a sub-analysis of a comprehensive injury and illness surveillance study carried out at the London 2012 Paralympic Games. The general methodology used to carry out the comprehensive injury and illness surveillance study has been previously described[8]. This will be summarized here, with inclusion of additional detail regarding the methodology utilized for the athletics-specific sub-analysis.

Procedures

The Paralympic Injury and Illness Surveillance System was approved by the International Paralympic Committee (IPC). Prior to initiation of the study, ethics board approval was obtained through [redacted] Athlete consent to utilize their de-identified medical data for research purposes was obtained at the time of their registration for the Games.

A total of 3565 athletes from 160 delegations participated in the comprehensive injury and illness surveillance study (four delegations declined participation for undisclosed reasons). A

132 comprehensive database of athlete demographic information was obtained from the IPC,
133 containing the following de-indentified information: age, gender, sport code, country code, and
134 accreditation number.

135 Data regarding injuries was gathered via two sources. First, a database was populated from the
136 electronic medical data capture system (EMDCS) (ATOS, France) utilized at all athlete medical
137 stations operated by the London Organizing Committee for the Olympic and Paralympic Games
138 (LOCOG). LOCOG medical staff entered all injury encounters when an athlete presented to a
139 medical station with a complaint consistent with the pre-determined definition of injury (see
140 below). A second database was populated by medical staff providing care for their own teams
141 utilizing a novel web-based injury and illness surveillance system (WEB-IISS) that was
142 developed specifically for the purposes of this study and is described in greater detail elsewhere[8].
143 Utilization of the WEB-IISS allowed for the gathering of greater clinical detail regarding injury.

144 The injury incidence rate (IR) was defined as the number of injuries per 1000 athlete-days.
145 Further detail regarding the calculation of athlete-days has been described[8]. The injury incidence
146 proportion (IP) was defined as the percentage of athletes reporting an injury, calculated as the
147 number of injuries per 100 athletes (%).

148 For the purposes of the comprehensive study, our definition of injury, previously described by
149 Derman et al.[8], was 'any newly acquired injury as well as exacerbations of preexisting injury that
150 occurred during training and/or competition of the 14 day pre-competition and competition
151 period of the London 2012 Paralympic Games.' An acute traumatic injury was considered 'an
152 injury that was caused by an acute precipitating traumatic event.' An acute on chronic injury was
153 considered 'an acute injury in an athlete with symptoms of a chronic injury in the same

anatomical area.' Finally, a chronic (overuse) injury was considered 'an injury that developed over days, weeks or months and was not associated with any acute precipitating event.'

Athletics-specific sub-analysis

Data regarding injuries in athletics was gathered concurrently with data for the larger study, as outlined above. For the athletics-specific sub-analysis, injury data was extracted for the total 10-day athletics competition period of the Games, therefore accounting for a total of 9,770 athlete-days.

Additionally, for both ambulant and wheelchair athletes competing in track disciplines, "sprint" versus "distance" events were defined as previously described in the literature[2], with 100 m, 200 m, and 400 m events considered as "sprints," and 800 m, 1500 m, 5000 m, and marathon (42.2 km) events considered as "distance." Previously utilized definitions of "middle" and "long" distance[2] were combined to simply "distance" for the purpose of this analysis, given that: a) a low total number of Paralympic athletes compete in the long distance events (5000 m and marathon), and b) many Paralympic athletes cross-over to compete in many or all "distance" events from 800 m to marathon, particularly in the sport of wheelchair racing.

To enable the reporting of meaningful, sport-specific data regarding the injury IR and injury IP in athletics, further data was extracted from the IPC athlete database regarding athlete classification and event type. This allowed for the characterization of injuries per impairment category (derived from classification data) as well as for the comparison of track versus field disciplines.

Statistical Analysis

Data were available in the form of counts indicating the number of injuries experienced by each athlete. An athlete could report more than one injury over the 10-day athletics competition period of the Games, and athletes could compete in more than one event. Standard descriptive statistical analysis were conducted, including numbers, proportions (including 95% confidence interval [CI]) and incidences (including 95% CI) in the total sample as well as for sub-groups divided out by event discipline, impairment type, sex, and age. The 95% CI was used to determine significant differences in the incidence data. Incidence rate ratios (IRRs with 95% CI) were additionally used to compare data by sex and age as well as to compare ambulant track versus wheelchair racing disciplines.

RESULTS:

Overall incidence of injuries (track and field)

Of the total 3565 athlete participating in the larger comprehensive injury and illness surveillance study, 977 athletes from 138 countries participated in the sport of athletics. This accounted for 86.4% of the total 1130 athletes competing in athletics at the 2012 London Paralympic Games.

Incidence proportion (IP)

A total of 216 injuries were reported (IP=18.4 injuries/100 athletes, 95% CI; 16.0 – 20.9) during the total 10-day period. Of these, 95 injuries in 497 athletes occurred in track disciplines (IP=17.1 injuries/100 athletes, 95% CI; 13.8 – 20.4) and 121 injuries in 480 athletes occurred in field disciplines (IP=19.8 injuries/100 athletes, 95% CI; 16.2 – 23.4).

Incidence rate (IR)

The injury incidence rate (IR: injuries per 1000 athlete-days) in athletics for the total period was 22.1 (95% CI 19.5 - 24.7). There was no significant difference in the IR in track (19.1, 95% CI; 15.7 - 22.6) compared to field disciplines (25.2, 95% CI; 21.3 - 29.1).

Injury Incidence Rate (IR) in track disciplines

IR by impairment category

In track disciplines, a total of 36 injuries occurred in 121 ambulant amputee athletes (IR=29.8, 95% CI; 21.6 - 37.9), 37 injuries occurred in 160 ambulant visually impaired athletes (IR=23.1, 95% CI; 16.6 - 29.7), and 10 injuries occurred in 98 ambulant cerebral palsy (CP) athletes (IR=10.2, 95% CI; 4.2 - 16.2). Ambulant track athletes with visual impairment and amputation experienced a significantly higher incidence of injury than track athletes with CP [IRR=2.27 (95% CI; 1.1 - 5.11) and IRR=2.92 (95% CI; 1.42 – 6.59) respectively] (Table 1). The lowest injury IR was seen in athletes participating in wheelchair racing, who experienced total of 15 injuries (IR=10.6, 95% CI; 5.5 - 15.6). The risk of injury in ambulant track events was two-fold that in wheelchair racing (IRR=2.07, 95% CI; 1.19 – 3.86).

IR by sex and age category

A total of 78 injuries occurred in 355 male athletes (IR=22.0, 95% CI; 17.7 - 26.3) and 17 injuries occurred in 142 female athletes (IR=12.0, 95% CI; 6.6 - 17.3), indicating that male athletes in track disciplines experience a significantly higher incidence of injury when compared to females (IRR=1.84, 95% CI; 1.08 – 3.31) (Table 1). There was no statistically significant difference in injury IR amongst athletes aged 26-34 (IR=22.3, 95% CI; 16.3 - 28.3), athletes aged 13-25 (IR=17.6, 95% CI; 12.5 - 22.8), and athletes aged 35+ (IR=16.5, 95% CI; 9.3 - 23.7).

Injury Incidence Rate (IR) in field disciplines

IR by impairment category

In field disciplines, a total of 54 injuries occurred in 343 ambulant throws athletes (IR=15.7, 95% CI; 11.9 - 19.6). In comparing ambulant throws impairment categories, the injury IR was significantly higher for athletes in short stature throws when compared to the overall group (Table 2). A total of 42 injuries occurred in 177 athletes participating in seated throws (IR=23.7, 95% CI; 17.5 – 30.0), indicating that seated throws athletes experienced a significantly higher IR of injury when compared to wheelchair racing athletes. In jumping disciplines, a total of 45 injuries occurred in 137 athletes (IR=32.8, 95% CI; 25.0 - 40.7). Overall, athletes competing in ambulant jumps experienced a significantly higher injury IR compared to athletes competing in ambulant throws.

IR by sex and age category

A total of 81 injuries occurred in 315 male athletes (IR=25.7, 95% CI; 20.9 - 30.5) and 40 injuries occurred in 165 female athletes (IR=24.2, 95% CI; 17.7 - 30.8), indicating no sex-related difference in injury incidence in field disciplines (Table 2). There was no statistically significant difference in injury IR amongst athletes aged 26-34 (IR=29.5, 95% CI; 22.7 - 36.3), athletes aged 13-25 (IR=23.9, 95% CI; 17.2 – 30.6), and athletes aged 35+ (IR=21.7, 95% CI; 15.2 – 28.3).

Characteristics of injuries

Ambulant athletes (track or field discipline)

Overall, a total of 159 injuries occurred in 658 ambulant athletes (IR=24.2, 95% CI; 20.9 – 27.4) (Table 3). There was no statistically significant difference in injury IR amongst athletes in jumping disciplines (IR=32.8), sprinters (IR=24.0), distance runners (IR=19.7), and throws

(IR=20.5). For the total ambulant group, significantly more injuries occurred in competition (IR=10.2, 95% CI; 7.9 - 12.5) than in training (IR=3.2, 95% CI; 1.8 - 4.5). In competition, ambulant athletes experienced a total of 67 injuries, with significantly higher IR during the event (IR=6.2, 95% CI; 4.4 – 8.1) as opposed to warm-up (IR=3.6) or cool-down (IR=0.3). Of the total 159 injuries, 80 were classified as acute traumatic resulting in a significantly higher IR (IR=12.2, 95% CI; 9.7 – 14.7) compared to 33 acute on chronic (IR=5.0, 95% CI; 3.3 – 6.7) and 46 chronic overuse (IR=7.0, 95% CI; 5.0 – 8.9). Additionally, there was a significantly higher IR of non-time loss injuries (0-1 days missed) (IR=17.3, 95% CI; 14.4 – 20.2) when compared to time loss injuries (IR=6.7, 95% CI; 4.8 – 8.6).

Wheelchair/seated athletes

Overall, a total of 57 injuries occurred in 319 wheelchair or seated athletes (IR=17.9, 95% CI; 13.7 – 22.1) (Table 3). Athletes in seated throwing disciplines experienced a higher IR of injury (IR=23.7, 95% CI; 17.5 – 30.0) when compared to wheelchair racing (IR=10.6, 95% CI; 5.5 - 15.6). There was a significantly higher IR in competition (IR=7.5, 95% CI; 4.6 – 10.4) than in training (IR=2.2, 95% CI; 0.6 - 3.8). In competition, wheelchair or seated athletes experienced a total of 24 injuries, with a similar IR during the event (IR=4.4, 95% CI; 2.1 - 6.6) and warm-up (IR=2.2, 95% CI; 0.6 - 3.8), but lower IR during cool-down (IR=0.9, 95% CI; -0.1 - 2.0) compared to the IR during an event. Of the total 57 injuries, 28 were classified as acute traumatic (IR=8.8) compared to 12 acute on chronic (IR=3.8) and 17 overuse (IR=5.3), and the IR for these showed no statistically significant difference. The IR of non-time loss injuries (0-1 days missed) (IR=13.8, 95% CI; 10.0 – 17.6) was significantly greater than time loss injuries (IR=4.1, 95% CI; 1.9 – 6.2).

Location of injury

Ambulant athletes (track or field discipline)

Ambulant athletes experienced the greatest proportion (% of injuries) of injuries to the thigh (16.4% of total injuries) (Table 4). The knee (11.9% of total injuries), lumbar spine/low back (11.3% of total injuries) and lower leg (10.7% of total injuries) were the next most commonly injured anatomical regions. Ambulant athletes competing in track most commonly injured the thigh (n=19), compared to ambulant athletes competing in field who most commonly injured the knee (n=12) or ankle (n=10). In the total ambulant group, injuries to the lower trunk and lower extremity accounted for 83.7% of all injuries.

Wheelchair/seated athletes

Wheelchair or seated athletes experienced the greatest proportion (% of injuries) of injuries to the shoulder/clavicle (19.3% of total injuries) (Table 5). The elbow (15.8% of total injuries), knee (10.5% of all injuries) and upper arm (8.8% of total injuries) were the next most commonly injured anatomical regions. Wheelchair athletes competing in track most commonly injured the shoulder/clavicle, upper arm, or neck/cervical spine (for each, n=2), compared to seated athletes competing in field who most commonly injured the shoulder/clavicle (n=9). In the total wheelchair or seated group, injuries to the neck or upper extremity accounted for 61.5% of all injuries.

DISCUSSION:

This study is the first to report detail on the incidence and factors associated with injury in the sport of athletics (track and field) at the Paralympic Games. For the 10-day competition period, the injury incidence rate was 22.1/1000 athlete-days. The injury IR in track disciplines was

similar to the injury IR in field disciplines. Regarding factors associated with injuries and characteristics of injury during major competition in Paralympic athletics, the main findings of this study are that: 1) in track disciplines overall, male athletes experience a higher IR of injury than female athletes (IRR 1.84), 2) ambulant jumps athletes experience a higher IR of injury than ambulant throws athletes, 3) ambulant athletes with visual impairment and amputation experience a higher IR of injury in track disciplines when compared to ambulant athletes with cerebral palsy (IRR 2.27 and IRR 2.92, respectively), 4) wheelchair/seated athletes competing in seated throws (field) experience a higher IR of injury than those competing in wheelchair racing (track) (IR 23.7 and IR 10.6, respectively), 5) for both ambulant and wheelchair/seated athletes, the majority of injuries are not time-loss, 6) age group is not associated with injury in Paralympic athletics, and 7) the location of injury varies dependent upon athlete impairment category and athletics event discipline.

When comparing the results of this study to other investigations involving the sport of athletics, it is noted that injury patterns involving able-bodied athletes also reveal a higher incidence of injury in competition than in training, although able-bodied athletes experienced a higher incidence of time loss-injuries (36% of total injuries across 13 international athletics championships) compared to the athletes in this study[10]. Additionally, in ambulant athletes without an impairment, the most frequently observed diagnosis was thigh strain[1,2,3,10], similar to the findings of this study in which the thigh was the most common anatomical region injured in ambulant athletes with an impairment. Given varied definitions of injury incidence rate and injury incidence proportion across studies, it is somewhat difficult to create a direct comparison of these descriptors for athletes with and without an impairment. The majority of prior studies involving large, international athletics competitions in able-bodied athletes utilized “injuries per

311 1000 registered athletes" to describe injury incidence proportion data[1,2,3]. When comparing
312 injury incidence proportion utilizing "injuries per 1000 registered athletes" versus "injuries per
313 100 athletes" (such as was utilized in this study), it appears that athletes with disabilities
314 experience more injuries (18.4 injuries per 100 athletes in the current study) than able-bodied
315 athletes competing in the sport of athletics (range of 97.0 - 135.4 injuries per 1000 registered
316 athletes across studies). It should be noted, however, that the aforementioned studies within a
317 population of athletes without a disability did not utilize injury incidence rate as a primary
318 outcome measure, and thus it is difficult to compare the injury experience over competitions of
319 varying duration.

320 One important finding of this study was that ambulant athletes with cerebral palsy were less
321 likely to experience injury in track disciplines (IR10.2) when compared to ambulant athletes who
322 have either an amputation (IR 29.8) or whom are visually impaired (IR 23.1). When comparing
323 these impairment groups, it is noted that athletes with CP are likely to have an increase in muscle
324 tone that may prohibit full, forceful lower extremity eccentric muscle contraction during sprints
325 and distance running events. This physiological difference amongst athletes with and without CP
326 may in fact be protective against lower extremity injury, although further studies are needed to
327 determine the full nature of the biomechanical changes that occur in ambulant athletes with
328 increased lower extremity tone.

329 Additionally, this study revealed that wheelchair/seated athletes are more likely to experience
330 upper extremity injury in throws when compared to wheelchair racing. This is contrary to prior
331 assumptions regarding injury patterns in wheelchair/seated athletes, for whom wheelchair racers
332 were assumed to be at highest risk. Although further biomechanical studies are necessary to
333 define the mechanism of injury, one hypothesis is that seated throws athletes are more likely to

334 experience upper extremity injury due to the explosive nature the throw itself, with an injury
335 mechanism similar to what has been defined in other overhead throwing athletes[14]. Furthermore,
336 wheelchair/seated athletes typically lack function in the legs and core, which are known to be
337 important power generators in explosive throwing events. Thus, the upper extremity may be
338 subject to increased forces throughout the throwing mechanism. Given these findings, future
339 shoulder injury prevention programs should focus on athletes participating in seated throws, with
340 a focus on scapular stabilization, mitigating kinetic chain dysfunction such as the presence of
341 glenohumeral internal rotation deficit (GIRD), and closed kinetic chain strengthening with focus
342 on muscle balance.

343 This is the first and largest prospective cohort study of injury incidence and risk factors for injury
344 in the sport of Paralympic athletics. As athletics is the largest and one of the most high-profile
345 sports on the Paralympic Games program, a greater understanding of athlete injury patterns is
346 critical for sport injury prevention. Additionally, this study is the first to report injury incidence
347 rates in Paralympic athletics, accounting for athlete exposure and thus enabling comparison to
348 other events of varied sport discipline and duration. Through the development of a custom-built,
349 web-based injury surveillance tool, the authors were able to gather greater detail on injuries as
350 well as the nature of each athlete's impairment, thus enabling comparison of injury incidence
351 rates across impairment types.

352 This study is inherently limited by several factors. First, given that injury data collection was
353 dependent on London Organizing Committee medical personnel and team physicians entering a
354 daily report of injuries, it is possible that the injury IR is underestimated. Additionally, the
355 medical encounter forms at the Organizing Committee medical stations (EMDCS) included
356 several non-mandatory fields and did not include information regarding injury severity, injury

mechanism, and/or associated risk factors. Thus, some injury logs could be submitted with empty data fields, and did not include detailed information. As the Paralympic Injury and Illness Surveillance Study continues, developments to the Organizing Committee medical record system are expected to enhance the ability of researchers to acquire meaningful detail on the types and quantity of injuries sustained. Although compliance was good in the present study (86.4% of athletes competing in the sport of athletics), further effort will be necessary to engage the full participation of all athletes, which could further limit selection bias. It is noted that these results only describe information on injuries sustained during the competition period of the Paralympic Games, whereas many injuries in the sport of athletics likely occur out of competition given that athletes often train individually and in non-centralized locations. This limitation is similar to other large epidemiological studies in the sport of athletics[9]. Finally, the number of injuries recorded was not large enough to allow for a multivariate analysis, which limited the authors' ability to determine independent risk factors for injury. As data collection will continue at the Rio 2016 Summer Paralympic Games, it is expected that compiled athletics data will enable multivariate analysis into the future.

CONCLUSION:

This study is the first prospective comprehensive assessment of the incidence, characteristics, and factors associated with injury in the sport of Paralympic athletics, the largest sport on the Paralympic Games program. Ambulant athletes are particularly at risk for lower extremity injury, although athletes with cerebral palsy may be at decreased risk compared to athletes from other ambulant impairment categories. Amongst wheelchair/seated athletes, those involved in throws are at particularly high risk for shoulder injury. Importantly, these sport-specific findings can

inform the work of physicians, therapists, athletic trainers, and coaches when planning for injury prevention programs that protect the health of Paralympic athletes, noting that the incidence and anatomical region of injury varies based on athlete impairment category and event discipline.

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448 **Table 1: Injury incidence proportion (IP) and incidence rate (IR) by sex, age, and impairment category for track events at the**
449 **London Paralympic Games during the athletics competition period (10 days)**

		Total number of athletes participating	Athlete days	Number of injuries	Injury incidence proportion (IP) (injuries per 100 athletes)	Injury incidence rate (IR) (injuries per 1000 athlete-days)	Injury incidence rate (IR) 95% confidence Intervals	Incidence rate ratio (IRR)	Incidence Rate Ratio (IRR) 95% confidence intervals
Overall		497	4970	95	17.1	19.1	15.7 - 22.6		
Male		355	3550	78	19.2	22.0	17.7 - 26.3	1.84	1.08 – 3.31
Female		142	1420	17	12.0	12.0	6.6 - 17.3	1	
Age 13-25		210	2100	37	15.2	17.6	12.5 - 22.8	1.07	0.59-2.02
Age 26-34		184	1840	41	21.2	22.3	16.3 - 28.3	1.35	0.75-2.53
Age 35+		103	1030	17	13.6	16.5	9.3 - 23.7	1	
Ambulant track (all)		402	4020	88	19.4	21.9	17.8 – 25.9	2.07	1.19-3.86
	Ambulant amputee	121	1210	36	26.4	29.8	21.6 - 37.9		
	Ambulant VI†	160	1600	37	20.0	23.1	16.6 - 29.7		
	Ambulant CP*	98	980	10	9.2	10.2	4.2 - 16.2		

racing									

†VI = visually impaired *CP = cerebral palsy

Table 2: Injury incidence proportion (IP) and incidence rate (IR) by sex, age, and impairment category for field events at the London Paralympic Games during the athletics competition period (10 days)

		Total number of athletes participating	Total number of athlete days	Number of injuries	Injury incidence proportion (IP) (injuries per 100 athletes)	Injury incidence rate (IR) (injuries per 1000 athlete-days)	Injury incidence rate (IR) 95% confidence Intervals	Incidence Rate Ratio (IRR)	Incidence Rate Ratio (IRR) 95% confidence intervals
Overall		480	4800	121	19.8	25.2	21.3 - 29.1		
Male		315	3150	81	20.3	25.7	20.9 - 30.5	1.06	0.72-1.59
Female		165	1650	40	18.8	24.2	17.7 - 30.8	1	
Age 13-25		155	1550	37	18.7	23.9	17.2 - 30.6	1.09	0.67-1.81
Age 26-34		173	1730	51	22.0	29.5	22.7 - 36.3	1.35	0.85-2.17
Age 35+		152	1520	33	18.4	21.7	15.2 - 28.3	1	
Ambulant jumps (all)		137	1370	45	24.1	32.8	25.0 – 40.7		
	Ambulant VI†	50	500	20	26.0	40.0	26.4 – 53.6	2.16	0.79-7.36
	Ambulant amputee	43	430	14	27.9	32.6	18.6 – 46.6	1.76	0.6-6.23
	Ambulant CP*	27	270	5	14.8	18.5	3.9 – 33.2	1	

Ambulant throws (all)		240	2400	50	14.2	20.5	15.7 – 26.0		
	Ambulant short stature	20	200	10	35.0	50.0	28.1 - 71.9	3.23	1.77-7.98*
	Ambulant VI†	49	490	9	14.3	18.4	7.5 – 29.2	1.19	0.45-3.0
	Ambulant amputee	87	870	18	18.4	20.7	12.2 – 29.2	1.34	0.62-2.97
	Ambulant CP*	84	840	13	13.1	15.5	7.7 – 23.2	1	
Seated throws		177	1770	42	19.2	23.7	17.5 – 30.0	1.53	0.81-3.11

455 *CP = cerebral palsy †VI = visually impaired

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Table 3: Number of injuries and Injury incidence rate (IR) by track or field discipline, and characteristics of injury at the London Paralympic Games during the athletics competition period (10 days)

			Ambulant					Wheelchair/Seated			
			Sprints* n (IR)	Distance† n (IR)	Jumps n (IR)	Throws n (IR)	Total n (IR)	Sprints* n (IR)	Distance† n (IR)	Throws n (IR)	Total n (IR)
Athletes participating			233	122	137	166	658	110	32	177	319
Total number of injuries			56 (24.0)	24 (19.7)	45 (32.8)	34 (20.5)	159 (24.2)	11 (10.0)	4 (12.5)	42 (23.7)	57 (17.9)
Timing of injuries											
	In training		7 (3.0)	3 (2.5)	6 (4.4)	5 (3.0)	21 (3.2)	3 (2.7)	0 (0.0)	4 (2.3)	7 (2.2)
	In competition total		21 (9.0)	14 (11.5)	19 (13.9)	13 (7.8)	67 (10.2)	4 (3.6)	3 (9.4)	17 (9.6)	24 (7.5)
		Warm-up	8 (3.4)	1 (2.5)	4 (2.9)	9 (5.4)	24 (3.6)	2 (1.8)	0 (0.0)	5 (2.8)	7 (2.2)
		Competition	13 (5.6)	7 (8.2)	14 (10.2)	4 (2.4)	41 (6.2)	2 (1.8)	3 (9.4)	9 (5.1)	14 (4.4)
		Cool-down / recovery	0 (0.0)	1 (0.8)	1 (0.7)	0 (0.0)	2 (0.3)	0 (0.0)	0 (0.0)	3 (1.7)	3 (0.9)
Non-sport-related injuries			1 (0.4)	0 (0.0)	3 (2.2)	0 (0.0)	4 (0.6)	1 (0.9)	0 (0.0)	2 (1.1)	3 (0.9)
Acuity of injury											
	Acute traumatic		28 (12.0)	11 (9.0)	22 (16.1)	19 (11.4)	80 (12.2)	6 (5.5)	4 (12.5)	18 (10.2)	28 (8.8)
	Acute on chronic		9 (3.9)	6 (4.9)	9 (6.6)	9 (5.4)	33 (5.0)	2 (1.8)	0 (0)	10 (5.6)	12 (3.8)
	Overuse injury		19 (8.2)	7 (5.7)	14 (10.2)	6 (3.6)	46 (7.0)	3 (2.7)	0 (0)	14 (7.9)	17 (5.3)
Time-loss injuries											
	0-1 days missed		39 (16.7)	17 (13.9)	29 (21.2)	29 (17.5)	114 (17.3)	9 (8.2)	3 (9.4)	32 (18.1)	44 (13.8)
	> 1 day missed		17 (7.3)	7 (5.7)	15 (10.9)	5 (3.0)	44 (6.7)	2 (1.8)	1 (3.1)	10 (5.6)	13 (4.1)

*Sprint events are classified as the 100 m, 200 m, and 400 m

†Distance events are classified as the 800 m, 1500 m, 5000 m, and marathon

Table 4: Injury incidence rate (IR) per anatomical region in ambulant athletes at the London Paralympic Games during the athletics competition period (10 days)

Anatomical region	Track	Field	Number of injuries	Proportion of all injuries
Thigh	19	7	26	16.4%
Knee	7	12	19	11.9%
Lumbar spine/lower back	11	7	18	11.3%
Lower leg	11	6	17	10.7%
Foot	8	6	14	8.8%
Ankle	4	10	14	8.8%
Shoulder/clavicle	2	9	11	6.9%
Hip and Groin	6	4	10	6.3%
Elbow	0	5	5	3.1%
Wrist	2	3	5	3.1%
Pelvis/sacrum/buttock	2	1	3	1.9%
Trunk and abdomen	2	1	3	1.9%
Upper arm	1	1	2	1.3%
Thoracic spine/upper back	0	2	2	1.3%
Neck/cervical spine	0	2	2	1.3%
Multiple body locations	1	1	2	1.3%
Stump	1	1	2	1.3%
Toe	2	0	2	1.3%
Head and face	0	1	1	0.6%
Genitalia	1	0	1	0.6%
Total	80	79	159	100%

Table 5: Injury incidence rate (IR) per anatomical region in wheelchair or seated athletes at the London Paralympic Games during the athletics competition period (10 days)

Anatomical region	Track	Field	Number of injuries	Proportion of all injuries
Shoulder/clavicle	2	9	11	19.3%
Elbow	1	8	9	15.8%
Knee	1	5	6	10.5%
Upper arm	2	3	5	8.8%
Wrist	1	3	4	7.0%
Thigh	1	3	4	7.0%
Lumbar spine/lower back	1	2	3	5.3%
Pelvis/sacrum/buttock	1	2	3	5.3%
Thoracic spine/upper back	0	2	2	3.5%
Lower leg	1	1	2	3.5%
Neck/cervical spine	2	0	2	3.5%
Chest	0	1	1	1.8%
Forearm	0	1	1	1.8%
Thumb	0	1	1	1.8%
Foot	0	1	1	1.8%
Hip and Groin	1	0	1	1.8%
Multiple body locations	1	0	1	1.8%
Total	15	42	57	100%