The Epidemiology of Injuries in Football at the London 2012 Paralympic Games

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Abstract

Background: The epidemiology of injury in Paralympic football has received little attention. A study of all sports at the London 2012 Paralympic Games identified football 5-a-side as the sport with the highest injury rate, meriting further detailed analysis, which may facilitate the development of strategies to prevent injuries.

Objective: To examine the injury rates and risk factors associated with injury in Paralympic football.

Design: Secondary analysis of a prospective cohort study of injuries to football 5-a-side and football 7-a-side athletes.

Setting: London 2012 Paralympic Games.

Participants: Participants included 70 football 5-a-side athletes and 96 football 7-a-side athletes. Athletes from all but one country chose to participate in this study.

Methods: The Paralympic Injury and Illness Surveillance System was used to track injuries during the Games, with data entered by medical staff.

Main Outcome Measurements: Injury incidence rate (IR) and injury incidence proportion (IP).

Results: The overall IR for football 5-a-side was 22.4 injuries/1000 athlete-days (95% confidence interval [CI], 14.1-33.8) with an IP of 31.4 injuries per 100 athletes (95% CI, 20.9-43.6). In 5-a-side competition, 62.5% of injuries were associated with foul play. The overall IR for football 7-a-side was 10.4 injuries/1000 athlete-days (95% CI, 5.4-15.5), with an IP of 14.6 injuries per 100 athletes (95% CI, 7.5-21.6). The most commonly injured body region in both sports was the lower extremity.

Conclusions: To our knowledge, this study is the first to examine IR and risk factors associated with injury in Paralympic football. Future studies are needed to determine mechanisms of injury and independent risk factors for injury, thus informing prevention strategies.

Introduction

Football (more familiarly known in the United States as soccer) is arguably the world's most popular sport, and injury rates in football have been studied extensively in elite able-bodied athletes [1, 2, 3, 4 and 5]. In recent studies, injury rates in male able-bodied football players have been reported at 27.0 injuries per 1000 player-days [5], with an injury incidence proportion at the summer Olympic Games of 27 injuries/100 players [1]. Approximately 70% of injuries affect the lower limb [4], and 56% of injuries are not associated with time loss [4]. Authors of a study examining football injuries at the 2012 London Olympic Games reported

that 74.2% of football injuries occurred in competition and that the injury incidence rate (IR) for football was one of the highest of all Olympic summer sports [1].

The International Paralympic Committee (IPC) has completed injury surveillance at the last 3 Winter Games—a major advance in Paralympic injury epidemiology [6 and 7]. Injury and illness surveillance was first systematically conducted at summer Paralympic Games in London in 2012 [8 and 9]. Injuries in Paralympic football have not previously been prospectively studied.

Two versions of football are played in the Paralympic Games: football 5-a-side and football 7-a-side. Football 5-a-side, which is played by athletes with visual impairment, started out as a game for children in schools for the visually impaired (VI) and has become an increasingly popular sport. It evolved in different countries before coming under the governance of the International Blind Sports Federation (IBSA) in 1996. Subsequently, an internationally recognized set of rules adapted from the International Federation of Associated Football was developed for the sport [10]. Under these regulations, football 5-a-side made its debut at the 2004 Athens Paralympic Games, and thereafter it grew to its largest number of participants at the 2012 London Paralympic Games. Each team has 4 outfield players and a sighted goalkeeper. Each game has 2 periods lasting 25 minutes and is played on a pitch sized 40 × 20 m for international matches. The pitch is surrounded by boarding (kickboards), 1-1.2 m in height, to form a perimeter and assist players in determining their location on the pitch. The ball, which contains a sound system, makes a noise when it is in motion so players can detect the ball's location. Although athletes with different levels of visual impairment can participate, all players must use an IBSA-approved eyeshade to ensure an equal level of visual impairment during competition. Full details of the rules are available at the IBSA Web site [10].

Football 7-a-side has been a Paralympic sport since 1984 and is played exclusively by athletes with central neurologic injury, including cerebral palsy and traumatic brain injury. Athletes must have ataxia, hypertonia, or athetosis. Players are divided into 4 classes based on their level of physical impairment [11]. The sport is similar to able-bodied football, with the following exceptions: 7 players are on the field at a time per team, the measurements of the playing field are smaller, there is no offside rule, throw-ins may be made with just one hand, and matches consist of 2 periods of 30 minutes each [12].

Injury surveillance is essential to evaluating risk factors for participation in sport with a view to inform the development and evaluation of prevention strategies and protect the long-term health of athletes [13]. Well-developed research methodologies [14, 15, 16 and 17] are in place to study injuries in professional football, which have been well documented for many years [18]. The lessons learned from these studies are being put into practice in efforts to improve the health of players.

Willick et al [9] reported IR values for all sports at the London 2012 Paralympic Games. The overall IR was 12.7 injuries/1000 athlete-days across all sports (95% confidence interval [CI], 11.7-13.7). Football 5-a-side was identified as the sport with the highest IR (22.4 injuries/1000 athlete-days). The authors of this study also reported an IR for football 7-a-side of 11.2 injuries/1000 athlete-days, which is similar to the overall rate reported for

Paralympic athletes in all sports. More in-depth analysis of this same dataset was performed to better characterize injuries in the hope of guiding future injury prevention strategies specific to these sports. Although the incidence rates provide important information, the timing and anatomic location of the injuries, in addition to the demographic information of the injured athletes, should improve injury characterization for guiding these strategies.

The objective of this study was to determine the IR, characteristics of injury, and risk factors for injury in athletes playing football 5-a-side and football 7-a-side at the London 2012 Paralympic Games.

Methods

This sport-specific cohort study was a component of the larger injury and illness surveillance study completed by the IPC at the London 2012 Paralympic Games. One of the 8 football 5-a-side teams in the tournament opted not to participate in the study, whereas all 8 football 7-a-side teams participated. Study participants included 70 athletes from 7 countries who participated in the football 5-a-side competition and 96 athletes from 8 countries who participated in the football 7-a-side competition. Data were collected over a 14-day period, including 3 days prior to the start of competition and 11 days of the competition period. The 7 participating teams in football 5-a-side teams each played 3 group matches (a total of 21 match exposures) followed by 14 medal and ranking match exposures, thus totaling 35 match exposures. The 8 football 7-a-side teams each played 3 group matches (a total of 24 match exposures) followed by 16 medal and ranking match exposures, thus totaling 40 match exposures. A match exposure is defined as one team playing one game; therefore, one match involves 2 match exposures.

Procedures

The Paralympic Injury and Illness Surveillance System was approved by the IPC. Prior to initiation of the study, ethics board approval was obtained through the University of Brighton in the United Kingdom (FREGS/ES/12/11) and the University of Cape Town Health Sciences Research Ethics Committee in South Africa (HREC/REF 436/2012). The athletes provided consent for the use of their de-identified medical data for research purposes at the time of their registration for the Games.

A comprehensive database of basic athlete demographic information was obtained from the IPC, containing the following de-identified information: age, country code, and accreditation number.

Data regarding injuries were gathered from two sources. The first source was a database from an electronic medical data capture system (Atos, Paris, France) that was used at all the athlete medical stations operated by the London Organizing Committee for the Olympic and Paralympic Games (LOCOG). LOCOG medical staff entered all injury encounters when an athlete presented to a medical station with a report of an injury consistent with the predetermined definition of injury. The second source was a database from a novel Web-based injury and illness surveillance system (WEB-IISS) used by medical staff providing care for their own teams; this surveillance system was developed specifically for the purposes of

this study [19]. With use of the WEB-IISS, greater clinical detail regarding injuries could be gathered. The final database contained no information that could personally identify any individual athlete.

Injury Definitions

For the purposes of this study, an injury was defined as "any newly acquired injury, as well as exacerbations of pre-existing injury that occurred during training and/or competition of the 14 day precompetition and competition period of the London 2012 Paralympic Games." An acute traumatic injury was considered "an injury that was caused by an acute precipitating traumatic event." An acute on chronic injury was 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."

Statistical Analysis

Descriptive statistics including means (95% CI), medians (range), and proportions (95% CI) were used to describe athlete characteristics. IR (95% CI) estimates were based on Poisson regression analysis controlling for important covariates, clustering by country, and offset for exposure days. Injury IRs and 95% CIs were estimated based on the frequency of injuries reported (eg, overall, by age group, and by anatomic region) and the total number of athlete-days of participation based on the total number of athlete-days reported for each delegation. The injury incidence proportion (IP; 95% CI) was reported as the number of injuries per 100 athletes. The 95% CI was used to determine significant differences in the incidence data.

Results

Football 5-a-Side

Injury Incidence Proportion and Incidence Rate

The 7 teams participating each consisted of a squad of 10 players consisting of 8 VI outfield players and 2 sighted goalkeepers (n = 70 players). Thus, with data collection over a 14-day period, the total exposure for training and competition was 980 athlete-days. Table 1 outlines the incidence rates for the 70 football 5-a-side athletes who participated in our study. Duration of time lost from the injury was not reliably recorded and thus was not included in the analysis.

Table 1. Injury incidence proportion and incidence rate at the London Paralympic Games for the sport of football 5-a-side during the precompetition and competition period (14 days)

	No. of Athletes	No. of Injuries	IP*	IR†	IR 95% CI
Overall	70	22	31.4	22.4	14.1-33.8
Position					
Goalkeepers (sighted)	14	0	0	0	0-18.6
Outfield (visually impaired)	56	22	39.3	28.1	17.7-42.2
Timing of sport-related injuries					
Prior to Games	56	7	12.5	8.9	3.6-18.3
During Games—in training	56	6	10.7	7.7	2.8-16.7
During Games—in competition	56	8	14.3	10.2	4.4-20
During Games—out of sport	56	1	1.8	1.3	0-3.8
Acuity of injury					
AT	56	12	21.4	15.3	7.6-23.0
AOC	56	5	8.9	6.4	2.1-14.8
CO	56	5	8.9	6.4	2.1-14.8

IP = injury incidence proportion; IR = injury incidence rate; CI = confidence interval; AT = acute traumatic injury; CO = chronic overuse injury; AOC = acute on chronic injury.

∗ Injuries per 100 athletes.
† Injuries per 1000 athlete-days.

During the 14-day period of the Games, 22 injuries were documented, resulting in an IP of 31.4 injuries per 100 athletes (95% CI, 20.9-43.6) and an IR of 22.4 injuries per 1000 athlete-days (95% CI, 14.1-33.8). Analysis revealed that 21 injuries were recorded by National Paralympic Committee (NPC) medical staff via the WEB-IISS, with only one injury recorded by LOCOG medical staff via the electronic medical data capture system.

A review of the injury data by position showed that none of the goalkeepers (sighted players) experienced an injury—all injuries were incurred by the VI outfield players. Thus, calculations for 56 VI players who trained and competed for 14 days resulted in a total 784 athlete-days exposure. As such, the IP among the VI athletes was 39.3 injuries per 100 athletes (95% CI, 26.5-53.2) and the IR was 28.1 (95% CI, 17.7-42.2) injuries per 1000 athlete-days. All further analyses relate to VI outfield players only. The number of injuries reported by participating countries ranged from 0-9 injuries per team over the duration of the Games.

Acute Versus Overuse Injuries

When the categories of acute-onset injuries and acute on chronic injuries are combined, it becomes clear that acute injuries occur more frequently than chronic overuse injuries in football 5-a-side. Only 5 overuse injuries were reported in this VI cohort for an IR of 6.4 per 1000 athlete-days (95% CI, 2.1-14.8). Of the 17 acute and acute on chronic injuries, 8 occurred during competition, 6 occurred during training, 2 occurred prior to village entry, and 1 injury was not sport related. For all acute injuries, the IR was 21.7 per 1000 athlete-days (95% CI, 12.7-34.5). For acute sport-related injuries (excluding the previllage and nonsport injury), the IR was 17.9 injuries per 1000 athlete-days (95% CI, 9.8-29.8).

Eight acute injuries occurred in competition (IR = 10.2 [95% CI, 4.4-20.0]). A total of 33 matches were played, involving 8 outfield VI players per match, which totals 264 player-games. Although substitutions were made during matches, only 4 players were on the field of play at any one time. The risk of any player sustaining an acute injury in a match was thus 1 in 33 or 3.03% (95% CI, 1.32-5.88).

All 8 injuries in competition were classified as extrinsic in mechanism, including 7 injuries that entailed contact with other athletes and 1 injury in which contact with the ball led to the injury. Among these acute competition injuries with extrinsic mechanisms, 5 of 8 (62.5%) were reported as relating to foul play and contact with another athlete.

Anatomic Location of Injuries

The lower extremity was the most common site of injury for all injury types. The head and neck accounted for 25% of acute competition injuries and 18% of all injuries, and the knee was the most commonly injured area (Table 2).

Table 2. Injury incidence rate by anatomic region at the London Paralympic Games for football 5-a-side* during the precompetition and competition period (14 days)

Anatomic Region	No. of Injuries	Proportion of All Injuries, %	IR†
Knee	4	18.2	5.1
Lower leg	3	13.6	3.8
Head/face	3	13.6	3.8
Trunk/abdominal	2	9.1	2.6
Foot	2	9.1	2.6
Ankle	2	9.1	2.6
Wrist/hand	1	4.5	1.3
Shoulder	1	4.5	1.3
Neck	1	4.5	1.3
Lumbar spine	1	4.5	1.3
Hip/groin	1	4.5	1.3
Totals	22	100	28.1

IR = injury incidence rate.

∗ n = 56 outfield players (excluding goalkeepers).
† Injuries per 1000 athlete-days.

Football 7-a-Side

Injury Incidence Proportion and Incidence Rate

The 8 teams that participated in the study each consisted of a squad of 12 players (n = 96 players). Thus, with data collection over a 14-day period, the total exposure for training and competition was 1344 athlete-days.

During this period, 14 injuries were documented, resulting in an IP of 14.6 injuries per 100 athletes (95% CI, 7.5-21.6) and an IR of 10.4 injuries per 1000 athlete-days (95% CI, 5.4-15.5;

Table 3). There was a trend toward a higher injury rate in the 26- to 34-year-old age group compared with younger and older athletes, but this trend did not reach statistical significance.

Table 3. Injury incidence proportions and incidence rates at the London Paralympic Games for football 7-a-side during the precompetition and competition period (14 days)

	No. of Athletes	No. of Injuries	IP*	IR†	IR 95% CI
Overall	96	14	14.6	10.4	5.4-15.5
Age group, y					
13-25	48	4	8.3	6.0	0.4-11.5‡
26-34	45	10	22.2	15.9	7.2-24.5‡
35-67	3	0	0	0	–
Initial timing of sport-related injuries					
Prior to Games	96	1	1.0	0.7	0-2.2
During Games—in training	96	3	3.1	2.2	0-4.7
During Games—in competition	96	9	9.4	6.7	2.5-10.9
Acuity of injury					
Acute traumatic	96	10	10.4	7.4	3.1-11.8
Acute on chronic	96	3	3.1	2.2	0-4.7
Chronic overuse	96	1	1.0	0.7	0-2.2
Time-loss injuries					
0-1 days missed	96	7	7.3	5.2	1.5-8.9
>1 day missed	96	5	5.2	3.7	0.5-6.9
Time not specified	96	2	2.1	1.5	

IP = injury incidence proportion; IR = injury incidence rate; CI = confidence interval.

∗ Injuries per 100 athletes.
† Injuries per 1000 athlete-days.
‡ Incidence rate ratio between youngest age groups = 2.7 (95% CI, 0.8-11.8).

Seven of the 14 reported injuries (50%) resulted in less than 1 day of time lost from training or competition. Five injuries resulted in more than 1 day lost from training and competition. Time loss was not reported for 2 of the injuries (Table 3).

Acute Versus Overuse Injuries

The most common onset of injury was acute traumatic in nature (71% of all injuries), followed by acute-on-chronic injuries (22%). Only one chronic overuse injury occurred (7.1% of all injuries). For all acute injuries, consisting of acute traumatic injuries combined with acute-on-chronic injuries, the IR was 9.7 (95% CI, 4.8-14.6), which was significantly more common than chronic injuries (IR, 0.7; 95% CI, 0.0-2.2). The majority of injuries occurred during competition (64% of all injuries; Table 3).

Anatomic Location of Injuries

Table 4 outlines the anatomic locations of injuries for the athletes. The lower extremity was involved in 12 of 14 injuries (86% of all injuries). The ankle (36% of all injuries) and knee

(29%) were the most commonly injured regions of the body. Five injuries (36% of all injuries) were due to contact with another athlete.

Table 4. Injury incidence rate by anatomic region at the London Paralympic Games for football 7-a-side during the precompetition and competition period (14 days)

	No. of Injuries	Proportion of All Injuries, %	IR*
Ankle	5	35.7	3.7
Knee	4	28.6	3.0
Thigh	1	7.1	0.7
Lower leg	1	7.1	0.7
Toe	1	7.1	0.7
Head/face	1	7.1	0.7
Undefined	1	7.1	0.7
Totals	14		10.4

IR = injury incidence rate.

∗ Injuries per 1000 athlete-days.

Discussion

This study is the first to prospectively examine injury rates and characteristics of injury in the sport of football at the Paralympic Games. We demonstrate an injury IR of 22.4 injuries per 1000 athlete-days in football 5-a-side and 10.4 injuries per 1000 athlete-days in football 7-a-side. Prior to the London Games, injury patterns in football 5-a-side were reported in only one study [20]. In this study, a group of 13 players who played in 5 international competitions for one nation were followed up during a 5-year period. Not all athletes played in all competitions. Only injuries that occurred during competition were documented. Twenty-three matches occurred during the period of the study, and 11 of the 13 players experienced some form of injury (incidence proportion, 84.6%). A total of 35 injuries were documented (mean injury frequency = 2.7 injuries per athlete over 5 years and 0.12 injuries per match). Traumatic injuries (80%) were more common than overuse injuries (20%), and the highest distribution of injuries involved the lower extremity (80%), followed by the head (8.6%), spine (5.7%), and upper extremity (5.7%). Although the study is limited by the small number of participants from only one nation, it does set a benchmark for comparison. To our knowledge, no studies have been performed that examine football 7-a-side exclusively.

Researchers with the International Paralympic Committee have successfully demonstrated a decrease in injury rates in the sport of sledge ice hockey through rules changes based on prospective analysis of injury characteristics [6]. The same model can be applied to Paralympic football, given the increased knowledge of injuries seen in this sport.

Football 5-a-Side

In total, nearly 50% of football 5-a-side players with a visual impairment sustained an injury during the 14-day period of the Games. Our findings were consistent with the Brazilian study [20] showing that the most commonly injured body region is the lower extremity. Head and neck injuries accounted for 25% of acute injuries during competition and 18% of

all (acute and chronic) injuries compared with 8.6% in matches in the Brazilian study [20]. The nature of the way the game is played makes patterns of injury different from those of traditional football. VI athletes play with a more upright posture compared with non-VI soccer athletes, which may expose them to collisions of the head. Additionally, a lack of vision reduces the athlete's ability to brace or block their head when anticipating an oncoming blow. This finding contrasts with the able-bodied football population and highlights the susceptibility of the head and neck to injury in VI athletes; thus forms of protective headgear could be examined for injury prevention.

In this study, more than 60% of competition-related injuries were reported as being associated with foul play, which is double the percentage previously identified in elite able-bodied football (29%) [21]. To avoid collisions, players must abide by an important communication rule in VI football. It is the duty of the player without the ball to say the word “voy” clearly and in a timely fashion each time he or she is moving toward the ball. The expression “voy” is a universally known expression in the world of VI football, adopted from Spanish and meaning “I go.” Gabriel Mayr's diploma thesis states that this rule “gives the present ball holder the certainty that he or she learns in advance that an opponent is approaching. If the player does not say ‘Voy,’ the referee should punish the team with a foul” [22]. It is crucial that referees apply the laws strictly and correctly in an attempt to prevent player collisions. Based on our data, it appears that the most effective preventive strategy would be to encourage strict enforcement of these rules.

Football 7-a-Side

The IRs for the football 7-a-side athletes in our study appear to be lower than those of elite able-bodied football players [1, 4 and 5], although they follow the trends described in able-bodied football of injuries occurring more commonly in competition and not resulting in significant time loss. The lower incidence of injury compared with able-bodied athletes has been shown in ambulant athletes with cerebral palsy in the sport of athletics (also known as track and field in North America) (C. Blauwet, unpublished observation, September 2012) as well, although the reasons for these differences have not been elucidated. It also should be noted that several studies examine male and female able-bodied football players, whereas only male athletes compete in football 7-a-side. Female athletes have demonstrated similar rates of injury in football compared with male athletes in the Olympic Games [4].

Several previous studies have examined injuries in para-athletes but have not provided an in-depth examination of athletes competing in football 7-a-side. Recently, Willick et al [9] reported on IRs from all sports using the same dataset and showed that football 7-a-side athletes sustained injuries at a rate similar to that of all sports combined. Derman et al [19] demonstrated that for all summer Paralympic sports, upper limb injuries were more common than lower limb injuries during these Games. This finding contrasts with our sport-specific findings, which emphasizes the importance of identifying sport-specific injury patterns. Our results suggest that preventive strategies should focus on prevention of lower extremity injuries, particularly of the ankle and knee, and especially in the 26- to 34-year-old age group. Proprioceptive ankle training or bracing/taping, both of which have been demonstrated to be an effective method in the prevention of ankle sprains [23], may be effective means of preventing ankle injuries in this cohort.

Football athletes with central neurologic injury such as cerebral palsy may have a greater risk of muscle strain and injury because of spasticity and weakness and are heterogeneous in their abilities and clinical presentation [24 and 25]. Athletes with cerebral palsy have been shown to sustain soft tissue injuries and lacerations more often than athletes with other physical impairments [26]. Nyland et al [27] demonstrated that Paralympic athletes with cerebral palsy sustained similar rates of injuries of the knee, shoulder, leg/ankle, and hand/finger when accounting for all sports.

This study has limitations common to many sports injury epidemiology studies conducted at major games. Despite the large size of the Games, fewer than 100 athletes participated in football 5-a-side and in football 7-a-side. Therefore, subtle findings may not have been detected. It is possible that the IR is underestimated because data collection is dependent upon medical personnel entering a daily report of injuries. It is impossible to ensure that the NPC medical personnel reported all injuries assessed in their medical stations in the Paralympic Village. To estimate overall injury rates, denominator data have been estimated based on the number of athletes and 14 days of athlete exposure at the London Paralympics. As such, injury rates may be underestimated if all athletes were not at risk of injury throughout the entire games period. In addition, injuries that occurred in competition may have been more likely to be reported compared with noncompetition injuries, because competition injuries are often more significant and memorable and occur within the proximity of medical personnel. Furthermore, the available data do not allow for determination of an association between injury and other potential causative factors such as player position, field surface, time of injury during a match, and whether an injury affected an athlete's spastic or paretic limb versus a limb unaffected by the athlete's neurologic condition. The low number of injuries also does not allow for a multivariate analysis, which could be used to determine independent risk factors for injury. To further characterize mechanisms of injury, future research should include analysis of injuries captured on video to elucidate specific mechanisms. Finally, the estimation of time loss to define injury severity could be inaccurate because the medical professional who completed either the LOCOG medical encounter form or the Web-based injury survey guessed the number of training and competition days that an athlete was likely to lose based on the initial presentation. In the future, improved data collection methodology will enable us to overcome some of these limitations and provide for more informative injury data. Specifically, further refinements in the injury surveillance system are needed to capture more detailed information about specific diagnoses and mechanisms of injury.

Conclusion

To our knowledge, this cohort study is the first to examine injury IR and factors associated with football-related injuries at the Paralympic Games. Among the 20 summer Paralympic sports in which athletes competed at the London 2012 Paralympic Games, the highest IR was recorded for football 5-a-side, whereas football 7-a-side had an IR similar to that of all the other sports in which athletes competed at the Games. For football 7-a-side, athletes primarily sustained acute injuries during competition. Of the injuries sustained, 50% resulted in less than 1 day of time lost from training and competition. The most commonly affected injury locations for athletes were the knee and ankle. For football 5-a-side, the majority of injuries occurred in competition and were deemed to be related to foul play

resulting in collisions, which deserves further in-depth evaluation of illegal play and more rigid application of the rules by referees. Protective headgear may have a role in injury prevention if the high incidence of head and neck injuries (25%) during competition is confirmed in further studies.

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