

Injuries and illnesses during the 2021 South America wheelchair basketball championships: an epidemiological study

Diego J. Bogado¹, Rodrigo A. Martínez Stenger², Jesica E. Blajman³, Gonzalo M. Santiago³, Carina S. Palma¹, Valeria N. Quiróz¹, Máximo Barrios¹, Elisa N. Mamani¹

¹Universidad Nacional de Hurlingham. Instituto de Salud Comunitaria. Villa Tesei. Provincia de Buenos Aires. Argentina. ²Hospital Doctor Abel Zubizarreta. Ciudad Autónoma de Buenos Aires. Argentina. ³Universidad Nacional de Rafaela. Rafaela. Provincia de Santa Fe. Argentina.

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Summary

Introduction: Several international sports federations have implemented a standardized injury registration system during their championships. However, very few studies have included athletes with disabilities during major competitions, apart from the Paralympic Games. Therefore, the objective of this study is to evaluate the rate and characteristics of illnesses and injuries during the 2021 South America Wheelchair Basketball Championships.

Material and method: The coaching staff of the 11 participating teams (a total of 129 players) were asked to report daily all the health problems that have occurred and their characteristics in a standardized form. Prevalence and incidence rates were calculated.

Results: In this study 108 health problems were reported, equivalent to 83.7 per 100 players [95% CI: 67.9-99.5], with 8 time-loss health problems (6.2 per 100 players [95% CI: 1.9-10.5]) and a total of 74 medical attention injuries (57.4 per 100 players [95% CI: 44.3-70.4]). Were reported 15 diseases, and the most affected organ systems were ophthalmologic, gastrointestinal, and genitourinary. More injuries were recorded during matches (n=43). The most affected regions were shoulder/clavicle (24.7%), hand/fingers (23.7%) and neck/cervical spine (12.9%). The most frequent conditions were muscle contractures/cramps (32.2%), and the predominant mechanism was overuse (53.8%). 2.2% of concussions produced during training were reported. Most of the recorded events were without time loss and with return to full participation between zero and one day.

Conclusion: Monitoring of health problems during competitions is essential to determine sport-specific injury risk factors, and a complex approach should be implemented for the recognition of their characteristics in wheelchair basketball players. In this way, adequate preventive measures can be developed.

Key words:

Epidemiology. Athletic injuries.
Illnesses. Para-athletes.
Wheelchair sports.

Lesiones y enfermedades durante el campeonato sudamericano de baloncesto en silla de ruedas 2021: un estudio epidemiológico

Resumen

Introducción: Varias federaciones deportivas internacionales han implementado un sistema estandarizado de registro de lesiones durante sus campeonatos. Sin embargo, muy pocos estudios han incorporado a deportistas con discapacidad durante los principales campeonatos, aparte de los Juegos Paralímpicos. Por lo tanto, el objetivo de este estudio es evaluar la tasa y características de las enfermedades y lesiones durante el Campeonato Sudamericano de Baloncesto en Silla de Ruedas 2021.

Material y método: Se solicitó a los cuerpos técnicos de los 11 equipos participantes (un total de 129 jugadores), que reportaran diariamente todas las afecciones ocurridas y sus características en un formulario estandarizado. Se calcularon las tasas de prevalencia e incidencia.

Resultados: Se reportaron 108 afecciones, equivalentes a 83,7 por 100 jugadores [IC 95%: 67,9-99,5], con 8 afecciones de tiempo perdido (6,2 por 100 jugadores [IC 95%: 1,9-10,5]) y un total de 74 lesiones de atención médica (57,4 por 100 jugadores [IC 95%: 44,3-70,4]). Se informaron 15 enfermedades, y los sistemas orgánicos más afectados fueron el oftalmológico, gastrointestinal y genitourinario. Se registraron más lesiones durante los partidos (n=43). Las regiones más afectadas fueron hombro/clavícula (24,7%), mano/dedos (23,7%) y cuello/columna cervical (12,9%). Las afecciones más frecuentes fueron las contracturas/calambres musculares (32,2%), y el mecanismo predominante fue el sobreesfuerzo (53,8%). Se reportó un 2,2% de conmociones producidas durante los entrenamientos. La mayoría de los eventos registrados fueron sin pérdida de tiempo y con retorno a la plena participación entre cero y un día.

Conclusión: El seguimiento de problemas de salud durante las competiciones es esencial para determinar los factores de riesgo de lesiones específicas del deporte, y se debe implementar un enfoque complejo para el reconocimiento de sus características en jugadores de baloncesto en silla de ruedas. De esta manera se podrán desarrollar medidas preventivas adecuadas.

Palabras clave:

Epidemiología. Lesiones Deportivas.
Enfermedades. Paratletas.
Baloncesto en silla de ruedas.

Correspondence: Diego Javier Bogado
E-mail: diego.bogado@unahur.edu.ar

Introduction

Wheelchair basketball (WB) is an adaptation of basketball and is played by people with different physical disabilities. It is a high-performance sport for people with disabilities and the most important competitions are the Paralympic Games (POG) and the World Championship, which are held every 4 years. While the epidemiology of injury in Olympic sports has been intensively researched^{1,2}, it has not been examined in so much detail in Paralympic sports³. However, with the growing popularity of para-sport over the past few decades, the number of publications on injuries and illnesses in this sports population has increased significantly⁴.

Some of the first articles published found that basketball players have one of the highest incidences of injury among wheelchair sports⁵ and during the 1992 POGs it was reported that 79% of British basketball players suffered an injury⁶. Injuries were monitored more systematically at the summer POGs in 2012⁷ and 2016⁸, at which WB was played. WB was reported to have an injury incidence rate of 12.0 injuries per 1,000 athlete-days [CI 95%: 8.3-16.8] in 2012 and 12.8 injuries per 1,000 athlete-days [CI 95%: 9.5-17.4] in 2016, and more traumatic injuries were reported than injuries through overuse in WB at the 2012 POGs⁷. Meanwhile, Hollander *et al.*³ assessed the rate and characteristics of injuries during the 2018 Wheelchair Basketball World Championship (WBWC) and reported 100 injuries, which is equivalent to 75.8 per 100 athletes [CI 95%: 60.9-90.7] or 68.9 injuries per 1,000 athlete-days [CI 95%: 55.4-82.4]. In addition, 8 time loss (TL) injuries (6.1 TL injuries per 100 athletes [CI 95%: 1.9-10.3] or 5.5 TL injuries per 1,000 athlete-days [CI 95%: 1.7-9.3]) were reported and more injuries occurred during matches (n=68) than during training.

Since epidemiological analysis is the first step to developing appropriate injury prevention strategies⁹, several international sports federations have implemented a standardised injury reporting system during their championships^{2,3}. However, very few studies have looked into athletes with disabilities during major competitions, other than the Paralympic Games³. For this reason, the aim of this study is to describe the rate and characteristics of injuries and illnesses during the 2021 South America WB Championships (SAWBC) held in Buenos Aires, Argentina.

Materials and methods

Design, environment, and study participants

A prospective follow-up study of illnesses and injuries occurring during the 2021 SAWBC was conducted. The total population consisted of 11 teams from 7 different countries with a total of 129 athletes (men: 7 teams [n=81]; women: 4 teams [n=48]). The SAWBC were held from 28 November to 4 December (female) and from 6 to 13 December (male) 2021 in Buenos Aires, Argentina. During the 15 days of the championships, 31 matches were played, 10 by women's teams and

21 by men's teams. The total exposure was 310 athlete-matches and 984 athlete-days.

For the monitoring of athletic health problems during the SAWBC, the 2020 declaration of the International Olympic Committee¹⁰ and its translation adapted to para-sport⁴ were used as a guide. An "athletic health problem"¹¹ or "complaint" was defined as any physical manifestation (illness) or musculoskeletal manifestation (injury) suffered by the athlete during the championships, irrespective of the need for medical attention or the consequences in terms of participation¹². A contact from each team reported daily details of all health problems on a standardised illness and injury reporting form. The form was an adapted version of those used by the International Olympic Committee (IOC), the International Association of Athletics Federations (IAAF) and the International Swimming Federation (FINA) with predefined categories for location, type, cause, guidance regarding diagnosis, match/training and estimated time loss¹³⁻¹⁵, and with items suggested for para-sport⁴. The functional classification (1-4.5) of the athletes was in accordance with the relevant volume of action for the WBC¹⁶. The reporting form for athletic health problems was completed virtually through a web platform and was available in Spanish and Portuguese.

The study was presented in written and audiovisual format by email and through social networks to the contacts in each delegation the week before the start of the SAWBC. All the teams were briefed on the purpose and logistics of the study.

During both championships, a member of the research group was present at the venue to encourage and assist with participation in cooperation with the local organising committee. Contact was also maintained by telephone with the contacts from each delegation individually in two shifts per day. Response rates and data quality were analysed daily. The duplication of data entries or reports with incongruous features were resolved by consensus between DB and RM. The confidentiality of all the information was guaranteed and it was not possible to identify any individual athlete or team. The athlete's accreditation number was used to consult the player database to find out the age, sex and nationality of the injured or ill athlete and the database was de-identified after the Championships². All the authors followed the rules of the Declaration of Helsinki. The study reports in accordance with the STROBE guidelines for reporting observational studies¹⁷.

Calculation of exposure and injury rate

The squad sizes and team match exposure were determined based on the publicly available list and schedule¹⁸. All the teams had training sessions on match and non-match days before the end of the championships. Athlete-match exposure was calculated by multiplying the number of players on the field by the number of games¹²⁻¹⁴ and athlete-training day exposure as the number of players per team multiplied by the number of training sessions¹⁹. Athlete-days exposure was calculated by multiplying the number of players registered by the number of days of the SAWBC²⁰. The health problem rates were calculated as the

number of problems per 100 players and per 1,000 athlete-days, and were reported with a confidence interval (CI) of 95%³.

Statistical analysis

Descriptive statistics were used to present the data. Results are described as means with standard deviation or frequencies with percentage. The differences in location, type and mechanism of injury between groups (match vs. training and women vs. men) were analysed using chi-square tests. Significance levels of $p < 0.05$ and confidence intervals of 95% were used²¹. All the data were processed using Excel (version 2108, Microsoft Corporation) and InfoStat (version 12.0).

Results

4 women's and 7 men's teams with a total of 129 players (mean age \pm SD of 32.9 ± 8.3) from 7 different countries took part in this study (Table 1). These 11 teams played 31 games and completed 62 training sessions over a total of 984 athlete-days. The exposure time and number and rates of health problems during the SAWBC are shown in Table 2. 108 health problems were reported, equivalent to 83.7 per 100 athletes [CI 95%: 67.9-99.5]. Of these, 44 problems were suffered by female players (91.7 problems per 100 players; [CI 95%: 64.6-118.8]) and 64 by male players (79.0 problems per 100 players; [CI 95%: 59.7-98.4]).

8 time loss (TL) health problems (6.2 TL problems per 100 players [CI 95%: 1.9-10.5]) were reported, 6 in women (12.5 TL problems per 100 players; [CI 95%: 2.5-22.5]) and 2 in men (2.5 TL problems per 100 players; [CI 95%: 0.0-5.9]) (Table 2).

Table 1. Characteristics of all the players taking part in the 2021 South America Wheelchair Basketball Championships.

	All the players taking part in the SAWBC	Women	Men
Number	129	48 (37.2)	81 (62.8)
Age			
Mean (SD)	32.9 (8.3)	31.6 (8.2)	33.7 (8.3)
Range	16-56	17-50	16-56
	n (%)	n (%)	n (%)
Sport classification			
1.0	24 (18.6)	10 (20.8)	14 (17.3)
1.5	7 (5.4)	1 (2.1)	6 (7.4)
2.0	17 (13.2)	7 (14.6)	10 (12.3)
2.5	16 (12.4)	6 (12.5)	10 (12.3)
3.0	14 (10.9)	6 (12.5)	8 (9.9)
3.5	10 (7.8)	3 (6.3)	7 (8.6)
4.0	27 (20.9)	9 (18.8)	18 (22.2)
4.5	14 (10.9)	6 (12.5)	8 (9.9)

SD: standard deviation; SAWBC: South America Wheelchair Basketball Championships

Comparisons between the different problems and subgroups are shown in Table 3. Significant differences were observed between injuries in matches, peri-competition activities and training with respect to location, type, mechanism of injury and the mechanism associated with the mode of injury onset ($\chi^2 = 44.83$, $p = 0.04$; $\chi^2 = 39.44$, $p = 0.02$; $\chi^2 = 8.23$, $p = 0.04$, $\chi^2 = 30.13$, $p = 0.01$, respectively; Table 3).

Table 2. Exposure, number and incidence of all health problems, time loss health problems and medical attention health problems at the 2021 South America Wheelchair Basketball Championships.

Number of	Men	Women	Total
Athletes	81	48	129
Championship days	8	7	15
Athlete-days	648	336	984
Matches	21	10	31
Athlete-matches	210	100	310
Training sessions	42	20	62
Athlete-training days	486	240	726
Health problems	64	44	108
Medical (illnesses)	7	8	15
Musculoskeletal (injuries)	57	36	93
Injuries in matches	27	16	43
Injuries in training	17	12	29
Injuries in peri-competition activities	4	5	9
Injuries in other activities	9	3	12
TL health problems	2	6	8
TL injuries in peri-competition activities	0	1	1
TL injuries in training	1	2	3
TL illnesses	1	3	4

(continuation)

Table 2. Exposure, number and incidence of all health problems, time loss health problems and medical attention health problems at the 2021 South America Wheelchair Basketball Championships (continuation).

MA injuries	41	33	74
Health problems per 100 athletes (CI ± 95%)	79.0 (59.7-98.4)	91.7 (64.6-118.8)	83.7 (67.9-99.5)
Injuries in matches	33.3 (20.8-45.9)	33.3 (17.0-49.7)	33.3 (23.4-43.3)
Injuries in training	21.0 (11.0-31.0)	25.0 (10.9-39.1)	22.5 (14.3-30.7)
Illnesses	8.6 (2.2-15.0)	16.7 (5.1-28.2)	11.6 (5.7-17.5)
TL health problems per 100 athletes	2.5 (0.0-5.9)	12.5 (2.5-22.5)	6.2 (1.9-10.5)
TL injuries in matches	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
TL injuries in training	1.2 (0.0-3.7)	4.2 (0.0-9.9)	2.3 (0.0-5.0)
TL illnesses	1.2 (0.0-3.7)	6.3 (0.0-13.3)	3.1 (0.1-6.1)
MA injuries per 100 athletes	50.6 (35.1-66.1)	68.8 (45.3-92.2)	57.4 (44.3-70.4)
Health problems per 1,000 athlete-days (CI ± 95%)	98.8 (74.6-123.0)	131.0 (92.3-169.6)	109.8 (89.1-130.5)
Injuries per 1,000 athlete-days	88.0 (65.1-110.8)	107.1 (72.1-142.1)	94.5 (75.3-113.7)
Illnesses per 1,000 athlete-days	10.8 (2.8-18.8)	23.8 (7.3-40.3)	15.2 (7.5-23.0)
TL health problems per 1,000 athlete-days	3.1 (0.0-7.4)	17.9 (3.6-32.1)	8.1 (2.5-13.8)
TL injuries per 1,000 athlete-days	1.5 (0.0-4.6)	8.9 (0.0-19.0)	4.1 (0.1-8.0)
TL illnesses per 1,000 athlete-days	1.5 (0.0-4.6)	8.9 (0.0-19.0)	4.1 (0.1-8.0)
MA injuries per 1,000 athlete-days	63.3 (43.9-82.6)	98.2 (64.7-131.7)	75.2 (58.1-92.3)
Injuries in training per 1,000 athlete-days of training	35.0 (18.4-51.6)	50.0 (21.7-78.3)	39.9 (25.4-54.5)
TL injuries in training per 1,000 athlete-days of training	2.1 (1.1-3.0)	8.3 (3.6-13.0)	4.1 (2.6-5.6)
Injuries in matches per match (CI ± 95%)	1.3 (0.8-1.8)	1.6 (0.8-2.4)	1.4 (1.0-1.8)
Injuries in matches per 1,000 athlete-matches	128.6 (80.1-177.1)	160.0 (81.6-238.4)	138.7 (97.2-180.2)
Injuries in matches per 100 athlete-matches	12.9 (8.0-17.7)	16.0 (8.2-23.8)	13.9 (9.7-18.0)
Injuries in matches per 1,000 athlete-hours	192.9 (120.1-265.6)	240.0 (122.4-357.6)	208.1 (145.9-270.3)
TL injuries in matches per match	0.00 (0.0-0.0)	0.00 (0.0-0.0)	0.00 (0.0-0.0)
TL injuries in matches per 1,000 athlete-matches	0.00 (0.0-0.0)	0.00 (0.0-0.0)	0.00 (0.0-0.0)

TL: time loss; AM: medical attention; CI: confidence interval.

The injuries suffered by female and male players differed significantly in the type and mechanism associated with the mode of injury onset ($\chi^2 = 15.87, p = 0.04$ and $\chi^2 = 18.5, p = 0.002$), but not in the mechanism of injury or location ($\chi^2 = 1.28, p = 0.26$; $\chi^2 = 13.16, p = 0.21$; Table 3).

Of all the health problems reported, 49 (45.4%) new injuries and 6 (5.6%) new illnesses were recorded during the days the championships lasted. The distribution of the types of health problems is shown in Figure 1.

As for the relationships with sports activity¹⁰, 85 (78.7%) directly related health problems, 15 (13.9%) indirectly related health problems and 8 (7.4%) health problems unrelated to sports activity were reported (Figure 2).

Injuries during the championships

During the matches, 43 injuries occurred, which equates to an incidence of 1.4 injuries per match [CI 95%: 1.0-1.8] or 138.7 injuries per match per 1,000 athlete-matches [CI 95%: 97.2-180.2] (Table 2).

The predominant locations by anatomical region of the injuries were shoulder/clavicle (23; 24.7%), hand/fingers (22; 23.7%) and neck/cervical spine (12; 12.9%) (Table 3). The most common types were muscle contracture/cramp (30; 32.3%), contusion/haematoma (14; 15.1%) and

Figure 1. Types of health problems during the 2021 South America Wheelchair Basketball Championships.

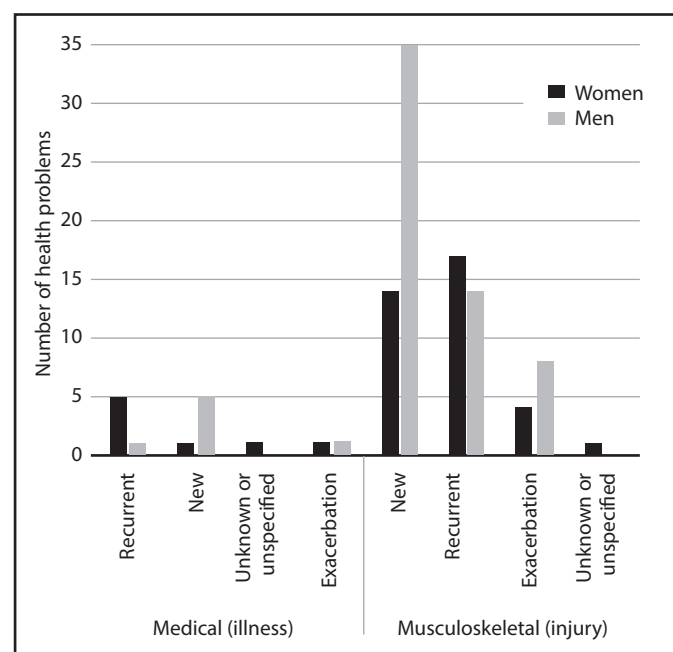
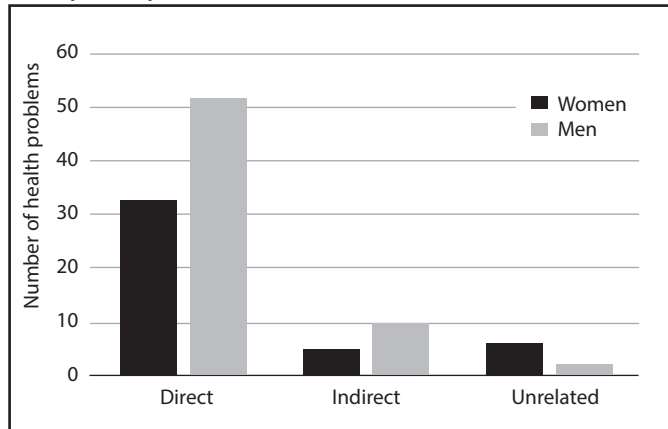


Figure 2. Relationship between the health problem and sports activity during the 2021 South America Wheelchair Basketball Championships.



tendinopathy (13; 14.0%). The most common health problems were tendinopathy in the shoulder (n=11), followed by muscle contracture in the neck and cervical spine (n=10) and sprained fingers (n=9) (Table 4). The predominant mechanisms of injury were repetitive/overuse (53.8%) with gradual onset (36.6%) and acute (46.2%) with sudden onset (43.0%) (Table 3).

4 time loss (TL) injuries were reported during the championships; 4.1 TL injuries per 1,000 athlete-days [CI 95%: 0.1-8.0], with a maximum of 3 days for full return to sport. These were concussion (with or without loss of consciousness), muscle contracture/cramp in the neck/cervical spine area, sprained fingers from direct contact with the ball, and elbow contusion from indirect contact with another player.

27 injuries were reported from contact, with 29.6% from direct contact with a moving object and 37% from indirect contact with another player (Figure 3).

Table 3. Characteristics of injuries in matches, peri-competition activities, training and other activities, and of illnesses during the 2021 South America Wheelchair Basketball Championships.

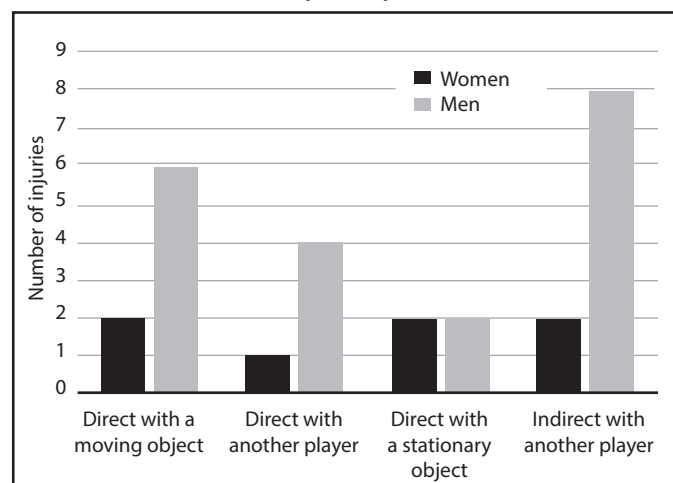
	Matches n = 43 n (%)	Peri-competition activities n=9 n (%)	Training n = 29 n (%)	Other activities n = 12 n (%)	Women n = 36 n (%)	Men n = 57 n (%)	Total n = 93 n(%)
Location							
Shoulder/ Clavicle	8 (18.6)	1 (11.1)	11 (37.9)	3 (25.0)	9 (25.0)	14 (24.6)	23 (24.7)
Hand/ Finger	15 (34.9)	1 (11.1)	5 (17.2)	1 (8.3)	6 (16.7)	16 (28.1)	22 (23.7)
Neck/Cervical spine	2 (4.7)	4 (44.4)	3 (10.3)	3 (25.0)	7 (19.4)	5 (8.8)	12 (12.9)
Thorax/Cervical spine	5 (11.6)	2 (22.2)	1 (3.4)	2 (16.7)	2 (5.6)	8 (14.0)	10 (10.8)
Elbow	5 (11.6)	0 (0.0)	1 (3.4)	0 (0.0)	1 (2.8)	5 (8.8)	6 (6.5)
Lumbar spine/Pelvis/Sacrum	2 (4.7)	1 (11.1)	2 (6.9)	1 (8.3)	5 (13.9)	1 (1.8)	6 (6.5)
Forearm	1 (2.3)	0 (0.0)	3 (10.3)	0 (0.0)	1 (2.8)	3 (5.3)	4 (4.3)
Arm	3 (7.0)	0 (0.0)	1 (3.4)	0 (0.0)	2 (5.6)	2 (3.5)	4 (4.3)
Knee	1 (2.3)	0 (0.0)	0 (0.0)	2 (16.7)	2 (5.6)	1 (1.8)	3 (3.2)
Head/ Face	0 (0.0)	0 (0.0)	2 (6.9)	0 (0.0)	1 (2.8)	1 (1.8)	2 (2.2)
Hip/ Pubis	1 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	1 (1.1)
Type							
Contracture/ Cramp	7 (16.3)	5 (55.6)	11 (37.9)	7 (58.3)	14 (38.9)	16 (28.1)	30 (32.3)
Contusion/ Haematoma	10 (23.3)	3 (33.3)	0 (0.0)	1 (8.3)	2 (5.6)	12 (21.1)	14 (15.1)
Tendinopathy	5 (11.6)	1 (11.1)	7 (24.1)	0 (0.0)	5 (13.9)	8 (14.0)	13 (14.0)
Pain	4 (9.3)	0 (0.0)	4 (13.8)	2 (16.7)	8 (22.2)	2 (3.5)	10 (10.8)
Sprain/Joint or ligament injury	5 (11.6)	0 (0.0)	4 (13.8)	1 (8.3)	4 (11.1)	6 (10.5)	10 (10.8)
Abrasion/ Laceration	7 (16.3)	0 (0.0)	1 (3.4)	0 (0.0)	1 (2.8)	7 (12.3)	8 (8.6)
Blister	3 (7.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	2 (3.5)	3 (3.2)
Bursitis/ Synovitis	2 (4.7)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)	3 (5.3)	3 (3.2)
Concussion (with/without unconsciousness)	0 (0.0)	0 (0.0)	2 (6.9)	0 (0.0)	1 (2.8)	1 (1.8)	2 (2.2)
Mechanism and mode of onset							
Repetitive/ Overuse	17 (39.5)	6 (66.7)	21 (72.4)	6 (25.0)	22 (61.1)	28 (49.1)	50 (53.8)
Gradual	9 (20.9)	3 (33.3)	17 (58.6)	5 (20.8)	10 (27.8)	24 (42.1)	34 (36.6)
Combination	4 (9.3)	3 (33.3)	2 (6.9)	0 (0.0)	9 (25.0)	0 (0.0)	9 (9.7)
Sudden	4 (9.3)	0 (0.0)	2 (6.9)	1 (4.2)	3 (8.7)	4 (7.0)	7 (7.5)
Acute	26 (60.5)	3 (33.3)	8 (27.6)	6 (25.0)	14 (38.9)	29 (50.9)	43 (46.2)
Sudden	25 (58.1)	2 (22.2)	8 (27.6)	5 (20.8)	12 (33.3)	28 (49.1)	40 (43.0)
Gradual	1 (2.3)	1 (11.1)	0 (0.0)	0 (0.0)	1 (2.8)	1 (1.8)	2 (2.2)
Combination	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)	1 (2.8)	0 (0.0)	1 (1.1)
Time loss (in days)							
0	36 (83.7.6)	6 (66.7)	24 (82.8)	7 (58.3)	25 (69.4)	48 (84.2)	73 (78.5)
1-2	5 (11.6)	2 (22.2)	5 (17.2)	4 (33.3)	7 (19.4)	9 (15.8)	16 (17.2)
3-6	2 (4.7)	1 (11.1)	0 (0.0)	1 (8.3)	4 (11.1)	0 (0.0)	4 (4.3)

(continuation)

Table 3. Characteristics of injuries in matches, peri-competition activities, training and other activities, and of illnesses during the 2021 South America Wheelchair Basketball Championships. (Continuation).

Number of illnesses	Women n = 8 n (%)	Men n = 7 n (%)	Total n = 15 n (%)
Affected system and medical problem			
Ophthalmological	0 (0.0)	3 (42.9)	3 (20.0)
Conjunctivitis	0 (0.0)	2 (28.6)	2 (13.3)
Unknown or unspecified	0 (0.0)	1 (14.3)	1 (6.7)
Gastrointestinal	3 (37.5)	0 (0.0)	3 (20.0)
Diarrhoea	3 (37.5)	0 (0.0)	3 (20.0)
Urogenital	3 (37.5)	0 (0.0)	3 (20.0)
Overactive bladder	2 (25.0)	0 (0.0)	2 (13.3)
Urinary tract infection	1 (12.5)	0 (0.0)	1 (6.7)
Respiratory	1 (12.5)	1 (14.3)	2 (13.3)
Pulmonary dysfunction	1 (12.5)	0 (0.0)	1 (6.7)
Rhinorrhoea/ congestion	0 (0.0)	1 (14.3)	1 (6.7)
Dermatological	0 (0.0)	2 (28.6)	2 (13.3)
Pressure ulcer	0 (0.0)	1 (14.3)	1 (6.7)
Abrasion	0 (0.0)	1 (14.3)	1 (6.7)
Dermatological. Ophthalmological	0 (0.0)	1 (14.3)	1 (6.7)
Stye	0 (0.0)	1 (14.3)	1 (6.7)
Gastrointestinal. Haematological	1 (12.5)	0 (0.0)	1 (6.7)
Fatigue/ Overtraining Syndrome	1 (12.5)	0 (0.0)	1 (6.7)
Time loss (in days)			
0	4 (50.0)	6 (85.7)	10 (66.7)
1-2	1 (12.5)	1 (14.3)	2 (13.3)
3-4	3 (37.5)	0 (0.0)	3 (20.0)

Figure 3. Types of injury contacts during the 2021 South America Wheelchair Basketball Championships.

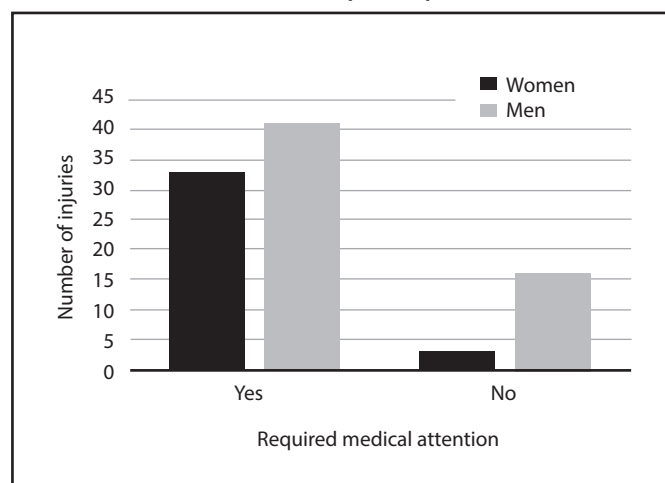


A total of 74 (79.6%) medical attention (MA) injuries (57.4 MA injuries per 100 players [CI 95%: 44.3-70.4] or 75.2 MA injuries per 1,000 athlete-days [CI 95%: 58.1-92.3]) and 19 (20.4%) injuries which did not require medical attention were reported (Figure 4).

Illnesses during the championships

During the championships, 15 athletes were ill: 8 women players and 7 men. The organ systems most affected were ophthalmological (n = 3; 20%), gastrointestinal (n = 3; 20%) and genitourinary (n = 3; 20%) (Table 3).

Figure 4. Medical-attention injuries during the 2021 South America Wheelchair Basketball Championships.



4 time loss (TL) illnesses or 4.1 TL illnesses per 1,000 athlete-days [CI 95%: 0.1-8.0], with a maximum of 4 days for full return to sport, were reported. These were nausea/vomiting, overactive bladder, urinary tract infection and conjunctivitis.

Like the items reported during the 2018 WBWC³, data were provided on the number and rates of health problems by sport classification, and there also appear to be differences with a wide-ranging distribution over sport classification. (Table 5).

Table 4. Injured body part and types of injuries during the 2021 South America Wheelchair Basketball Championships.

Part of the body	Abrasion/ Laceration	Blister	Bursitis/ Synovitis	Concussion	Contracture/ Cramp	Contusion/ Haematoma	Pain	Sprain/ Ligament injury	Tendinopathy	Total
Head	0	0	0	2	0	0	0	0	0	2
Neck/ Cervical spine	0	0	0	0	10	0	2	0	0	12
Thorax/ Dorsal spine	0	0	0	0	4	6	0	0	0	10
Lumbar spine/Pelvis/ Sacrum	0	0	0	0	3	1	2	0	0	6
Shoulder/ Clavicle	0	0	1	0	7	0	4	0	11	23
Arm	0	0	0	0	3	1	0	0	0	4
Elbow	1	0	2	0	0	1	1	0	1	6
Forearm	0	0	0	0	3	0	0	0	1	4
Hand/ Fingers	5	3	0	0	0	5	0	9	0	22
Hip/ Pubis	1	0	0	0	0	0	0	0	0	1
Knee	1	0	0	0	0	0	1	1	0	3
Total	8	3	3	2	30	14	10	10	13	93

Table 5. Number of Injuries and injury rates during the 2021 South America Wheelchair Basketball Championships by sport classification.

Sport classification	Injuries n = 93 n (%)	Illnesses n = 15 n (%)	Women n = 44 n (%)	Men n = 64 n (%)	Total n = 108 n (%)	Health problems/ 100 athletes n = 108 IR (CI 95%)	Injuries/1,000 athlete-h n = 43 IR (CI del 95%)
1.0 (n = 24)	15 (13.9)	2 (1.9)	9 (20.5)	8 (12.5)	17 (15.7)	70.8 (37.2-104.5)	7.6 (1.5-13.6)
1.5 (n = 7)	5 (4.6)	2 (1.9)	1 (2.3)	6 (9.4)	7 (6.5)	100.0 (25.9-174.1)	20.3 (2.5-38.0)
2.0 (n = 17)	13 (12.0)	2 (1.9)	10 (22.7)	5 (7.8)	15 (13.9)	88.2 (43.6-132.9)	9.1 (1.1-17.2)
2.5 (n = 16)	15 (13.9)	1 (0.9)	3 (6.8)	13 (20.3)	16 (14.8)	100.0 (51.0-149.0)	17.1 (5.3-29.0)
3.0 (n = 14)	8 (7.4)	2 (1.9)	2 (4.5)	8 (12.5)	10 (9.3)	71.4 (27.2-115.7)	4.9 (0.0-11.7)
3.5 (n = 10)	5 (4.6)	1 (0.9)	2 (4.5)	4 (6.3)	6 (5.6)	60.0 (12.0-108.0)	2.9 (0.0-8.7)
4.0 (n = 27)	18 (16.7)	4 (3.7)	9 (20.5)	13 (20.3)	22 (20.4)	81.5 (47.4-115.5)	10.2 (3.5-16.9)
4.5 (n = 14)	14 (13.0)	1 (0.9)	8 (18.2)	7 (10.9)	15 (13.9)	107.1 (52.9-161.4)	16.7 (4.3-13.6)

CI 95%: 95% confidence interval; IR: injury rate.

Discussion

This is the first prospective epidemiological study of WB during a major South American competition in which illnesses and not only musculoskeletal injuries were recorded. The overall rate of health problems was 83.7 injuries per 100 players or 109.8 injuries per 1,000 athlete-days. Just over half of the injuries were reported as due to overuse with a gradual onset mode and a third were classified as muscle contractures, mainly in the neck and cervical spine. 47% of the injuries occurred during matches.

The mechanisms of injury were different between training sessions and matches, but not between female and male players. The differences found when the mechanism of injury was analysed in isolation compared to when it was analysed associated with the mode of onset could

be explained by the recent introduction of the latter categorisation, which might still have posed difficulties of interpretation at the time of reporting. It should be clarified that, although it has been argued that peri-competition injuries should be included as training injuries^{0,12}, this study kept reports of injuries of this kind separately because we consider that they occur in an environment other than the situation of training and competition.

Rates and characteristics of the health problems

The injury rate during the SAWBC was substantially higher (94.5 injuries per 1,000 athlete-days [CI: 75.3-113.7]) than those reported during the 2012 POGs⁷, with 12.0 (CI: 8.3-16.8) injuries per 1,000 athlete-days, and the 2016 POGs⁸, with 12.8 (CI: 9.5-17.4) injuries per 1,000 athlete-days, and higher than the injury rate reported during the 2018 WBWC³,

with 68.9 injuries per 1,000 athlete-days (CI: 55.4-82.4). These differences could result from the definitional criteria for athletic health problems applied in this study, as this is a general term which includes, but is not limited to, injuries that require medical attention¹⁰.

The time loss (TL) injury rate (4.1 TL injuries per 1,000 athlete-days) was lower than the incidence of TL injuries reported at the 2018 WBWC (5.5 TL injuries per 1,000 athlete-days). The TL illness rate was also 4.1 TL illnesses per 1,000 athlete-days, but unfortunately illnesses were not reported during the POGs or the WBWC. In male players, 40% of these problems were new and predominant in the ophthalmological and dermatological systems; while in female players, 40% of these problems were recurrences and predominant in the gastrointestinal and genitourinary systems. In this regard, the need could also be highlighted to monitor medical problems for their impact on sports participation²² during championships held in just a few days. In this way, sports events which have medical services could be better prepared to address and solve such problems.

Most injuries occurred to the shoulder and hand/fingers, and to the cervical and dorsal spine. This is consistent with other reports on wheelchair sports^{6,23} and could be explained by the high demands placed on the upper limbs by the actions that playing WB involves^{23,24}.

In this study, 53.8% of the injuries occurred due to overuse. Similar data were reported during the 2018 WBWC (52%)³; while acute injuries were more prevalent at the 2012 POGs (65%)⁷. Both mechanisms of injury are considered to be a major problem in WB and should be addressed through prevention strategies.

In contrast to the 2016 POGs⁸, where no cases of concussion were reported, despite several reported incidents of blows to the head²⁵, and to data reported during the 2018 WBWC, where no cases of concussion were reported³; in this study 2.2% of concussions (with or without loss of consciousness) occurring during training were reported. The most recent data from the POGs, which report high rates of head and face injuries, demonstrate the need to make progress in the identification of these types of problems²⁵. A recent study by Herring *et al.*²⁶ may provide pointers regarding this initiative.

Methodological considerations and limitations

Variations in the definitions and methodologies used for previous studies of injuries in Paralympic sports cause inconsistencies in the reported data and it is difficult to compare results^{27,28}.

It has been mentioned that para-athletes often do not have access to a team doctor. For this reason, in this study, it was considered that the data could be reported by other health personnel or a team contact⁴ accompanied by a trained volunteer from the research team. We believe that daily telephone communication with each delegation and being able to report using an online form favoured daily compliance with the reports²⁹, but we also recognise that this could result in insufficient reports on injuries and illnesses. Therefore, this population may not be representative of all elite WB players and may not be representative of all non-elite players at regional level.

In the same vein, the term "medical attention" refers to an assessment of a player's medical condition by a qualified physician¹². This study recorded injuries that required medical/physiotherapeutic attention, defined as any orders given or therapeutic measure indicated by anyone who is involved in the health care of the athletes and implements an action plan to improve their health¹⁴.

For the surveillance of recurrent problems or exacerbations, it is necessary to have monitored previous injuries and illnesses, and used similar indexing before the start of the championships. All the technical staff also need to have experience in reporting¹⁰. In para-sport, this is especially relevant as para-athletes may have a greater number of recurrent problems⁴.

With regard to exposure times, in order to simplify analysis³⁰, training and match days were documented at team level¹³ and, therefore, injury rates in training and matches may have been underestimated if individual players missed a training session or did not participate in any matches. The female teams had to play more matches during the tournament compared to the male teams, which increased the female players' match exposure.

Like the study during the 2018 WBWC³, the sample size of this study was not big enough for an in-depth analysis of the effect of sport classification on injury risk. The reasons for the differences between the health problem rates in different competition settings and the patterns of health problems between the different sport classifications call for more detailed analysis²⁹. In the future, studies on WB should consider including sport classification as a relevant factor³¹.

Although mental health problems in athletes are very relevant^{32,33} and some teams anecdotally reported certain manifestations, such as anxiety, stress and sleep disorders, this study did not cover problems of this kind. Future studies could include aspects related to mental health using recognition tools as a guide to identify athletes at risk³⁴. With the same criteria, as Bittencourt *et al.*³⁵ propose, a more complex approach should be implemented with respect to the dynamic interaction of risk factors and their recognition techniques to improve the prediction and prevention of health problems.

Conclusion

This study found a higher injury rate than those reported in the POGs and the WBWC. A more detailed analysis of the characteristics of health problems revealed a large number of problems without time loss and with a return to full participation of between zero and one day. Most of the injuries were directly related to sports activity, primarily during matches, and were mostly seen on the shoulder and hand/fingers. Just over half of the injuries were reported as due to overuse with a gradual onset mode and a third were classified as muscle contractures, especially in the neck and cervical spine. Eight time loss problems and no serious injuries were reported.

As for the mechanisms of injury, these were different between training sessions and matches, but not between female and male players. Among the acute injuries, the sudden onset mode by indirect contact

with another player and direct contact with a moving object proved the most prevalent.

Regarding medical problems, in male players, new conditions with predominance in the ophthalmological and dermatological systems were mainly observed, while in female players the problems were recurrences with predominance in the gastrointestinal and genitourinary systems. It is necessary to highlight the importance of monitoring medical problems for their impact on sports participation during championships held in just a few days. In this way, the technical bodies and sports events which have medical services could be better prepared to address and solve such problems.

Epidemiological studies are fundamental when it comes to protecting the health of para-athletes. Well-designed health problem surveillance and precise data collection followed by careful analysis are elementary building blocks for the prevention of athletic health problems. Greater precision in the records can be achieved by continuing with the implementation of systematised follow-ups of health problems manifested by para-athletes at local level and including trained professionals in technical bodies.

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Conflict of interest

The authors declare that there is no conflict of interest.

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