



Original article

Epidemiology of Sport Injuries in Elite Female Wheelchair Basketball Players in Iran

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Abstract. Wheelchair basketball, a contact sport popular among disabled athletes, carries a high musculoskeletal injury risk. This cross-sectional study examined injury patterns, incidence, mechanisms, severity, and types in 63 elite Iranian female players (aged 18–35) from a population of 75, using retrospective data from 2021–2022 via a standardized form. Over 14,472 exposure hours, 27 injuries occurred (1.86 per 1,000 hours), mostly during training (66.7%, n=18) than competitions (33.3%, n=9). Collisions with opponents/wheelchairs were the main mechanism (33.3%). Injuries were predominantly mild (37%, 4–7 days absence), with muscle cramps/spasms most common (37%), affecting shoulders/clavicles (51.9%). Chronic (66.7%) and recurrent (63%) injuries prevailed. Findings emphasize upper limb/chronic risks, advocating targeted prevention like improved warm-ups and strength training to enhance athlete safety.

Keywords: Musculoskeletal, Training, Competition, Chronic, Athlete, Acute

Introduction

Wheelchair basketball is a variant of basketball adapted for individuals with disabilities. Its history dates back to the 1940s–1960s when American veterans with disabilities began playing the sport post-World War II. Over time, it gained global recognition. Due to the physical strength, technique, and speed required, wheelchair basketball is one of the most prominent and exciting sports in the Paralympics (Sá et al., 2022).



International competitions for individuals with disabilities became common in the latter half of the 20th century. Many individuals with physical disabilities regularly participate in wheelchair basketball (Sá et al., 2022). Like other sports, the frequency of training and competitions can lead to physical and sports-related injuries in athletes. Given the importance of physical mastery, technique, physical and mental resilience, and proper body positioning on the wheelchair, combined with the intensity of professional training and competitions, sports injuries in this discipline are expected to be significant.

The global popularity of basketball has led to increased attention to related injuries and their prevention/treatment. However, in wheelchair basketball, this remains a research gap that requires attention (Sá et al., 2022). Unilateral upper limb injuries, particularly in wheelchair-dependent sports like marathon racing, basketball, and tennis, are common, placing chronic stress and imbalance on joints (Soo Hoo et al., 2018). Studies indicate that wheelchair users often experience chronic soft tissue injuries, such as shoulder impingement syndrome, rotator cuff tears, sprains, and strains. The most reported soft tissue injuries in wheelchair athletes occur in basketball and track and field (Curtis & Black, 1999), similar to patterns observed in women's gymnastics where upper extremity injuries predominate due to repetitive loading (Sands et al., 1993).

Understanding injuries and risk factors is a critical aspect of standardizing sports disciplines, aiding in injury prevention and providing strategies for maximum athlete safety. Recent years have seen an increase in sports injury epidemiology research, providing valuable data for designing prevention strategies and planning to mitigate injury consequences for medical-rehabilitation teams, coaches, and athletes (Amatto et al., 2021). These goals are achievable through systematic and precise epidemiological studies. According to van Mechelen et al.'s model for injury epidemiology and prevention, the first and fundamental step in designing preventive strategies is epidemiological research (van Mechelen et al., 1992). Thus, identifying injury causes, types, and severity is essential for prevention. Such studies are recommended for examining sports-related injuries across various sports, including wheelchair basketball. For instance, Hollander et al. (2020) conducted a prospective cohort study on injury epidemiology during the 2018 Wheelchair Basketball World Championships, reporting 100 injuries among 132 players, equivalent to 75.8 injuries per 100 players or 68.9 injuries per 1,000 hours of exposure. Kasitinon et al. (2021a) examined injury and illness incidence in intercollegiate wheelchair basketball teams, reporting 62 health-related incidents, including 48 injuries and 14 illnesses, with an overall injury incidence of 12.2 and 13.1 per 1,000 athlete-exposures for men and women, respectively. Similarly, Weith et al. (2023c) investigated the epidemiology of injuries and illnesses in elite wheelchair basketball players over a whole season, highlighting patterns in training and competition contexts. These findings align with broader elite sports surveillance, such as during the 2012 London Olympics, where injury risks varied significantly by discipline (Engebretsen et al., 2013).

Most existing studies focus on traditional basketball. However, wheelchair basketball is a dynamic sport with evolving competitiveness, necessitating updated epidemiological evidence. To our knowledge, no comprehensive epidemiological study has examined sports injuries among wheelchair basketball players in Iran. Given the growing interest in disability sports, their popularity, and the importance of regular physical activity for individuals with disabilities, investigating the epidemiology of wheelchair basketball injuries in

Iran is essential due to the lack of data. Thus, this study aims to explore the epidemiology of sports injuries in elite female wheelchair basketball players in Iran.

Methods

Participants. In this retrospective epidemiological study, participants were selected from active elite female wheelchair basketball players in Iran. A total of 63 elite female players with at least three years of regular athletic activity participated. The age range was 18–35 years. The study covered the 2021–2022 period, and all participants completed an informed consent form prior to participation.

Demographic Characteristics of Participants. Demographic data on age, height, weight, and body mass index (BMI) of wheelchair basketball players are presented in Table 1.

Table 1: Demographic Characteristics of Wheelchair Basketball Players

Variable	Mean	SD	Minimum	Maximum
Age (years)	27.06	5.31	18	35
Height (cm)	161.92	12.24	149	180
Weight (kg)	63.96	6.56	48	76
BMI	21.73	2.21	15.19	25.33

Of the 63 participants, the mean age was 27.06 years, mean weight was 63.96 kg, mean height was 161.92 cm, and mean BMI was 21.73.

Data Collection. Data on injury occurrence were collected retrospectively over a 12-month period using a Retrospective Injury Questionnaire (RIQ) based on a standardized sports injury registration form. Participants completed the questionnaire at baseline. The form, adapted from studies on wheelchair basketball in various countries (e.g., Hollander et al., 2020; Kasitnon et al., 2021a), included demographic information (age, disability type, disability classification, offensive/defensive role, daily/weekly activity level, disability cause, injury history, athletic background, championship history, dominant limb, etc.) and injury-specific data (injury occurrence, mechanism, severity, timing, affected region, and type). The questionnaire also included a section on injuries sustained during sports activities in the past 12 months, recording anatomical location, injury type, nature (acute or overuse), context (contact/non-contact, training/competition), date of occurrence, and recovery time. Data were systematically collected via an online questionnaire. Due to the COVID-19 pandemic, virtual platforms were used to distribute and explain the injury registration form. A link to the form was created on the Persian online survey platform and sent to athletes with disabilities. Participants were asked to record all injuries experienced during training and competitions in the past year (2021–2022). Collected data were subsequently analyzed.

Injury Definitions and Severity. An injury was defined as any physical complaint from a game or training session resulting in an inability to fully participate in a game or training for at least one day (Fuller et al., 2006). Overuse injuries were defined as those emerging gradually without a single identifiable event, while acute injuries resulted from a specific, identifiable event causing significant impact (Bahr & Krosshaug, 2005). An injury was classified as recurrent if it was a subsequent episode of the same type and at the same

anatomical location as a previous injury, occurring after the athlete had returned to full participation following the initial injury (Fuller et al., 2006). Injuries that did not meet this criterion were classified as new injuries. Injury mechanisms described how injuries occurred (Bahr & Krosshaug, 2005). Injury severity, per Fuller et al. (2006), was defined by the duration of absence from regular training or competition: minimal (1–3 days), mild (4–7 days), moderate (8–28 days), or severe (29+ days).

Data Analysis. This descriptive retrospective study aimed to determine the incidence of sports injuries in female wheelchair basketball players. Statistical methods included means, standard deviations, percentages, and tables. The chi-square test was used to examine differences between variables. Data were analyzed using SPSS version 24. To assess injury prevalence and frequency, injury risk and incidence rates were calculated. The most accurate method for expressing injury incidence is the relative incidence rate, calculated as the number of new injuries during the study period divided by the total time at risk. The total hours of exposure for each participant during training and competitions over one year were summed.

Results

Descriptive indices (dominant limb, disability type, activity level, athletic history, weekly activity, training duration, playing style, warm-up practices, and injuries) are presented in Table 2.

Table 2: Descriptive Indices of Wheelchair Basketball Players

Index	Category	Number (N)	Percentage (%)
Dominant Hand	Right	52	82.5
	Left	11	17.5
Dominant Leg	Right	46	73.0
	Left	17	27.0
Disability Type	Congenital	28	44.4
	Acquired	35	55.6
Activity Level	Club	29	46.0
	National	34	54.0
Athletic History	3–5 years	16	25.4
	5–7 years	18	28.6
	>7 years	29	46.0
Wheelchair Sports History	3–5 years	19	30.2
	5–7 years	26	41.3
	>7 years	18	28.6
Weekly Activity	3 sessions	33	52.4
	4 sessions	23	36.5
	5–6 sessions	7	11.1

Index	Category	Number (N)	Percentage (%)
Training Duration	<1 hour	3	4.8
	1–2 hours	40	63.5
	2–3 hours	19	30.2
	>3 hours	1	1.6
Playing Style	Offensive	39	61.9
	Defensive	24	38.1
Warm-Up	Yes	63	100.0
	No	0	0.0
Warm-Up Duration	<15 minutes	35	55.6
	15–30 minutes	20	31.7
	31–45 minutes	8	12.7
	>45 minutes	0	0.0
Injury	Yes	27	42.9
	No	36	57.1

Injury Incidence Rate per 1,000 Training Hours. Of the 63 participants, 36 (57.1%) reported no injuries, while 27 (42.9%) reported injuries in the past year. A total of 27 injuries occurred, with players exposed to 14,472 hours of risk, which calculated during training and competitions over one year were summed. The injury incidence rate was 1.86 injuries per 1,000 hours of wheelchair basketball training.

Injury Timing (Training vs. Competition). Table 3 shows the timing of injuries among elite female wheelchair basketball players, categorized as training or competition, with further details on training (warm-up, cool-down, strength training, during practice) and competition (quarters).

Table 3: Timing of Recorded Injuries in Wheelchair Basketball Players

Variable	Time/Phase	Number Observed	Percentage (%)
Injury Timing	Training	18	66.7
	Competition	9	33.3
Training Injuries	Cool-Down	0	0.0
	Warm-Up	5	18.5
	Strength Training	5	18.5
	During Practice	17	63.0
Competition Injuries	First Quarter	4	14.8
	Second Quarter	4	14.8
	Third Quarter	6	22.2

Variable	Time/Phase	Number Observed	Percentage (%)
	Fourth Quarter	13	48.1

Overall, 66.7% (18 cases) of injuries occurred during training, and 33.3% (9 cases) during competitions, with no significant difference in timing [$\chi^2 = 3.001$, $P = 0.083$] (Table 3). A significant difference was found in training injury indices [$\chi^2 = 10.667$, $P = 0.005$], with 18.5% of injuries during warm-up, 18.5% during strength training, and 63% during practice. A significant difference was also observed in competition injury indices (quarters) [$\chi^2 = 8.111$, $P = 0.044$] (Table 3).

Injury Mechanisms. Table 4 presents the mechanisms of sports injuries recorded in wheelchair basketball players.

Table 4: Mechanisms of Recorded Sports Injuries in Wheelchair Basketball Players

Mechanism	Number Observed	Percentage (%)
Collision with Own Wheelchair	4	14.8
Collision with Opponent's Wheelchair/Player	9	33.3
Contact with Ball during Pass/Shot	5	18.5
During Defense	4	14.8
Loss of Balance/Fall from Wheelchair	5	18.5
Total	27	100.0

The chi-square test showed no significant difference in injury mechanisms [$\chi^2 = 3.185$, $P = 0.527$] (Table 4).

Injury Severity. Table 5 shows the severity of injuries in elite female wheelchair basketball players, categorized as no absence, minimal, mild, moderate, severe, or long-term.

Table 5: Severity and Absence Duration in Wheelchair Basketball Players

Severity (Absence Duration)	Number Observed	Percentage (%)
No Absence (Minor)	2	7.4
1–3 Days (Minimal)	9	33.3
4–7 Days (Mild)	10	37.0
8–28 Days (Moderate)	4	14.8
28 Days–6 Months (Severe)	1	3.7
>6 Months (Long-Term)	1	3.7
Total	27	100.0

Injury Incidence by Anatomical Region. Table 6 shows the anatomical regions affected by injuries in elite female wheelchair basketball players.

Table 6: Injury Incidence by Anatomical Region in Wheelchair Basketball Players

Region	Number Observed	Percentage (%)
Head/Face	1	3.7
Neck	2	7.4
Shoulder/Clavicle	14	51.9
Arm/Elbow	3	11.1
Wrist/Fingers	5	18.5
Thoracic Spine	2	7.4
Total	27	100.0

Injury Types. Table 7 presents the types of sports injuries recorded in wheelchair basketball players.

Table 7: Types of Recorded Sports Injuries in Wheelchair Basketball Players

Injury Type	Number Observed	Percentage (%)
Fracture	3	11.1
Dislocation/Subluxation	4	14.8
Tendon Tear/Inflammation	3	11.1
Muscle Cramp/Spasm	10	37.0
Ligament Injury (Sprain/Tear)	3	11.1
Bruising/Contusion/Hematoma	1	3.7
Abrasion/Scratch/Skin Laceration	0	0.0
Nerve Injury (Brain, Spinal Cord, Peripheral)	1	3.7
Cartilage/Meniscus Injury	2	7.4
Total	27	100.0

A total of 27 injuries were recorded. Additionally, 33.3% (9 cases) were acute injuries, and 66.7% (18 cases) were chronic. Of the injuries, 63% (17 cases) were recurrent, and 37% (10 cases) were new.

Discussion

In this retrospective study, 42.9% (27 cases) of wheelchair basketball players reported injuries, with a total of 27 injuries occurring over 14,472 hours of exposure, resulting in an injury incidence rate of 1.86 per 1,000 hours. Of these, 66.7% (18 cases) occurred during training, and 33.3% (9 cases) during competitions.

The most common injury mechanism was collisions with the opponent's wheelchair or player. The majority of injuries caused 4–7 days of absence (mild), with the shoulder and clavicle being the most affected anatomical regions. Muscle cramps and spasms were the most frequent injury type, with 33.3% acute and 66.7% chronic injuries. Additionally, 63% of injuries were recurrent, and 37% were new.

Wheelchair basketball is one of the most popular adaptive sports, with dedicated leagues for youth, intercollegiate, and adults across various divisions in the United States (Sá et al., 2022). However, a review found limited studies focused on wheelchair basketball, all of which were cross-sectional (Sá et al., 2022). Literature review revealed no studies specifically examining sports injuries in elite female wheelchair basketball players in Iran. However, several international studies have explored injury prevalence, including those by Kasitinon et al. (2021a), Hollander et al. (2020), and Weith et al. (2023c). Kasitinon et al. (2021a) reported 62 health-related incidents, including 48 injuries and 14 illnesses, with injury incidence rates of 12.2 and 13.1 per 1,000 athlete-exposures for men and women, respectively. Hollander et al. (2020) monitored injuries during the 2018 Wheelchair Basketball World Championships, reporting 100 injuries among 132 players, equivalent to 75.8 injuries per 100 players. Weith et al. (2023c) reported injuries and illnesses in elite players over a full season, with patterns similar to championship events.

This study found that nearly half (42.9%) of elite national female athletes reported injuries in the past year. Given the contact nature of the sport and its mechanics, involving high-speed wheelchair movements, significant collision-related injuries are expected. The injury incidence rate of 1.86 per 1,000 hours was lower than in previous studies, likely due to differences in exposure measurement units and competition levels, as prior studies focused on high-intensity events like the 2012 London and 2016 Rio Paralympics (Brombacher et al., 2025). A study from the 2012 London Paralympics observed varied injury epidemiology across sports, highlighting the need for sport-specific longitudinal studies (Brombacher et al., 2025; Engebretsen et al., 2013). Reported injury incidence rates were 12 per 1,000 athlete-days in 2012 (Brombacher et al., 2025) and 12.8 in 2016 (Derman et al., 2018). Differences in injury prevalence and incidence may stem from variations in training intensity, competition level, match duration, tournament type, and participant numbers. The highly competitive nature of international events like the Paralympics likely accounts for these discrepancies. It should be noted that direct comparison of injury incidence rates across studies should be made with caution. The current study calculated injury incidence based on hours of exposure, whereas some previous studies, such as Kasitinon et al. (2021a), reported rates per 1,000 athlete-exposures. This methodological difference in the denominator limits direct equivalence of incidence rates. Nevertheless, the present findings are more comparable to studies that also utilized exposure hours, such as Hollander et al. (2020).

Training injuries (66.7%) were more frequent than competition injuries (33.3%). This aligns with Kasitinon et al. (2021a), who reported higher injury rates during training (76% in men, 91.3% in women) compared to competitions (24% in men, 8.7% in women). However, Hollander et al. (2020) reported 68 injuries during competitions and 32 during training, contrasting with this study. The higher training injury rate in this study may be attributed to the sample's gender and fewer competition opportunities for women in Iran, reducing competition-related exposure. Additionally, training duration (minimum three sessions per week, 1–2 hours each) and inadequate warm-up times (55.6% <15 minutes, 31.7% 15–30 minutes, 12.7% 31–45 minutes)

likely contributed to higher training injuries, potentially exacerbated by the physical activity paradox where intensive occupational-like training increases health risks unlike leisure activity (Holtermann et al., 2018). The majority of injuries were mild (4–7 days absence). Limited studies have examined injury severity, but Hollander et al. (2020) reported a median absence duration of 8 days.

Injury epidemiology studies emphasize the importance of identifying affected anatomical regions to enhance prevention and control strategies. The shoulder and clavicle were the most affected regions, consistent with prior studies showing upper limb injuries, particularly in the shoulder, elbow, wrist, and fingers, as dominant in wheelchair basketball (Hollander et al., 2020; Kasitinon et al., 2021a; Sá et al., 2022). Kasitinon et al. (2021a) reported 56.3% of injuries in the upper limbs, while Hollander et al. (2020) noted shoulder (14%), elbow (11%), and hand/finger (10%) injuries, alongside cervical (16%) and thoracic (15%) spine injuries. Sá et al. (2022) found the shoulder to be the most affected body region overall (22.1%). Upper limb injuries, particularly in the shoulder, are linked to repetitive movements, limb usage, and techniques required by the sport, such as wheelchair propulsion, shooting, and defense (Karasuyama et al., 2023). The shoulder's anatomical instability increases its injury risk (Cuéllar et al., 2017), and interventions like kinesiology taping may improve scapular control and reduce impingement symptoms (Shih et al., 2018a). Unlike traditional basketball, where force originates from the lower limbs, wheelchair basketball relies on the trunk and upper limbs, contributing to lumbar and upper limb injuries (Sá et al., 2022).

Conclusions

This study found a low sports injury incidence rate (1.86 per 1,000 hours) among elite female wheelchair basketball players. The most common injury mechanism was collisions with opponents or their wheelchairs (33.3%), with muscle cramps/spasms (37%) being the most frequent injury type and mild injuries (37%) predominant. Most injuries occurred in the upper limbs, particularly the shoulder and clavicle (51.9%), with higher injury rates during training than competitions. Additionally, 63% of injuries were recurrent, and 66.7% were chronic. No prior studies on wheelchair basketball injury epidemiology exist in Iran, and international studies show inconsistent findings (Sá et al., 2022). Given the importance of these results, injury prevention may be helpful to minimize injuries. Coaches, athletes, and stakeholders may help reducing injury rates through targeted prevention programs.

Study Limitations. This study has limitations, including its retrospective design and reliance on online questionnaires with a limited sample size. Retrospective studies may be subject to recall bias which may affect injury reporting and incidence estimates, as participants may not fully or accurately recall past injuries. The study was single-gender, focusing only on female athletes, and did not account for disability classification in the epidemiology analysis.

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