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"UNVEILING THE SHADOWS: A REVIEW ON INJURIES IN WHEELCHAIR BASKETBALL ATHLETES – NAVIGATING AN ERA OF NEGLIGENCE"

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ABSTRACT

Background: Wheelchair basketball, an adapted version of the sport, has been integral to the Paralympic Games (POG) since the 1960s, providing individuals with diverse physical disabilities a platform for competitive engagement. However, despite the recognition of sports injuries and their multifaceted effects on athletes' physiology, physical well-being, and psychology, there remains a gap in understanding specific aspects within the context of wheelchair basketball. This study addresses the existing limitations in defining and describing injuries, particularly concerning their location, mechanisms, and risk factors.

Aim: This study investigates common injuries in wheelchair basketball athletes, primary injuries, and affected anatomical regions in wheelchair basketball athletes.

Material and methods: The data was collected from various databases and search engines like Google Scholar, PubMed, Research Gate, and Science Direct using the following keywords: “sports injuries”, “common injuries”, “wheelchair athletes”, and “para-athletes”.

Results: Ninety-seven studies were initially identified, with full reading conducted for 79 articles. Sixty articles were excluded for not meeting inclusion criteria, resulting in a final analysis of 19 studies. After reviewing 19 articles the study found that the shoulder was the most affected region and the upper body was the most affected body segment. The least affected were lower limbs.

Discussion: The study indicates that wheelchair basketball athletes experience diverse injuries primarily linked to the biomechanics of anatomical structures. The upper limbs, particularly the shoulder region, exhibited the highest injuries. The prevalence of contact in the sport significantly influences the injury pattern, with the shoulder, hand, head, and spine identified as the most affected body regions in this research.

Keywords: Para-athletes, sports injuries, biomechanics, recurring injuries.

INTRODUCTION:

Wheelchair basketball, a modified version of the sport, is played by individuals with diverse physical disabilities. Included in the Paralympic Games (POG) since the 1960s, it has become an integral part of the event. The International Wheelchair Basketball Federation (IWBF) has been organizing official world championships since 1975, with the current frequency being every two years following the Summer POG**. (Hollander, K et al 2018**) Wheelchair basketball is a fiercely competitive sport and spans various levels, including junior, collegiate, recreational, national, and international play. **(Wessels et al 2011)** It is played by 2 teams of five players in each team, with a duration of four quarters of 10 minutes which includes players with physical impairments who can be alloted to eight different classes of athletes with various types of physical disabilities, ranging from spinal cord injury and lower limb amputation to poliomyelitis sequelae. These athletes actively participate in the competitions. **(Rocco, F et 2006)** As a contact sport with repetitive shoulder movements involved in actions like throwing and passing the basketball and maneuvering the wheelchair, wheelchair basketball exhibits a relatively high incidence of sports injuries ranking as the second most prone to injuries. The most prevalent injuries are often soft tissue in nature, stemming from overuse or accidental incidents. **(David l et al 1995)** In Paralympic games, the incidence rates of injuries vary between 10 and 26.5 per 1000 athlete-days more than that in non-disabled athletes. **(Donald Kasitinon et al)**

Diverse repercussions accompany sports injuries, negatively affecting athletic performance. When athletes suffer injuries, the need to abstain from activity arises, with withdrawal durations ranging from a day to several months. Extended absence often results in detraining, leading to a noticeable decline in strength and agility **(Hsu, C. et al., 2017)**. Furthermore, psychological factors such as anxiety, stress, depression, fear of recurring injuries, and low self-esteem may accompany sports injuries. The repetitive nature of propulsion in wheelchair sports often gives rise to conditions like peripheral nerve entrapments, repetitive strain injuries, premature osteoporosis, pressure sores, and muscle imbalance, with upper limb injuries being particularly prevalent (**Huzmeli et al., 2017)**. Utilizing a wheelchair inherently strains the shoulder joint. Engaging in sports like wheelchair basketball may contribute to heightened stress on the shoulder joints, leading to dysfunctions and pain in this area **(García-Gómez et al., 2019)**. Therefore, understanding the mechanisms, consequences, and preventive measures for sports injuries in Paralympic sports is crucial **(IWFB, 2018).**

Exploring injury prevention can aid in formulating, executing, and assessing strategies by investigating injury incidence, severity, risk factors, and mechanisms **(M. Mahmoudkhani et al 2023)**. A study conducted during the London 2012 Paralympic Games highlighted variations in injury epidemiology across different sports. Emphasizing the necessity for specific longitudinal studies in each modality, the findings revealed that wheelchair basketball in London 2012 witnessed 34 injuries, with 65% categorized as acute and 23% as overuse injuries. **(Sá K et al 2022)** Although there is literature available on basketball and prevalent injuries, Paralympic sports still lack the evidence. This study aims to provide a detailed description of sports injuries in wheelchair basketball, with a focus on aspects such as location, mechanism, and risk factors. A comprehensive review was conducted to assess the common injuries and their characteristics among wheelchair basketball athletes.

METHODOLOGY:

Search strategy: The data was collected from various databases and search engines like Google Scholar, PubMed, Research Gate, Science Direct, etc Articles were retrieved from electronic databases using the following terms: “injury”, “sports injury”, “injuries”, and “wheelchair basketball.

Literature identification: The articles addressing literature data about injury prevelance in wheelchair basketball, and the main characteristics of primary sports injuries in wheelchair basketball were retrieved. Articles underwent an initial screening for relevance. Subsequently, the complete texts of potentially relevant articles underwent thorough review. Any discrepancies among reviewers concerning study inclusion were addressed during meetings for resolution. Data extracted from the studies encompassed various aspects of

wheelchair basketball injuries, including injury types, body regions affected, injury levels, year of publication, objectives, sample characteristics, gender distribution, and primary outcomes.

Inclusion criteria: The study included are summarised in the TABLE 1. Most of them were non experimental. Studies that were included had the following criteria: involving wheelchair basketball athletes, papers written in English only, and numerical statistics of injuries in wheelchair basketball athletes due to lack of literature available thus the data was retrieved from 1992-2023 providing quantitative data of injuries in wheelchair basketball athletes. First screening identified 101 articles in the databases. After removing duplicate articles , 97 studies were gathered where Full reading was only available for 79 articles in which 60 articles did not meet the inclusion criteria and were excluded. Finally, 19 studies were identified as eligible in the final analysis. (TABLE 2)

Table 1: Type of studies involved in the review

Sl. no	Author, year	objectives	Sample size	Type of study	results
1	*Karla K et al;2012*	To estimate the incidence rate of concussions in wheelchair basketball.	263	Survey	Within the sample of 263 wheelchair basketball players, 6.1% reported experiencing a concussion in the current season. Of those experiencing concussions during the current season, 44% did not report their concussion. Of those not reporting the incident, 67% did not because they did not want to be removed from physical activity. Analysis by sex indicated that 5.82% of the male athletes sustained a concussion during the current season, and 14.36% had sustained an injury during their athletic career. Female athletes, however, sustained concussions at a higher rate, with 6.67% having concussions during the current season and 30.6% during their athletic careers. Women were also 2.5 times more likely to sustain a

					concussion than men. Athletes were most likely to report their concussion to their coach (60% of concussed athletes).
2	Karsten Hollander et al;2019	to assess therate and char-acteristics ofinjuries duringthe Wheelchair Basketball World	336	Prospectiv e cohort study	11 teams (132 players) reported 100 injuries, equivalent to 75.8 per 100 players (95% CI: 60.9- 90.7) or 68.9 per 1000 player-days (55.4-82.4). Eight time-loss injuries were reported (6.1

		Championships2018 (WBWC).			injuries per 100 players [95% CI: 1.9-10.3] or 5.5 injuries per 1000 player-days [1.7-9.3]).
3	Esra Dogru Huzmeli et al;2017	to determinethe prevalenceand nature of injuries in wheelchair sports participants.	15	survey	26.6% of them had injury in the past one year and 75% of them had injuries because of muscle tears.
4	Diego J. Bogado e tal;2022	to evaluate therate and characteristics of illnesses andinjuries during the 2021 SouthAmerica Wheelchair Basketball Championships.	129	prospectivefollow-up study	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.
5	Hirotaka Mutsuzaki et al;2014	to use ultrasonography to investigated deep tissue injuries in male wheelchair basketball players of a Japanese national team,and to determine factors associated withthe injuries(e.g., body massindex, class of wheelchair basketball, underlying disease, lengthof athletic career, and whether use ofwheelchair is primarily for playing	12 representatative players and 8 candidate national players.	Observationalstudy	Nine (45%) players had low-echoic lesions, which were detected in 10 of 60 areas. Eight lesions were detected in the sacral region and two lesions were detected in the ischial region. More players with spinal cord injury had low-echoic lesions [9 (69.2%) of 13 players], compared to players with skeletal system disease [0 (0%) of 7 players, p 1⁄4 0.002]. Players who used a wheelchair in daily life were more likely to have low-echoic lesions [8 (66.74%) of 12 players], compared to players who primarily used a wheelchair for playing basketball [1 (12.5%) of 8 players, p 1⁄4 0.010]. Deep tissue injuries were detected in 45% of male Japanese wheelchair basketball players on the national team.

		basketball).			

6	*Kathleen A. Curtis et al;1999*	To assess activity level, medical history, and the prevalenceand intensityof shoulder an dupper extremitypain experienced during functional activities in female athleteswho compete in wheelchairs.	46	Descriptiveself-report survey.	The average age of the respondentswas 33.2 *(* 29.1) years, with an average of 12.5 (+ 10.2)yearsofwheelchair us e.Theirdisabilitiesinclud e d39%spinalcordinjury,2 8 % variouslowerextremity mu sculoskeletalandneuro musculardisabilities, 13%postpolio paralysis, 11%spina bifida, and 9%amputations. Only 14%ofthe subjects reportedshoulder pain prior to wheelchair use. Incontrast,72% of thesubjects reportedshoulder pain since wheelchair use, with 52%reporting currentshoulder pain. Overall, the subjects scored an average *5* SD performancecorrectedt otal WUSPI score of 15.6 +20.5 on a scale of 0 to 150 points, with 0 representingno pain. The highest intensity of shoulder pain was reported durin g household

					chores ,propulsion on ramps or inclines, liking overhead,and while sleeping.
7	Fernanda Moraes Roccoet al;2006	To identify themost frequen tsport injuries ofbasketball wheelchair players	26	Survey	spinal cord injury corresponded to 42% of the patient, poliomielites to 31%, lower limb amputation to 27%. Sport practice varied form 2 months to 13 years, with an average of 6.5

					years.

					Mean training periods was 21 hours weekly. Pain complaint was present in 54%of these athletes , being mostly localized in the upper limbs (79%). Only 6% of the sample had never had an injury during a game or training.Of the 11 spinal cord injured patients, 3 (27%) were not playing because of pressure sores (isquiadic, sacral and paravertebral). Among the musculosqueletal injuries, 75% were installed acutely, and 25% due to chronic repetitive efforts.
8	Kenji Tsunodaet al;2021	to investigate the association of wheelchair user's shoulder pain inde x (WUSPI) with physical examinations for tendinitis inthe long head ofthe biceps tendon (LHBT) and range ofmotion (ROM) of shoulder movements among female	21	Cross sectional study	The mean total WUSPI score was 9.55 ± 13.35 points. The players were more likely to experience shoulder pain during activities related to wheelchair pushing and object lifting. A higher total WUSPI score was strongly and moderately associated with positive findings of TBGP (effect size r 1⁄4 0.82) and speed test (r 1⁄4 0.49), respectively. Furthermore, the total WUSPI score was significantly associated with limited ROM in shoulder abduction (r 1⁄4 0.47) and flexion (r 1⁄4 0.43). Receiver operating characteristic analysis showed that

		wheelchair basketball players from theJapanese national team.			the total WUSPI score had a significant area under the

					curve (AUC) for positive findings of TBGP (AUC 1⁄4 0.98), speed test (AUC 1⁄4 0.83), and limited ROM in abduction (AUC 1⁄4 0.84). When optimal cut-points were set by the Youden index, total WUSPI scores of 4.1 points (sensitivity 1⁄4 1.00, specificity 1⁄4 0.92), 11.3 points (sensitivity 1⁄4 0.80, specificity 1⁄4 0.81), and 3.3 points (sensitivity 1⁄4 1.00, specificity 1⁄4 0.65) were recommended for screening positive findings of TBGP, speed test, and limited ROM in abduction, respectively.
9	Saleky García Gómez et al;2017	to detect the influence of shoulder pain (SP) in WB sportskills.	51	survey	the type of disability of the population studied was spinal cord injury, amputation and others disability related to orthopedics lesion beingmost common SCI (21. 6% females, 39. 2% males). 33.3% of the players are class 2-2.5 (13.7% females, 19.6% males).

10	Ricardo Ortega-Santiago et al;2019	This study investigated thepresence of mechanical pain hypersensitivity and trigger points in the neck-shoulder muscles in elite wheelchair basketball players with/without	40	Cross sectional study	Wheelchair basketball players with shoulder painshowed lower pressurepain thresh-olds over theC5-C6 joint and second metacarpal than elite wheelchair basketball players without pain (between-groups differences: 1.1, 95%CI 0.4, 1.8 and 1.8, 95%CI 0.8, 2.8, respec-tively) and able-bodied

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		shoulder pai nand asymptomatic able-bodied elite basketball players.			basketball players without pain (between-groups differences: 0.8, 95%CI 0.4, 1.2; 1.6, 95%CI 0.8, 2.4, respectively). The mean number of myofascial trigger points for wheelchair basketball players with unilateral shoulder pain was 4.8 ± 2.7 (2 ± 1 active, 2.9 ± 2.2 latent). Wheelcha irbasketball players and able-bodied basketball players without shoulder pain exhibited a similar number of latent triggerpoints (2.4 ± 2.0 and 2.4 ± 1.8, respectively).Wheelchair basketball players with shoulder pain exhibited higher number of active myofascial trigger points than those without pain (either with or without wheelchair), but all groups had a similar number of latenttrigger points (P < 0.05).

11	Poliane Silva Freitas et al;2019	This study aimed to compare the isokinetic peak torque and, secondarily, other parameters ofthe rotator cuffin the shoulders of paraplegicwheelchair basketball athletes andnon-athletes controls. Design: Cross-	36	Cross-sectional study	Peak torque/weight, work, and muscle power of wheelchair basketball athletes were significantly greater than those of the control group ($P < 0.05$), but there were no statistical differences between dominant and non-dominant upper limb. Internal rotators were stronger than the external rotators both forathletes and for non-athletes. There is a positive correlation between peak torque andtime since injury.

		sectional study.			
12	Karina Sá et al;2023	Knowledge and understanding of the most diverse aspects surrounding theemergence of sports injuries stand out as oneof the pillars for sporting success.	41	epidemiological cohort	The athletes who composed the sample perform a high volume of training. The majority did not present with injuries before the competition. There was a prevalence of17.1% of injuries during the competition, an incidence of 0.17 injuries per athlete and an incidence rate of 0.03 injuries per athlete-hour or four injuries per one thousand athletes-days. The injuries that occurred during the competition were mostly in the shoulder region ,characterized as traumatic, by indirect contact with other athletes, which occurred when propelling the wheelchair, and were of low severity.

13	Mohammadr eza Mahmoudkhani et al;2023	to investigatethe rate and characteristics of injuries in the2021-2022 Iran Wheelchair Basketball League and dpresent prevention strategies.	129	retrospectivestudy	111 injuries were registered, equivalent to 132 per 100 players (95% CI: 100-180) and 8.16 Injuries per 1000 hours of athlete exposure (6.2- 9.8). Also, 77.8% occurred during training and 22.2% in competitions. Most injuries affected the fingers and hands (35.13%), and shoulders (22.57%). The most common types of injuries were contusions

					(30.63%), laceration and skin lesion (23.42%), and muscle spasms (13.51%), in which, half of the injuries were slight (0-1 days), 27.8% (mild 4-7 days), and 22.2% moderate (8-28 days).Also, 66.9% of injurieswere new, and 33.1%were recurrent. Most situations and actionsleading to injury includequick wheelchair pushing (29.72%), the intense ballhitting (17.14%), andsudden stops or changesof direction of thewheelchair (12.63%). Amultiple linear regression analysis (Enter method) demonstrated (R2 Adjusted=0.530) Wheelchair inappropriateness (P=0.015), lack ofprotective equipment (P=0.028), and previous injury (P=0.003) explainedclose to 55% of the injuryrate.

14	*David L. jackson et al;1996*	to determinethe prevalenceand severity of median neuropathy atthe wrist in these athletes.	33	survey	Thirty percent of theseathletes had symptomsconsistent with carpal tunnel syndrome (CTS). and 70% of these had electrodiagnostic confirmation of this injury. Overall, 52% of the 33 athletes had electrodiagnostic findings of median neuropathy at the wrist with nine athletes (27%) exhibiting bilateral abnormalities.

					Four athletes (12%) hadabnormal electrodiagnostic findingsinvolving the ulnar nerve at the wrist.
15	Necmiye Un Yildirim et al;2010	to compar eshoulder pain between wheelchair basketball players with trunk contro land wheelchair basketball players withouttrunk control.	60	survey	There was no statistically significant difference between the two groups based on the number of years of wheelchair use, active sport years, weekly working hours, and weekly training hours ($p > 0.05$). Statisticall y significant differences were found between wheelchair basketball players with trunk control and wheelchair basketball players with trunk control with respect to the duration of their disability, the daily number of transfers made to wheelchair, and Performance Corrected Wheelchair User's Shoulder Pain Index (PC- WUSPI) score ($p < 0.05$). The total PC-WUSPI scorewas higher among players without trunk control ($p <0.05$).

16	Donald Kasitino n et al;2019	To determin ethe incidence ofsports-related injuries and illnesses amongmen's and women's intercollegiate wheelchair basketball teams throughout aseason.	28	Prospectiv e surveillanc estudy.	62 health-related incidents, including 48injuries and 14 illnesses,were prospectively reported during the season. Overall injury incidence rates were 12.2 {95% confidence interval (CI) 7.4 to 17.4} and 13.1 (95% CI 7.8 to 18.4) injuries per 1000 athlete-exposures among males and females, respectively.These equated to RRs of

					1.53 (95% CI 1.03 to 2.27) (males) and 2.01 (95% CI 1.34 to 3.02) (females) when compared to the rates previously publishedon NCAA non-disabledbasketball players, indicating a statistically significant increase in injury risk. Injuries most commonly involved the upper extremities (56.3%). Illnesses commonly involved the gastrointestinal (35.7%) or respiratory (21.4%) systems.
17	S. Uzun et al;2012	to investigatemus-cular endurance andfatigue in wheelchair basketball ath-letes with SCIusing surface electromyography hy (SEMG) andmaximal torquevalues.	35	Cross sectional study	the athletes are less fatigable during the task effort than the nonathletes. Nor-malized MDF slope decay exhibited similar results between the groups as %DET, while the slope of the nor- malized RMS failed to show any significant differences among the groups (p [0.05). MDF and %DET could be useful for the evaluation of muscle fatigue in wheelchair basketball training.

18	Mehmet Akif Serinken et al;2013	To investigates the effect ofDOMS on theupper extremities motor performance byconducting an eccentric	10	Cross sectional study.	The study found a statistically significant increase in blood CK activity and positioning sense loss, and a decrease in the pressure-pain threshold, as well as the shooting percentages in the exercise group when

		exercise load on the elbow flexormuscles.			compared with the control.
19	Hiroshi Yuine et al;	Evaluation of hand functionsand distal radioulnar jointinstability in elite wheelchair basketball athletes	9	cross-sectionalpilot study	TFCC injuries in seven wrists were confirmed using MRI findings (38.9%). The ulnar deviation ROM values of the TFCC-injured wrist (n = 7) and intact (n = 11) groups were 38.6 ± 8.0° and 48.6 ± 7.8°, respectively. The ulnar deviation ROM was significantly smaller in the TFCC-injured wrists ($p = 0.02$, $r = -0.54$). In the TFCC-injured wrists, no correlation was observed between the displacement-to-force ratio and the handfunction assessment. Incontrast, the displacement-to-force ratio negatively correlated with grip strength, arm circumference, and forearm circumference in the intact wrists (Pearson correlation coefficient r = − 0.78, − 0.61, and − 0.74, respectively). The GLMMshowed that the

					displacement-to-force ratio significantly affectedgrip strength, arm circumference, andforearm circumfer- encein the intact group.

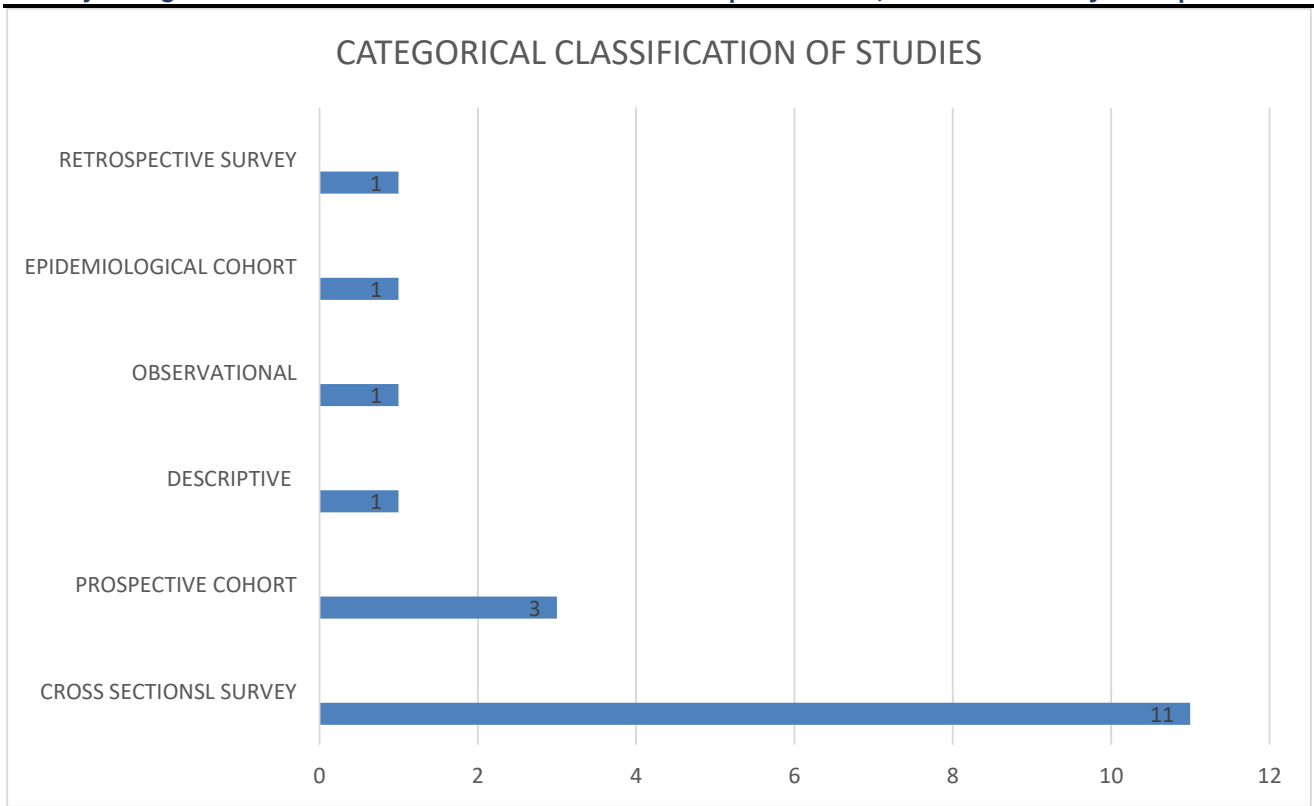

Table 1: Type of studies involved in the review

RESULT

The body region with the most frequently occurring injuries was the shoulder (n=102), followed by the head (n=55), as detailed in Table 3. Among the body segments, the upper limbs accounted for the most injuries, followed by the Head/Face, Trunk, and Lower Limbs detailed in Table 4. Primary diagnoses included Concussion, Muscle Injury/Contusion, Myalgia, and Pressure Injuries.

Region/Location	Number of injuries
Shoulder	102
Spine (Cervical, thoracic, lumbar)	54
Wrist	53
Elbow	47
Forearm	3
Arm	15
Hand/Fingers	21
Face	5
Head	58
Ribs	1
Abdomen	5
Sciatic region	17
Knees	3
Thigh	2

Table 3. Summary of injury about anatomical location

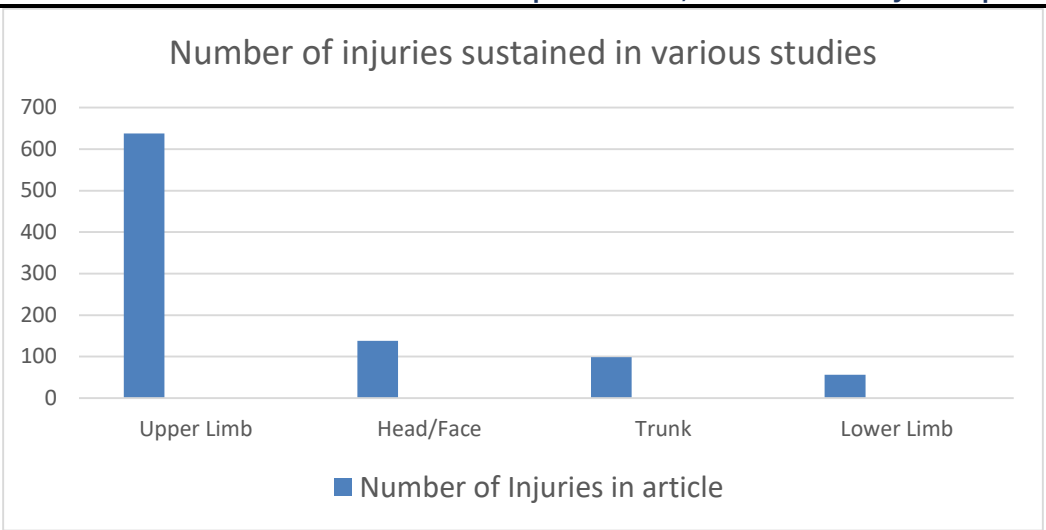

Table 4. Number of injuries sustained in various studies

DISCUSSION

The objective of this review was to identify prevalent injuries, their characteristics, epidemiological details, and the impacted body regions among wheelchair basketball athletes. This review encompassed studies involving 1,328 players of both genders. The key findings indicate that out of the participants, 931 players experienced injuries, with the upper limb being the most frequently affected.

3.1 Sports Injury Mechanism in wheelchair basketball

Sports injuries can be distributed as traumatic or load when considering the medium. Injuries due to trauma are subjected to single, specific, and identifiable event, which can involve contact (similar to the body colliding with structures or an opponent) or do without contact (e.g., sprains). Load injuries, on the other hand, stem from repetitious microtrauma, lacking a specific identifiable event. These injuries may manifest with a sudden or gradual onset. (**Huzmeli et al., 2017)** Athletes in sports practice face both traumatic and load injuries. In wheelchair basketball, the sport's biomechanics play a significant part in injury circumstances. The over use of the shoulder joint in activities like throwing and passing can lead to load injuries. also, abrupt changes in direction during the match on court and collisions with other athletes may lead to traumatic injuries. Understanding the biomechanics of the sport is essential for injury mitigation and enhancing sports performance. **(Sá K et al 2022)**

UPPER LIMB INJURIES

In the reports, injuries in the fritters, hands, wrists, forearms, arms, and shoulders were grouped as upper-branch injuries in wheelchair basketball. The highest frequency of injuries occurs in the shoulder region, attributed to repetitive movements inherent in the sport, such as wheelchair propulsion and biomechanics specific to this playing position. Additionally, the shoulder's anatomical instability makes it more susceptible to injuries. Unlike traditional basketball players who generate force from the lower limbs, wheelchair basketball relies on power transmission through the upper body, particularly the shoulder area. **(Sá K et al 2022)** The prevalent assessments identified muscle spasms in the cervical or shoulder area as the most common, trailed by instances of skin lesions or bruises on the elbow. Primary injury mechanisms observed encompassed overuse and acute trauma resulting from contact with fellow players. **(Hollander, K et al 2018**) Upper extremity injuries were predominantly noted in participants of wheelchair basketball, attributable to the sport's demanding nature on upper extremity function, surpassing the endurance and strength levels of the individuals. The reported preventive measures for these injuries primarily included warm-up routines and the application of cold packs in instances of pain. It is

recommended that comprehensive education on injury prevention strategies be provided to all players. Additionally, the consideration of protective gear for hands is advisable to mitigate the risk of injuries. (**Huzmeli et al., 2017)** The pain of the shoulder is a common circumstance in wheelchair basketball players. **(Jekiełek, M. et al 2021**) As the literature suggets, shoulder injuries in wheelchair sports are influenced by patterns of the impact and rotator cuff injuries, leading to pain, decreased muscle strength, and restricted range of motion. These injuries leads to changes in biomechanics of the body and positioning, resulting in muscle shortening and pose challenges in both athletes performance and daily activities. These issues are associated with repetitive and forceful movements performed overhead, commonly observed in this sports. Along with the shoulder concerns, injuries due to the wheels in the hands and wrists primarily manifests as fractures and sprains. **(Sá K et al 2022)**

HEAD INJURIES

Concussion, the primary head injury studied, stems from biomechanical forces during sports, often due to direct blows. It manifests with neurological symptoms such as loss of consciousness, memory issues, headaches, nausea, and visual disturbances. Notably, structural neuroimaging shows no abnormalities. A conclusive diagnosis requires ruling out external factors like drugs or injuries. While athletes typically recover from symptoms, a gradual return to sports is crucial, especially in high-contact sports like basketball where concussion rates are elevated. **(Sá K et al 2022)** Individuals reliant on wheelchairs were found to have a 50% lower likelihood of experiencing a concussion compared to non-wheelchair users. Initial assumptions suggested that those with greater function and stability might better safeguard themselves during falls due to enhanced muscle control. However, new speculation considers that athletes with higher function might move at higher speeds, increasing injury risk. Alternatively, their elevated center of mass or less stable wheelchair setups could contribute to a higher susceptibility to tipping over. **(Karla K et al 2012)**

LOWER LIMB INJURIES

Injuries more prevalent in the lower limbs among wheelchair basketball athletes encompass pressure sore injuries, contusions, and skin abrasions. Pressure sores commonly occur in players relying on wheelchairs for mobility, particularly those with sensitivity changes in areas in contact with the chair, such as the sciatic and sacral regions. Notably, athletes with spinal cord injuries are at a higher risk. (**Huzmeli et al., 2017)** Lower-classified players, with greater trunk instability, face increased susceptibility to pressure injuries compared to higher-classified counterparts, who exhibit better postural control. These injuries pose risks like poor blood circulation, sustained pressure, and skin friction, exacerbated by sweat during sports, potentially leading to severe conditions like sepsis. If untreated, these injuries may result in practice suspension until complete healing. **(Shimizu et al 2017)**

SPINAL INJURIES (CERVICAL, THORACIC AND LUMBAR)

While spinal injuries aren't directly linked to sports participation, permanent wheelchair users frequently experience high incidences of spine-related pain, particularly in the lumbar region. This population appears more prone to such pain compared to the general populace. **(Sá K et al 2022)** The discomfort, whether acute or chronic, may stem from inadequate ergonomic features in their chairs, as extended periods of sitting can lead to pain due to a lack of anatomical adjustments. Factors like sedentary behavior, muscle inactivity, and neuropathies also contribute. Preventive measures, including changes in positioning, engagement in physical activities, and proper ergonomic chair adjustments, are crucial for averting pain and preserving individuals' quality of life. (**Huzmeli et al., 2017)**

CONCLUSIONS

This review highlights the multifaceted nature of injuries in wheelchair basketball and we resolute that the most involved body regions were the shoulder, hand, head, and spine. Traumatic and load injuries are common in wheelchair basketball, influenced by the sport's biomechanics, including repetitive use of the shoulder joint and collisions during play. Upper limb injuries, particularly in the shoulder region, dominate the reported cases. Muscle spasms, skin lesions, and bruises were frequently observed, mainly resulting from overuse and acute trauma. Shoulder injuries, often associated with impact patterns and rotator cuff issues, pose challenges in maintaining muscle strength and range of motion. Prevention strategies, such as warm-ups, cold packs, and defensive equipment, are recommended. Head injuries, notably concussions, pose significant concerns in high-contact sports like wheelchair basketball. Gradual return to sports is crucial for athletes recovering from these injuries. Interestingly, wheelchair users were found to have a lower likelihood of concussions, sparking speculation about the impact of factors like speed and wheelchair stability. Lower limb injuries, including pressure sores, contusions, and abrasions, are prevalent, particularly in players with spinal cord injuries. The susceptibility to pressure injuries is higher in lower-classified players, necessitating measures to address poor blood circulation, sustained pressure, and skin friction. Spinal injuries, though not directly related to sports, contribute to heightened incidences of spine-related pain, emphasizing the need for ergonomic chair adjustments and preventive measures.

FUTURE PERSPECTIVE

By understanding the predominant injuries in wheelchair basketball, there is an opportunity to structure training programs geared toward prevention. Currently lacking, the creation of an injury prevention protocol specific to wheelchair basketball becomes imperative. Considering the highlighted injuries, such a protocol could incorporate a targeted program for preventing pressure injuries, a type with significant implications for training and athlete participation. Additionally, a set of exercises mimicking sports movements, progressively enhancing difficulty, could serve as both warm-up routines and activities to improve upper limb and core strength. Implementing these preventive strategies not only reduces the risk of injuries but also, in the unfortunate event of an injury, minimizes the downtime for athletes, promoting a quicker return to sports participation.

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