



Review

Shoulder Pain Biomechanics, Rehabilitation and Prevention in Wheelchair Basketball Players: A Narrative Review

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Citation: Fari, G.; Latino, F.; Tafuri, F.; Dell'Anna, L.; Raelle, M.V.; Fai, A.; De Serio, C.; Intonti, G.; De Salvo, A.L.; Ricci, V.; et al. Shoulder Pain Biomechanics, Rehabilitation and Prevention in Wheelchair Basketball Players: A Narrative Review. *Biomechanics* **2023**, *3*, 362–376. <https://doi.org/10.3390/biomechanics3030030>

Academic Editors: Francois Prince and Shaghayegh Bagheri

Received: 30 May 2023

Revised: 5 August 2023

Accepted: 8 August 2023

Published: 10 August 2023



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Abstract: Wheelchair basketball (WB) is an increasingly popular sport that guarantees numerous health benefits for people with disabilities who regularly practice it, such as an improved quality of life and psychophysical well-being. However, WB is a contact and high-stress sport, which exposes players to frequent overloads and injuries, mainly affecting the upper limbs. Therefore, shoulder pain (SP) is the most common musculoskeletal disorder among WB players, forcing them to suspend or abandon this sport activity. This narrative review aims to summarize all the known literature on this topic and to be a starting point for further research. Firstly, it explores the biomechanical causes that lead to SP and the underlying diseases, among which the most recurrent are rotator cuff tendinopathies. Furthermore, this overview deepens the most effective and specific rehabilitation programs for SP in WB players and it emphasizes the need for further studies to trial new rehabilitative protocols using novel technologies to make them faster and more personalized. In this regard, the general recommendation still remains to perform a combination of exercises such as strengthening, endurance and stretching exercises of various durations and intensities. To conclude, the most important prevention strategies are described, underlining the need for constant sport-specific training led by qualified personnel and suggesting some insights on possible new research aimed at improving wheelchair ergonomics, stressing the importance of a multidisciplinary team fully dedicated to the individual athlete.

Keywords: shoulder; musculoskeletal pain; rehabilitation; prevention; wheelchair; basketball; sport; adaptive sports; disability; biomechanics; Paralympic

1. Introduction

Wheelchair basketball (WB) is one of the most popular Paralympic sports [1]. It is still rapidly growing in popularity and the international competitions are even more numerous all around the world [1]. The increasing professionalism level and interest in this sport among people with disabilities require a more scientific view of this game [2]. WB is a valid tool to promote physical and mental wellness, especially in people with disabilities [3]. Sports in general [4,5], and WB in particular [6], have a positive impact on different aspects of everyday life, decreasing depression, phobias, anxiety and improving quality of life. Moreover, it could provide an opportunity to find gainful employment compared with nonathletic persons with disabilities [7].

On the other hand, this sport carries along some risks. WB is a cause of several injuries, the most typical of which involve the upper limbs [8]. In particular, shoulder pain (SP) is the most frequent complaint and consequence of WB-related injuries. Indeed, the shoulder is commonly affected by trauma and overuse when practicing WB [9]. These injuries are primarily caused by the high shoulder performance and biomechanical loads which are required for this sport's specific gestures [10]. Therefore, it is very important to prevent upper limb injuries in these athletes in order to guarantee regular sport practice and the ability to maintain daily life activities. Although the positive aspects and risks of this sport are known, there are no current well-coded prevention strategies and rehabilitation shoulder protocols [11], which inevitably require an overall study of the mechanisms and musculoskeletal disorders underlying SP.

For this review, a search was carried out on Pubmed, Cochrane and Medline considering all the studies of the last thirty years which dealt with epidemiology, disease, prevention and rehabilitation of shoulder pain in wheelchair basketball players. Then, a descriptive overview of this scientific literature was performed.

The aim of this literature narrative review is thus to be the first, to our knowledge, to enclose all the concerns surrounding SP and consequently investigate its epidemiology, biomechanics and musculoskeletal pathologies that could cause it, highlighting the best rehabilitation and prevention techniques for WB-related SP.

2. Biomechanics and Musculoskeletal Disorders Underlying Shoulder Pain in WB Players

WB is a contact, overuse and overhead sport, so it is natural to expect that shoulders are extremely exposed to the risk of injuries [12].

Moreover, the continuous use of the wheelchair, which depends on individual weight-bearing, creates unnatural biomechanical efforts on the upper limbs, which are primarily designed for transfers and mobility [13]. As a consequence, SP, which is also a common complaint in the general population [14], is even more frequent among wheelchair users, particularly those who regularly practice WB [8].

In 2020, a standardized injury reporting system was developed during the WB World Championship and showed that 14% of all recorded injuries concerned the shoulders [15]. A systematic review by Sà et al. investigated the most common injuries among WB players and reported that injuries most commonly involve the upper limbs (47.2%) [16]. Karasuyama et al. recently confirmed the high prevalence of SP in WB players that ranges from 38–75%, with an incidence rate of around 14% [17].

SP is a musculoskeletal complaint potentially influenced by many different factors [8].

It seems obvious that SP incidence could be influenced by age [18], gender [9], daily wheelchair use [19] and type of disability [20]. Nevertheless, SP related to WB is a very specific disorder, typical of an equally specific population, characterized by people who regularly practice WB, who should be considered the net of some inhomogeneous features due to their peculiar profile [8].

Indeed, regarding the assessment of the SP in WB players, the Wheelchair User's Shoulder Pain Index (WUSPI) scale, which is traditionally dedicated to SP in wheelchair users, is not always considered when investigating SP related to sport gestures [21]. So,

Yıldırım et al. proposed a new tool to specifically evaluate SP during WB activities, distinguishing it from the pain derived from the activities of daily living [22]. This factor is emblematic of the peculiarity and clinical significance of SP in WB players.

However, why is SP so common in WB? Firstly, WB has biomechanical characteristics that require performance with high physical effort for the shoulders [8]. This sport involves intermittent phases of high intensity that combine wheelchair maneuvers and ball manipulation [23]. Moreover, repetitive and overhead movements, such as reaching, propulsion, throwing, passing and sudden changes of direction with a wheelchair can be responsible for an increased load on the shoulders [24,25].

Wheelchair propulsion itself seems particularly overloading for the shoulder complex [26]. In fact, WB propulsion mechanics encourage the scapula's systematic protraction, leading to altered posture and tighter anterior muscles. This is indirectly demonstrated by the acute biceps tendon changes related to wheelchair sports overuse [27]. In fact, these tendons are front stabilizers which suffer as a result of the sporting use of the wheelchair. This mechanism involves the anterosuperior structures of the shoulder. Fast and inclined wheelchair propulsion kinetics determine a strong vertical and posterior load on the shoulder, which could cause a compression of the subacromial structures against the overlying acromion, thus causing exposure to impingement syndromes [20]. As a consequence, compensatory muscle imbalances can be caused both by long-term wheelchair-sport-related propulsion and by poor training programs in the strengthening of rotator cuff and scapular stabilizer muscles [28]. Shoulders have to be mobile enough to allow a full range of motion (ROM), but simultaneously they have to be stable enough to maintain integrity and to organize external forces [29,30]. As a result, constant and specific training is necessary to protect and improve shoulder functionality [31]. This is the reason why better-trained wheelchair athletes usually experience less SP than less-trained players [32]. The lack of well-balanced sports training inevitably exposes WB players to the risk of overload due to poor control of the forces exerting the shoulders [29]. Each athlete has to gradually increase their tolerance to force intensity. When the individual levels of amplitude, frequency and duration of external loading are exceeded, the risk of SP due to overload drastically rises (Figure 1) [33].



Figure 1. Summary of biomechanical causes of shoulder pain in wheelchair basketball players.

Nevertheless, WB-specific movements are sometimes less stressful for the shoulders. Chénier et al. evaluated the impact of dribbling on the joint and push rim kinetics in WB athletes [1]. They found that sprinting was associated with a peak shoulder load ranging from 13% to 346% higher than in previous studies on standard wheelchair propulsion, while dribbling, which is a typical WB-specific gesture, reduced the peak external forces in the anterior and medial direction at the shoulder compared to sprinting without a ball [1].

Another main concern is the effect of trunk control on the shoulder. Since WB is an adapted sport, biomechanics is strictly linked to the athlete's sitting position and trunk control [34]. Unlike running basketball players, for whom the strength for the throw comes from the lower limbs, the transmission of power to the pull in WB players derives from the trunk, hence increasing shoulder overuse [34].

It is therefore no coincidence that, according to the WB classification system, the score assigned to each player on the court depends precisely on their control of the trunk [35]. A better trunk extensor and flexor strength and balance give greater stability and tolerance to loads, ensuring a better performance and a higher classification score [36]. On the other hand, the posterior pelvic tilt position associated with poor trunk control in WB players causes a rise of thoracic kyphosis and a forward head position, resulting in anterior displacement of the shoulder girdles, consequently causing exposure to SP [37]. The shoulder joint was not designed for lifting weights, but when trunk is not stable, shoulders are overloaded to ensure pushing movements and postural adjustments on wheelchairs, experiencing increased axial loads, intra-articular pressure and soft tissue compression [38]. It follows that the Performance-Corrected Wheelchair User's Shoulder Pain Index (PC-WUSPI) score is higher among WB players without trunk control [37].

Moreover, dynamic control of sitting posture is important for a correct scapula–thoracic and glenohumeral function in terms of WB performance [39]. Players with a scarce dynamic trunk control at a lumbopelvic level tend to sit with their pelvis tilted 15 degrees more to the posterior plan than players with a normal trunk control [40]. This position improves their balance, but it also exacerbates loads on the rotator cuff when rapid movements on the court are required. In the long period, there is a high risk of developing degenerative tendons tears and SP [40]. Devising new seating solutions could therefore be very useful in countering this problem. Janssen-Potten et al. showed that an altered sitting posture with a forward inclination may decrease fatigue for manual long-term wheelchair users, and this could also be a promising option for professional WB players [41].

With specific regard to the musculoskeletal diseases underlying SP in WB players, rotator cuff tears, and particularly impingement syndrome, are the most common diagnosis, but not the only ones (Figure 2) [42].

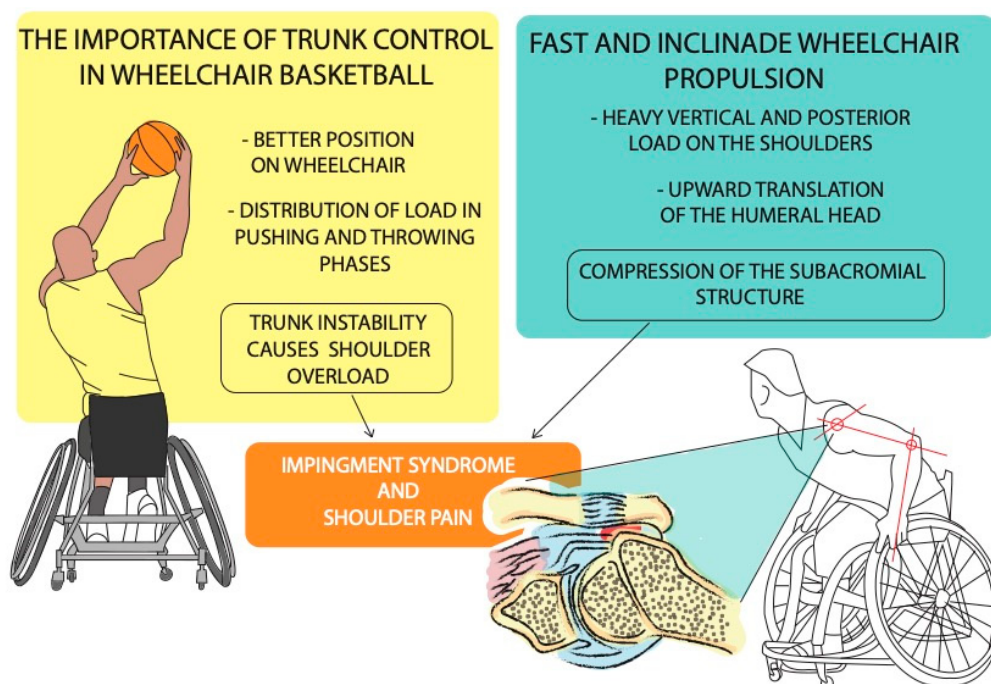


Figure 2. Trunk instability and compression of the subacromial structures are the main reasons why impingement syndrome represents the most common diagnosis that leads to shoulder pain in wheelchair basketball players.

As described above, rotator cuff tendons, especially supraspinatus, are extremely exposed to biomechanical stress both for the reduction of subacromial space and for the excessive efforts due to under-load rotational movements during sports practice. A study by Ortega-Santiago et al. identified a localized hypersensitivity and a significant number of trigger points at the shoulder and cervical spine level in elite male WB players with SP compared to asymptomatic elite male WB players and elite male able-bodied basketball players (Figure 3) [43].

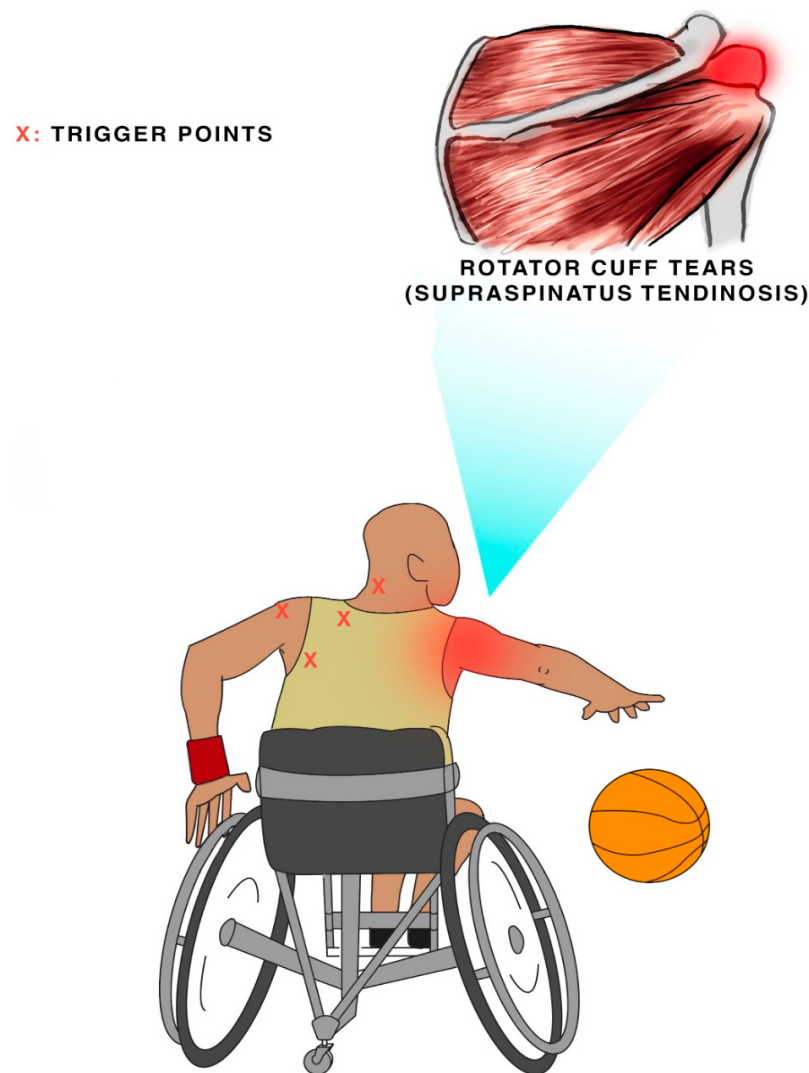


Figure 3. The most frequent localization of active trigger points at shoulder and cervical spine level in wheelchair basketball players.

This suggests that WB has similarities and differences to running basketball that still need to be investigated in their ability to determine shoulder muscle affections. In 2022, Sakai et al. used magnetic resonance as a diagnostic tool to determine the diseases which cause SP in WB players [44]. They confirmed that the most frequent shoulder tear is supraspinatus tendinosis due to reduced acromion–humeral distance. However, they also highlighted a high frequency of glenohumeral and acromioclavicular joint osteoarthritis. As mentioned before, high external glenohumeral forces in the posterior and lateral directions and high internal movements in flexion and adduction are strong biomechanical stresses for these joints, and they are strictly related to an increased prevalence of edema and thickening of the coracoacromial ligament [45,46]. In addition, falls and contrasts can cause direct trauma on shoulder joints, also determining SP [47].

Finally, even tendinitis in the long head of the biceps tendon could be a possible cause of SP in WB athletes (Figure 1) [48]. The biomechanical importance of this tendon, which works in synergy with the rotator cuff, in anterior shoulder mobility is well known [49]. Tsunoda et al. found an interesting correlation between WUSPI score and the presence of this tendinitis in a cohort of female WB players [48]. In particular, it seems that a sport-related tenderness in the bicipital groove point could lead to shoulder ROM limitation and SP.

The direct knowledge of all these findings in terms of biomechanics and musculoskeletal pathologies that cause SP requires us to deepen all the available strategies to achieve rehabilitative outcomes as rapidly and effectively as possible and mainly to prevent SP in those who practice WB, allowing them to continue playing regularly, without leaving the field.

3. Shoulder Pain in Wheelchair Basketball Players: Prevention Strategies

As previously stated, SP in WB players is due to many different biomechanical and physical factors, on which it is often not possible to intervene [32]. On the other hand, prevention strategies can be aimed at some modifiable aspects relating to players' physical preparation and to the ergonomics of the wheelchairs used in WB [50].

With regard to physical training, there are few studies about the prevention programs to avoid injuries and SP in disabled athletes, especially in WB players [51,52].

One of the starting bases for injury prevention in all sports is good training [53,54]. In a study by Cavaggioni et al. [55], it was demonstrated that a customized training program in Paraspports is important not only for improving performance but also for preventing injuries. It should be advised and followed by a professional coach who can personalize and modify it during different phases and according to the sport and athlete's characteristics [56]. The demand for optimal performance requires specific tactical and technical training strategies to improve physical abilities, particularly for wheelchair athletes [57]. According to them, residual functions can be trained on the field and in the wheelchair with adapted exercises such as wheelchair ergometers, manual cycling and endurance training [58]. These interventions should be aimed at the shoulders by reinforcing functional movement patterns and scapula kinematics symmetry through strength and coordination exercises, which could be also performed using elastic band and biofeedback methods [58]. Moreover, as a complement to strengthening workouts, passive shoulder stretching should be encouraged in all wheelchair athletes to improve proprioceptive abilities and gradually increase joint ROM [59,60]. Turbanski et al. demonstrated the effectiveness of a 8-week resistance training including five load exercises in improving upper limb strength and power in wheelchair athletes and enhancing performance in sport activities, but also in ADLs [61]. This muscle training increases shoulder stability, consequently decreasing the risk of injury and SP. With specific regard to WB players, a 2017 systematic review by Heyward et al. suggested the use of handcycling in elite athletes in general physical preparation phases, when there are no upcoming competitions, in order to reduce the risk of shoulder disorders [2]. In fact, unlike the manual wheelchair, handcycling allows the user to evenly distribute the glenohumeral contact force throughout the propulsion cycle, thus increasing stability, reducing overuse of the joint itself and preventing SP (Figure 4) [62].

Wilroy et al. proposed a 6-week strengthening and stretching intervention program which decreases risk factors for shoulder injury in WB athletes implementing internal and external rotation ROM and strength [63]. Despite a small sample size, this protocol seems promising as it improves scapular kinematics and SP relief and it is performed in a mixed setting, both home-based and in a controlled physiotherapeutic laboratory. With regard to this, in parallel with a more complex training program specifically organized for these athletes and followed by qualified personnel, even simple exercises carried out independently at home can give satisfactory results. Indeed, a home-based shoulder exercise protocol by García-Gómez et al. significantly reduced the risk of injury and SP, implementing the joint ROM. This could represent an easy and feasible complementary prevention program for WB

players if they are previously well instructed by their trainers [64]. Paulson et al. showed that longitudinal monitoring of both internal and external individual training load (TL) is important to improve performance, reduce the risk of injury and monitor improvements over time, in order to optimize preparation physics within a team environment [65].

BENEFITS OF USING HANDCYCLE WHILE EXERCISING

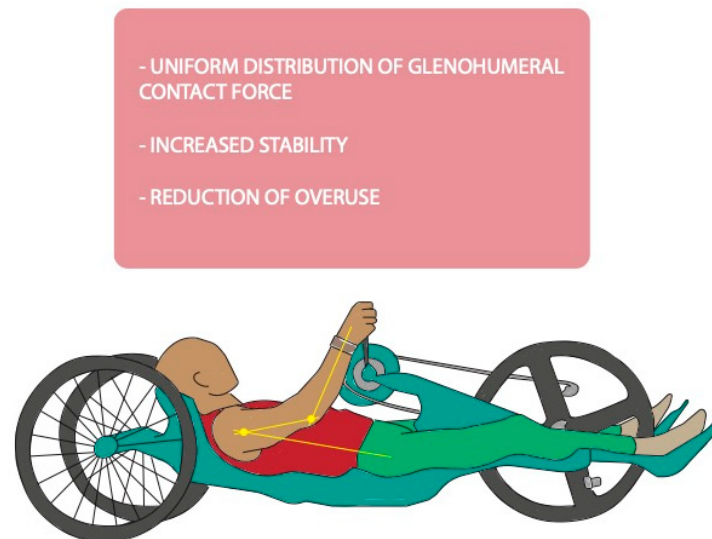


Figure 4. Benefits of using handcycles while exercising. Shoulder position without overhead movement protects the shoulder itself from pain onset.

In addition, the medical history of WB players should be analyzed in detail. In fact, in some of these athletes, precisely because of the main injury that led them to wheelchair use, respiratory [66] and cardiovascular [67] alterations may coexist [68]. These cardiorespiratory disorders can determine more rapid upper limb fatigue and lower performance as well as easy general fatigability, which is also potentially responsible for shoulder injury [69]. In these cases, it would be indicated to provide respiratory and cardiological training programs to prevent fatigue and to improve the efficiency of the musculoskeletal system, protecting it from overloads [70].

Even the ergonomics of sports wheelchairs can be modified with a view to improving the performance of WB players, limiting the risk of SP and injuries. However, this balance between high performance and safety is difficult to achieve, and it represents a great challenge for all the health professionals involved in wheelchair sport injury management. Athlete and wheelchair should be considered as a single entity since the wheelchair itself should be understood as an integral part of the player's body [71]. As a consequence, the tools necessary to guarantee this union must be carefully considered. Thus, the use of restraints during the game should be further investigated as an opportunity to optimize dynamic posture and to give stability to the shoulders, in addition to adequate athletic training and muscle strengthening [72]. Despite the belief of some WB players that contentions may limit their performance, it has already been shown that the use of straps by WB players increases their active trunk movement, gives better stability and limits the number of injuries [73]. In this way, the propulsion is more effective and causes less strain on the shoulders.

It has been demonstrated that some particular wheelchairs' features can improve the performance of these athletes, consequently also reducing the muscles' fatigability in order to prevent SP. In fact, Veeger et al. showed that some non-modifiable factors, such as better classification scores and greater experience, but also some modifiable factors, such as correct wheel axis height, hand rim diameter, camber angle and a suitable vertical distance between the shoulder and rear wheel axis, are positively associated with mobility

performance and shoulder stability [74]. On the contrary, the vertical distance between the front seat height and the footrest is often difficult to set for the needs of each athlete and could negatively influence mobility, thus causing exposure to falls and upper limbs injuries. The position of the seat, understood as both inclination and height, the camber of the rear wheel, the size of the wheels and the diameter and materials of the hand rim have caught the attention of many experts, who have tried to study the best solutions [75,76]. It was shown that a new flexible and high-friction hand rim is able to reduce finger and wrist flexor activity during propulsion [77]. The main limitation of the current findings is that the literature mostly deals with the best features for wheelchair users in ADLs, while it rarely focuses on sport-related injury prevention strategies, especially in WB players. Nevertheless, some solutions that make wheelchairs perform better in everyday life may also be valid on the court. Gorce et al. demonstrated that low and backward seat position allows a greater propulsion efficiency, but it could also increase the risk of upper limb injuries due to unbalanced joint positions and amplitudes [78]. Applying this finding to the WB, this seat position could determine a strong shoulder overuse, particularly to the damage of the rotator cuff.

On the other hand, a correct shoulder position during WB practice can greatly reduce the risk of injury [79]. A 2019 review by Riley et al. suggests the possibility of filming, either trivially with a video to be viewed later in slow motion or by more efficient methods, such as of players during games so that their misplaced postures could be studied, customizing wheelchair adaptations specific to each athlete and avoiding SP [70]. The available literature also suggests that just before the release of the wheelchair, right at the end of the stroke, the elbow should be slightly flexed and the joint itself should be 1–2 inches ahead of the most forward part of the pushing rim [80–82]. In addition, since the movement of internal rotation of the glenohumeral joint during pushing can cause impingement with powerful strokes, it would be safe to pay special attention to it, in order to prevent SP [83].

Based on these findings, a good prevention program should include personalized training, modified during different phases of athletic condition and designed according to the athlete's characteristics and medical history. It should be focused on: endurance; shoulder strength exercises to reinforce functional movement patterns and scapula kinematic symmetry; and passive shoulder stretching to gradually increase joint ROM. In addition, the wheelchair should be projected not only to improve performance, but also to help the athletes to reduce injury risks.

Finally, it seems clear now that a multidisciplinary approach is essential to prevent SP in this category of patients [84–86]. Specifically, a team consisting of specialized medical doctors, physiotherapists and orthopedic technicians and competent trainers is indispensable for a high and safe performance, preventing SP and overall injuries. It seems appropriate for these figures to coordinate and work together for the player's well-being [87]. Further studies for SP prevention in WB players are therefore needed.

4. Shoulder Pain in Wheelchair Basketball Players: Rehabilitation Updates and Challenges

Whereas there are many exercise protocols focused on treating SP in the everyday wheelchair users [88,89], only a few are dedicated to relieving SP in WB players, which will be discussed in this paragraph. As a consequence, WB players' rehabilitation protocols are still not specific to the needs of these athletes.

In addition, all the available therapies face the inability to provide complete rest, as the upper limbs are often needed for the activities of daily living (ADLs), particularly in people with a spinal cord injury (SCI) [89]. With regard to these patients, a review by Cratsenberg et al. stated that therapeutic exercise is effective in relieving SP, leading to a slow but long-term reduction in WUSPI scores [90]. In particular, a combination of strengthening exercises, targeting the posterior shoulder muscles for power and endurance, and stretching exercises, targeting the muscles of the anterior shoulder joint structures, are generally recommended. However, the duration of interventions in reviewed studies varied

widely, ranging from 8 weeks to 6 months. The intensity of exercise protocols was variable as well; even a daily exercise program by Curtis et al. produced an initial worsening of the SP two months after the baseline [91], and therefore it cannot be excluded that an increasing intensity represents an overload that exacerbates pain in the short term. It follows that it is still necessary to investigate the effectiveness of these therapeutic protocols in relation to duration, intensity and type of exercise.

With regard to wheelchair athletes, Riley et al. provided an interesting rehabilitation protocol experiencing SP related to subacromial impingement [70]. The authors developed a protocol divided into acute, maintenance and performance phases, including both rotator cuff and periscapular muscles to increase subacromial space; they underlined the importance of strengthening exercises for pectoralis, triceps and biceps in the last phase to promote power and speed when an athlete returns to sport. They also highly recommended that these performance exercises are not carried out until low-level sport activities are pain-free, not exceeding 3 sets of 10 repetitions without causing fatigue.

The need to ensure faster and more intense rehabilitation for a quicker return to the field of WB athletes has led in recent years to the development of some home-based therapeutic exercise protocols. The results of these protocols applied to wheelchair users affected by SP are really encouraging in terms of SP reduction and shoulder functional improvement, since it is possible to develop high-intensity training programs that are also easy and feasible to carry out at home [92]. However, the same cannot be said at the moment for WB athletes. In fact, in 2019 García-Gómez et al. published a study which investigated the effectiveness of a 10-week shoulder home-based exercise program (SHEP) for WB elite athletes suffering from SP [64]. Compared to the control group, the intervention group did not achieve significant improvement in pain relief and shoulder ROM. As the authors stated, these findings could be attributed to the fact that professional WB athletes are called to high performance and are engaged in close competitions. As a result, they undergo constant efforts that affect rehabilitation effects. According to this, WB athletes require regular shoulder evaluations and maintenance exercise strategies to stabilize the shoulder joint and prevent injuries when they perform ADLs and sports activities [64]. An exercise program including a warm-up phase, resistance training and stretching positions could guarantee flexibility and balance of shoulder muscles, avoiding SP both in nonathletic and in athletic WB players.

New technologies could provide great help in improving rehabilitation outcomes in WB players. Telerehabilitation represents a growing opportunity, and its applications are increasing, especially since the COVID-19 pandemic [93–95]. In 2014, Van Straaten et al. showed the effectiveness of home exercise on the SP, function and strength of manual wheelchair users with SCI [88]. They carried out a 12-week home exercise program for rotator cuff and scapular stabilization, including a high dose of 3 sets of 30 repetitions, 3 times weekly under the therapist's supervision via videoconferencing. All the outcome measures improved at all detection times and these results were later confirmed by a systematic review that stated the functional and quality of life benefits of telerehabilitation for people with disabilities [96]. However, there are still no similar studies specifically dedicated to WB players.

At the same time, surface electromyography (sEMG) seems a valid tool to speed up the recovery from SP in this athletic population. A recent study by Fari et al. demonstrated that real-time deltoid muscle activity and shoulder ROM monitoring using sEMG provides a better improvement both in SP and in sport-specific gestures, such as the 20 m straight line test, when compared to a control group who underwent the same rehabilitation protocol without control [97]. In fact, after a 4-week program and at an 8-week follow-up, the intervention group achieved greater and more rapid results. This might be attributed to the possibility of customizing and correcting the exercises' execution in real time, through the use of a screen that allows the patient to practice in a biofeedback method and the therapist to detect any motor dyskinesias. The same sEMG device was also used for investigating the supraspinatus muscle activity as the rehabilitation keystone to reduce SP and improve

shoulder ROM in WB players [98]. A four-week exercise protocol (two exercise sessions per week, one hour per session) was carried out, adapting volume and intensity for each individual within a pain-free range. Each session included resistance exercises with rubber bands and increasing weights for strengthening shoulder rotators, adductors, abductors and extensors, with particular attention to supraspinatus, and it ended with stretching exercises for all the muscles of the shoulder girdle. The rehabilitation improvements were encouraging and in line with other similar studies regarding the application of sEMG for SP treatment in wheelchair users [99]. Accordingly, the rotator cuff dysfunctions should be investigated, specifically treated and, where possible, prevented both for WB players and for wheelchair users who do not practice any sport.

In conclusion, it seems mandatory to take an innovative SP rehabilitation path for WB players which exploits new technologies [100,101]. The goal is making the treatments more personalized and creating an individual rehabilitation project [102,103]. At the same time, the rehabilitative protocols should be more homogeneous and standardized, while also having the aim of making the outcomes more objective.

The purpose of this is to implement the potential of sports rehabilitation, which requires specific protocols based on sports characteristics and athletes' musculoskeletal pain [104,105], particularly for WB players.

5. Conclusions

SP in WB players is an increasingly important issue. A better knowledge of the pathologies that cause it and the mechanisms underlying the onset of SP could be the starting point to find its solution and consequently reduce its negative impact on wheelchair athletes. Rehabilitation should be even more personalized and specific to the characteristics of each athlete, also taking into consideration the underlying pathologies that made the athlete themselves a disabled person and using new emerging technologies to accelerate their return to the field and thus avoid prolonged suspension from sport activities. The main limitation of this study is that it is a purely narrative review, the purpose of which is descriptive and not based on statistical data. However, a strong point is that this review focuses on everything related to shoulder pain in WB, and this can be useful to promote the safe practice of this sport. Prevention strategies should focus on physical training and wheelchair features, which turns out to be an integral part of athletes' bodies. The focus on these players should be carried out by a multidisciplinary professional team consisting of physiotherapists, physiatrists, orthopedic technicians and specialized coaches, so that people with disabilities can practice WB with regularity, thus obtaining great benefits for their health, both mentally and physically.

Author Contributions: Conceptualization, G.F., L.D., M.V.R. and F.L.; methodology, G.F.; software, A.F., C.D.S., G.I. and A.L.D.S.; validation, V.R. and F.T.; formal analysis, V.B. and A.B.; investigation, G.F., L.D., M.V.R. and F.L.; resources, G.F., L.D. and M.V.R.; data curation, G.F., L.D., S.F., F.L. and M.V.R.; writing—original draft preparation, G.F., L.D., M.V.R. and F.L.; writing—review and editing, G.F. and M.R.; visualization, M.V.R. and E.S.; supervision, M.M. and A.B.; project administration, M.M.; funding acquisition, M.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets used and/or analyzed during the current study will be made available upon reasonable request to the corresponding author, G.F.

Conflicts of Interest: The authors declare no conflict of interest.

References

- Chénier, F.; Alberca, I.; Gagnon, D.H.; Faupin, A. Impact of Sprinting and Dribbling on Shoulder Joint and Pushrim Kinetics in Wheelchair Basketball Athletes. *Front. Rehabil. Sci.* **2022**, *3*, 863093. [\[CrossRef\]](#) [\[PubMed\]](#)
- Heyward, O.W.; Vegter, R.J.K.; de Groot, S.; van der Woude, L.H.V. Shoulder complaints in wheelchair athletes: A systematic review. *PLoS ONE* **2017**, *12*, e0188410. [\[CrossRef\]](#)
- Nowak, M.A.; Kolbowicz, M.; Kuska, M.; Sygit, K.; Sygit, M.; Nowak, L.; Kotarska, K. The Intensity of the Health Behaviors of People Who Practice Wheelchair Basketball, Wheelchair Rugby and Para-Rowing. *Int. J. Environ. Res. Public Health* **2022**, *19*, 7879. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ströhle, A. Sports psychiatry: Mental health and mental disorders in athletes and exercise treatment of mental disorders. *Eur. Arch. Psychiatry Clin. Neurosci.* **2019**, *269*, 485–498. [\[CrossRef\]](#)
- Fari, G.; Lunetti, P.; Pignatelli, G.; Raele, M.V.; Cera, A.; Mintrone, G.; Ranieri, M.; Megna, M.; Capobianco, L. The Effect of Physical Exercise on Cognitive Impairment in Neurodegenerative Disease: From Pathophysiology to Clinical and Rehabilitative Aspects. *Int. J. Mol. Sci.* **2021**, *22*, 11632. [\[CrossRef\]](#)
- Fiorilli, G.; Iuliano, E.; Aquino, G.; Battaglia, C.; Giombini, A.; Calcagno, G.; di Cagno, A. Mental health and social participation skills of wheelchair basketball players: A controlled study. *Res. Dev. Disabil.* **2013**, *34*, 3679–3685. [\[CrossRef\]](#) [\[PubMed\]](#)
- Sahlin, K.B.; Lexell, J. Impact of Organized Sports on Activity, Participation, and Quality of Life in People with Neurologic Disabilities. *PM&R* **2015**, *7*, 1081–1088.
- Fari, G.; Macchiarola, D.; Quarta, F.; Bianchi, F.P.; Caforio, L.; Cutti, A.G.; Megna, M.; Ranieri, M. Epidemiology of Injuries in Wheelchair Basketball: Trauma Versus Overuse Mechanism and Prevention Rehabilitative Strategies. *J. Prosthet. Orthot.* **2023**, *35*, 32–37. [\[CrossRef\]](#)
- Curtis, K.A.; Black, K. Shoulder pain in female wheelchair basketball players. *J. Orthop. Sports Phys. Ther.* **1999**, *29*, 225–231. [\[CrossRef\]](#)
- Cools, A.M.; Maenhout, A.G.; Vanderstukken, F.; Declève, P.; Johansson, F.R.; Borms, D. The challenge of the sporting shoulder: From injury prevention through sport-specific rehabilitation toward return to play. *Ann. Phys. Rehabil. Med.* **2021**, *4*, 101384. [\[CrossRef\]](#)
- Fairbairn, J.R.; Huxel Bliven, K.C. Incidence of Shoulder Injury in Elite Wheelchair Athletes Differ Between Sports: A Critically Appraised Topic. *J. Sport Rehabil.* **2019**, *28*, 294–298. [\[CrossRef\]](#)
- Vanlandewijck, Y.; Theisen, D.; Daly, D. Wheelchair propulsion biomechanics: Implications for wheelchair sports. *Sports Med.* **2001**, *31*, 339–367. [\[CrossRef\]](#) [\[PubMed\]](#)
- Ambrosio, F.; Boninger, M.L.; Souza, A.L.; Fitzgerald, S.G.; Koontz, A.M.; Cooper, R.A. Biomechanics and strength of manual wheelchair users. *J. Spinal Cord Med.* **2005**, *28*, 407–414. [\[CrossRef\]](#) [\[PubMed\]](#)
- Notarnicola, A.; Maccagnano, G.; Maresca, L.; Oliva, M.C.; Fari, G.; Papagni, G.; Pignatelli, G.; Covelli, I.; Gioia, G.; Bianchi, F.P.; et al. Is extracorporeal shockwave therapy effective even in the treatment of partial rotator cuff tear? *J. Biol. Regul. Homeost. Agents* **2020**, *34*, 709–714. [\[PubMed\]](#)
- Hollander, K.; Kluge, S.; Glöer, F.; Riepenhof, H.; Zech, A.; Junge, A. Epidemiology of injuries during the Wheelchair Basketball World Championships 2018: A prospective cohort study. *Scand. J. Med. Sci. Sports* **2020**, *30*, 199–207. [\[CrossRef\]](#)
- Sá, K.; Costa e Silva, A.; Gorla, J.; Silva, A.; Magno e Silva, M. Injuries in Wheelchair Basketball Players: A Systematic Review. *Int. J. Environ. Res. Public Health* **2022**, *19*, 5869. [\[CrossRef\]](#)
- Karasuyama, M.; Oike, T.; Okamatsu, S.; Kawakami, J. Shoulder pain in wheelchair basketball athletes: A scoping review. *J. Spinal Cord Med.* **2022**, *1–7*. [\[CrossRef\]](#)
- Alm, M.; Saraste, H.; Norrbrink, C. Shoulder pain in persons with thoracic spinal cord injury: Prevalence and characteristics. *J. Rehabil. Med.* **2008**, *40*, 277–283. [\[CrossRef\]](#)
- Brose, S.W.; Boninger, M.L.; Fullerton, B.; McCann, T.; Collinger, J.L.; Impink, B.G.; Dyson-Hudson, T.A. Shoulder ultrasound abnormalities, physical examination findings, and pain in manual wheelchair users with spinal cord injury. *Arch. Phys. Med. Rehabil.* **2008**, *89*, 2086–2093. [\[CrossRef\]](#)
- Kuiig, K.; Rao, S.S.; Mulroy, S.J.; Newsam, C.J.; Gronley, J.K.; Bontrager, E.L.; Perry, J. Shoulder joint kinetics during the push phase of wheelchair propulsion. *Clin. Orthop. Relat. Res.* **1998**, *354*, 132–143.
- Harvey, L.A.; Glinsky, J.V. Clinimetrics: The Wheelchair User's Shoulder Pain Index (WUSPI). *J. Physiother.* **2019**, *65*, 55. [\[CrossRef\]](#) [\[PubMed\]](#)
- Yıldırım, N.Ü.; Büyükoztürk, Ş.; Bayramlar, K.; Özenin, N.; Külünkoğlu, B.A.; Çoban, Ö. Developing a shoulder pain scale for wheelchair basketball players. *J. Back Musculoskelet. Rehabil.* **2019**, *32*, 479–485. [\[CrossRef\]](#) [\[PubMed\]](#)
- Crespo-Ruiz, B.M.; Del Ama-Espinosa, A.J.; Gil-Agudo, A.M. Relation between kinematic analysis of wheelchair propulsion and wheelchair functional basketball classification. *Adapt. Phys. Act. Q.* **2011**, *28*, 157–172. [\[CrossRef\]](#)
- Van Drongelen, S.; Van der Woude, L.H.; Janssen, T.W.; Angenot, E.L.; Chadwick, E.K.; Veeger, D.H. Mechanical Load on the Upper Extremity During Wheelchair Activities. *Arch. Phys. Med. Rehabil.* **2005**, *86*, 1214–1220. [\[CrossRef\]](#)
- Ferreira da Silva, C.M.A.; de Sá, K.S.G.; Bauermann, A.; Borges, M.; de Castro Amorim, M.; Rossato, M.; Gorla, J.I.; de Athayde Costa e Silva, A. Wheelchair skill tests in wheelchair Basketball: A systematic review. *PLoS ONE* **2022**, *17*, e0276946. [\[CrossRef\]](#)
- Stöhr, H.; Zimmer, M. Rollstuhlbasketball aus orthopädischer Sicht [Wheelchair basketball from the orthopedic viewpoint]. *Sport. Sportschaden* **1997**, *11*, 109–115. [\[CrossRef\]](#)

27. van Drongelen, S.; Boninger, M.L.; Impink, B.G.; Khalaf, T. Ultrasound imaging of acute biceps tendon changes after wheelchair sports. *Arch. Phys. Med. Rehabil.* **2007**, *88*, 381–385. [[CrossRef](#)] [[PubMed](#)]
28. Dec, K.L.; Sparrow, K.J.; McKeag, D.B. The physically challenged athlete: Medical issues and assessment. *Sports Med.* **2000**, *29*, 245–258. [[CrossRef](#)]
29. Fari, G.; de Sire, A.; Fallea, C.; Albano, M.; Grossi, G.; Bettoni, E.; Di Paolo, S.; Agostini, F.; Bernetti, A.; Puntillo, F.; et al. Efficacy of Radiofrequency as Therapy and Diagnostic Support in the Management of Musculoskeletal Pain: A Systematic Review and Meta-Analysis. *Diagnostics* **2022**, *12*, 600. [[CrossRef](#)]
30. Veeger, H.E.J.; van der Helm, F.C.T. Shoulder function: The perfect compromise between mobility and stability. *J. Biomech.* **2007**, *40*, 2119–2129. [[CrossRef](#)] [[PubMed](#)]
31. Dehghansai, N.; Lemez, S.; Wattie, N.; Baker, J. Training and development of Canadian wheelchair basketball players. *Eur. J. Sport Sci.* **2017**, *17*, 511–518. [[CrossRef](#)]
32. Fullerton, H.D.; Borckardt, J.J.; Alfano, A.P. Shoulder pain: A comparison of wheelchair athletes and nonathletic wheelchair users. *Med. Sci. Sports Exerc.* **2003**, *35*, 1958–1961. [[CrossRef](#)]
33. Hoozemans, M.J.; van der Beek, J.; Frings-Dresen, M.H.; van Dijk, F.J.; van der Woude, L.H. Pushing and pulling in relation to musculoskeletal disorders: A review of risk factors. *Ergonomics* **1998**, *41*, 757–781. [[CrossRef](#)]
34. Morrow, M.M.; Kaufman, K.R.; An, K.N. Scapula kinematics and associated impingement risk in manual wheelchair users during propulsion and a weight relief lift. *Clin. Biomech.* **2011**, *26*, 352–357. [[CrossRef](#)]
35. Cavedon, V.; Zancanaro, C.; Milanese, C. Physique and Performance of Young Wheelchair Basketball Players in Relation with Classification. *PLoS ONE* **2015**, *10*, e0143621. [[CrossRef](#)]
36. Santos, S.D.; Krishnan, C.; Alonso, A.C.; Greve, J.M. Trunk Function Correlates Positively with Wheelchair Basketball Player Classification. *Am. J. Phys. Med. Rehabil.* **2017**, *96*, 101–108. [[CrossRef](#)]
37. Yildirim, N.U.; Comert, E.; Ozengin, N. Shoulder pain: A comparison of wheelchair basketball players with trunk control and without trunk control. *J. Back Musculoskelet. Rehabil.* **2010**, *23*, 55–61. [[CrossRef](#)]
38. Bayley, J.C.; Cochran, T.P.; Sledge, C.B. The weight-bearing shoulder. The impingement syndrome in paraplegics. *J. Bone Jt. Surg.* **1987**, *69*, 676–678. [[CrossRef](#)]
39. Seelen, H.A.; Vuurman, E.F. Compensatory muscle activity for sitting posture during upper extremity task performance in paraplegic persons. *Scand. J. Rehabil. Med.* **1991**, *23*, 89–96. [[CrossRef](#)]
40. Weisman, A.; Masharawi, Y. Does Altering Sitting Posture Have a Direct Effect on Clinical Shoulder Tests in Individuals with Shoulder Pain and Rotator Cuff Degenerative Tears? *Phys. Ther.* **2019**, *99*, 194–202. [[CrossRef](#)]
41. Janssen-Potten, Y.J.; Seelen, H.; Drukker, J.; Huson, T.; Drost, M.R. The effect of seat tilting on pelvic position, balance control, and compensatory postural muscle use in paraplegic subjects. *Arch. Phys. Med. Rehabil.* **2001**, *82*, 1393–1402. [[CrossRef](#)]
42. Soo Hoo, J.A.; Kim, H.; Fram, J.; Lin, Y.S.; Page, C.; Easthausen, I.; Jayabalan, P. Shoulder pain and ultrasound findings: A comparison study of wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users. *PM&R* **2022**, *14*, 551–560.
43. Ortega-Santiago, R.; González-Aguado, Á.J.; Fernández-de-Las-Peñas, C.; Cleland, J.A.; de-la-Llave-Rincón, A.I.; Kobylarz, M.D.; Plaza-Manzano, G. Pressure pain hypersensitivity and referred pain from muscle trigger points in elite male wheelchair basketball players. *Braz. J. Phys. Ther.* **2020**, *24*, 333–341. [[CrossRef](#)]
44. Sakai, M.; Mutsuzaki, H.; Shimizu, Y.; Okamoto, Y.; Nakajima, T. Characteristic MRI findings of the shoulder, elbow, and wrist joints in elite wheelchair basketball players. *BMC Sports Sci. Med. Rehabil.* **2022**, *14*, 141. [[CrossRef](#)] [[PubMed](#)]
45. Mercer, J.L.; Boninger, M.L.; Koontz, A.; Ren, D.; Dyson-Hudson, T.; Cooper, R. Shoulder joint kinetics and pathology in manual wheelchair users. *Clin. Biomech.* **2006**, *21*, 781–789. [[CrossRef](#)] [[PubMed](#)]
46. Fari, G.; Pignatelli, G.; Macchiarola, D.; Bernetti, A.; Agostini, F.; Fornaro, M.; Mariconda, C.; Megna, M.; Ranieri, M. Cartilage damage: Clinical approach. *Minerva Orthop.* **2022**, *73*, 20–27. [[CrossRef](#)]
47. Morse, K.W.; Hearn, K.A.; Carlson, M.G. Return to Play after Forearm and Hand Injuries in the National Basketball Association. *Orthop. J. Sports Med.* **2017**, *5*, 2325967117690002. [[CrossRef](#)] [[PubMed](#)]
48. Tsunoda, K.; Mutsuzaki, H.; Kanae, K.; Tachibana, K.; Shimizu, Y.; Wadano, Y. Associations between wheelchair user's shoulder pain index and tendinitis in the long head of the biceps tendon among female wheelchair basketball players from the Japanese national team. *Asia-Pac. J. Sports Med. Arthrosc. Rehabil. Technol.* **2021**, *24*, 29–34. [[CrossRef](#)] [[PubMed](#)]
49. Kannus, P.; Natri, A. Etiology and pathophysiology of tendon ruptures in sports. *Scand. J. Med. Sci. Sports* **1997**, *7*, 107–112. [[CrossRef](#)]
50. Fari, G.; Fischetti, F.; Zonno, A.; Marra, F.; Maglie, A.; Bianchi, F.P.; Messina, G.; Ranieri, M.; Megna, M. Musculoskeletal Pain in Gymnasts: A Retrospective Analysis on a Cohort of Professional Athletes. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5460. [[CrossRef](#)]
51. Walford, S.L.; Requejo, P.S.; Mulroy, S.J.; Neptune, R.R. Predictors of shoulder pain in manual wheelchair users. *Clin. Biomech.* **2019**, *65*, 1–12. [[CrossRef](#)]
52. Rimmer, J.H.; Riley, B.; Wang, E.; Rauworth, A.; Jurkowski, J. Physical activity participation among persons with disabilities: Barriers and facilitators. *Am. J. Prev. Med.* **2004**, *26*, 419–425. [[CrossRef](#)]
53. Aytar, A.; Zeybek, A.; Pekyavas, N.O.; Tigli, A.A.; Ergun, N. Scapular resting position, shoulder pain and function in disabled athletes. *Prosthet. Orthot. Int.* **2015**, *39*, 390–396. [[CrossRef](#)]

54. Notarnicola, A.; Covelli, I.; Maccagnano, G.; Marvulli, R.; Mastromauro, L.; Ianieri, G.; Boodhoo, S.; Turitto, A.; Petruzzella, L.; Fari, G.; et al. Extracorporeal shockwave therapy on muscle tissue: The effects on healthy athletes. *J. Biol. Regul. Homeost. Agents* **2018**, *32*, 185–193. [[PubMed](#)]
55. Cavaggioni, L.; Trecroci, A.; Tosin, M.; Iaia, F.M.; Alberti, G. Individualized dry-land intervention program for an elite Paralympic swimmer. *J. Sports Med. Phys. Fit.* **2019**, *59*, 82–86. [[CrossRef](#)] [[PubMed](#)]
56. Fari, G.; Notarnicola, A.; DI Paolo, S.; Covelli, I.; Moretti, B. Epidemiology of injuries in water board sports: Trauma versus overuse injury. *J. Sports Med. Phys. Fit.* **2021**, *61*, 707–711. [[CrossRef](#)]
57. Fletcher, J.R.; Gallinger, T.; Prince, F. How Can Biomechanics Improve Physical Preparation and Performance in Paralympic Athletes? A Narrative Review. *Sports* **2021**, *9*, 89. [[CrossRef](#)]
58. Bonavolontà, V.; Cataldi, S.; Latino, F.; Carvutto, R.; De Candia, M.; Mastroilli, G.; Messina, G.; Patti, A.; Fischetti, F. The Role of Parental Involvement in Youth Sport Experience: Perceived and Desired Behavior by Male Soccer Players. *Int. J. Environ. Res. Public Health* **2021**, *18*, 8698. [[CrossRef](#)]
59. Gomes Costa, R.R.; Dorneles, J.R.; Lopes, G.H.; Gorla, J.I.; Ribeiro Neto, F. Medicine Ball Throw Responsiveness to Measure Wheelchair Basketball Mobility in Male Players. *J. Sport Rehabil.* **2021**, *30*, 1230–1232. [[CrossRef](#)]
60. Paulson, T.; Goosey-Tolfrey, V. Current Perspectives on Profiling and Enhancing Wheelchair Court Sport Performance. *Int. J. Sports Physiol. Perform.* **2017**, *12*, 275–286. [[CrossRef](#)]
61. Turbanski, S.; Schmidbleicher, D. Effects of heavy resistance training on strength and power in upper extremities in wheelchair athletes. *J. Strength Cond. Res.* **2010**, *24*, 8–16. [[CrossRef](#)] [[PubMed](#)]
62. Arnet, U.; van Drongelen, S.; Scheel-Sailer, A.; van der Woude, L.H.; Veeger, D.H. Shoulder load during synchronous handcycling and handrim wheelchair propulsion in persons with paraplegia. *J. Rehabil. Med.* **2012**, *44*, 222–228. [[CrossRef](#)] [[PubMed](#)]
63. Wilroy, J.; Hibberd, E. Evaluation of a Shoulder Injury Prevention Program in Wheelchair Basketball. *J. Sport Rehabil.* **2018**, *27*, 554–559. [[CrossRef](#)]
64. García-Gómez, S.; Pérez-Tejero, J.; Hoozemans, M.; Barakat, R. Effect of a Home-based Exercise Program on Shoulder Pain and Range of Motion in Elite Wheelchair Basketball Players: A Non-Randomized Controlled Trial. *Sports* **2019**, *7*, 180. [[CrossRef](#)]
65. Paulson, T.A.; Mason, B.; Rhodes, J.; Goosey-Tolfrey, V.L. Individualized Internal and External Training Load Relationships in Elite Wheelchair Rugby Players. *Front. Physiol.* **2015**, *6*, 388. [[CrossRef](#)] [[PubMed](#)]
66. Galeiras Vázquez, R.; Rascado Sedes, P.; Mourelo Fariña, M.; Montoto Marqués, A.; Ferreira Velasco, M.E. Respiratory management in the patient with spinal cord injury. *BioMed Res. Int.* **2013**, *2013*, 168757. [[CrossRef](#)] [[PubMed](#)]
67. Carter, G.T. Spinal cord injury rehabilitation. *Phys. Med. Rehabil. Clin.* **2014**, *25*, xiii–xiv. [[CrossRef](#)]
68. Sharif, S.; Jazaib Ali, M.Y. Outcome Prediction in Spinal Cord Injury: Myth or Reality. *World Neurosurg.* **2020**, *140*, 574–590. [[CrossRef](#)]
69. Jensen, M.P.; Truitt, A.R.; Schomer, K.G.; Yorkston, K.M.; Baylor, C.; Molton, I.R. Frequency and age effects of secondary health conditions in individuals with spinal cord injury: A scoping review. *Spinal Cord* **2013**, *51*, 882–892. [[CrossRef](#)]
70. Riley, A.H.; Callahan, C. Shoulder Rehabilitation Protocol and Equipment Fit Recommendations for the Wheelchair Sport Athlete with Shoulder Pain. *Sports Med. Arthrosc. Rev.* **2019**, *27*, 67–72. [[CrossRef](#)]
71. Dutton, R.A. Medical and Musculoskeletal Concerns for the Wheelchair Athlete: A Review of Preventative Strategies. *Curr. Sports Med. Rep.* **2019**, *18*, 9–16.
72. Hayes, K.; Callanan, M.; Walton, J.; Paxinos, A.; Murrell, G.A. Shoulder instability: Management and rehabilitation. *J. Orthop. Sports Phys. Ther.* **2002**, *32*, 497–509. [[CrossRef](#)]
73. Marszałek, J.; Molik, B. Reliability of measurement of active trunk movement in wheelchair basketball players. *PLoS ONE* **2019**, *14*, e0225515. [[CrossRef](#)]
74. Veeger, T.T.J.; de Witte, A.M.H.; Berger, M.A.M.; van der Slikke, R.M.A.; Veeger, D.H.E.J.; Hoozemans, M.J.M. Improving Mobility Performance in Wheelchair Basketball. *J. Sport Rehabil.* **2019**, *28*, 59–66. [[CrossRef](#)]
75. Mason, B.S.; van der Woude, L.H.; Goosey-Tolfrey, V.L. The ergonomics of wheelchair configuration for optimal performance in the wheelchair court sports. *Sports Med.* **2013**, *43*, 23–38.
76. Miccinilli, S.; Bravi, M.; Morrone, M.; Santacaterina, F.; Stellato, L.; Bressi, F.; Sterzi, S. A Triple Application of Kinesio Taping Supports Rehabilitation Program for Rotator Cuff Tendinopathy: A Randomized Controlled Trial. *Ortop. Traumatol. Rehabil.* **2018**, *20*, 499–505. [[CrossRef](#)]
77. Richter, W.M.; Rodriguez, R.; Woods, K.R.; Karpinski, A.P.; Axelson, P.W. Reduced finger and wrist flexor activity during propulsion with a new flexible handrim. *Arch. Phys. Med. Rehabil.* **2006**, *87*, 1643–1647.
78. Gorce, P.; Louis, N. Wheelchair propulsion kinematics in beginners and expert users: Influence of wheelchair settings. *Clin. Biomech.* **2012**, *27*, 7–15.
79. Tweedy, S.M.; Beckman, E.M.; Geraghty, T.J.; Theisen, D.; Perret, C.; A Harvey, L.; Vanlandewijck, Y.C. Exercise and sports science Australia (ESSA) position statement on exercise and spinal cord injury. *J. Sci. Med. Sport* **2016**, *20*, 108–115. [[CrossRef](#)]
80. Bundon, A.; Mason, B.S.; Goosey-Tolfrey, V.L. Expert Users' Perceptions of Racing Wheelchair Design and Setup: The Knowns, Unknowns, and Next Steps. *Adapt. Phys. Act. Q.* **2017**, *34*, 141–161.
81. Villaceros, J.; Pérez-Tejero, J.; Garrido, G.; Grams, L.; López-Illescas, Á.; Ferro, A. Relationship between Sprint Velocity and Peak Moment at Shoulder and Elbow in Elite Wheelchair Basketball Players. *Int. J. Environ. Res. Public Health* **2020**, *17*, 6989. [[CrossRef](#)]

82. Ferro, A.; Pérez-Tejero, J.; Garrido, G.; Villaceros, J. Relationship between Sprint Capacity and Acceleration of Wrists in Wheelchair Basketball Players: Design and Reliability of a New Protocol. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10380. [\[CrossRef\]](#)
83. García-Fresneda, A.; Carmona, G.; Yanci, J.; Iturricastillo, A. Initial Maximum Push-Rim Propulsion and Sprint Performance in Elite Women's Wheelchair Basketball: Differences Between Players' Functional Classification. *Int. J. Sports Physiol. Perform.* **2022**, *17*, 1187–1195. [\[CrossRef\]](#)
84. Santamato, A.; Ranieri, M.; Cinone, N.; Stuppiello, L.A.; Valeno, G.; De Sanctis, J.L.; Fortunato, F.; Solfrizzi, V.; Greco, A.; Seripa, D.; et al. Postural and Balance Disorders in Patients with Parkinson's Disease: A Prospective Open-Label Feasibility Study with Two Months of Action Observation Treatment. *Park. Dis.* **2015**, *2015*, 902738. [\[CrossRef\]](#)
85. Palma, D.D.; Tafuri, D. Special needs and inclusion in sport management: A specific literature review. *Sport Sci.* **2016**, *9* (Suppl. S2), 24–31.
86. Gaetano, R.; Domenico, T.; Gaetano, A. Physical activity and its relation to body and ludic expression in childhood. *Mediterr. J. Soc. Sci.* **2015**, *6* (Suppl. S2), 293. [\[CrossRef\]](#)
87. Spina, S.; Facciorusso, S.; Cinone, N.; Armiento, R.; Picelli, A.; Avvantaggiato, C.; Ciritella, C.; Fiore, P.; Santamato, A. Effectiveness of robotic balance training on postural instability in patients with mild Parkinson's disease: A pilot, single blind, randomized controlled trial. *J. Rehabil. Med.* **2021**, *53*, jrm00154. [\[CrossRef\]](#)
88. Van Straaten, M.G.; Cloud, B.A.; Morrow, M.M.; Ludewig, P.M.; Zhao, K.D. Effectiveness of home exercise on pain, function, and strength of manual wheelchair users with spinal cord injury: A high-dose shoulder program with telerehabilitation. *Arch. Phys. Med. Rehabil.* **2014**, *95*, 1810–1817.e2. [\[CrossRef\]](#)
89. Akkurt, H.; Karapolat, H.U.; Kirazli, Y.; Kose, T. The effects of upper extremity aerobic exercise in patients with spinal cord injury: A randomized controlled study. *Eur. J. Phys. Rehabil. Med.* **2017**, *53*, 219–227. [\[CrossRef\]](#)
90. Cratsenberg, K.A.; Deitrick, C.E.; Harrington, T.K.; Kopecky, N.R.; Matthews, B.D.; Ott, L.M.; Coeytaux, R.R. Effectiveness of Exercise Programs for Management of Shoulder Pain in Manual Wheelchair Users with Spinal Cord Injury. *J. Neurol. Phys. Ther.* **2015**, *39*, 197–203. [\[CrossRef\]](#)
91. Curtis, K.A.; Tyner, T.M.; Zachary, L.; Lentell, G.; Brink, D.; Didyk, T.; Gean, K.; Hall, J.; Hooper, M.; Klos, J.; et al. Effect of a standard exercise protocol on shoulder pain in long-term wheelchair users. *Spinal Cord* **1999**, *37*, 421–429.
92. Gauthier, C.; Brosseau, R.; Hicks, A.L.; Gagnon, D.H. Feasibility, Safety, and Preliminary Effectiveness of a Home-Based Self-Managed High-Intensity Interval Training Program Offered Long-Term Manual Wheelchair Users. *Rehabil. Res. Pract.* **2018**, *2018*, 8209360.
93. Seron, P.; Oliveros, M.J.; Gutierrez-Arias, R.; Fuentes-Aspe, R.; Torres-Castro, R.C.; Merino-Osorio, C.; Nahuelhual, P.; Inostroza, J.; Jalil, Y.; Solano, R.; et al. Effectiveness of Telerehabilitation in Physical Therapy: A Rapid Overview. *Phys. Ther.* **2021**, *101*, pzab053.
94. Bernetti, A.; Fari, G.; Mangone, M.; Fiore, P.; Santilli, V.; Paoloni, M.; Agostini, F. Medical management of osteoarthritis during the COVID-19 pandemic: A challenge for the present and the future. *Ann. Ig.* **2022**, *34*, 184–189.
95. Eichler, S.; Rabe, S.; Salzwedel, A.; Müller, S.; Stoll, J.; Tilgner, N.; John, M.; Wegscheider, K.; Mayer, F.; Völler, H.; et al. Effectiveness of an interactive telerehabilitation system with home-based exercise training in patients after total hip or knee replacement: Study protocol for a multicenter, superiority, no-blinded randomized controlled trial. *Trials* **2017**, *18*, 438.
96. Dias, J.F.; Oliveira, V.C.; Borges, P.R.T.; Dutra, F.C.M.S.; Mancini, M.C.; Kirkwood, R.N.; Resende, R.A.; Sampaio, R.F. Effectiveness of exercises by telerehabilitation on pain, physical function and quality of life in people with physical disabilities: A systematic review of randomised controlled trials with GRADE recommendations. *Br. J. Sports Med.* **2021**, *55*, 155–162.
97. Fari, G.; Megna, M.; Fiore, P.; Ranieri, M.; Marvulli, R.; Bonavolontà, V.; Bianchi, F.P.; Puntillo, F.; Varrassi, G.; Reis, V.M. Real-Time Muscle Activity and Joint Range of Motion Monitor to Improve Shoulder Pain Rehabilitation in Wheelchair Basketball Players: A Non-Randomized Clinical Study. *Clin. Pract.* **2022**, *12*, 1092–1101.
98. Fari, G.; Megna, M.; Ranieri, M.; Agostini, F.; Ricci, V.; Bianchi, F.P.; Rizzo, L.; Fari, E.; Tognolo, L.; Bonavolontà, V.; et al. Could the Improvement of Supraspinatus Muscle Activity Speed up Shoulder Pain Rehabilitation Outcomes in Wheelchair Basketball Players? *Int. J. Environ. Res. Public Health* **2023**, *20*, 255.
99. Middaugh, S.; Thomas, K.J.; Smith, A.R.; McFall, T.L.; Klingmueller, J. EMG Biofeedback and Exercise for Treatment of Cervical and Shoulder Pain in Individuals with a Spinal Cord Injury: A Pilot Study. *Top. Spinal Cord Inj. Rehabil.* **2013**, *19*, 311–323.
100. Tognolo, L.; Coraci, D.; Fari, G.; Vallenari, V.; Masiero, S. Validity of ultrasound rectus femoris quantitative assessment: A comparative study between linear and curved array transducers. *Eur. J. Transl. Myol.* **2022**, *32*, 11040.
101. Schillizzi, G.; Alviti, F.; D'Ercole, C.; Elia, D.; Agostini, F.; Mangone, M.; Paoloni, M.; Bernetti, A.; Pacini, P.; Polti, G.; et al. Evaluation of plantar fasciopathy shear wave elastography: A comparison between patients and healthy subjects. *J. Ultrasound* **2021**, *24*, 417–422. [\[CrossRef\]](#)
102. Fari, G.; Santagati, D.; Pignatelli, G.; Scacco, V.; Renna, D.; Casciarano, G.; Vendola, F.; Bianchi, F.P.; Fiore, P.; Ranieri, M.; et al. Collagen Peptides, in Association with Vitamin C, Sodium Hyaluronate, Manganese and Copper, as Part of the Rehabilitation Project in the Treatment of Chronic Low Back Pain. *Endocr. Metab. Immune Disord. Drug Targets* **2022**, *22*, 108–115. [\[CrossRef\]](#)
103. Megna, M.; Marvulli, R.; Fari, G.; Gallo, G.; Dicuonzo, F.; Fiore, P.; Ianieri, G. Pain and Muscles Properties Modifications after Botulinum Toxin Type A (BTX-A) and Radial Extracorporeal Shock Wave (rESWT) Combined Treatment. *Endocr. Metab. Immune Disord. Drug Targets* **2019**, *19*, 1127–1133.

104. Fari, G.; Santagati, D.; Macchiarola, D.; Ricci, V.; Di Paolo, S.; Caforio, L.; Invernizzi, M.; Notarnicola, A.; Megna, M.; Ranieri, M. Musculoskeletal pain related to surfing practice: Which role for sports rehabilitation strategies? A cross-sectional study. *J. Back Musculoskelet. Rehabil.* **2022**, *35*, 911–917. [[CrossRef](#)]
105. de Sire, A.; Ammendolia, A.; Lippi, L.; Fari, G.; Cisari, C.; Invernizzi, M. Percutaneous electrical nerve stimulation (pens) as a rehabilitation approach for reducing mixed chronic pain in patients with musculoskeletal disorders. *Appl. Sci.* **2021**, *11*, 4257.

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