Shoulder pain and ultrasound findings: A comparison study of wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users

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Abstract

**Background:** Shoulder pain is one of the most common musculoskeletal concerns in manual wheelchair users including among athletes. However, there is a paucity of research characterizing both shoulder pain and shoulder pathology in this population.

**Objective:** To characterize and compare the prevalence of current shoulder pain and ultrasound metrics of shoulder pathology between wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users.

**Design:** Cross-sectional.

**Setting:** Chicago-area adaptive sport teams/programs and musculoskeletal clinics.

**Participants:** Thirty-four wheelchair athletes, six nonathletic wheelchair users, and 12 nonwheelchair users.

**Methods:** Self-reported shoulder pain was assessed by questionnaire and Wheelchair User Shoulder Pain Index (WUSPI). Shoulder physiology and pathology were assessed by physical and ultrasound evaluation of both shoulders by a sports medicine physician.

**Main Outcome Measures:** Questionnaire outcomes: Prevalence of current shoulder pain, total WUSPI score. Physical examination outcomes: total Physical Examination of Shoulder Scale (PESS) score. Sonographic outcomes: Acromiohumeral distance (AHD) and presence of shoulder pathology.

**Results:** The majority of wheelchair athletes (68%) and nonathletic wheelchair users (67%) experienced shoulder pain since using a manual wheelchair. Wheelchair basketball players had a mean WUSPI score of 17.2 (SD = 21.8), and athletes participating in handcycling, sled hockey, and quad rugby had mean scores of 4.91 (SD = 8.32), 7.76 (SD = 13.1), and 4.29 (SD = 7.75), respectively. Shoulder pathology was observed in 14 of 31 (45%) wheelchair athletes and 4 of 6 (67%) nonathletic wheelchair users (p = .41).

**Conclusions:** Although wheelchair use is a risk factor for shoulder pain, participation in amateur wheelchair sports may not be associated with increased risk of shoulder pain. It is possible that overhead sports such as wheelchair basketball may define a unique high-risk group. Further study is needed to examine this relationship and to determine whether there are differences between specific wheelchair sports.

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INTRODUCTION

Adaptive sports, particularly wheelchair sports, have seen substantial growth in participation and popularity in the last few decades. Competition at the Paralympic Games has intensified, and the number of community wheelchair sports programs have increased. As such, a better understanding of the injuries and illnesses affecting wheelchair athletes is needed. The International Paralympic Committee implemented an injury and illness surveillance system to collect data on injuries affecting Paralympic athletes. However, there are minimal studies examining injuries in individuals competing at the non-Paralympic level.

Shoulder pain is one of the most common musculoskeletal concerns among manual wheelchair users including wheelchair athletes. Wheelchair users have increased use of the shoulder during activities of daily living, such as transfers, mobility, and pressure relief. Studies in paraplegic individuals have shown a significantly higher prevalence of shoulder pain compared to able-bodied individuals, with documented prevalence estimates ranging from 40% to 78%. In addition, there are many studies that show a significantly higher rate of rotator cuff tears among paraplegic individuals. The increased prevalence of shoulder pain and injury in this population is likely related to increased demands on the shoulder leading to repetitive overuse of the stabilizing structures of the shoulder joint. Inability to rest the shoulder and lack of targeted shoulder strengthening programs may cause compensatory muscle imbalances putting the shoulder at further risk of injury such as rotator cuff impingement syndrome.

Only a few studies have investigated the prevalence and characteristics of shoulder pain in the population of athletic wheelchair users. The shoulder is the most commonly injured body part in wheelchair athletes, and studies examining shoulder pain prevalence among wheelchair athletes report estimates anywhere from 16% to 76%. The current literature presents conflicting evidence with respect to the relationship between participation in wheelchair sports and shoulder pain or injury. Some studies have suggested that athletic involvement is protective against shoulder pain, whereas others have found no difference between athletes and nonathletes. A recent study suggested that athletic involvement may put wheelchair users at increased risk of rotator cuff tear compared to nonathletes.

A commonly used and well-established research tool used to study shoulder pain and function in wheelchair users is the Wheelchair User Shoulder Pain Index (WUSPI). This instrument has been used frequently in prior research studies in wheelchair athletes to detect and monitor shoulder symptoms and accompanying loss of function by wheelchair users. Only one prior study used the WUSPI to compare wheelchair basketball players with nonathletic wheelchair user and found no difference in shoulder pain via WUSPI score; however, further studies are needed.

The most common imaging modalities used to evaluate shoulder pathology in these populations are magnetic resonance imaging and/or musculoskeletal ultrasound. Ultrasound has been increasingly popular because of low cost, portability, and ability to provide real-time, dynamic information. Ultrasound imaging has been shown to be comparable to magnetic resonance imaging for detecting soft tissue shoulder pathologies when images are obtained by an experienced sonographer. One measurement that is commonly used in radiology to help indicate rotator cuff pathology is the acromiohumeral distance (AHD). Prior literature has shown that a narrower AHD is indicative of rotator cuff pathology and shoulder impingement symptoms in a cohort of nonwheelchair users. Although AHD is not typically measured as part of a standard of care ultrasound examination, recent studies have shown that ultrasound can reliably measure this feature. To date, there have been no studies examining AHD in the wheelchair athlete population and very few studies examining the relationship between AHD measurements under ultrasound and shoulder pain or other physical exam findings.

At present there is a limited understanding as to the relationship between sports participation and the prevalence of shoulder pain in manual wheelchair users. The overall objective of the present study, therefore, is to compare the presence of shoulder pain between wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users and examine differences in physical exam findings as ultrasound metrics under correlation with AHD.

METHODS

This observational cross-sectional study was approved by the institutional review board at our institution.

Participants

Wheelchair athletes were defined as individuals participating regularly on competitive wheelchair sport teams.
Wheelchair athletes were recruited from several local adaptive sports teams located in the Chicago area including handcycling, wheelchair basketball, quad rugby, and sled hockey teams. We recruited only individuals who were members of these competitive adaptive sports team that practiced regularly and participated in competition. For the purposes of the study, sled hockey was considered a wheelchair sport although athletes use a sled on ice instead of a wheelchair. Nonathlete wheelchair users were defined as full-time wheelchair users (used wheelchair for all mobility and transfers) who reported no current or past participation in an organized adaptive sport and were recruited from a local research database. In order to achieve an age distribution comparable to wheelchair athletes, nonathletic wheelchair participants over 50 years of age were excluded. After wheelchair athletes and nonathletic wheelchair users were enrolled, the median age range was established and used as inclusion criteria to enroll nonwheelchair users from able-bodied faculty, staff, and medical volunteers at our institution. Exclusion criteria included inability to complete English-language questionnaires or history of prior shoulder surgery.

Questionnaires

All participants completed surveys assessing demographics, shoulder injury history, and sports participation history. Surveys collected information regarding patient age, gender, body mass index, handedness, years of manual wheelchair use, hours/day spent in manual wheelchair, diagnosis, participation in regular shoulder strengthening exercises, wheelchair sport played, years playing sport, months per year spent training, and hours/week spent training. Participants also provided information whether they currently had shoulder pain, whether they ever had shoulder pain during the time they used a wheelchair, and how many times in the last 12 months they had to sit out because of shoulder pain. Both athletic and nonathletic wheelchair users also completed the WUSPI, a 15-item, self-reported instrument measuring shoulder pain during activities of daily living. Rate of shoulder pain was assessed by yes/no answer regarding presence of current shoulder pain at time of survey. Individuals who were physically unable to complete the survey gave their responses verbally with research staff assistance.

Physical examination

Both shoulders were examined by one of two sports medicine physiatrists using the Physical Examination of Shoulder Scale (PESS). PESS was first used and created in a spinal cord injury population to better quantitatively assess shoulder physical exam findings. The PESS score is a composite of totals from 11 physical exam tests commonly used in clinical practice. These maneuvers include (1) palpation over the bicipital groove/biceps tendon, (2) palpation over the greater tuberosity/supraspinatus tendon, (3) palpation over the acromioclavicular joint, (4) Neer test, (5) Hawkins-Kennedy impingement sign, (6) painful arc, (7) supraspinatus (empty can) test, (8) resisted external rotation, (9) resisted internal rotation, (10) O’Brien test for labrum, and (11) O’Brien test for acromioclavicular joint. All physical examinations in both wheelchair and nonwheelchair users were performed with the participant in the seated position. Examiners were blinded to the results of the questionnaires and ultrasound findings.

Ultrasound examination

Both shoulders in each participant underwent ultrasound examination by a sports medicine physician experienced with sonographic technique. This practitioner was blinded to other parts of the study. A Mindray (Mahwah, NJ) TE7 ultrasound machine with a linear probe was used to collect images on seated participants. Ultrasound images were used to obtain AHD and to identify pathology. The following structures were imaged: acromioclavicular joint, biceps tendon, subscapularis, supraspinatus tendon, and subacromial bursa. Presence of pathology - defined as partial or complete tendon tear, tendinopathy, or bursitis - was determined by a sports medicine physician in a blinded fashion at a later date by reviewing saved ultrasound images. Pathology was defined as being present or absent. Two handcycling athletes and one sled hockey athlete declined the ultrasound evaluation.

AHD was defined as the smallest distance between the most inferior aspect of the acromion and the most superior aspect of the humeral head (Figures 1–3). Bony landmarks were manually identified by a licensed sports medicine physician blinded to other individual measures. The distance between landmarks was measured using MATLAB software (Mathwork, Natick, MA, USA) using our own unique script by converting the number of pixels between landmarks into a unit of length (Mindray N.A, Mahwah, NJ, USA). To convert the AHD in “pixels” seen on Matlab software into “cm” scale, we calculated a scale ratio from the “unit of length” provided by the US machine. AHD was measured with the shoulder in a neutral position, 60° of active arm abduction (AHD A60), and 60° of passive arm abduction (AHD P60).

Statistical analysis

Categorical and continuous variables were described as frequency (%) and mean, SD, respectively.
Two-sided, independent sample t-tests were used to make comparisons of interest. Statistical significance was evaluated at the .05-alpha level. Analyses were performed in R Version 3.6.3. using the “Compare Groups” package.49

RESULTS

Participant characteristics

A total of 34 wheelchair athletes, 6 nonathletic wheelchair users, and 12 nonwheelchair users were enrolled in this study. We sampled athletes from handcycling (N = 8), sled hockey (N = 9), quad rugby (N = 9), and wheelchair basketball (N = 8) teams. Athletes, nonathletes, and nonwheelchair users were similar in gender and body mass index. Nonathletic wheelchair users were somewhat older (mean: 43 years, SD: 12.4 years) compared to wheelchair athletes (mean: 35.8 years, SD: 8.76 years) and nonwheelchair users (mean: 30.4 years, SD: 6.49 years; Table 1).

Among wheelchair users, nonathletic participants had been using a wheelchair for longer (mean: 21.2 years, SD: 9.2 years) than wheelchair athletes (15.3 years, SD: 11.1 years), but hours per day spent in a manual wheelchair were similar. A higher percentage of wheelchair athletes participated in regular shoulder strengthening and injury prevention exercises (58.8%) compared to nonathletic wheelchair users (16.7%; Table 2). Years of competitive play, months of training per year, and hours of training per week are presented by sport in Table S1.

Shoulder pain prevalence, WUSPI, PESS

The majority of wheelchair athletes (68%) and nonathletic wheelchair users (67%) had a history of shoulder pain since using a manual wheelchair. We observed a nonsignificant doubling in WUSPI score among wheelchair athletes (mean: 8.39, SD: 14.1) compared to nonathletes (mean: 4.10, SD: 5.81; p value = .221). However, nonathletic wheelchair users (50%) had a higher rate of shoulder pain compared to wheelchair athletes (29.4%; p = .370), although this finding was not statistically significant. PESS scores were similar between groups (Table 3). Wheelchair users (32.5%) had a higher rate of shoulder pain...
compared to nonwheelchair users (0%; \( p = .024 \)) as well as higher PESS score in both dominant (\( p = .001 \)) and non-dominant shoulders (\( p = .004 \)) (Table 4).

Shoulder pain point prevalence was similar across sports: handcycling (25%), sled hockey (22.2%), quad rugby (33.3%), and wheelchair basketball (37.5%), but WUSPI scores were substantially higher in wheelchair basketball athletes (mean: 17.2, SD: 21.8) compared to other sports (handcycling: mean = 4.91, SD = 8.32; sled hockey: mean = 7.76, SD = 13.1; quad rugby: mean = 4.29, SD = 7.75). Dominant shoulder PESS scores were also higher in wheelchair basketball athletes (mean = 3.0, SD = 3.82) than in athletes participating in other sports (handcycling: mean = 1.57, SD = 2.15; sled hockey: mean = 2.0, SD = 3.50; quad rugby: mean = .56, SD = .88). A similar trend was observed on the nondominant arm (Table 5).

### Ultrasound findings

On ultrasound evaluation, 67% of nonathletic wheelchair users demonstrated at least one pathological finding compared to 45% of wheelchair athletes. There were no differences in type of shoulder pathology seen under ultrasound between groups. Pathology seen under ultrasound included biceps tendinopathy or partial tear, subscapularis partial tear, supraspinatus tendinopathy or partial tear, thickening of subacromial bursa, and acromioclavicular joint cortical irregularity.
AHD neutral, AHD active 60, and AHD passive 60 measurements were comparable between athletic and nonathletic wheelchair users in both dominant and nondominant shoulders (Table 3). A similar trend was observed across all wheelchair sports (Table 5).

Of the 40 wheelchair participants, 18 (49%) had a pathological finding on ultrasound whereas only 4 (36%) nonwheelchair users had a pathological finding. Compared to nonwheelchair users, wheelchair users had higher dominant-shoulder AHD in active 60 (mean = 0.95, SD = 0.26 vs mean = 0.78, SD = 0.09; p value = 0.007) and neutral positions (mean = 1.23, SD = 0.19 vs mean = 1.07, SD = 0.14; p value = 0.038). Although not statistically significant, AHD scores among wheelchair users were also higher in the passive position and in all positions in the nondominant arm.

We observed no association between AHD and WUSPI score among wheelchair users (Table S2).

**DISCUSSION**

This is the first study to characterize and directly compare both the prevalence of shoulder pain and shoulder ultrasound findings between wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users at the same time.

Prior studies have arrived at conflicting conclusions regarding whether participation in a wheelchair sport puts wheelchair users at increased risk for shoulder pain. We observe a nonsignificant doubling of WUSPI score among athletic wheelchair users compared to nonathletic wheelchair users. The large, but nonsignificant, difference in effect size between the two groups appears to be driven by the wheelchair basketball population. Overall, our data do suggest that participation in wheelchair sports is not associated with an increase in daily shoulder pain compared to nonparticipation. However, the possibility remains that the overhead motions unique to wheelchair basketball may be associated with different pain outcomes than other wheelchair sports. Future studies need to be done to look at this further as our sample size was very small.

Prior studies have used ultrasound in wheelchair athletes (tennis, table tennis, and archery) to study differences in shoulder pathological disease patterns.50,51 However prior studies have not compared ultrasound findings across different levels of athletic involvement and to nonwheelchair users. The ultrasound assessments used in this study included typical tendinous ultrasound shoulder structure evaluations performed clinically in addition to measurement of AHD, which is a more novel assessment in this population. We observed no evidence that participating in wheelchair sports increases the risk of structural damage to the shoulder. Prevalence of pathological findings were comparable between athletic and nonathletic wheelchair users, and no substantial differences in AHD or PESS measurements were observed. In addition, there were no substantial differences in prevalence or types of shoulder pathology found between wheelchair users and nonwheelchair users. This supports multiple other imaging studies noting that evidence of structural pathology on imaging does necessarily correlate with pain or clinical presentation.52-57 In general, all pathological findings seen on ultrasound should also be evaluated in the context of history and physical exam findings.

Compared with nonathletic wheelchair users, wheelchair athletes reported increased participation in regular shoulder strengthening exercises/training, which may provide some protection from the development of shoulder pain despite the increased upper extremity use by wheelchair sports participants. Of particular note, individuals who engage in wheelchair

### Table 4: Comparison of shoulder pain and ultrasound findings between wheelchair users and nonwheelchair users

<table>
<thead>
<tr>
<th></th>
<th>Wheelchair user (N = 40)</th>
<th>Nonwheelchair user (N = 12)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current shoulder pain prevalence (%)</td>
<td>13 (32.5%)</td>
<td>0 (0.00%)</td>
<td>.024</td>
</tr>
<tr>
<td>Dominant shoulder PESS score (SD)</td>
<td>1.69 (2.72)</td>
<td>0.08 (0.29)</td>
<td>.001</td>
</tr>
<tr>
<td>Nondominant shoulder PESS score (SD)</td>
<td>1.67 (3.00)</td>
<td>0.17 (0.39)</td>
<td>.004</td>
</tr>
<tr>
<td>Pathological finding on ultrasound (%)</td>
<td>18 (48.6%)</td>
<td>4 (36.4%)</td>
<td>.709</td>
</tr>
<tr>
<td>Dominant AHD A60 score (SD)</td>
<td>0.95 (0.26)</td>
<td>0.78 (0.09)</td>
<td>.007</td>
</tr>
<tr>
<td>Dominant AHD neutral score (SD)</td>
<td>1.23 (0.19)</td>
<td>1.07 (0.14)</td>
<td>.038</td>
</tr>
<tr>
<td>Dominant AHD P60 score (SD)</td>
<td>1.00 (0.27)</td>
<td>0.95 (0.23)</td>
<td>.666</td>
</tr>
<tr>
<td>Nondominant AHD A60 score (SD)</td>
<td>0.96 (0.27)</td>
<td>0.88 (0.11)</td>
<td>.225</td>
</tr>
<tr>
<td>Nondominant AHD Neutral score (SD)</td>
<td>1.23 (0.21)</td>
<td>1.19 (0.12)</td>
<td>.499</td>
</tr>
<tr>
<td>Nondominant AHD P60 score (SD)</td>
<td>0.99 (0.24)</td>
<td>0.94 (0.17)</td>
<td>.555</td>
</tr>
</tbody>
</table>

Abbreviations: A60, Active 60° (arm held actively abducted 60°); AHD, acromiohumeral distance; P60, passive 60° (arm held passively abducted 60°); PESS, Physical Exam Shoulder Scale (increased score = more pain).
sports have been shown to have improved overall health, employment status, mood, and quality of life. Although shoulder strengthening itself may not contribute to these global improvements, it likely does affect overall function in everyday life.

Our report is also the first to compare the presence of shoulder pain and pathology across wheelchair sports, including handcycling, sled hockey, quad rugby, and wheelchair basketball. Prior research has shown that risk factors of shoulder pain include increased age, wheelchair use duration, and trunk control. However, there has not been much literature to compare different wheelchair sports and risk of development of shoulder pain and pathology. Each wheelchair sport is unique and the athletes use their upper extremities in different ways to propel themselves and engage in gameplay. Wheelchair basketball requires overhead movements in addition to propulsion efforts. One prior study by Akbar et al showed that those who participated in overhead sports showed an estimated 2-fold risk increase to developing rotator cuff tears. In our study, wheelchair basketball players reported higher WUSPI scores (more pain with daily functional activities) and showed trend for higher PESS scores (more pain with physical exam of the shoulder) compared to other sports, although hypothesis testing was not performed because of sample size. Repetitive overhead motion may be more injurious than nonoverhead motion and may put participants at increased risk for shoulder impingement, rotator cuff injury, and pain. Although we observed no evidence of increased structural shoulder injury among wheelchair basketball players compared to other athletes, further studies with higher power may be needed to evaluate this further.

As described earlier, decreased AHD has been shown to be a measure of rotator cuff abnormality or shoulder impingement. Given prior studies had shown reliability of this measure under ultrasound, we thought it would be interesting to compare AHD measurements between the different groups. Compared to nonwheelchair users, wheelchair users had increased dominant-arm AHD in the neutral position and active 60° position. This is opposite to what we would have expected because, similar to prior studies, our study showed higher prevalence of shoulder pain among wheelchair users compared to nonwheelchair users, which would mean we would have expected decreased AHD measurement. It is unclear if this result has any clinical significance. It is possible that normal healthy controls may have different normative values compared to manual wheelchair users who use their shoulders every day in weightbearing activities. We observed no evidence that AHD measurements are associated with pain outcomes, possibly owing to lack of statistical power.

This study is subject to a number of limitations. First, our sample size is very limited; the regional

<table>
<thead>
<tr>
<th></th>
<th>Handcycling (N = 8)</th>
<th>Sled Hockey (N = 9)</th>
<th>Quad Rugby (N = 9)</th>
<th>Wheelchair Basketball (N = 8)</th>
<th>Nonathletic WCU (N = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current shoulder pain (%)</td>
<td>2 (25.0%)</td>
<td>2 (22.2%)</td>
<td>3 (33.3%)</td>
<td>3 (37.5%)</td>
<td>3 (50.0%)</td>
</tr>
<tr>
<td>WUSPI score (SD)</td>
<td>4.91 (8.32)</td>
<td>7.76 (13.1)</td>
<td>4.29 (7.75)</td>
<td>17.2 (21.8)</td>
<td>4.10 (5.81)</td>
</tr>
<tr>
<td>Dominant shoulder PESS score (SD)</td>
<td>1.57 (2.15)</td>
<td>2.00 (3.50)</td>
<td>0.56 (0.88)</td>
<td>3.00 (3.82)</td>
<td>1.33 (1.97)</td>
</tr>
<tr>
<td>Nondominant shoulder PESS score (SD)</td>
<td>1.43 (2.07)</td>
<td>0.67 (1.32)</td>
<td>1.11 (2.32)</td>
<td>2.25 (4.46)</td>
<td>3.50 (4.14)</td>
</tr>
<tr>
<td>Pathological finding on ultrasound (%)</td>
<td>3 (50.0%)</td>
<td>4 (50.0%)</td>
<td>4 (44.4%)</td>
<td>3 (37.5%)</td>
<td>4 (66.7%)</td>
</tr>
<tr>
<td>Dominant AHD A60 score (SD)</td>
<td>0.81 (0.20)</td>
<td>0.96 (0.24)</td>
<td>1.08 (0.28)</td>
<td>0.94 (0.23)</td>
<td>0.89 (0.30)</td>
</tr>
<tr>
<td>Dominant AHD neutral score (SD)</td>
<td>1.02 (0.10)</td>
<td>1.25 (0.09)</td>
<td>1.30 (0.15)</td>
<td>1.18 (0.16)</td>
<td>1.33 (0.31)</td>
</tr>
<tr>
<td>Dominant AHD P60 score (SD)</td>
<td>0.78 (0.18)</td>
<td>1.10 (0.29)</td>
<td>1.04 (0.25)</td>
<td>0.95 (0.23)</td>
<td>1.06 (0.34)</td>
</tr>
<tr>
<td>Nondominant AHD A60 score (SD)</td>
<td>0.84 (0.29)</td>
<td>1.02 (0.30)</td>
<td>1.03 (0.26)</td>
<td>0.89 (0.19)</td>
<td>0.96 (0.32)</td>
</tr>
<tr>
<td>Nondominant AHD neutral score (SD)</td>
<td>1.15 (0.24)</td>
<td>1.22 (0.20)</td>
<td>1.22 (0.18)</td>
<td>1.26 (0.13)</td>
<td>1.31 (0.34)</td>
</tr>
<tr>
<td>Nondominant AHD P60 score (SD)</td>
<td>0.83 (0.20)</td>
<td>1.06 (0.24)</td>
<td>1.06 (0.26)</td>
<td>0.92 (0.20)</td>
<td>1.04 (0.28)</td>
</tr>
</tbody>
</table>

Abbreviations: A60, active 60° (arm held actively abducted 60°); AHD, acromiohumeral distance; P60, passive 60° (arm held passively abducted 60°); PESS, Physical Exam Shoulder Scale (increased score = more pain); WCU, wheelchair user; WUSPI, Wheelchair User Shoulder Pain Index (increased score = more pain).
CONCLUSIONS

This study is the first to compare shoulder pain and to characterize shoulder ultrasound findings between wheelchair athletes, nonathletic wheelchair users, and nonwheelchair users. Results of this cross-sectional study suggest that participation in wheelchair sports may not increase the risk of shoulder pain and pathology when evaluating these studied sports together. However, if we evaluate each sport individually, wheelchair basketball may be an exception given the unique demands of the sport on the shoulder. We observed a nonsignificant trend that participation in wheelchair basketball may increase risk of developing shoulder pain, but a larger study comparing different wheelchair sports is needed. This study’s findings support prior studies demonstrating that wheelchair users (both athletes and nonathletes) have increased prevalence of shoulder pain and positive physical exam findings compared to nonwheelchair users. Longitudinal follow-up of these individuals over a significant period of time in a larger cohort may aid in characterizing the relationship between sports and shoulder pain in this population and further clarify the use of the ultrasound metrics as predictive markers of future pathology.

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REFERENCES


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