Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 01 July 2026
Revised 04 Aug 2026
Accepted 17 Aug 2026

Natural Resources for Human Health 2026, Vol. 6 (18s): 454–459

KEYWORDS:
Shoulder pain, RCRSP, strength, rotator cuff, SPADI.

The Association Between Shoulder Pain and Rotator Cuff Strength Loss: A Cross-Sectional Study

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ABSTRACT: Background: Rotator cuff-related shoulder pain (RCRSP) is the most common shoulder complaint. The interplay between shoulder pain and rotator cuff (RC) strength loss needs further investigation.

Objective: To investigate the association between shoulder pain intensity and RC muscle strength deficits among patients with RCRSP, to clarify whether pain-related inhibition contributes to functional impairment.

Methods: Fifty patients with RCRSP had enrolled to this study from orthopedic physiotherapy outpatient clinic, with mean age of 35 years. They were assessed for shoulder pain and disability using shoulder pain and disability index (SPADI) and isometric RC strength using hand-held dynamometer (HHD).

Results: There was significant, negative, fair correlation between isometric strength of supraspinatus, infraspinatus/teres minor, and subscapularis and shoulder pain and disability ($r=-0.29$ to -0.41, $P<0.05$).

Conclusion: Rotator cuff isometric strength deficits were evident in patients with RCRSP and were more closely related to pain. These findings suggest that early rehabilitation may emphasize pain reduction together with active exercises.

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INTRODUCTION

Shoulder pain affects up to 55% of the populations with incidence of up to 62/1000 person-year (Lucas et al., 2022). Rotator cuff-related shoulder pain (RCRSP) is the most common form of shoulder pain, presenting in 72% of all patients with shoulder pain (Tekavec et al., 2012; Zedan et al., 2018). The RCRSP encompasses rotator cuff tendinopathies (including calcific type) and partial and/or age-related, symptomatic tears, subacromial pain/impingement syndrome, and bursitis (Lewis, 2016; Lafrance et al., 2022). They share a common presentation of shoulder pain and impaired mobility and function especially with shoulder flexion, abduction, and external rotation (Lewis, 2016). In Egypt, one-year prevalence of shoulder pain from shoulder pathologies was 6.2% with 56.4% of them was rotator-cuff related (Samir et al., 2022).

The RCRSP can be classified clinically into irritable (characterized by easily aggravated and prolonged pain after provoking and night pain), non-irritable (characterized by pain/weakness more with elevation and external rotation, with no/minimal irritability, and end stage or advanced (characterized by massive and inoperable tears). Age, comorbidities, life style, loading, symptom duration can affect RCRSP (Lewis, 2016).

Shoulder pain can cause arthrogenic muscle inhibition (AMI)-a reflexive reduction in muscle activation from joint pain and swelling-that leads to muscle weakness in absence of structural failure/tear. This may lead to secondary injury if continued (Hopkins & Ingersoll, 2000). Rotator cuff muscle weakness or imbalance is a contributing factor for shoulder impingement and pain (Zedan et al., 2018).

Although, some studies (Beach et al., 1992; Reddy et al., 2000; Stackhouse et al., 2013; Manoso-Hernando et al., 2025) had addressed the relation between rotator cuff muscles, strength and shoulder pain and disability, they were limited by not studying all muscles (e.g. abductors) and disability (Stackhouse et al., 2013; Manoso-Hernando et al., 2025), including full tears (Manoso-Hernando et al., 2025), not controlling individual factors and hence not determining the exact functional/strength loss from the pain (Stackhouse et al., 2013; Manoso-Hernando et al., 2025), studying effect of acute, experimental pain (Stackhouse et al., 2013), one movement direction (scaption or external rotation) (Reddy et al., 2000; Stackhouse et al., 2013) and athletes (Beach et al., 1992), and using indirect, less clinical tool for force/strength assessment (Reddy et al., 2000). In addition to that, these studies showed contrasting findings. The current study aims to address these limitations.

Despite the success of the current available treatments for RCRSP (Zedan et al., 2028), symptoms may persist and recur, calling for a need for further assessment of this condition. In addition to that, depending entirely on magnetic resonance and ultrasonography can lead to wrong diagnosis and surgery as they usually show tears in asymptomatic subjects that also not correlated well with pain level (Lewis, 2016).

Understanding the interaction between pain and strength loss is therefore critical for designing effective rehabilitation strategies, as interventions targeting pain relief alone may not restore optimal muscle function, and strengthening programs may be limited by pain tolerance.

The aim of this study was to investigate the association between shoulder pain and disability and RC muscle strength deficits in patients with RCRSP. It was hypothesized that there would be significant correlation between shoulder pain and disability and RC isometric strength.

METHODS

Study design and setting:

This is a cross-sectional study that was conducted at the physiotherapy outpatient clinic of a university hospital. It was approved by IRB of faculty of Medicine-Zagazig University (ZU-IRB no. 2423/20-May-2026).

Eligibility criteria:

Fifty patients with RCRSP referred by orthopedists were enrolled in this study. They were included if they were adults (male and female >18 years), had subacute or chronic pain (>2weeks; as acute pain may limit assessment), had subacromial pain/impingement, shoulder bursitis, or rotator cuff tendinopathy, tendinitis or partial tear.

They were excluded if they had neuropathy, cancer, infection, frozen shoulder, macro-instability, rheumatoid arthritis, advanced osteoarthritis, full thickness rotator cuff tear (despite being one cause of RCRSP, it is excluded as it was studied before and not

usually a primary conservative/physiotherapy focus), cervical radiculopathy, history of spinal or upper limb fractures, trauma, surgery, or injection (<3 months).

Procedure:

Assessment of RC muscles, isometric strength:

Supraspinatus: patients were tested in standing position and were asked to hold their tested shoulder in 90-degrees scaption. Resistance was provided against further elevation, placing the dynamometer at three finger widths proximal to the styloid process of the radius.

Infraspinatus/Teres minor: patients were tested in supine position with arm by side, elbow flexed 90 degrees, and the tested shoulder in neutral rotation. The dynamometer was placed three finger widths proximal to the wrist crease dorsally. Patients were asked to perform external rotation against the device that was fixed by the wall, hold 5 seconds, and rest 10 seconds between repetitions. Average of three measurements of maximum strength were taken (in kilograms).

Subscapularis: patients were tested in supine position with arm by side, elbow flexed 90 degrees, and the tested shoulder in neutral rotation. The dynamometer was placed three finger widths proximal to the wrist crease ventrally. Patients were asked to perform internal rotation against the device that was fixed by a belt, hold 5 seconds, and rest 10 seconds between repetitions. Average of three measurements of maximum strength were taken (in kilograms).

Patients rested 1-2 minutes between measurements (or movement directions). The HHD is valid and reliable in measuring RC strength among patients with shoulder pathologies (Sørensen et al., 2020; Custódio et al., 2025).

Assessment of shoulder pain and disability:

Patients were asked to fill the Arabic-shoulder pain and disability index (SPADI) with the help of the researcher as needed. It is a self-reported and shoulder-specific questionnaire measuring pain (5 items) and disability (8 items) for shoulder pain patients. Item were scored on visual analogue scale (VAS) and measured with a ruler. Scores were summed for each section (pain and disability) separately. Arabic version of SPADI is valid and reliable in assessing pain and disability in patients with shoulder dysfunction (Alsanawi et al., 2015).

Statistical analysis:

Data were represented as means (±SD) for continuous variables and count (%) for categorical variables. The correlation between shoulder pain and disability and RC isometric strength were analyzed using Pearson's correlation coefficient as normality test showed that the variables did not violate the assumption of normality. SPSS version 27 (IBM Inc.) was used with the p-value set at ≤ 0.05. Correlation coefficients were interpreted as follows; ≤0.2=poor, 0.3-0.5=fair, 0.6-0.7=moderate, 0.7-0.9=strong, and 0.8-0.9=very strong (Akoglu, 2018).

Sample size was calculated using G*Power v3.1.9.7 (Franz Faul, Universität Kiel, Germany). Assuming a moderate correlation8 ($r = 0.39$) between shoulder pain and infraspinatus muscle activity, with $\alpha = 0.05$ and 80% power, the required sample size was 50 participants.

RESULTS

Figure 1 shows patients who were screened, assessed, and analysed.

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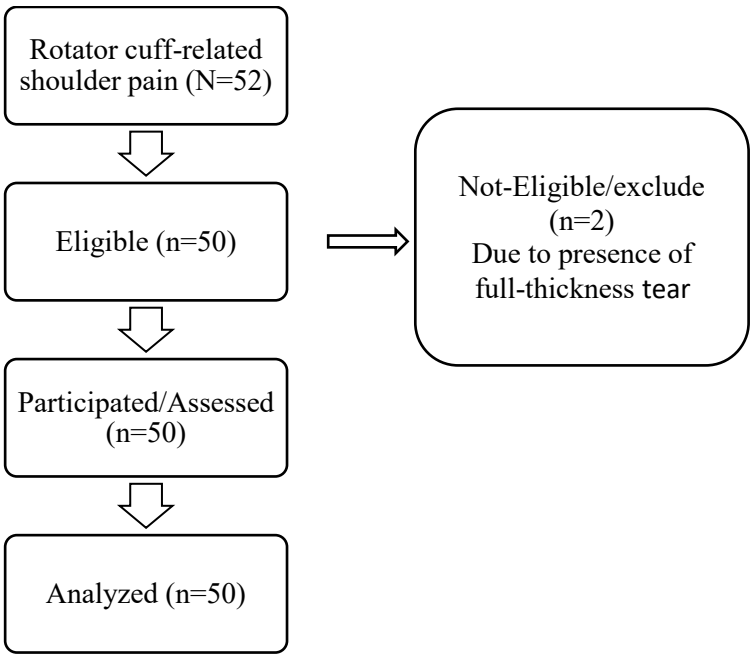


Figure 1. Participants flow chart.

Baseline characteristics:

Clinical and demographic data of all patients were presented in Table (1).

Table (1): Baseline characteristics

Baseline characteristics	Mean (±SD)
Age (years)	35±1.3
BMI (kg/m²)	29±0.9
Symptom duration (months)	14±2
Gender	M=12(24%), F=38 (76%)
Dominant arm affected	54%
Supraspinatus isometric strength (kg)	2.56(±1.02)
Infraspinatus/teres minor isometric strength (kg)	4.63(±1.67)
Subscapularis isometric strength (kg)	4.7(±2)
Shoulder pain-SPADI	32.9(±10.33) points
Shoulder disability -SPADI	38.9(±17.9) points

SD: Standard deviation, M: Male, F: Female, kg: Kilogram, SPADI: Shoulder pain and disability index.

Association between RC isometric strength and shoulder pain:

There was significant, negative, fair correlation between supraspinatus, infraspinatus/teres minor, and subscapularis isometric strength and shoulder pain (r= -0.33, -0.36 and -0.41, respectively, p-value<0.05). (Table 2).

Table (2): Association between RC isometric strength and shoulder pain

RC isometric strength	Shoulder pain		
	r	p-value	95% CI
Supraspinatus isometric strength	-0.33	0.002*	(-0.63 to -0.17)
Infraspinatus/teres minor isometric strength	-0.36	0.01*	(-0.58 to -0.09)
Subscapularis isometric strength	-0.41	0.003*	(-0.62 to -0.15)

(*): Significant at p-value<0.05, r: Pearson's correlation coefficient, CI: Confidence interval.

Association between RC isometric strength and shoulder disability:

There was significant, negative, fair correlation between supraspinatus, infraspinatus/teres minor, and subscapularis isometric strength and shoulder disability (r=-0.38, -0.31, and -0.29, p-value<0.05). (Table 3).

Table (3): Association between RC isometric strength and shoulder disability

RC isometric strength	Shoulder disability		
	r	p-value	95% CI
Supraspinatus isometric strength	-0.38	0.006*	(0.60 to -0.11)
Infraspinatus/teres minor isometric strength	-0.31	0.03*	(-0.54 to -0.03)
Subscapularis isometric strength	-0.29	0.04*	(-0.52 to -0.01)

(*): Significant at p-value<0.05, r: Pearson's correlation coefficient, CI: Confidence interval.

DISCUSSION

The main aim of this study was to investigate the association between shoulder pain and disability and RC isometric strength in patients with RCRSP.

Results of this study failed to reject the hypothesis of the study of significant correlation between shoulder pain and disability and RC isometric strength in patients with RCRSP. This finding aligns with previous literature emphasizing the interplay between pain and strength deficits in shoulder pathology.

Rotator cuff muscles increases glenohumeral congruency by acting as humeral head compressor. Weak RC muscles increases superior translation of the humeral head decreasing the subacromial space during elevation and compressing the subacromial contents (Michener et al., 2003).

The present study supports the work of Struyf et al. (2013), who demonstrated that patients with SIS benefit from a 4-week shoulder stability training program, resulting in reduced pain and improved function as measured by SPADI. Similarly, Stackhouse et al. (2003) reported a 32% reduction in external rotation (ER) force in patients with painful shoulder syndromes, highlighting the functional impact of pain-related inhibition on RC strength. Muscle imbalances within the RC have been consistently associated with shoulder pain (Michener et al., 2003).

However, the findings of the current study diverge from those of Beach et al. (2005), who reported no significant correlation between shoulder pain and muscle strength, but rather a negative correlation between pain and shoulder muscle endurance. This discrepancy may reflect differences in measurement approaches, as endurance testing captures sustained performance under fatigue, whereas isometric dynamometry quantifies peak force output. Additionally, Krief & Huguet (2015) found no association between shoulder pain, disability, and the size or location of RC tears, suggesting that structural pathology alone does not fully explain functional impairment.

Taken together, these contrasting findings highlight the complexity of RCRSP, where pain, neuromuscular inhibition, and muscle imbalance interact to influence strength and disability. The present study adds to the growing body of evidence that pain-related strength deficits are clinically relevant in RCRSP and should be addressed in rehabilitation programs that combine pain management with targeted RC strengthening, rather than focusing solely on structural pathology or endurance training. This dual approach may optimize functional recovery and reduce disability in RCRSP patients.

CONCLUSION

Rotator cuff isometric strength may have a role in improving shoulder pain, disability and should be addressed in future studies.

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