Rotator Cuff Rehabilitation Exercises Improving Athletes' Functional Activity:

A Systematic Review

Authorship: Erin Rose Cruz, OTS, Bradley Huffman, OTS, Natalie Luong, OTS, Irene Nelson, OTS, Cricket Porter, OTS

Abstract: Rotator cuff injuries are amongst the most common injuries in athletes. While many rehabilitative therapists prescribe exercise to patients, we have yet to understand how it may impact functional ability. The aim of this systematic review was to answer this research question: In athletes with rotator cuff injuries, do rehabilitative exercises improve functional activity? We conducted a literature search following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Literature related to rotator cuff injuries and rehabilitative exercises, found through databases such as EBSCO, Google Scholar, and a search of the American Journal of Occupational Therapy using Hawai'i Pacific University's online library databases and resources. Five studies met the inclusion criteria. The outcomes of these studies indicate that rehabilitative exercises improve strength and range of motion and decrease pain, thus improving functional activity of athletes with rotator cuff injuries.

Importance: The glenohumeral joint is one of the most complex and important joints in the human body. However, there is very little research on how to improve the functional activities of professional and amateur athletes who rely on this joint.

Objective: The focus of this systematic review was to identify, evaluate, and synthesize the current literature concerning rotator cuff injuries to determine the efficacy of rehabilitation exercise on improving athletes' functional activity.

Data Sources: A literature search occurred between May 6, 2024 and May 10, 2024. Follow up searches were conducted on May 17, 2024. Databases included EBSCO, Google Scholar, in addition to a search of the American Journal of Occupational Therapy using Hawai'i Pacific University's online library databases. Search terms included "athletes" or "sports" or "athletics", "rotator cuff tear" or "rotator cuff injury" or "rotator cuff pain", "rehabilitative exercises", "functional outcomes", "functional activity" or "functional outcomes", as well as combinations of these terms.

Study Selection and Data Collection: This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Published studies on rotator cuff injuries and exercise rehabilitation interventions were included in the systematic review. Data from presentations, non-peer reviewed literature, and dissertations were excluded.

Findings: Five studies were included, with two being Level I studies and three being Level II studies according to the American Occupational Therapy Association's Levels of Evidence. The outcomes of these studies indicate that rehabilitative exercises improve strength and range of motion and decrease pain, thus improving functional activity of individuals with rotator cuff injuries.

Conclusion and Relevance: Rehabilitative exercises are effective and improve functional activity for athletes. By using occupational therapy assessments and interventions, practitioners can determine the functional ability of rotator cuff injuries as it results in a reduction of pain while strengthening muscles and increasing range of motion.

What This Systematic Review Adds: There are limited high quality studies that evaluate how rehabilitation exercises improve functional mobility in individuals with rotator cuff injuries. This systematic review provides a starting point for evaluating the efficacy of rehabilitation exercises in occupational therapy practice. More research is needed to examine different exercise protocols, figure out the best duration and intensity for rehabilitation exercises, and understand the long-term effects of various treatments. Furthermore, future research should include larger sample sizes and broader populations.

Key words: athletes, rotator cuff, shoulder, rehabilitative exercises, functional activity

Introduction

The glenohumeral joint is one of the most complex and important joints in the human body. This ball and socket joint is crucial to upper extremity movement. The scapula, humerus, and clavicle are the three bones involved in the joint. Surrounding the bones are the rotator cuff muscles: subscapularis, supraspinatus, infraspinatus, and teres minor. Their job is to stabilize the shoulder in all directions and movements the glenohumeral joint can produce. When these muscles fail either due to injury or disease, occupations both big and small become very hard to accomplish due to diminished upper extremity range of motion (ROM) and stability.

Rotator cuff-related pain is reported as the most common shoulder pain (Powell et al., 2022). Rotator cuff injuries can cause lifelong problems affecting all stages of life. These injuries can happen to anyone but are seen very frequently among athletes both professional and amateur. Due to the commonality and severity of rotator cuff injuries this review was necessary to help athletes of all kinds get back to their chosen occupation. The focus of this systematic review was to review literature to understand how to increase functional activity amongst athletes with a rotator cuff injury.

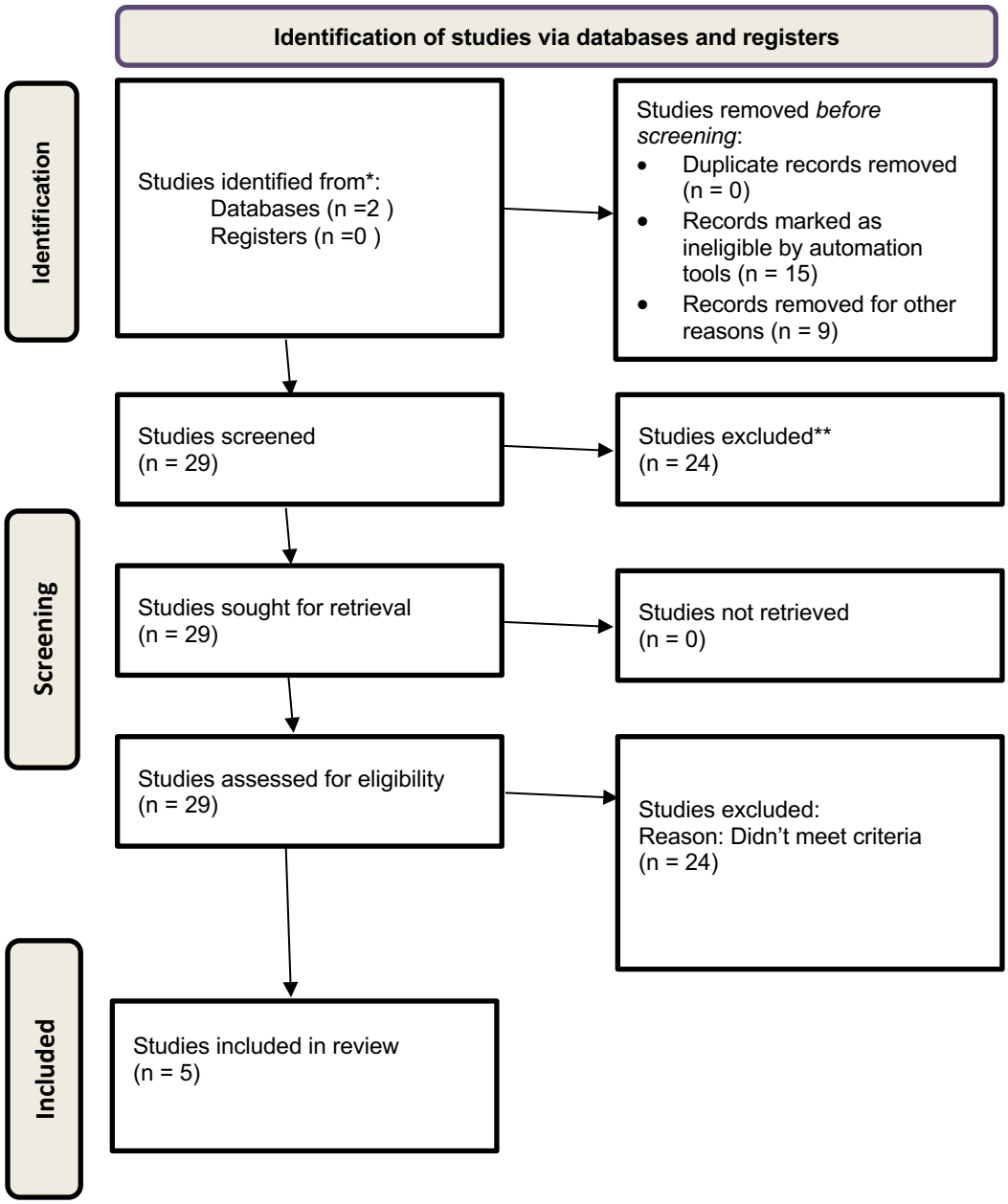
Method

The systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and incorporated recommended processes for conducting a systematic review. The guiding research question for this systematic review was: In athletes with rotator cuff injuries, do rehabilitative exercises improve functional activity?

A broad search of the literature occurred between May 6, 2024, and May 10, 2024. An additional search was conducted May 17, 2024, to ensure all relevant research was included. The inclusion criteria for studies in this systematic review were as follows: peer-reviewed, published in English, and dated between 2014-2024. Exclusion criteria, in addition to those studies that did not meet the inclusion criteria, included articles that were systematic reviews, scoping reviews, dissertations, and presentations. A search for relevant literature was completed using electronic databases: EBSCO, Google Scholar, and a search of the American Journal of Occupational Therapy through Hawai'i Pacific University's online library database. Search terms included "athletes," "sports," or "athletics"; "rotator cuff tear," "rotator cuff injury," or "rotator cuff pain"; "rehabilitative exercises"; "functional outcomes", "functional activity," or "functional outcomes" and combinations of these terms. Appendix A provides an extensive list of all search terms used for this systematic review. The initial search included five articles related to the research topic (Figure 1). Five independent reviewers completed the screening and selection of the studies, assessed their quality, and extracted the data.

Figure 1

PRISMA Flow Diagram



Results

Five studies met the inclusion criteria. The articles were assessed according to their risk of bias, level of evidence, and quality. This systematic review included five studies that contained relevant information regarding athletes with rotator cuff injuries, and how rehabilitative exercises improve functional activity. The information from these articles was divided into two themes: improved strength and ROM and decreased pain. Two were Level I

studies and three were Level II studies (see Appendix B). The Cochrane risk-of-bias guidelines were used to assess each article (see Appendix C).

Increased Strength and Range of Motion

Christensen et al. (2016) evaluated a rehabilitative exercise protocol consisting of two exercises over five months targeting muscle strength of anterior deltoid and teres minor. A hand-held dynamometer was used to test strength of shoulder abduction, flexion, and internal and external rotation. The baseline for abduction was a mean of 50.2 degrees with an increase to 62.5 degrees ($p=0.009$). The baseline for flexion was 23.5 degrees with an increase to 33.7 degrees ($p=0.036$). The exercise protocol was compared at baseline, and at 3 and 5 months. Two different exercises were performed three times a week with a correlating training log for documentation. The most improvement was shown at the 5-month mark. In addition to strength, Christensen et al. (2016) found that ROM increased significantly for abduction with the baseline starting at a mean of 93.7 degrees to 128.1 degrees. The mean difference was 34.4 degrees with a p-value of 0.005. Non-significant increases were also found for flexion and external rotation.

Dejaco et al. (2017) found that rehabilitative exercise (eccentric and conventional) increased rotator cuff muscle strength through a 12-week daily home-based regimen. The Constant Murley (CM) was used as the outcome measure to evaluate strength at baseline, and at 6, 12 and 26 weeks. The maximum CM score is 100 points, which indicates excellent shoulder function. After the intervention of rehabilitative exercises, the CM scores showed mean increases from baseline of 14.4 ($p < 0.001$) for eccentric exercise and 9.8 ($p < 0.001$) for conventional exercise. In addition to strength, the CM was also used to evaluate ROM. By the end of the 12-week exercise program and 26-week follow-up, participants showed increases in ROM (forward flexion, abduction, and external rotation) with 95% confidence intervals.

Singh et al. (2018) reported on the effects of rehabilitative exercises on strengthening external rotator muscles and trapezius muscles. The authors use raw electromyography (EMG) signals on each muscle to determine the total movement of the specific muscle. EMG activity of each muscle, namely posterior deltoid, infraspinatus, teres-minor, upper trapezius, middle trapezius, and lower trapezius muscles, was measured using Biopac System with the Ag-AgCl bipolar electrodes of 10 mm diameter. The authors used three different exercises to determine which muscles were affected. Exercise 1 was prone horizontal abduction at 90 degrees with full external rotation with thumb right up. Exercise 2 was side lying external rotation with elbow on the trunk. Exercise 3 was external rotation at 90-degree abduction and elbow flexion at 90 degrees in standing position. The results using the EMG tests yielded results that the rehabilitative exercises improved strength.

Dube et al. (2023) conducted a 12-week intervention showing that concentric and eccentric exercises are effective in improving strength in individuals with rotator cuff injuries.

Isometric strength was assessed using a handheld dynamometer. They generalize that exercises can typically improve strength, and that additional factors such as education may be beneficial.

Powell et al. (2022) conducted a survey that revealed a consensus amongst physiotherapists, commonly citing that exercise improves rotator muscle strength and recommended prescribing it to patients. They reported that nearly all respondents (99%) would prescribe exercise for rotator cuff injuries. The respondents indicated that resistance exercise was the most common type of exercise physiotherapists prescribed, with 60.8% (288 out of 474) choosing it. This type of exercise was selected about three times more often than the next most common type, motor control exercise, which was chosen by 21.5% (102 out of 474) of physiotherapists. The third most common type was a combination of the two previously stated.

Limitations of the studies on the impacts of rehabilitative exercises on strength and ROM included lack of a control group (Christensen et al., 2016), short intervention periods (Dejaco et al., 2017), small sample size (Singh et al., 2018), sample bias (Dube et al., 2023), and external validity (Powell et al., 2022).

Pain

In the survey done by Powell et al. (2022), they found that by prescribing exercises the patients reported a decrease in pain. Respondents' most selected mechanisms to explain improvements in shoulder pain included increased muscle strength (n = 293), muscle endurance (n = 239) and enhanced shoulder motor control (n = 238).

Dube et al. (2023) used interventions in this study to address the issue of kinesiophobia. In the education group, the participants were given advice on how to manage their pain as well as ways to modify activities to limit the pain. In the strengthening group, the participants were told to do weight bearing exercises, their pain levels were assessed, and exercises were adjusted accordingly. Lastly, the motor control group was given pain reduction techniques while performing motor control exercises. Overall, the interventions were aimed at reducing kinesiophobia by providing education and motor and strengthening exercises that can reduce pain and lead to less fear when moving the shoulder. Assessments were measured using the QuickDash and the Western Ontario Rotator Cuff (WORC) Index at baseline, 3 weeks, 6 weeks, 12 weeks, and 24 weeks. While all three groups showed improvement in symptoms, the addition of motor control exercises and strengthening did not result in better outcomes than the education alone.

Christensen et al. (2016), showed that rehabilitative exercises decreased pain significantly for shoulder activities including abduction, flexion, and external rotation according to the Visual Analogue Scale (VAS). Flexion at 90 degrees produced the most pain, such that the patients stopped the exercise. Reported pain from the VAS decreased for all directions except for abduction. VAS abduction saw a 2.0 mean difference, VAS flexion saw a 1.0 mean difference, and VAS external rotation saw a 0.5 mean difference. All p-values were significant ($p \leq 0.05$).

The interventions included in this study were patient education, pain management, exercise protocol, and modifying exercises according to pain and difficulty.

Dejaco et al. (2017) also used the VAS, a participant-reported pain scale ranging from 0-100 to evaluate pain during ADLs. Higher scores indicate greater pain intensity. Results showed significant decreases in VAS scores, indicating significant decreases in pain intensity due to the rehabilitative exercises (eccentric and conventional exercise).

Singh et al. (2018) used three different exercises to help strengthen and reduce pain in the masonry workers' rotator cuff muscles. Exercises that produce high rotator cuff synergy may be useful in alleviating shoulder pain. However, a further consideration of least involvement of posterior deltoid muscle while strengthening rotator cuff muscles may be a better choice to increase strength and reduce pain.

Limitations of the studies on the effects of rehabilitative exercises on pain reduction include external validity (Dube et al., 2023; Powell et al., 2022), small sample size with limited variation (Singh et al., 2018), no control group (Christensen et al., 2016; Dube et al., 2023), and limited duration of intervention period (Dejaco et al., 2017).

Discussion

The results of this systematic review suggest that rehabilitative exercises are effective to improve functional activity for individuals with rotator cuff injuries. Among the five articles were two overarching themes, improving strength and ROM and decreasing pain. All five articles concluded that rehabilitative exercises do improve functional activity of the rotator cuff.

Neuromuscular exercise programs support the improvement of rotator cuff injuries. Individuals who suffer from rotator cuff tendinopathy can benefit from eccentric and rehabilitation exercises. Strengthening exercises along with education on pain management as well as activity modification are both helpful in reducing pain symptoms in individuals who have rotator cuff injuries. Rehabilitation exercises that produce high rotator cuff synergy are shown to be useful in alleviating shoulder pain. Furthermore, physiotherapists and other experts express a consensus in prescribing rehabilitative exercises.

The findings from these articles match with previous research that rehabilitation exercise programs can improve shoulder function. Future research studies should use more standardized guidelines such as the best exercises and durations. These findings can be applied to athletes and non-athletes alike recovering from rotator cuff injuries.

Limitations

The limitations of the systematic review are consistent with the PRISMA guidelines. The synthesis of the articles was done correctly. The result was the synthesis of five articles, which was a very limited amount of data. Another 24 articles were additionally identified but were

excluded because of non-relevance. There is a possibility of other sources available that were not identified which could give more information regarding rehabilitative exercises for rotator cuff injuries. Researching articles with the date range of 2014-2024 could be a limitation as well because of the amount of information available before 2014.

Implications for Occupational Therapy Practice

From the knowledge gained from the systematic review, there are future implications for occupational therapists to implement in their scope of practice. This can be related to the implementation of rehabilitation services post sport related injury for professional and leisure athletes. In addition, evidence supports occupational therapy interventions to effectively improve the functional activity of the shoulder. The outcome measures utilized in the studies included the dynamometer for measuring strength and ROM (Christensen et al., 2016; Dube et al., 2023) as well as patient reported pain scales during ADLs (Christensen et al., 2016; Dejaco et al., 2017; Dube et al., 2023). With the success of occupational therapy interventions, future studies can be conducted in relation to the reduction of surgery and early intervention. Furthermore, other individuals with rotator cuff injuries including athletes and non-athletes, could benefit from rehabilitative exercises to improve functional activity.

- Occupational therapists have a role in providing interventions that can help improve functional activity for rotator cuff injuries
- Interventions provided by occupational therapists can improve strength and ROM as well as decrease pain
- Individuals who are non-athletes can similarly benefit from interventions to improve functional activity
- Future studies can be conducted in relation to the reduction of surgery interventions for rotator cuff injuries

Conclusion

In conclusion, all five studies used in this systematic review provide evidence that rehabilitative exercises do improve athletes' functional activity with rotator cuff injuries. Additional research is necessary to identify if rehabilitative exercises improve a non-athlete's functional activity compared to an athlete. By using occupational therapy assessments and interventions, practitioners can determine the functional ability of a patient with a rotator cuff injury as it results in a reduction of pain while strengthening muscles and increasing ROM.

References

Christensen, B. H., Andersen, K. S., Rasmussen, S., Andreasen, E. L., Nielsen, L. M., & Jensen, S.L. (2016). Enhanced function and quality of life following 5 months of exercise therapy for patients with irreparable rotator cuff tears–an intervention study. *BMC Musculoskeletal Disorders, 17*, 252. https://doi.org.10.1186/s12891-016-1116-6

Dejaco, B., Habets, B., Loon, C., Grinsven, S., Cingel, R., van Loon, C., van Grinsven, S., & van Cingel, R. (2017). Eccentric versus conventional exercise therapy in patients with rotator cuff tendinopathy: A randomized, single blinded, clinical trial. *Knee Surgery, Sports Traumatology, Arthroscopy, 25*(7), 2051–2059. https://doi-org.hpu.idm.oclc.org/10.1007/s00167-016-4223-x

Dube, M.-O., Desmeules, F., Lewis, J. S., & Roy, J.-S. (2023). Does the addition of motor control or strengthening exercises to education result in better outcomes for rotator cuff-related shoulder pain? A multiarm randomised controlled trial. *British Journal of Sports Medicine, 57*(8), 457-463. https://doi.org/10.1136/bjsports-2021-105027

Powell, J. K., Schram, B., Lewis, J., & Hing, W. (2023). Physiotherapists nearly always prescribe exercise for rotator cuff-related shoulder pain; but why? A cross-sectional international survey of physiotherapists. *Musculoskeletal Care, 21*(1), 253-263. https://doi.org/10.1002/msc.1699

Singh, G. K., Srivastava, S., Kumar, M., & Ratnakar, S. (2018). Effects of selected rehabilitative exercises on external rotator muscles and trapezius muscles of masonry workers. *Work, 60*(3), 437–444. https://doi.org/10.3233/wor-182757

Appendix A

Search Terms

athletes or sports or athletics
AND
rotator cuff tear or rotator cuff injury or rotator cuff pain
AND
rehabilitative exercise* or therapeutic exercise*
AND
functional activity or functional outcomes

Appendix B

Evidence Table

Author/Year	Level of Evidence Study Design Risk of Bias	Participants Inclusion Criteria Study Setting	Intervention and Control Groups	Outcome Measures	Results
Christensen et al. (2022)	*One Group Pre/Post Test* 2B *Risk of Bias* Low	*Participants* N= 30 (70.4 years; 33% female) *Inclusion Criteria* Rotator cuff symptoms present for a minimum of 3 months with tear of the supraspinatus and infraspinatus; ability to read Danish	*Intervention 1:* Patient education on diagnosis, managing pain, and exercise protocol. *Intervention 2:* Exercise protocol for 5 months of 2 exercises 3x a week. *Intervention 3:* Modifying exercises according to pain and degree of challenge during and after exercises.	*Cognitive* ● Oxford Shoulder Score Questionnaire *Activity/Function* ● EQ-5D-5L Questionnaire ● Strength ● ROM ● Muscle	*Significant Findings* Testing results of the Oxford Shoulder Scores, EQ-5D index, Abduction ROM, strength were significantly improved from 3 months to 5 months. Patients significantly improved their shoulder function and quality of life after the 5-month exercise program. *Nonsignificant Findings* ROM for flexion and external rotation were small and nonsignificant. Similar results of the strength of internal and external rotation.
Dejaco et al. (2017)	Intervention study RCT 1B Risk of bias: low	Participants N= 36	intervention: 12-week	Objective: ROM & strength	Both groups: -significant increase in the Constant Murley score

		Inclusion criteria: rotator cuff tendinopathy	daily home-based exercise programme isolated eccentric exercise (EE) group (n = 20, mean age = 50.2 ± 10.8 years) conventional exercise (CG) group (n = 16, mean age = 48.6 ± 12.3 years)	Subjective: pain & ADLs Visual analogue scale (VAS) was used to evaluate pain during ADLs	-significant decrease in VAS scores -No difference was found between the groups
Singh et al. (2018)	Intervention study 2B Study Design: Exploratory Risk of Bias Low	*Participants* N=10 (0% female). *Inclusion criteria* Ten male subjects chosen are masonry workers having a minimum four years work-experience, medium to severe pain intensity, moderate to high pain frequency, and medium to high pain duration	*Intervention 1:* (Exercise 1) Prone horizontal abduction at 90◦ with full external rotation with thumb right up. *Intervention 2:* (Exercise 2) Side lying ER with elbow on the trunk. *Intervention 3:* (Exercise 3) ER at 90◦ abduction and	*Activity/Function* ● Questionnaire ● Informed Consent ● Exercises ● ROM ● Muscle	*Significant Findings* Dynamic stabilization of rotator cuff muscles plays an important role in achieving functional stability of the shoulder for masonry workers, especially those who are involved in overhead activities. Therefore exercises 1 and 3, which produced high rotator cuff

			elbow flexion at 90◦ in standing position.		synergy, may be useful in alleviating shoulder pain *Nonsignificant Findings* None
Dubé et al. (2023)	Intervention study Level 1B RCT *Risk of Bias* moderate	*Participants* *N*= 123 *Inclusion criteria* (1) 18-75 years of age (2) symptoms lasting longer than 3 months (3) presence of a painful arc in flexion or abduction (4) presence of a positive Neer sign or Hawkins-Kennedy Test (5) presence of pain when resisting humeral external rotation or abduction, or positive Jobe Test	*Intervention 1:* Advice and education program *Intervention 2:* Education and shoulder and strengthening program *Intervention 3:* Education and motor rehabilitation exercise program	*Symptoms and Functional Limitations* - Quick Dash - Western Ontario Rotator Cuff Index - Short Form Brief Pain Inventory *Pain-Related and Fear Catastrophizing* - Tampa Scale of Kinesiophobia *US measurement of AHD and SS and IS* - 12 MHz linear array probe	*Significant Findings* - MCE or strengthening exercises did not offer additional benefits in reducing symptoms and functional limitations of individuals w/ RCRSP over education alone

		(6) ability to speak English or French *Study setting* Clinical			
Powell et al. (2022)	Cross-Sectional International Survey 2B *Risk of Bias* Low	*Participants* N= 480 *Inclusion Criteria* Physiotherapists were able to participate in this study if they were, (1) registered with their national accrediting body, (2) at the time of the survey were treating people seeking care for shoulder pain, (3) aged 18 years and above, and (4) were proficient in the English language	*Intervention 1:* Exploring physiotherapists beliefs of the possible mechanisms underpinning exercise therapy in the management of RCRSP.	*Activity/function* ● Questionnaire	*Significant Findings* Almost all (99%) respondents indicated they would prescribe exercise for the type of presentation described in the clinical vignette. Resistance exercise was the most common type of exercise physiotherapists would prescribe.
Note. ROM = Range of Motion; RCRSP = Rotator Cuff Related Shoulder Pain; ER= External Rotation;					

Appendix C

Risk-of-Bias Table

Risk-of-Bias Table: Randomized Controlled Trial (RCT) and Non-RCT										
	Selection Bias (Risk of bias arising from randomization process)			Performance Bias (effect of assignment to intervention)		Detection Bias		Attrition Bias	Reporting Bias	Overall risk-of-bias (low, moderate, high
Citation	Random Sequence Generation	Allocation Concealment (until participants enrolled and assigned)	Baseline difference between intervention groups (suggest problem with randomization?)	Blinding of Participants During the Trial	Blinding of Study Personnel During the Trial	Blinding of Outcome Assessment: Self-reported outcomes	Blinding of Outcome Assessment: Objective Outcomes (assessors aware of intervention received?)	Incomplete Outcome Data (data for all or nearly all participants	Selective Reporting (results being reported selected on basis of the results?)	
Christensen et al. (2016)	+	+	-	+	+	+	-	+	+	low
Dejaco et al. (2017)	+	+	+	-	-	+	+	+	-	moderate

Note. Categories for risk of bias are as follows: Low risk of bias (+), unclear risk of bias (?), high risk of bias (–). Scoring for overall risk of bias assessment is as follows: 0–3 minuses, low risk of bias (L); 4–6 minuses, moderate risk of bias (M); 7–9 minuses, high risk of bias (H).

Citation. Table format adapted from Higgins, J. P. T., Sterne, J. A. C., Savović, J., Page, M. J., Hróbjartsson, A., Boutron, I., . . . Eldridge, S. (2016). A revised tool for assessing risk of bias in randomized trials. Cochrane Database of Systematic Reviews 2016, Issue 10 (Suppl. 1), 29–31. https://doi.org//10.1002/14651858.CD201601

Risk-of-Bias Table

Risk of Bias for Before-After (Pre-Post) Studies with No Control Group												
Citation	Study question or objective clear	Eligibility or selection criteria clearly described	Participants representative of real-world patients	All eligible participants enrolled	Sample size appropriate for confidence in findings	Intervention clearly described and delivered consistently	Outcome measures pre-specified, defined, valid/reliable, and assessed consistently	Assessors blinded to participant exposure to intervention	Loss to follow-up after baseline 20% or less	Statistical methods examine changes in outcome measures from before to after intervention	Outcome measures were collected multiple times before and after intervention	Overall risk of bias assessment (low, moderate, high risk)
Powell et al. (2023).	Y	Y	Y	N	Y	N	Y	N	N	Y	N	moderate
Dubé et al. (2020	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	moderate
Singh et al. (2017)	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Low

Note. Y = yes; N = no; NR = not reported. Scoring for overall risk of bias assessment is as follows: 0–3 N, Low risk of bias (L); 4–8 N, Moderate risk of bias (M); 9–11 N, High risk of bias (H).

Citation. Table format adapted from National Heart Lung and Blood Institute. (2014). Quality assessment tool for before–after (pre–post) studies with no control group. Retrieved from https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools