The effect of scapular stabilization exercises on shoulder pain, scapular dyskinesis, muscle strength, and function in patients with subacromial impingement: a systematic review

El efecto de los ejercicios de estabilización escapular sobre el dolor de hombro, la discinesia escapular, la fuerza muscular y la función en pacientes con pinzamiento subacromial: una revisión sistemática

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Abstract

Objectives: A correlation between subacromial pain syndrome (SAPS) and altered scapular movement has been previously documented. This study sought to evaluate the impact of therapies targeting scapular components on alleviating shoulder pain, enhancing function, increasing range of motion (ROM), and improving muscular strength in people with shoulder pain and dysfunction.
Data Sources: Systematic searches were conducted across six major databases for the period 2010 to 2024; these included Google Scholar, CINAHL, CENTRAL, MEDLINE, PubMed, and Science Direct.
Study Selection: Randomized controlled trials (RCTs) examining the use of scapular stabilization exercises as interventions in patients with scapular dyskinesis (SD) and subacromial impingement syndrome (SAIS) were included in this systematic review (SR). This review was written based on the PRISMA guidance.
Data Extraction: Each study's methodological quality was evaluated using the PEDro scale.
Data Synthesis: This systematic review analyzed seven randomized controlled trials on scapular dyskinesia exercises. Results were mixed, with four studies showing significant effects while three found none. The variability in exercise types and combinations with other therapies could have influenced these outcomes.
Conclusions: Scapular stabilization exercises aid recovery from shoulder impingement syndrome and scapular dyskinesia. Reviewed studies show heterogeneous results leading to inconclusive evidence on their effectiveness for improving scapular function and reducing discomfort. Nevertheless, these exercises are significant for addressing neuromuscular and biomechanical deficiencies, while the role of specific stabilization exercises in comprehensive rehabilitation remains unclear.

Keywords

Scapular stabilization exercises, scapular dyskinesis, subacromial impingement.

Resumen

Objetivos: Se ha documentado previamente una correlación entre el síndrome de dolor subacromial (SAPS) y el movimiento escapular alterado. Este estudio buscó evaluar el impacto de las terapias dirigidas a los componentes escapulares para aliviar el dolor de hombro, mejorar la función, aumentar el rango de movimiento (ROM) y mejorar la fuerza muscular en personas con dolor y disfunción de hombro.
Fuentes de datos: Se realizaron búsquedas sistemáticas en seis bases de datos principales para el período 2010 a 2024; estos incluyeron Google Scholar, CINAHL, CENTRAL, MEDLINE, PubMed y Science Direct. Selección de estudios: En esta revisión sistemática (RE) se incluyeron ensayos controlados aleatorios (ECA) que examinaron el uso de ejercicios de estabilización escapular como intervenciones en pacientes con discinesia escapular (DE) y síndrome de pinzamiento subacromial (SAIS). Esta revisión se escribió en base a la guía PRISMA.
Extracción de datos: La calidad metodológica de cada estudio se evaluó mediante la escala PEDro.
Síntesis de datos: Esta revisión sistemática analizó siete ensayos controlados aleatorios sobre ejercicios de discinesia escapular. Los resultados fueron mixtos, con cuatro estudios que mostraron efectos significativos, mientras que tres no encontraron ninguno. La variabilidad en los tipos de ejercicio y combinaciones con otras terapias podría haber influido en estos resultados.
Conclusiones: Los ejercicios de estabilización escapular ayudan a la recuperación del síndrome de pinzamiento del hombro y la discinesia escapular. Los estudios revisados muestran resultados heterogéneos que conducen a evidencia no concluyente sobre su efectividad para mejorar la función escapular y reducir las molestias. Sin embargo, estos ejercicios son importantes para abordar las deficiencias neuromusculares y biomecánicas, mientras que el papel de los ejercicios específicos de estabilización en la rehabilitación integral sigue sin estar claro.

Palabras clave

Ejercicios de estabilización escapular, discinesia escapular, pinzamiento subacromial.

Introduction

It is estimated that musculoskeletal problems currently impact more than 1.7 billion people worldwide. This is an important issue, as such conditions are frequently linked to chronic pain, impairment, functional limitations, disability, decreased productivity, and low quality of life (Fatoye, 2018). According to recent research, the third most prevalent musculoskeletal condition is shoulder pain (Kamonseki et al, 2021), as well as subacromial impingement syndrome (SAIS), the most common shoulder condition, which accounts for between 44 and 65 percent of all complaints of shoulder pain at doctors' surgeries (Van der Windt et al, 1995).

Subacromial pain syndrome (SAPS) results in discomfort in the shoulder. This is characterized by a weakening in the rotator cuff muscles and pain that is either triggered or exacerbated by repetitive overhead exercises in the midrange of rotator cuff manual resistance testing (Kelley et al, 2013). 65% or more of all persistent shoulder symptoms are associated with SAPS, according to (Michener et al, 2003; Van der Windt et al, 1996), which commonly reduces life quality and increases disability (Chipchase et al, 2000). Modified scapula and clavicle kinematics are among the deficits commonly linked with SAPS (Lawrence et al, 2014). This may also cause neuromuscular weakness during deconditioning, atrophy from improper use, glenohumeral instability, or stiffness (Ludewig & Reynolds, 2009), as well as insufficient brain activity or motor control (McClure & Michener, 2015).

This emphasizes the necessity of maintaining proper scapular motion and position to attain the best possible functioning of the shoulder joint (De Mey et al, 2012).

Scapular dyskinesia is defined as a visible change in the scapula's location and motion pattern relative to the thoracic cage during either static or dynamic scapular movement. Impingement syndrome, rotator cuff tears, instability, and shoulder injuries have been linked to scapular dyskinesia (Kibler & McMullen, 2003; Kibler et al, 2013), and it may also occur due to variations in stabilizing muscle activity around the scapula (McClure et al, 2009).

Normal scapular placement and mechanics can be influenced by weakness or dysfunction in the scapular muscles. This may, in turn, lead to abnormal loads on the capsular structures, compression of the rotator cuff, and reduced performance (Paine & Voight, 1993). Scapulothoracic motion kinematics may also be compromised in individuals suffering from subacromial impingement syndrome (Han et al, 2012; Graichen et al, 2000; Ludewig & Cook, 2000; Yano et al., 2010). Treatment for subacromial impingement syndrome has been widely studied in the literature, with conservative options accounting for 90 to 95%. Most of these Available options include rotator cuff strengthening exercises (Brumitt, 2006; Celik et al, 2009), stretching (Kluemper et al, 2006). Immobilization, range-of-motion (ROM) exercises that are passive, active, and assisted, mobilization methods, and exercises performed at home (Faber et al, 2006) and physical therapy techniques like heat, transcutaneous electrical nerve stimulation, and ultrasound (US) (Van der Heijden et al, 1997; Shehab & Adham, 2000) however, the exercise had the greatest effect on such cases. Therefore, exercise therapy plays a significant role in shoulder rehabilitation, developing the ability of scapula position and regulating motions, which is critical for proper upper limb stability and function. Additionally, a growing amount of research is demonstrating how beneficial exercise is for restoring shoulder muscle power, with kinematics offering a valid treatment option for subacromial impingement syndrome. However, Acromioplasty and surgical decompression are more frequently utilized to restore the subacromial space in severe cases.

Therapeutic exercises have been shown to significantly enhance shoulder function, scapular stabilization, flexibility, range of motion, proprioceptive neuromuscular facilitation (PNF), and rotator cuff strength (Roy et al, 2009; Ravichandran et al, 2020). The significance of scapular stabilization exercises in the conservative management of subacromial impingement syndrome (SAIS) has been recently recognized. Workouts focus on scapular stabilizing muscles like the lower trapezius and serratus anterior to address irregular scapular mechanics that might lead to impingement. Scapular-focused therapy is crucial due to abnormal scapular motion, such as increased anterior tilt and decreased upward rotation, which have been linked to the pathogenesis of SAIS (Ludewig & Braman, 2011; Kibler et al, 2013).

Consequently, Proper scapular position and mobility are essential for maintaining the subacromial space and minimizing mechanical stress on the rotator cuff and surrounding structures. Those patients

with scapular dyskinesia and SAIS often exhibit abnormalities such as reduced upward rotation, increased anterior tilt, and excessive internal rotation (McClure et al, 2004; Kibler et al, 2013). As aforementioned causes, Scapular stabilization exercises enhance scapular kinematics, muscle activation, and general shoulder function by addressing these deficiencies. Although the number of studies assessing the benefits of stabilization exercises of the scapula has increased recently, their results are frequently contradictory, and there are inconsistent results about the efficacy of those studies, which might be due to their designs, procedures, patient demographics, and outcome metrics. For instance, some studies show minimal functional benefits or equivocal effects on long-term outcomes, while others indicate considerable changes in scapular kinematics and pain reduction (Turgut et al, 2017; Shankar et al, 2021). These contrasting outcomes thus require the application of a systematic study to offer greater insight. By optimizing conservative treatment strategies, a comprehensive evaluation may also reduce the need for surgical interventions.

These contrasting results in literature regarding the stabilization exercise might be due to the needs of specific rehabilitation requirements which are established according to each patient's category in terms of demographic, changed scapular mechanics, and related neuromuscular deficiencies (Kibler et al, 2013). Clinical practitioners are required to customize therapies for each subgroup. Thus, a systematic review might highlight how well these exercises address the underlying biomechanical and neuromuscular deficiencies.

Standardized protocols for scapular stabilization exercises are also lacking regarding differences in the type, intensity, frequency, and length of relevant exercises. Such heterogeneity means that translating findings into clinical practice is challenging. Nevertheless, A systematic review identifying developments across effective therapies and emphasizing best practice could thus help in the creation of standardized, evidence-based guidelines. Therefore, this systematic review was established to evaluate the impact of therapies targeting scapular components on alleviating shoulder pain, enhancing function, increasing ROM, and improving muscular strength in people with shoulder pain and dysfunction.

Method

This systematic review adhered to the PRISMA 2020 guidelines for reporting systematic reviews and meta-analyses.

Searches and Data Sources

Studies were found by looking through the literature across a variety of indexing databases, specifically Google Scholar, CINAHL, CENTRAL, MEDLINE, PubMed, and Science Direct for the period 2010 to 2024. The following keywords were used: "subacromial impingement," " impingement syndrome," "scapular dyskinesis," scapular stabilization exercises such as scapula strength exercise or scapula-focused exercise, and "scapular exercises." The search terms were combined using the Boolean operators "AND" and "OR." The search was conducted in July 2024; we searched using the pertinent databases from the beginning to July 2024. The search terms used were drawn from online sources, and PROSPERO prospectively registered the systematic review under trial registration number CRD42024540564.

Study Selection

The studies selected featured participants with shoulder pain from SAPS and scapular dyskinesia who were assigned to receive either an exercise intervention focused on scapular stabilization exercises or an intervention that did not address scapular components. This SR thus included only randomized controlled trials (RCTs).

Three reviewers independently assessed all prospective titles and abstracts identified by the search outlined above, extracting the relevant information from these individually to determine the whole text documents assessed. The reviewed articles were restricted to those written in the English language and available for full-text. When there were disagreements, the three reviewers discussed them and, if needed, double-checked by two reviewers.

Shoulder pain and one positive outcome from the Jobe, Hawkins, empty can, full scan, or Neer tests were prerequisites for inclusion. being used to establish a clinical diagnosis (Cools et al, 2003; Cools et al,

2008; Moraes et al, 2008). The studies selected also focused on participants who were at least eighteen years old. Studies that (1) included at least one clinical outcome measure of shoulder range of motion (ROM), function, pain, muscle strength, or clinical measures of scapular positioning were eligible for this systematic review; (2) used at least one form of physiotherapeutic scapular-stabilization exercise treatment; (3) contained at least one shoulder function clinical outcome measure; and/or (4) were otherwise identified as randomized controlled trials (RCTs). Studies were excluded if they included individuals with a history of cervical spine involvement, shoulder fractures, or other severe injuries, neurological conditions, or shoulder surgery that could result in shoulder muscle weakness.

Criteria for Inclusion and Exclusion

Table 1. Inclusion and Exclusion criteria

Criteria for inclusion	Criteria for Exclusion
Featuring adults with SIS and SD Focused on adults aged 18 to 75 years RCT English language Full-text	Previous neck or shoulder surgery Previous shoulder injury Systemic illness, shoulder instability History of spinal or upper limb fracture

The term "scapular stabilization exercise intervention" was used to refer to exercises that target the scapulothoracic joint or the muscles that move the scapula to the thorax, including the levator scapulae, rhomboids, trapezius, and serratus anterior. Scapular stabilization exercises that lasted longer than four weeks were required for study inclusion. Rotator cuff-focused interventions were not included. Interventions in physical therapy that did not focus on the scapulothoracic joint (such as cervical intervention or stretching and mobilization of the glenohumeral joint) or Unaddressed cases were employed as comparisons.

The included studies' outcome measures in this SR were derived from valid and reliable tools, such as the Shoulder Pain and Disability Index's pain subscale [SPADI], the Numerical Rating Scale [NRS], or the Visual Analogue Scale [VAS]. Shoulder Disability Questionnaire (SDQ), Western Ontario Rotator Cuff (WORC), SPADI score, Disabilities of the Arm, Shoulder, and Hand (DASH), shoulder muscular strength, and shoulder range of motion (ROM) were also recognized as outcomes for shoulder function. Scapular outcome measures such as the scapular slide test (LSST), scapular positioning, and scapular kinematics are 3-dimensional tests. Additionally, forward shoulder posture and pectoralis muscle length were assessed.

Extraction of Data and Evaluation of Quality

After data extraction, reliability was checked by two reviewers, while a further non-involved reviewer independently evaluated the possibility of bias. Therefore, each study was graded using the PEDro critical evaluation tool, which is reliable and valid for physiotherapy experimental research. The PEDro Scale is effective due to its reliability, sensitivity, and ease of use (Maher et al, 2003). PEDro. However, criterion 1—which deals with external validity—was not applied during the scoring procedure. Otherwise, each requirement was assessed using a "yes" or "no" decision. One point was awarded for "yes," and zero for "no," setting the highest possible score as ten points. Low risk of bias was attributed to any study with a minimum four-point PEDro score overall. When the reviewers disagreed on an article's quality score, agreement was sought via discussion. Where needed, a third opinion was sought.

Data Synthesis

In systematic reviews, the narrative synthesis method is commonly used to synthesize results in a given context. Developments in guidance in recent literature enable more transparent and methodical techniques to be used for narrative synthesis, with an emphasis on combining data regarding the effectiveness of particular interventions, in addition to looking at factors influencing how those interventions are implemented. Strict standards were used in the current SR to choose the best available evidence. To mitigate this, the PEDro Scale was used to evaluate each study's methodological quality. However, a narrative synthesis utilizing a rating system for levels of evidence was necessary due to study heterogeneity regarding the measurement of scapula biomechanics outcomes (van Tulder et al, 1997). Results

were compiled using the rating system, which is displayed in Table 2, to ensure that the caliber and results of each study were sufficiently taken into account.

Table 2. Levels Of Evidence

Strong evidence	Consistent findings among multiple high-quality RCTs
Moderate evidence	Consistent findings among multiple low-quality RCTs and/or one high-quality RCT
Limited evidence	One low-quality RCT
Conflicting evidence	Inconsistent findings among multiple RCTs
No evidence from trials	No RCTs

Study & Participant Characteristics

Table 4 provides a summary of each study's characteristics and results. Convenience sampling was used to include 344 participants (mean age 47.9 years) across the seven studies; 209 of these were men, and 135 were women. The research was carried out in Turkey (Başkurt et al, 2011; Turgut, et al 2017; Yuksel & Yesilyaprak, 2024), Belgium (Struyf et al, 2013), India (Shah et al, 2014), Iran (Moezy et al, 2014), and Brazil (Hotta et al, 2020).

Interventions and Comparisons

Although the content of each study differed, they all assessed scapular stabilization exercises in comparison to conventional exercise. Scapula stabilization exercises were included for the intervention group in four studies that compared these to what they called “traditional exercises” (Başkurt et al, 2011; Shah et al, 2014; Turgut et al., 2017; Hotta et al, 2020). Additionally, Başkurt et al. (2011) included a component of advice. However, one study contrasted an intervention consisting of scapular mobilization, pendulum exercises, shoulder stretching, strengthening, and proprioceptive exercises with glenohumeral joint passive mobilizations and eccentric exercises for the rotator cuff. Nevertheless, some scapula stabilization exercises were also included for the intervention group (Yuksel & Yesilyaprak, 2024). The last study also compared exercise therapy focused on scapula stabilization, which consisted primarily of stretches, exercises, and advice, with physical therapy that included range-of-motion exercises (ROM) and electrotherapy modalities (Moezy et al, 2014).

Assessment of quality:

Table 3 shows the outcomes of PEDro scoring. Four of the seven studies were scored as high quality. All the studies used random allocation; however, five lacked allocation concealment. Blinded assessment of various outcomes was used in three studies; however, blinding of subjects or therapists was consistently absent. In three studies, intention-to-treat (ITT) analysis was detectable.

Table 3. PEDro score of included studies

PEDro Criteria	Z Başkurt et al 2011	F Struyf et al 2013	M Shah et al 2013	Azar Moezy et al 2014	E Turgut et al 2017	GH Hotta et al 2020	E Yuksel et al 2024
1. Eligibility criteria were specified	NO	YES	YES	YES	NO	YES	YES
2. Random allocation	YES	YES	YES	YES	YES	YES	YES
3. Allocation was concealed	NO	NO	NO	NO	NO	YES	YES
4. Similarity between groups at baseline	YES	YES	YES	YES	YES	YES	YES
5. Blinding of subjects	NO	NO	NO	YES	NO	YES	NO
6. Blinding of therapists	NO	NO	NO	YES	NO	NO	NO
7. Blinding of assessors	NO	YES	NO	YES	NO	YES	NO
8. Measure at least one key outcomes were obtained from more than 85% of the subjects	YES	YES	YES	YES	NO	YES	YES
9. Intention to treat analysis	NO	YES	NO	NO	NO	YES	NO
10. Between-group statistical comparisons reported for at At least one key outcome	YES	YES	YES	YES	YES	YES	YES
11. Point and variable measures for at least one key outcome measure	YES	YES	YES	YES	YES	YES	YES
Total score	5/10	7/10	5/10	8/10	4/10	9/10	6/10

Characteristics of individual studies

Table 4. Characteristics of Individual Studies

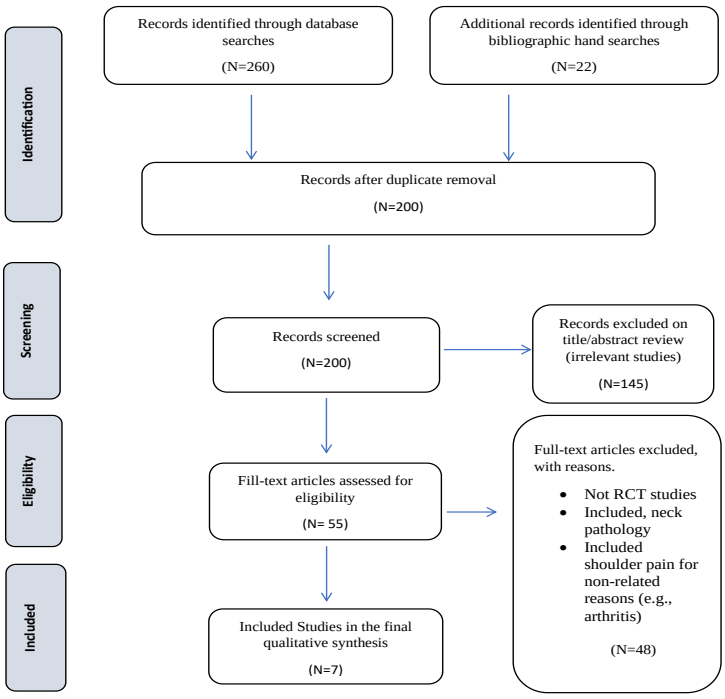
Authors	Design	Participants	Intervention & follow-up	Outcome measures	Result	Conclusion
Baskurt et al. (2011) Turkey	RCT PEDro score= 5/10 EL=1b	40 Unilateral SIS, (Neer stage I & II) 27 F-13 M	Wall push-ups, wall slide exercises, standing weight shifts, double arm balancing, scapular PNF, and scapular clock exercises. n=20 3 sessions / 6 weeks,	Assessment of shoulder joint mobility, pain intensity using the Visual Analogue Scale, anterior strengthening exercises targeting the trapezius, serratus anterior, and rotator cuff muscles, joint position sense evaluation, Lateral Scapular Slide Test (LSST), and the Western Ontario Rotator Cuff Index.	The intervention group exhibited notable improvements in both scapular dyskinesis and joint position sense, with statistical significance (P<0.05).	Stabilization exercises of the Scapula offer superior results to conventional programs.
Sturyf et al. (2013) Belgium	Double-blinded RCT PEDro score= 7/10 EL=1b	22 Subjects with SIS 12 F-10 M	manual scapular mobilization. Flexibility exercises targeting the pectoralis minor, levator scapulae, and rhomboid muscles, combined with scapular motor control training n=10 One or three per week for 12 weeks baseline, after nine sessions	The assessment encompasses pain evaluation using the Visual Analogue Scale and Numerical Rating Scale, visual inspection for scapular tilting and winging, assessment of forward head posture, measurement of isometric shoulder elevation strength, evaluation of scapular motor control and upward rotation, determination of pectoralis minor muscle length, and completion of a shoulder disability questionnaire.	The control group did not show any statistically significant differences. The intervention group experienced significant reductions in pain, with Cohen's d values of 0.76, 1.04, and 0.92, respectively. Additionally, there were notable improvements in self-reported disability (Cohen's d = 0.93, P = 0.0), indicating a substantial and clinically meaningful treatment effect.	Scapular stabilization exercises effectively reduce pain and enhance function in those suffering from shoulder impingement syndrome. Power calculation to include 46 participants.
Moezy et al. (2014 Iran	RCT PEDro score= 8/10 EL=1b	68 Patients with SIS 55 F- 13 M 75.8% of subjects in the ET group and 87.7% of the PT group were female.	Scapular PNF, TheraBand strengthening exercises, scapular clocks, and posterior capsule and pectoral stretches. n=33 Engage in three sessions per week over a six-week period, performing three sets of ten repetitions per exercise using varying resistance levels of TheraBand.	Assessment of pain using the Visual Analogue Scale (VAS), measurement of shoulder external rotation and abduction range of motion (ROM), evaluation of forward shoulder translation, analysis of forward head posture, assessment of scapular rotation and protraction, and determination of pectoralis minor muscle length.	There was no discernible variation in the groups' pain reduction (P=0.576). The scapular exercise group demonstrated significant reductions in mid-thoracic curvature, forward head posture, and shoulder protraction, with P-values lower than 0.0001, indicating a major, clinically significant therapy impact.	Exercise interventions based on scapular stabilization improve shoulder posture, pectoralis minor flexibility, shoulder range, and forward head reduction. The study aims to investigate the rate of pain
Turgut et al. (2017a) Turkey	RCT PEDro score= 4/10 EL=1b	30 young adult patients with SIS 14 F-16 M Types 1 and 2 of scapula dyskinesia	Wall push-ups with ipsilateral leg raises and wall slides with squats. Perform a diagonal squat with a lawnmower row, a squat with the robbery exercise, then a contralateral single-leg squat to counterbalance scapular retraction. n=15 12 weeks	SPADI (Turkish), 3-dimensional scapular kinematics.	In both groups, SPADI resulted in a statistically significant improvement in pain and disability. Significant differences were seen between the groups in scapular upward rotation, posterior tilt, and external rotation.	Specific scapular stabilization exercises can help patients lessen pain and disabilities. Power calculation to include 39 participants.
Shah et al (2014) India	RCT PEDro score= 5/10 EL=1b	60 patients with SIS 29 F- 31M	Shoulder flexor, abductors, horizontal abductors, and external rotators strengthening exercises; pectoralis major, levator scapulae, cross chest, wand, and pendulum stretches; scapula stability exercises; and scapula PNF exercises N=30 6 sessions per week for 4 weeks 3 sets and 8 repetitions assessment at baseline after 4 weeks	Shoulder pain and disability index (SPADI), visual analogue scale, Lateral Scapula Slide test (LSST)	Both groups (conventional physiotherapy alone and with scapular stability exercises) showed improvement. The Clinical Trial Group (with Scapular Stability Exercises) showed a highly significant improvement over the control group. in: VAS, SPADI, and LSST. Paired and unpaired *t*-tests showed extremely	Adding stability exercises for the scapula to conventional physiotherapy enhances the effectiveness of reducing pain and improving disability in patients with impingement.

					significant differences ($p < 0.001$).	
Hotta et al. (2020) Brazil	RCT PEDro score= 9/10 EL=1b	60 patients with shoulder impingement syndrome 42 F-18 M	Strengthening of the periscapular muscles (upper, middle, lower, and serratus anterior) versus periscapular strengthening +(SSE) depression and distraction of the scapula in front of a mirror N=30 Exercise load 60% 0f one repetition max 3 sessions per week for 8 weeks 3 sets, 10 repetitions, then 12 repetitions after 4 weeks, -15 repetitions after 5 weeks.	SPADI, Shoulder ROM (by inclinometer), kinesiophobia, Global perceived effect satisfaction with treatment, Scapula position,	Adding stabilization exercises of the scapula to periscapular strengthening did not show any significant additional benefit ($p > 0.05$) in terms of pain, function, muscle strength, or ROM. Both groups improved similarly over time.	Adding stabilization exercises of the scapula to a periscapular strengthening program does not offer further pain relief or enhanced shoulder function in patients with SAPS. However, periscapular strengthening alone may be sufficient to manage symptoms in these patients.
Yksel et al 2024 Turkish	RCT PEDro score= 6/10 EL=1b	64 patients with SIS type 2 30 F- 34 M Power calculation to be 64 subjects included in the study	Shoulder stretching, range-of-motion exercises, proprioceptive exercises, pendulum exercises, and scapular mobilization. Exercise for Scapular Stabilization (scapula clock, push up, T exercise, forward punch, and wall slide 5 sessions per week for 4 weeks 2-3 sets of 10 repetitions with TheraBand	Visual analogue scale (VAS), ROM of the shoulder, muscle strength, (SPADE) presence of scapular dyskinesis test (SDT)	In comparison to the control group, the scapular stabilization exercise training group demonstrated greater improvement in shoulder disability, scapular dyskinesis, pain, and muscle strength ($p < 0.05$). But when it came to shoulder motion and scapular upward rotation, there was no statistically significant time-group interaction ($p > 0.05$).	In patients with SPS and scapular dyskinesis, stabilization exercises combined with shoulder mobilization, stretching, and strengthening are beneficial for enhancing shoulder function, lowering pain, and improving scapular dyskinesis.

Results

STUDY SEARCH: Seven articles were selected to be included in this review:

Figure 1. PRISMA Follow diagram



The outcome of this systematic review did not find a well-defined result about which optimal exercise for scapula dyskinesia, as the authors were in conflict in reporting their results. Three out of the included studies reported no significant differences were found among groups, whereas the other four studies reported significant effects were found among groups. Those authors applied different types of scapula stabilization exercises combined with strengthening exercises or other conventional therapies, which interferes with the actual effect of that exercise. Overall, scapular stabilization exercises appear to form an essential part of rehabilitation programs for scapular dyskinesia and impingement syndrome. The integration of these exercises with other therapeutic modalities might offer better outcomes in terms of addressing both the biomechanical and neuromuscular aspects of these conditions. Therefore, Future research should aim to standardize intervention protocols and incorporate longer follow-up periods to solidify these findings and enhance clinical applicability.

Discussion

Presently, Exercises have been investigated widely in the literature for the management of musculoskeletal disorders such as shoulder disorders. However, there is a vast mixture of exercises used for the treatment of shoulder cases, such as strengthening exercises, stretching exercises, and scapula stabilization exercises. According to SAPS treatment, many studies in the literature investigated a different therapeutic exercise program that consists of motor learning to restore normal movement patterns and stretching the anterior and posterior shoulder girdles, strengthening exercises, and muscle relaxation techniques, while there is no consensus on which is the optimal exercise regime or which standardized exercise parameters with specific duration for implementation. Therefore, this SR aims to investigate the effect of scapula stabilization exercise for SAPS patients in terms of decreasing pain, enhancing shoulder ROM, rotator cuff muscles, and scapular dyskinesis.

Seven RCT studies in this SR investigated different forms of scapula stabilization exercises versus conventional therapy for SIS patients with various grades of dyskinesia. The result of that study was no consensus to report the optimal stabilization exercise in terms of exercise regimes, duration of therapeutic program, and exercise load for those patients. However,

Başkurt et al., 2011; Shah et al., 2014; Turgut et al., 2017; Yuksel & Yesilyaprak, 2024, reported a significant effect of stabilization exercise for SIS patients, who represent 194 participants out of 344 participants included in that study. However, these studies investigated participants with various grades of dyskinesia or without dyskinesia, except Shah et al. 2014

; he had not stated a clear grade of scapula dyskinesia, which might affect the result of the study. Likewise, Turgutet al., 2017 conducted their study on young adults, which restricted the internal validity of their study, leading to undefined outcomes for such patients. Moreover, the researchers are implementing therapeutic exercise with a variety of protocols and durations of exercise, which reflects inconsistency in exercise programs, and it is challenging for clinicians to consider in clinical practice.

Furthermore, the sample size was too small in Turgut et al., 2017; studies, as the statistical power calculation suggested that it should be at least 39 participants in the study, whereas only 30 participants were included. Despite that, Turgut et al. (2017) reported that 6 weeks of stabilization exercise might show an increase in muscle power when compared with conventional therapy, as the clinicians consider the exercise parameters, the grade of scapula dyskinesia, and the time of follow-up. Though in those studies, 4-6 weeks are considered preliminary. Overall, all points mentioned above form a challenge to state a well-defined result regarding the application of stabilization exercises for scapula dyskinesia patients.

The last three studies were conducted by Hotta et al., 2020; Moezy, Sepehrifar, & Dodaran, 2014; Struyf et al., 2013, with 150 participants, 60,68,22 participants respectively.

Their result stated that there was no significant statistical difference between the groups. In terms of sample size, the studies included sufficient numbers of participants and used a power calculation to estimate the sample size, except that Struyf et al., 2013 included 22 participants despite a statistical power calculation suggesting including 46 participants.

The therapeutic exercise in these studies included different stabilization exercises, which have different aims, such as scapula motor control training, Scapular PNF, and depression and distraction of the scapula in front of a mirror combined with strengthening exercise, which might not reflect the actual effect.

The results of this review could not highlight the effectiveness of scapular stabilization exercises in treating scapular dyskinesia and shoulder impingement syndrome. The conflict in improvements in scapular kinematics, pain alleviation, and functional outcomes was noted in the included studies. These results imply that the underlying neuromuscular and biomechanical deficits linked to dyskinesia and impingement are addressed by stabilization exercises that target scapular mechanics. Widespread agreement regarding the biomechanical and functional benefits of the scapula. Therefore, the scapula stabilization exercise should be investigated alone or combined with strengthening exercises and stretching exercises, in comparison with other strengthening exercises in a particular case of patients, to reflect which is optimal for that patient and report the actual effect of that exercise to be applied in clinical practice.

Overall, scapular stabilization exercises appear to form an essential part of rehabilitation programs for scapular dyskinesia and impingement syndrome. The integration of these exercises with other therapeutic modalities appears to offer better outcomes in terms of addressing both the biomechanical and neuromuscular aspects of these conditions. Future research should thus aim to standardize intervention protocols and incorporate longer follow-up periods to solidify these findings and enhance clinical applicability.

Review Strengths and Limitations

This SR has demonstrated several notable advantages. It fills a clinically significant gap in the treatment of shoulder dysfunction by offering a targeted assessment of a significant therapeutic strategy. This evaluation included a thorough literature search across several databases to gather all relevant studies in the field, adhering to PRISMA principles to ensure transparency and reproducibility. Emphasis was then placed on patient-centered outcomes such as muscle activation patterns, pain reduction, and range of motion, which provided insightful information for clinical applications. The critical review of the articles included was ensured by the use of standardized quality assessment tools. The review does, however, have some limitations. Direct comparisons were minimized by the significant variety in the scapular stabilization exercises utilized in different research projects, including differences in exercise types, duration, and intensity. Comparability was further limited by inconsistent outcome metrics and a dearth of comprehensive kinematic data on scapular motion. Additionally, many studies' long-term effects are unknown due to a focus on short-term results. The conclusions may be weakened by methodological flaws such as limited sample sizes and the significant risk of bias in some cases. The exclusion of research with poor results or non-English publications may also have led to publication and language biases.

Integration and Implications

The results of the selected research papers were synthesized to provide clinical practitioners with a clear vision of how to select optimal care strategies for SAIS patients, which are likely to include scapula stabilization exercises. The efficiency of these exercises in resolving dyskinetic movement patterns is further increased in combination with other therapeutic approaches, including stretching, strengthening, and patient education; however, these therapies provide a focused approach to rehabilitation by addressing underlying neuromuscular deficiencies and biomechanical abnormalities.

Future studies should concentrate on improving exercise protocols for certain patients, investigating the long-term effects of scapular stabilization, and assessing effectiveness across a range of patient populations. Utilizing technological innovations such as telerehabilitation platforms may also make these therapies more widely accessible and encourage adherence in remote locations, and this should also be investigated.

Conclusion

Scapular stabilization exercises are an essential part of scapular dyskinesia and SAIS rehabilitation. Together, the reviewed studies could not confirm the effectiveness of such exercises in enhancing scapular mechanics and function and minimizing discomfort, highlighting their significance in treating neuromuscular and biomechanical deficiencies. The available evidence is inconclusive regarding the inclusion of specific stabilization exercises for scapula dyskinesia in comprehensive rehabilitation programs.

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List of Abbreviations

SAPS = Subacromial Pain Syndrome

ROM = Range of Motion

RCT = Randomized Controlled Trial

SD = Scapular Dyskinesis

SAIS = Subacromial Impingement Syndrome

SR = Systematic Review

PEDro = Physiotherapy Evidence Database

PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

CENTRAL = Cochrane Central Register of Controlled Trials

PNF = Proprioceptive Neuromuscular Facilitation

SPADI = Shoulder Pain and Disability Index

NRS = Numerical Rating Scale

VAS = Visual Analogue Scale

SDQ = Shoulder Disability Questionnaire

WORC = Western Ontario Rotator Cuff Index

DASH = Disabilities of the Arm, Shoulder, and Hand

LSST = Lateral Scapular Slide Test

EL = Evidence Level

ET = Exercise Therapy

ITT = Intention-to-Treat

SSE = Scapular Stabilization Exercises

US = Ultrasound

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