Comparative Study on the Effectiveness of Scapular Stabilization Exercises and Shoulder Strengthening Exercises on Hand Grip Strength and Shoulder Function among Subacromial Impingement Syndrome Patients

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ABSTRACT

Objectives: The purpose of this study was to compare the effects of shoulder strengthening exercises and scapular stabilisation exercises on shoulder function, range of motion, and hand grip strength in mechanical exposure workers with subacromial impingement syndrome.

Study design: A comparative experimental study with two parallel groups at Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai.

Methods: Using convenient sampling, forty mechanical exposure workers who had shoulder pain for at least six weeks were selected and divided into two groups of twenty. Over the course of six weeks, Group B received shoulder strengthening exercises and Group A received scapular stabilisation exercises for 45 minutes three times a week. At baseline and after six weeks, the following outcome measures were evaluated: shoulder function (DASH score), range of motion (internal and external rotation) (goniometer), and hand grip strength (handheld dynamometer). For both intra and inter group analysis, the paired samples t test and independent samples t test were employed, respectively.

Results: All outcome indicators showed statistically significant improvements for both groups ($p < 0.05$). In contrast to Group B, Group A had demonstrated noticeably higher gains in hand grip strength (mean gain: 5.10 vs. 1.75), internal rotation (5.00° vs. 2.75°), external rotation (5.25° vs. 2.00°), and DASH score reduction (4.00 vs. 1.70).

Conclusion: In mechanical exposure workers with subacromial impingement syndrome, scapular stabilisation exercises improved hand grip strength, range of motion, and shoulder function more effectively than shoulder strengthening exercises.

Keywords: Shoulder, subacromial impingement syndrome, hand grip, DASH score, Scapular stabilization

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INTRODUCTION:

Subacromial impingement syndrome (SAIS) is the most common cause of shoulder pain accounting for 44% -65% of all complaints of shoulder pain [(1)]. Subacromial impingement syndrome (SIS) has been found to be most common diagnosis for shoulder pain and represents a significant health problem associated with marked impairments and disabilities [(2)]. SAIS can be defined as encroachment of the subacromial soft tissues underneath the acromial arch as the arm is elevated, especially in overhead positions [(3)]. The prevalence of SAIS varies between 2% and 8% in the general working population and between 6% and 10% in occupational groups with high mechanical exposure, such as those employed in manufacturing, seafood processing, and slaughterhouses [(4)].

The humeral head inferiorly and the acromion, coracoacromial ligament, and acromioclavicular joint superiorly define the subacromial space, which has a typical height of 1.0 to 1.5 centimetres. Impingement may result from any anomaly affecting the intervening structures, such as the biceps tendon, bursa, and rotator cuff tendons [(5)].

There are six degrees of freedom for the glenohumeral joint: three translations and three rotations. The humerus rotates externally during active abduction in the scapular plane, which is necessary to release capsular ligamentous limitations to permit maximum elevation and to clear the larger tuberosity beneath the coracoacromial arch [(6)]. The humeral head translates 1-3 mm superiorly during the first 30-60° of glenohumeral elevation. After that, it stays reasonably centred on the glenoid with translations of less than 1 mm, exhibiting essentially ball and socket kinematics above 60° of elevation[(7)].

The acromio-humeral distance shrinks and the subacromial space's contact pressure rises during glenohumeral abduction. Subacromial tissues are mechanically compressed as a result of superior and anterior humeral head translation, which intensifies these alterations [(8)]. The scapula demonstrates a pattern of upward rotation, external rotation, and posterior tilting during glenohumeral elevation. During glenohumeral elevation the clavicle retracts posteriorly and elevates, putting the scapula in essentially a more superior and posterior position [(9)]. Individuals with subacromial impingement usually exhibit greater internal rotation, decreased upward rotation, and decreased scapular posterior tilting. These kinematic alterations are linked to changed thoracic and cervical spine posture, infraspinatus and teres minor fatigue, and weak or malfunctioning scapular muscular [(10)].

SAIS encompasses a spectrum of subacromial space pathologies including partial thickness rotator cuff tears, rotator cuff tendinosis, calcific tendinitis, and subacromial bursitis. The main consequences of SAIS are functional loss and disability [(11)]. It has been estimated that rotator cuff problems, including impingement and associated rotator cuff tendonitis and bursitis, account for nearly one-third of shoulder pain complaints [(12)]. If not alleviated, impingement can progress to tears of the rotator cuff tendons [(13)]. Repetitive impingement rather than traumatic injury is believed to be the predominant mechanism of rotator cuff tear development [(14)].

In addition to shoulder kinematic deviations, anatomic abnormalities, repetitive eccentric overload, ischemia, and degeneration of the rotator cuff tendons [(15)] have all been proposed as etiologic factors. Frequent or sustained use of the arm at or above shoulder level during occupational tasks has additionally been identified as a significant risk factor, particularly when holding a load or tool overhead [(16, 17)]. Impingement is thought to be due to inadequate space for clearance of the rotator cuff tendons as the arm is elevated, and it has been hypothesized that specific kinematic changes further minimize this space in persons with impingement symptoms [(18)].

Tendon damage can be greatly exacerbated by overuse activity and coracoacromial ligament thickening. Furthermore, excessive superior and anterior humeral head translation brought on by posterior capsular tightness may change glenohumeral kinematics, reducing subacromial space and increasing mechanical compression of the subacromial tissues [20]. Excessive superior translation of the humeral head resulting from rotator cuff weakness can lead to a decrease in the subacromial space during elevation and thus increased mechanical compression of the subacromial contents [21].

Neer outlined three impingement stages: Stage I (bursa and cuff oedema and bleeding, usually in patients under 25); Stage II (irreversible rotator cuff fibrosis and tendonitis, usually in individuals between 25 and 40); and Stage III (partial or full rotator cuff tears, usually in patients over 40) [22].

For distal upper extremity function, proximal scapular stability is crucial. The scapular muscles improve the functional performance of daily living activities by providing this stability and transferring power from the trunk and lower extremities to the upper extremities [23]. Failure of scapular stabilisation results in inefficient shoulder complex function, which damages the upper extremity kinetic chain and puts the person at risk for lower neuromuscular performance and upper quarter injuries [24].Subacromial impingement syndrome dramatically reduces grip strength, which is crucial for mechanical exposure workers and impacts their ability to perform their jobs. There is still little data on how scapular stabilisation exercises affect hand grip strength, despite numerous studies on the subject. Therefore, the purpose of this study was to examine the effects of shoulder strengthening and scapular stabilisation exercises on shoulder function, hand grip strength, and range of motion in this population**.**

MATERIALS AND METHODS:

Study design & setting: At Chennai's Vels Institute of Science, Technology, and Advanced Studies (VISTAS), a comparative experimental study was carried out.

Ethical clearance: The Departmental Ethical Committee gave its approval to the study (SOPT/VISTAS/DEC/190/202). Prior to enrolment, all participants were told about the nature and objective of the investigation, and before the trial started, each participant provided written informed consent.

Participants: For this study, convenient sampling was used to choose 40 mechanical exposure workers who had shoulder pain that persisted for six weeks. Participation was open to both male and female mechanical exposure workers. The participants were split into two groups of twenty each: Group B (shoulder strengthening exercise group) and Group A (scapular stabilisation exercise group).

Inclusion Criteria: To be eligible for inclusion, participants had to meet at least three of the following clinical criteria: a painful arc between 60 degrees and 120 degrees, a positive Neer impingement sign, a positive Hawkins Kennedy test, a positive job's supraspinatus test, and tenderness on palpation of the supraspinatus and infraspinatus tendon insertion.

Exclusion Criteria: The study excluded workers with mechanical exposure who had rheumatoid arthritis, cervical pathology, shoulder fractures or dislocations, shoulder surgery history or shoulder instability.

Outcome measures: All participants were evaluated at baseline and at the end of the sixth week using the following outcome measures:

- o Hand Grip Strength - measured using a handheld dynamometer
- o Range of Motion - measured using a goniometer
- o Shoulder Function and Quality of Life - assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score

Intervention: Every participant underwent a thorough evaluation on the initial visit. Over the course of six weeks, each group got 45 minutes of their particular interventions three times a week.

Group A: Scapular Stabilisation Exercises: Shoulder retraction, shoulder diagonals, angel wings, active push with a plus, and physioball scapular exercises were among the scapular stabilisation exercises given to Group A.

SHOULDER RETRACTION

SHOULDER DIAGONALS

Figure 1: Shoulder retraction
Figure 2: Shoulder diagonals

ANGEL WINGS

Figure 3: Angel wings

ACTIVE: PUSH WITH A PLUS

Figure 4: Active push with a plus

PHYSIOBALL SCAPULAR EXERCISES

Figure 5 & 6: Physioball scapular exercises

Group B: Shoulder Strengthening Exercises (45 minutes with training frequency of 3 times per week for 6 weeks): Standing rows at 45 degrees and 90 degrees, anterior shoulder stretching, active thoracic extension (sternal lift in sitting with lumbar-thoracic dissociation), scapular shrugs and shoulder external rotation strengthening in neutral were all given to Group B.

SHOULDER EXTERNAL ROTATION STRENGTHENING IN NEUTRAL

Figure 7: Shoulder external rotation

SHOULDER INTERNAL ROTATION STRENGTHENING IN NEUTRAL

Figure 8: Shoulder internal rotation

STANDING ROWS AT 45° OR 90°

Figure 9: Standing row at 45º **Figure 10:** Standing row at 90º

ANTERIOR SHOULDER STRETCH

Figure 11: Anterior shoulder stretch

ACTIVE THORACIC EXTENSION

Sternal lift in sitting with lumbar-thoracic dissociation.

Figure 12: Active thoracic extension

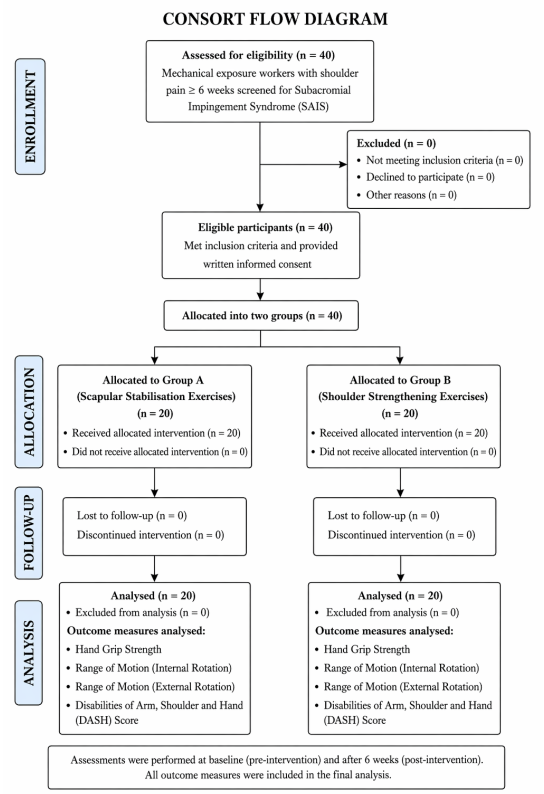
SCAPULAR SHRUGS

Figure 13: Scapular shrugs

Statistical analysis:Descriptive and inferential statistics were used to analyse the data. For every continuous variable, such as hand grip strength, range of motion (internal and exterior rotation) and DASH score, the mean and standard deviation were calculated. The paired samples t test was used to compare intra group results before and after the intervention. The independent samples t test was used to compare groups A and B. For every analysis, $p < 0.05$ was used as the threshold for statistical significance.

RESULTS:

Forty mechanical exposure workers with subacromial impingement syndrome participated in the study. They were split evenly into two groups: Group A (n=20) received scapular stabilisation exercises, while Group B (n=20) received shoulder strengthening exercises. At baseline and after six weeks, both groups hand grip strength, shoulder range of motion (internal and external rotation) and DASH score were measured. After the six week intervention, both groups showed statistically significant improvements in every end measure. On all outcome indicators, however, Group A showed significantly greater improvements than Group B.



1.Descriptive statistics of all measures - Group A

	HAND GRIP STRENGTH	
	A HGS Pre	**A HGS Post**
Count	20	20
Min	12	19
Max	28	35

Table 1: Descriptive measures of HGS for Group A

The descriptive statistics for hand grip strength in Group A are shown in Table 1. Following the six week scapular stabilisation exercise program, the minimum hand grip strength value increased from 12 to 19 and the highest value climbed from 28 to 35, suggesting that all individuals in Group A had improved hand grip strength overall.

	RANGE OF MOTION (INTERNAL ROTATION)	
	A IR pre	**A IR Post**
Count	20	20
Min	30	40
Max	65	70

Table 2: Descriptive measures of IR for Group A

The internal rotation range of motion descriptive statistics for Group A are shown in Table 2. Following the intervention, the maximum value improved from 65° to 70° and the minimum value increased from 30° to 40°, demonstrating an overall improvement in internal rotation for all Group A participants.

	RANGE OF MOTION (EXTERNAL ROTATION)	
	A ER pre	**A ER Post**
Count	20	20
Min	30	35
Max	65	70

Table 3: Descriptive measures of ER for Group A

The range of motion for external rotation in Group A is shown in Table 3. Following the intervention, the maximum value climbed from 65° to 70° and the minimum value increased from 30° to 35°, demonstrating an overall improvement in external rotation for all Group A participants.

	DISABILITIES OF ARM, SHOULDER, HAND	
	A DASH Pre	**A DASH Post**
Count	20	20
Min	57	54
Max	79	75

Table 4: Descriptive measures of DASH for Group A

The descriptive data of Group A's DASH score are shown in Table 4. Following the intervention, the minimum score dropped from 57 to 54 and the maximum score dropped from 79 to 75, suggesting that all members of Group A had improved shoulder function and a general decrease in impairment.

1. **Descriptive statistics of all measures – Group B**

	HAND GRIP STRENGTH	
	B HGS Pre	**B HGS Post**
Count	20	20
Min	12	13
Max	28	29

Table 5: Descriptive measures of HGS for Group B

Group B's hand grip strength descriptive statistics are shown in Table 5. Following the six week shoulder strengthening exercise program, the minimum value climbed from 12 to 13 and the highest value increased from 28 to 29, suggesting a modest overall improvement in hand grip strength among Group B participants.

	RANGE OF MOTION (INTERNAL ROTATION)	
	B IR Pre	**B IR Post**
Count	20	20
Min	30	35
Max	65	65

Table 6: Descriptive measures of IR for Group B

The range of motion for internal rotation in Group B is shown in Table 6. Following the intervention, the minimum value rose from 30° to 35° while the maximum value stayed constant at 65°, indicating that participants with lower baseline values improved while those with higher baseline values did not exhibit additional gains.

	RANGE OF MOTION (EXTERNAL ROTATION)	
	B ER pre	**B ER Post**
Count	20	20
Min	30	35
Max	65	65

Table 7: Descriptive measures of ER for Group B

Following the intervention, the minimum value rose from 30° to 35° while the highest value stayed constant at 65°, as Table 7 illustrates. This pattern is comparable to internal rotation, where benefits were more noticeable among people with lower baseline values.

	DISABILITIES OF ARM, SHOULDER, HAND	
	B DASH Pre	**B DASH Post**
Count	20	20
Min	57	55
Max	79	78

Table 8: Descriptive measures of DASH for Group B

Inferential Statistics:

Intra-Group Analysis - Group A

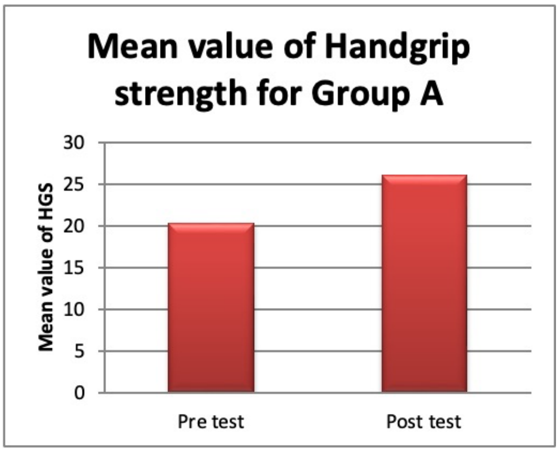
Hand Grip Strength

Table 9: Pre and post-test values of Hand Grip Strength - Group A

Testing the effect of Treatment A in improving the value of Hand Grip Strength (HGS)

	A HGS Pre	**A HGS Post**
Mean	**20.35**	**26.10**
SD	**4.98**	**5.08**
t value	**-8.503**	
P value	**0.000**	

The hand grip strength values for Group A before and after the test are shown in Table 9. After the six week scapular stabilisation exercise regimen, the mean hand grip strength rose from 20.35 to 26.10. Scapular stabilisation exercises significantly improved hand grip strength in Group A, according to the paired samples t-test ($t = -8.503$, $p = 0.000 < 0.05$). As a result, the null hypothesis was disproved.



Graph 1: Mean difference of HGS for Group A

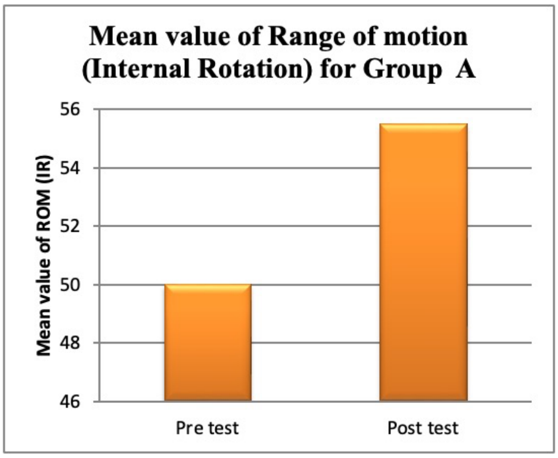
Testing the effect of Treatment A in improving the value of Range of motion (Internal Rotation)

	A ROM (IR) Pre	**A ROM (IR) Post**
Mean	**50.00**	**55.50**
SD	**9.59**	**8.72**
t value	**-11.000**	

P value	**0.000**

Table 10: Pre and post test value of ROM (IR) for Group A

The internal rotation range of motion values for Group A before and after the test are shown in Table 10. After the intervention, the mean internal rotation increased from 50.00° to 55.50°. Group A's internal rotation range of motion was greatly improved by scapular stabilisation exercises, according to the paired samples t-test, which showed a statistically significant improvement (t = -11.000, p = 0.000 < 0.05). As a result, the null hypothesis was disproved.



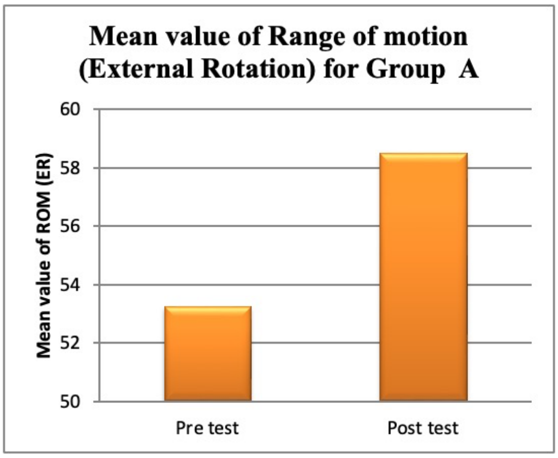
Graph 2: Mean difference of ROM (IR) for Group A

Testing the effect of Treatment A in improving the value of Range of motion (External Rotation)

	A ROM (ER) Pre	A ROM (ER) Post
Mean	**53.25**	**58.50**
SD	**10.29**	**10.52**
t value	**-21.000**	
P value	**0.000**	

Table 11: pre and post test value of ROM (ER) for Group A

The external rotation range of motion values for Group A before and after the test are shown in Table 11. After the intervention, the mean external rotation increased from 53.25° to 58.50°. Group A's external rotation range of motion was greatly improved by scapular stabilisation exercises, according to the paired samples t-test, which showed a statistically significant improvement (t = -21.000, p = 0.000 < 0.05). As a result, the null hypothesis was disproved.



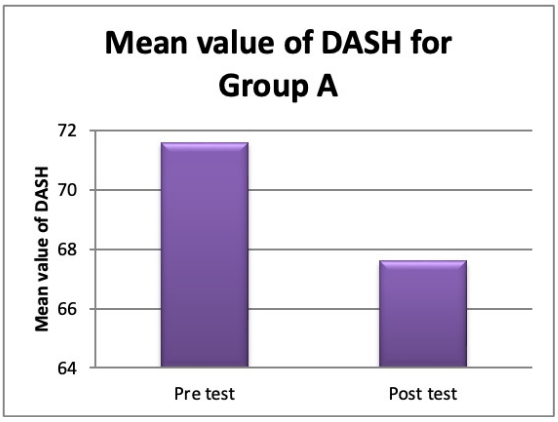
Graph 3: Mean difference of ROM (ER) for Group A

Testing the effect of Treatment A in reducing the value of Disabilities of Arm, Shoulder, Hand (DASH)

	A DASH Pre	A DASH Post
Mean	**71.60**	**67.60**
SD	**5.83**	**5.61**
t value	**22.509**	
P value	**0.000**	

Table 12: pre and post test value of DASH for Group A

The DASH score values for Group A before and after the test are shown in Table 12. After the intervention, the mean DASH score dropped from 71.60 to 67.60. Scapular stabilisation exercises significantly reduced disability and improved shoulder function in Group A, according to the paired samples t-test (t = 22.509, p = 0.000 < 0.05). As a result, the null hypothesis was disproved.



Graph 4: Mean difference of DASH for Group A

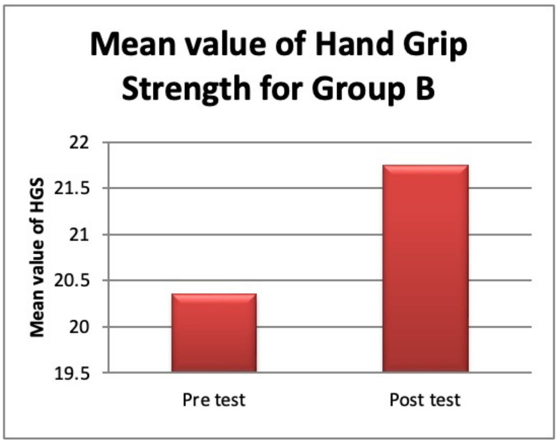
INTRA GROUP ANALYSIS (WITHIN GROUP ANALYSIS)–TREATMENT B

Testing the effect of Treatment B in improving the value of Hand Grip Strength (HGS)

	B HGS Pre	B HGS Post
Mean	**20.35**	**21.75**
SD	**4.98**	**4.57**
t value	**-7.628**	
P value	**0.000**	

Table 13: pre and post test value of HGS for Group B

Group B's hand grip strength values before and after the test are shown in Table 13. After the six-week shoulder strengthening exercise program, the mean hand grip strength rose from 20.35 to 21.75. Shoulder strengthening exercises considerably increased hand grip strength in Group B, according to the paired samples t-test, which showed a statistically significant improvement ($t = -7.628$, $p = 0.000 < 0.05$). Thus, the null hypothesis was disproved.



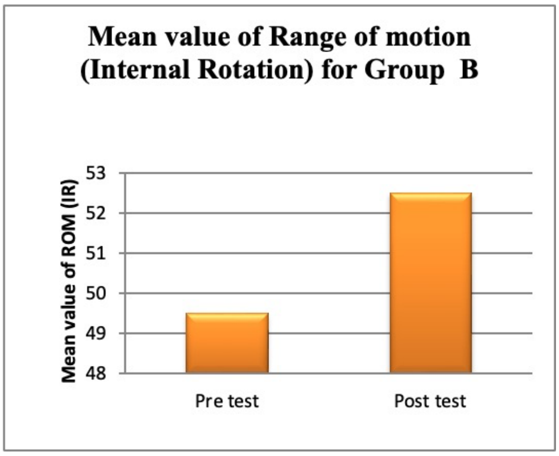
Graph 5: Mean difference of HGS for Group B

Testing the effect of Treatment B in improving the value of Range of motion (Internal Rotation)

	B ROM (IR) Pre	B ROM (IR) Post
Mean	**49.50**	**52.50**
SD	**9.30**	**7.69**
t value	**-1.600**	
P value	**0.000**	

Table 14: pre and post test value of ROM (IR) for Group B

Group B's internal rotation range of motion values before and after the test are shown in Table 14. After the intervention, the average internal rotation increased from 49.50° to 52.50°. Shoulder strengthening exercises considerably improved Group B's internal rotation range of motion, according to the paired samples t-test, which showed a statistically significant improvement ($t = -1.600$, $p = 0.000 < 0.05$). Thus, the null hypothesis was disproved.



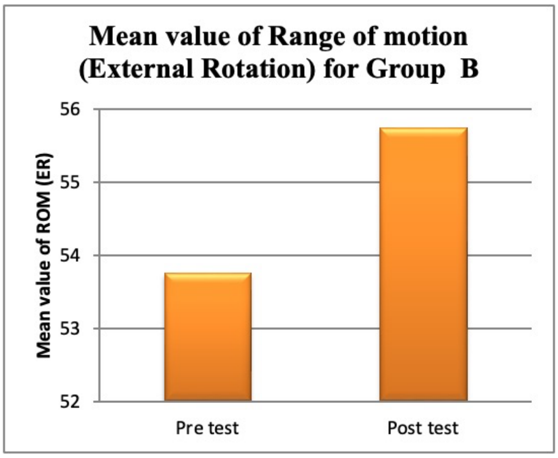
Graph 6: Mean difference of ROM (IR) for Group B

Testing the effect of Treatment B in improving the value of Range of motion (External Rotation)

	B ROM (ER) Pre	B ROM (ER) Post
Mean	**53.75**	**55.75**
SD	**10.37**	**9.21**
t value	**-0.823**	
P value	**0.002**	

Table 15: pre and post value of ROM (ER) for Group B

The external rotation range of motion values in Group B before and after the test are shown in Table 15. After the intervention, the average external rotation increased from 53.75° to 55.75°. Shoulder strengthening exercises considerably improved external rotation range of motion in Group B, according to the paired samples t-test, which showed a statistically significant improvement ($t = -0.823$, $p = 0.002 < 0.05$). Thus, the null hypothesis was disproved.



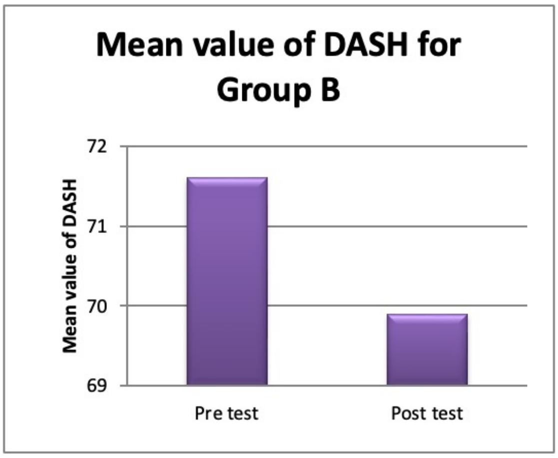
Graph 7: Mean difference of ROM (ER) for Group B

Testing the effect of Treatment B in reducing the value of Disabilities of Arm, Shoulder, Hand (DASH)

	B DASH Pre	B DASH Post
Mean	**71.60**	**69.90**
SD	**5.83**	**5.83**
t value	**10.376**	
P value	**0.000**	

Table 16: pre and post test value of DASH for Group B

The DASH score values for Group B before and after the exam are displayed in Table 16. After the intervention, the mean DASH score dropped from 71.60 to 69.90. Shoulder strengthening exercises significantly reduced disability and improved shoulder function in Group B, according to the paired samples t-test (t = 10.376, p = 0.000 < 0.05). As a result, the null hypothesis was disproved.



Graph 8: Mean difference of DASH for Group B

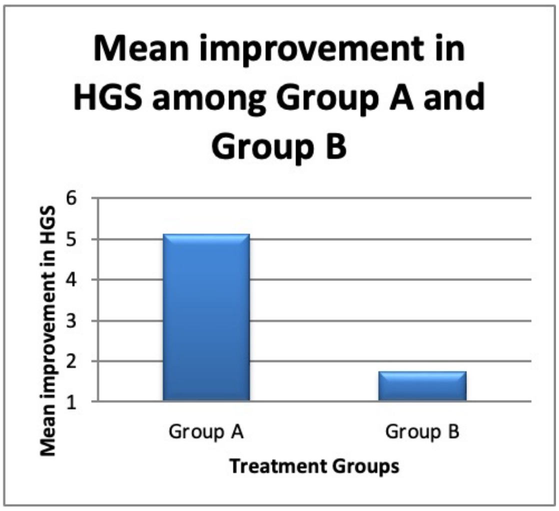
INTER GROUP ANALYSIS (BETWEEN GROUP ANALYSIS)

Comparing the effects of Treatments A and B in terms of change in the value HGS

	A HGS Diff	B HGS Diff
Mean	**5.10**	**1.75**
SD	**1.51**	**0.63**
t value	**9.095**	
P value	**0.000**	

Table 17: comparing post test value of HGS for Group A and Group B

The independent samples t-test showed a statistically significant difference between the two groups (t = 9.095, p = 0.000 < 0.05), as table 17 illustrates. Group A had a higher mean improvement in hand grip strength (5.10) than Group B (1.75). As a result, the null hypothesis was disproved, showing that among mechanical exposure workers with subacromial impingement syndrome, scapular stabilisation exercises significantly outperformed shoulder strengthening activities in enhancing hand grip strength.



Graph 9: comparing mean value of HGS for Group A and Group B

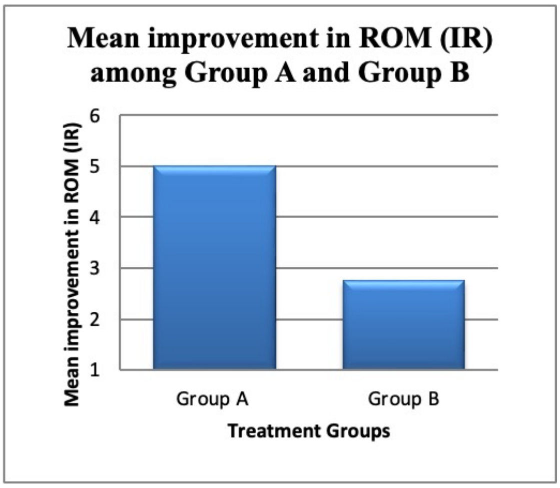
Comparing the effects of Treatments A and B in terms of change in the value ROM (Internal Rotation)

	A ROM (IR) Diff	B ROM (IR) Diff
Mean	**5.00**	**2.75**
SD	**0.00**	**2.55**

t value	**3.943**
P value	**0.000**

Table 18: comparing post test value of ROM (IR) for Group A and Group B

The independent samples t-test demonstrated a statistically significant difference between the two groups (t = 3.943, p = 0.000 < 0.05), as indicated in Table 18. Group A had a higher mean improvement in internal rotation (5.00°) than Group B (2.75°). As a result, the null hypothesis was disproved, showing that scapular stabilisation exercises improved internal rotation range of motion far more than shoulder strengthening activities.



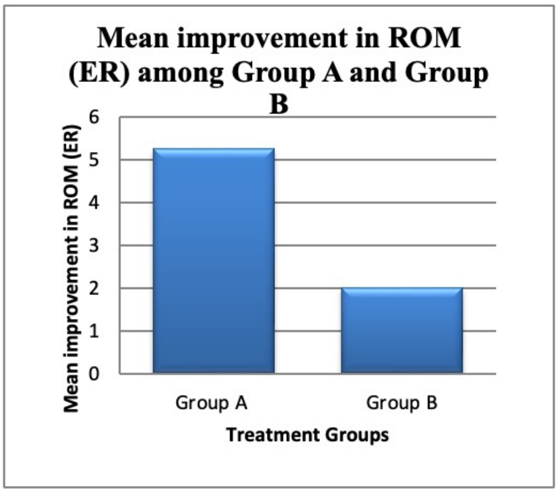
Graph 10: comparing mean value of ROM (IR) for Group A and Group B

Comparing the effects of Treatments A and B in terms of change in the value ROM (External Rotation)

	A ROM (ER) Diff	B ROM (ER) Diff
Mean	**5.25**	**2.00**
SD	**1.11**	**2.51**
t value	**5.284**	
P value	**0.000**	

Table 19: comparing post test value of ROM (ER) for Group A and Group B

The independent samples t-test showed a statistically significant difference between the two groups (t = 5.284, p = 0.000 < 0.05), as shown in table 19. Group A had a higher mean improvement in external rotation (5.25°) than Group B (2.00°). As a result, the null hypothesis was disproved, showing that scapular stabilisation exercises improved external rotation range of motion far more than shoulder strengthening activities.



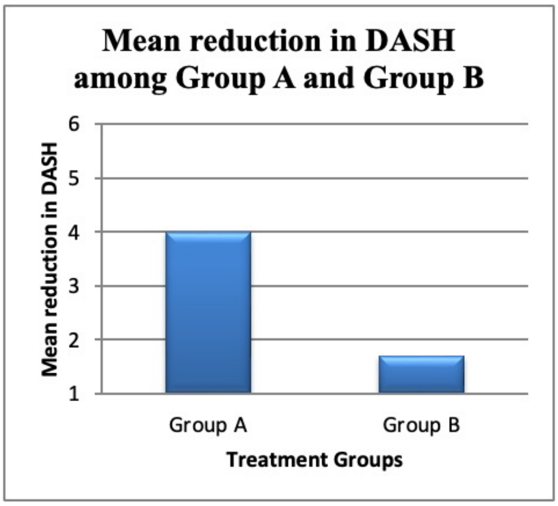
Graph 11: comparing mean value of ROM (ER) for Group A and Group B

Comparing the effects of Treatments A and B in terms of change in the value DASH

	A DASH Diff	B DASH Diff
Mean	**4.00**	**1.70**
SD	**0.79**	**0.73**
t value	**9.516**	
P value	**0.000**	

Table 20: comparing post test value of DASH for Group A and Group B

The independent samples t-test showed a statistically significant difference between the two groups (t = 9.516, p = 0.000 < 0.05), as table 20 illustrates. Group A experienced a higher mean decrease in DASH score (4.00) than Group B (1.70). In order to improve shoulder function and lessen handicap among mechanical exposure workers with subacromial impingement syndrome, scapular stabilisation exercises were found to be considerably more helpful than shoulder strengthening exercises. As a result, the null hypothesis was rejected.



Graph 12: comparing mean value of DASH for Group A and Group B

DISCUSSION:

The current study examined the effects of shoulder strengthening exercises and scapular stabilisation exercises on shoulder function, range of motion, and hand grip strength in mechanical exposure workers with subacromial impingement syndrome. Within each group, both therapies produced statistically significant gains in every outcome measure. However, in hand grip strength, internal rotation, external rotation, and DASH score, scapular stabilisation exercises (Group A) showed noticeably larger improvements than shoulder strengthening exercises (Group B). This suggests that focusing on proximal scapular stability yields better results in this population.

The idea of the kinetic chain provides an explanation for Group A's better improvement in hand grip strength. Peak scapulothoracic muscle activation occurs prior to the initiation of anterior deltoid, biceps, and triceps musculature during a reaching activity. The scapulothoracic musculature activates during the first 5–15% of the arm movement cycle.[25] The kinetic chain describes the proximal to distal sequencing of energy development and output in a variety of upper and lower extremity dominating jobs. The distal component's function can be greatly impacted by shifts in the locations of different kinetic chain segments. According to Joseph M. Day et al., individuals with lateral elbow tendinopathy who performed scapular muscle strengthening exercises had better shoulder function, stronger hand grips, and less pain. Additionally, Krithika Sethi et al. found that in patients with chronic lateral epicondylitis, scapular muscle strengthening exercises combined with traditional physiotherapy greatly enhanced pain-free grip strength and functional outcomes. It's These reports align with the current study's findings.

In terms of range of motion, Johnston TB et al. found that humeral rotation affects impingement during forward flexion. The greater tubercle encroaches on the acromion and coracoacromial ligament during internal rotation, but it rotates away from the acromial arch during external rotation, permitting elevation without impingement.As the head of the humerus approaches the coracoid process, impingement also happens during horizontal adduction, according to Neer CS et al. According to Phil Page et al., tension in the anterior shoulder girdle muscles may influence the leading edge of the coracoacromial ligament, making it more prone to tightness and ultimately causing structural impingement [29].

According to Mihata T. et al., abnormalities in the range of motion of glenohumeral rotation may lead to changes in shoulder kinematics, with excessive external rotation causing the humerus to translate more anteriorly and inferiorly.Azar Moezy et al. concluded that scapular stabilization-based exercise was effective in improving shoulder abduction, external rotation, decreasing forward head posture, and improving pectoralis minor flexibility among SAIS patients. They also reported that dysfunction in the kinetic chain resulting from poor scapular stabilisation can cause shoulder injuries and shoulder impingement syndrome.[31] According to Alan J. Howell et al., stabilised scapular stretching that addresses internal rotation, horizontal adduction, and flexion is most beneficial for patients with shoulder pain and range of motion deficiencies [32]. These reports are supported by the current study's results, which show that dynamic scapular stabilisation exercises greatly enhance SAIS patients' internal and external rotation.

Due to impingement of the muscle tissues enclosed within the subacromial area, patients with SAIS experience pain during shoulder motions, which affects shoulder function and quality of life. This results in less shoulder movement and makes it harder to carry out everyday tasks like putting things on a shelf and combing hair. Patients with shoulder pain may benefit from glenohumeral stabilisation in addition to scapular stabilisation exercises, according to Na-Young Jeon et al.[33] According to Maulik Shah et al., individuals with subacromial impingement syndrome have less pain and functional impairment when they combine standard exercise therapy with scapular stability exercises [34]. Jinhwa Jung et al. concluded that scapular stabilisation exercises improve shoulder function in patients with partial thickness rotator cuff tears after observing improvements in pain, range of motion, isokinetic strength, and endurance[35].Exercise treatment and scapular stabilisation exercises were found to be useful in reducing shoulder impairment, promoting normal motor function, and managing discomfort [36]. These reports align with the current study's findings.

STRENGTH'S OF THE STUDY:

The current study has a number of noteworthy advantages. This study fills a gap in the literature by being one of the few that explicitly assessed the impact of scapular stabilisation exercises on hand grip strength in mechanical exposure workers with subacromial impingement syndrome. A thorough evaluation of treatment results in the domains of strength, range of motion, and functional impairment was made possible by the use of three validated outcome measures: the handheld dynamometer, goniometer, and DASH score. To ensure uniformity in outcome measurement, both groups were evaluated at the same times and under the same circumstances.

LIMITATIONS OF THE STUDY:

The sample size was relatively small, which may limit the generalizability of the findings to the wider population of mechanical exposure workers. It is challenging to ascertain whether the gains seen were maintained after the six week intervention period because the trial was brief and no long term follow up was carried out. Furthermore, the analysis did not take gender differences into account, and the possible impact of sex on treatment results has not been investigated

RECOMMENDATIONS:

Larger sample sizes should be used in future research to increase the findings generalisability. To test the sustainability of results, studies with longer intervention durations and long-term follow up evaluations are advised. To provide a more thorough assessment of therapy efficacy, more research may be carried out using additional outcome measures.

CONCLUSION:

The results of this study show that in mechanical exposure workers with subacromial impingement syndrome, both scapular stabilisation exercises and shoulder strengthening exercises resulted in statistically significant improvements in hand grip strength, range of motion, and shoulder function. Over the course of six weeks, scapular stabilisation exercises were found to be considerably more successful than shoulder strengthening activities in all end measures, including hand grip strength, internal rotation, external rotation and DASH score. For mechanical exposure workers with subacromial impingement syndrome, scapular stabilisation exercises should be regarded as a successful rehabilitation strategy.

REFERENCES:

1. **VAN DER WINDT DA, KOES BW, DE JONG BA, BOUTER LM.** Shoulder disorders in general practice: incidence, patient characteristics, and management. Ann Rheum Dis 1995;54:959-64.

2. **D.S. MORRISON, B.S. GREENBUM AND A. EINHORN.** Shoulder impingement, Orthop Clin North Am 31(2000), 285–293.

3. **D.S. MORRISON, A.D. FROGAMENI AND P. WOODWORTH.** Nonoperative treatment of subacromial impingement **syndrome**, J Bone Joint Surg 79 (1997), 732–737.

4. **BJORN RIDDERVOLD, JOHAN HVIID ANDERSEN, ANNETT DALBOGE.** Occupational lifting, carrying, pushing, pulling loads and risk of surgery for subacromial impingement syndrome: a register-based cohort study. Occupational and Environmental Medicine 2022;79(9) 618-623.

5. **BIGLIANI LU, LEVINE WN.** Subacromial impingement syndrome. J Bone Joint Surg Am 1997;79:1854-68.

6. **BROWNE AO, HOFFMEYER P, TANAKA S**. Glenohumeral elevation studied in three dimensions. J Bone Joint Surg Br 1990;72: 843-5.

7. **LUDEWIG PM, COOK TM.** Translations of the humerus in persons with shoulder impingement symptoms. J Orthop Sports Phys Ther 2002;32:248-59.

8. **FLATOW EL, SOSLOWSKY LJ, TICKER JB**. Excursion of the rotator cuff under the acromion. Patterns of subacromial contact. Am J Sports Med 1994;22:779-88.

9. **VAN DER HELM FC, PRONK GM.** Three-dimensional recording and description of motions of the shoulder mechanism. J Biomech Eng 1995;117:27-40.

10. **SEITZ AL, MCCLURE PW, FINUCANE S.** Mechanisms of rotator cuff tendinopathy: intrinsic, extrinsic, or both? Clin Biomech (Bristol, Avon) 2011;26:1-12.

11. **KOESTER MC, GEORGE MS, KUHN JE.** Shoulder impingement syndrome. Am J Med 2005;118:452-5.

12. **MATSEN FA, ARNTZ CT.** Subacromial impingement. In: Rockwood C, Matsen F, eds. The Shoulder. Philadelphia: W.B. Saunders Co.; 1990:623–64.

13. **NEER CS.** Impingement lesions. Clin Orthop Rel Res. 1983;173:70–77.

14. **NIRSCHL RP.** Rotator cuff tendinitis: Basic concepts of pathoetiology. Instr Course Lect. 1989;38:439–445.

15. **FU FH, HARNER CD, KLEIN AH.** Shoulder impingement syndrome: a critical review. Clin Orthop Rel Res. 1991;269:162–173.

16. **RATHBUN JB, MACNAB I.** The microvascular pattern of the rotator cuff. J Bone Joint Surg Br. 1970;52:540–553.

17. **ZUCKERMAN JD, KUMMER FJ, CUOMO F, SIMON J, ROSENBLUM S, KATZ N.** The influence of coracoacromial arch anatomy on rotator cuff tears. J Shoulder Elbow Surg. 1992;1:4–14.

18. **KAMKAR A, IRRGANG JJ, WHITNEY SL.** Nonoperative management of secondary shoulder impingement syndrome. J Orthop Sports Phys Ther. 1993;17:212–224.

19. **KARDUNA AR, MCCLURE PW, MICHENER LA, SENNETT B.** Dynamic measurements of three-dimensional scapular kinematics: a validation study. J Biomech Eng 2001;123:184-90.

20. **REDDY AS, MOHR KJ, PINK MM, JOBE FW.** Electromyographic analysis of the deltoid and rotator cuff muscles in persons with subacromial impingement. J Shoulder Elbow Surg 2000;9:519-23.

21. **NEER CS.** 2nd. Impingement lesions. Clin Orthop Relat Res 1983:70-7.

22. **PARK JY, LEE SH, OH JH.** Scapular Dyskinesis. J Korean Should Elb Soc. 2009;12:271-277.

23. **PAINE RM, VOIGHT ML.** The role of the scapula. J Orthop Sports Phys Ther. 1993; 18:386-391.

24. **JOSEPH M. DAY.** Scapular Muscle Assessment In Patients With Lateral Epicondylalgia, Doctor of Philosophy Dissertation, College of Health Sciences, University of Kentucky, 2013.

25. **KRITHIKA SETHI.** Scapular muscles strengthening on pain, functional outcome and muscle activity in chronic lateral epicondylagia. J Othop Sci 2018;23(5) 777-782.

26. **JOHNSTON TB.** The movements of the shoulder joint. A plea for the use of the “plane of the scapula” as a reference for movements occurring at the humero-scapular joint. Br J Surg. 1937; 25:252-260.

27. **NEER CS.** 2nd Anterior acromioplasty for the chronic impingement syndrome in the

shoulder: a preliminary report. J Bone Joint Surg Am. 1972;54(1):41-50.

28. **PHIL PAGE.** Shoulder muscle imbalance and subacromial impingement syndrome in overhead athletes. Int J Sports Phys Ther. 2011;6(1):51-58.

29. **TERUHISA MIHATA.** Clinical results of arthroscopic superior capsule reconstruction fro irreparable rotator cuff tears. Arthroscopy.2013;29(3):459-70.

30. **AZAR MOEZY.** The effects of scapular stabilization based exercise therapy on pain, posture, flexibility and shoulder mobility in patients with shoulder impingement syndrome: a controlled randomized clinical trial. Med J Islam Repub Iran. 201427;28:87.

31. **ALAN J HOWELL, ANDREW BURCHETT, TIM L UHL.** Effectiveness of scapular stabilization versus non-stabilization stretching on shoulder range of motion, a randomized controlled trial. Int J Spots Phys Ther .2022;17(4):695-706.

32. **NA-YOUNG JEON, SEUNG-CHUL CHON.** Effect of glenohumeral stabilization exercises combined with scapular stabilization on shoulder function in patients with shoulder pain: A randomized controlled experimenter-blinded study. J Back Musculoskeletal Rehabil. 2018;31(2):259-265.

33. **MAULIK SHAH, JAYSHREE SUTARIA, ANKUR KHANT.** Effectiveness of Scapular stability exercises in the patient with the shoulder impingement syndrome. Indian Journal of Physical Therapy. 2014;2(1):79-84.

34. **JINHWA JUNG, KIHUN CHO, JAEHO YU.** Effects of scapular stabilizing exercise in patients with partial-thickness Rotator Cuff Tear. J Phys. Ther. Sci. 2012;24:1173-1175.

35. **C NETO, P PEZARAT, R OLIVERIA.** Effects of breast cancer treatment on shoulder function: What to expect and how to treat. Int Journal of Physical Therapy and Rehabilitation.2018;4.