



“Effect Of Rhythmic Stabilization Vs Strengthening Exercises On Shoulder Pain In Swimmers – An Experimental Study.”

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Abstract Background & Purpose: Shoulder pain is common in competitive swimmers due to repetitive overhead activity. This study aimed to compare the effectiveness of rhythmic stabilization exercises and strengthening exercises in reducing shoulder pain and improving function in swimmers. **Methodology:** An experimental study was conducted on 70 competitive swimmers aged 10–25 years, randomly divided into Group A (rhythmic stabilization) and Group B (strengthening). Interventions were given three times per week for four weeks. Outcome measures included SPADI, NPRS, and the Updated Swimmer Shoulder Pain Scale. **Results:** Both groups showed significant improvement in pain and function ($p < 0.001$); however, rhythmic stabilization produced significantly greater reductions across all outcome measures. **Conclusion:** Rhythmic stabilization exercises are more effective than strengthening exercises in reducing shoulder pain and improving function in competitive swimmers.

Keywords:

Swimmer's shoulder, rhythmic stabilization, strengthening exercises, shoulder pain

I. INTRODUCTION

There are several types swimmers such as common swimmers who swim for physical activity, some for recreational purpose and some are competitive swimmers. Recreational swimmers often prioritize enjoyment and general fitness, with variable training volume and intensity; recreational habits influence musculoskeletal conditioning differently than regimented training. Casual lap swimmers commonly focus on cardiovascular benefits and may adopt irregular schedules that do not produce the repetitive shoulder loading seen in competitive training. Competitive swimmers follow structured training plans that emphasize technique, speed, and endurance, which systematically expose the shoulder complex to high-frequency, high-duration loads. The competitive swimmers practice swimming for 6 days a week^{1,2,3}They swim 1200metre every day.

Sustained daily training at this frequency results in thousands of overhead stroke cycles per week, producing cumulative microtrauma if recovery, technique, and conditioning are suboptimal. Training of this magnitude requires careful periodization, targeted strength and motor-control work, and monitoring of training loads to prevent overuse symptoms. The repetitive demands of high-volume swimming amplify the importance of early detection and management of shoulder dysfunction to preserve performance and longevity in the sport.

Shoulder exerts a tremendous pressure on shoulder girdle including glenohumeral joint.⁴ The glenohumeral articulation tolerates large ranges of motion at the expense of passive stability and therefore depends heavily on dynamic muscular control and coordinated scapulothoracic function. Mechanical stresses during the catch and pull phases generate compressive and shear forces that must be absorbed and distributed by rotator cuff and scapular stabilizers to maintain joint health. When the dynamic stabilizers are overwhelmed by load or fatigue, abnormal kinematics and increased joint contact forces can develop, accelerating tissue overload.

The incidence of shoulder pain varies with a range of 52% -73%.^{5,6,7} The widely used term for the shoulder pain in swimmers is SWIMMER'S SHOULDER. This high incidence reflects a multifactorial problem encompassing technique, training volume, anatomical variation, and neuromuscular control deficits. Swimmer's shoulder is an umbrella term that typically captures a spectrum of conditions including rotator cuff tendinopathy, subacromial impingement, bursal irritation, and scapular dyskinesis rather than a single diagnostic entity. Recognition of this spectrum is essential for tailoring rehabilitation strategies that address the primary drivers of pain and dysfunction in each athlete.

Scapula plays a vital role in maintaining the stability of glenohumeral mobility whereas the stability of scapula depends upon the scapular muscles. Proper scapular orientation provides a stable platform for humeral rotation and optimizes the length-tension relationships of the rotator cuff and deltoid during force production.

Without adequate scapular control, the glenoid cannot provide an efficient mechanical base and the shoulder complex becomes reliant on compensatory motion patterns that increase injury risk. Clinical assessment of scapular position and motion is therefore a key component in evaluating swimmers with shoulder pain.

These muscles move the scapula and position the glenoid in normal glenohumeral kinematics. The impaired activities of these muscles contribute in resulting of shoulder impingement syndrome (SIS).^{8,9,10}

Altered timing or force generation in scapular movers shifts the subacromial space dynamics, increasing the likelihood of soft tissue compression between the humeral head and acromion. Interventions that restore coordinated activation and strength of scapular muscles can re-establish healthier kinematics and reduce mechanical irritation of vulnerable structures. Identifying which muscles are dysfunctional and how they alter movement is essential for designing specific, effective rehabilitation programs.

Altered stability of scapular muscle involves increased activity of upper trapezius, weakness of lower trapezius and serratus anterior, and delayed activation of lower trapezius.^{9,11,12} In swimmers different muscles act to stabilize scapula in different phases of swimming strokes like serratus anterior, trapezius, rhomboids, deltoid, and supraspinatus.¹³

This muscle imbalance pattern leads to excessive scapular elevation and a reduced posterior tilt and external rotation response, which are critical components of healthy scapular kinematics during overhead motion.

Task-specific demands of each stroke phase require timely recruitment of these muscles so that the scapula can orient the glenoid and dissipate forces during propulsion. Rehabilitation must therefore be phase-specific and task-relevant to translate gains in the clinic to improved control during the aquatic environment. Among these, serratus anterior and supraspinatus get into more fatigue as are active throughout freestyle stroke.¹⁴

Sustained activation without adequate recovery reduces force output and alters neuromuscular coordination, increasing reliance on accessory muscles that may not provide the ideal vector of force. Fatigue-related changes in muscle recruitment can produce alterations in stroke mechanics, potentially reducing efficiency and increasing symptomatic loading of periarticular tissues. Monitoring fatigue, prescribing graduated conditioning, and addressing endurance deficits in these muscles are critical to preventing the cascade that leads to pain and dysfunction. The above-mentioned causes may lead to tightness of the posterior capsule of glenohumeral joint affect humerus alignment and length tension relationship of muscles making it liable to microtrauma and impingement.¹²

Posterior capsular stiffness limits internal rotation and can provoke anterior-superior translation of the humeral head during forward flexion and internal rotation, narrowing the subacromial space. The resultant mechanical disadvantage alters rotator cuff mechanics and predisposes tendons to increased tensile and compressive loads at vulnerable angles of abduction and rotation. Addressing capsular mobility alongside motor-control interventions provides a more comprehensive approach to restoring normal shoulder biomechanics.

Strengthening of these muscles by exercise program aiming to restore balance activation of upper trapezius versus lower trapezius, and serratus anterior have been described in treatment of scapulothoracic dysfunction related to shoulder injuries.^{11,12,15} Progressive resistance training, neuromuscular re-education, and closed-chain exercises are commonly recommended to selectively target and retrain the scapular stabilizers. Evidence supports that task-specific strength gains and improved timing of activation are associated with reduced pain and better functional outcomes in overhead athletes when programs are appropriately dosed. Clinicians should individualize exercise selection, load, and progression to the athlete's symptom profile, stage of tissue healing, and competitive demands.

As strengthening may lead to more fatigue so alternatively there is rhythmic stabilization a form of proprioceptive neuromuscular facilitation (PNF) which includes alternate isometric antagonist muscles contractions against resistance intending to enhance muscle strength and balance, joint stability, and relief pain.^{16,17,18} It also improves proprioception, normalize kinaesthesia of the glenohumeral and scapulothoracic articulation in shoulder injuries of the overhead athletes^{19,20,21}

Rhythmic stabilization focuses on co-contraction and neuromuscular control rather than isolated concentric work, potentially offering stability improvements with less concentric metabolic cost. By emphasizing isometric control in functional joint positions, the technique trains the nervous system to coordinate multifaceted muscle responses required for dynamic sports tasks. Integration of rhythmic stabilization into rehabilitation may be especially useful in early-to-mid stages of recovery when pain or inflammation limit more aggressive strengthening. Few cases studies rhythmic stabilization as a component of shoulder rehabilitation program in athletes: swimmers and non- athletes.^{22,23}

These case reports and small series provide initial clinical insights into feasibility, safety, and potential benefits, but their limited sample sizes restrict generalizability and preclude definitive conclusions. Well-designed controlled trials are required to quantify effect sizes, clarify optimal dosing, and determine which patient subgroups derive the greatest benefit from rhythmic stabilization.

Comparison with established strengthening protocols will help define the role of rhythmic stabilization within staged rehabilitation pathways for swimmer's shoulder. So, this study aims to compare the effect of rhythmic stabilization-based rehabilitation program with joint mobilization versus scapular strengthening in patients with swimmer's shoulder. A direct comparison of these approaches will inform clinicians about relative efficacy for pain reduction, functional improvement, and restoration of sport-specific movement patterns in competitive swimmers.

Outcomes from this study can guide evidence-based selection of interventions, inform return-to-sport decisions, and support development of integrated protocols that combine manual therapy, neuromuscular training, and progressive strengthening. The results may also identify mechanistic changes in scapular kinematics and muscle activation patterns that explain clinical improvements and guide individualized treatment planning.

AIMS & OBJECTIVES

Aim:

To find the effectiveness of rhythmic stabilization exercises and strengthening exercises on reducing shoulder pain, improving shoulder function, and enhancing overall performance in competitive swimmers

Objective:

1. To evaluate the effect of rhythmic stabilization exercises on shoulder pain in swimmers.
2. To evaluate the effect of strengthening exercises on shoulder pain in swimmers.
3. To compare the effectiveness of rhythmic stabilization exercises and strengthening exercises on shoulder pain in swimmers.

MATERIALS AND METHODOLOGY

This experimental study will be conducted among competitive swimmers aged 10–25 years at selected swimming clubs or academies in Nashik over a duration of six months, with a sample size of 70 participants calculated using OpenEpi and selected through a purposive sampling technique. The study aims to determine the effect of rhythmic stabilization exercises versus strengthening exercises on shoulder pain in competitive swimmers. Both male and female swimmers with a minimum of one year of competitive swimming experience, shoulder pain persisting for at least three months, and a training frequency of at least three sessions per week will be included. Swimmers who have undergone shoulder surgery in the last six months, sustained acute shoulder injuries or fractures within three months, have systemic or neurological conditions affecting the shoulder, significant musculoskeletal disorders influencing swimming performance, irregular training patterns, or pregnancy will be excluded, and subjects unable to comply with the protocol will be withdrawn. Materials required include pen, paper, chair, plinth, pillow, towel roll, and weighing scales. Outcome measures will include the Shoulder Pain and Disability Index (SPADI), a reliable self-reported questionnaire assessing shoulder pain and functional limitation, and the Updated Swimmer's Shoulder Pain Scale, a validated sport-specific tool designed to evaluate shoulder pain and functional impact related to swimming-specific movements and training demands.

PROCEDURE

After obtaining ethical clearance from the appropriate committee, the study was initiated in accordance with ethical guidelines, and all participants were briefed about the purpose, benefits, potential risks, and confidentiality of the study in their native language, following which written informed consent was obtained. Subjects were selected based on predefined inclusion and exclusion criteria to ensure homogeneity of the sample. Eligible participants were randomly allocated into Group A or Group B using a computer-generated blinded randomization method (WINPEPI) to minimize selection bias. Pre-treatment assessment of shoulder pain and functional disability was carried out using the Shoulder Pain and Disability Index (SPADI) and the updated swimmer's functional scale, with participants positioned comfortably and given clear instructions for accurate scoring. Group A received graduated rhythmic stabilization exercises along with posterior capsule stretching, while Group B underwent scapular muscle strengthening exercises combined with posterior capsule stretching; all exercises were demonstrated clearly and performed in standing, sitting, or lying positions with emphasis on correct technique and progression. Both groups received intervention sessions three times per week on alternate days for four weeks, with each session including warm-up, exercise protocol, and cool-down. Following completion of the 12 treatment sessions, post-treatment assessments were conducted using the same outcome measures to evaluate changes in shoulder pain severity and functional disability and to determine the effectiveness of the interventions.

DATA ANALYSIS

Non-parametric tests were used due to non-normal data distribution, with the Wilcoxon Signed-Rank Test for within-group comparisons and the Kruskal-Wallis Test for between-group analysis. Both groups showed significant improvement in pain and disability after intervention ($p < 0.001$); however, Group A (rhythmic stabilization) demonstrated greater reduction in SPADI scores, pain levels, and swimmer-specific shoulder pain scores compared to Group B (strengthening exercises). Between-group analysis confirmed that improvements in Group A were statistically superior ($p < 0.001$), with large effect sizes and no reported adverse events, indicating better efficacy and safety of rhythmic stabilization exercises.

RESULT

Table 1. Summary of Outcome Measures

OUTCOME MEASURE	GROUP A	GROUP B
NPRS Rest Pre Intervention	4.5	4.4
NPRS Rest Post Intervention	0.7	2.5
NPRS Rest Mean Change	3.8	1.9
NPRS Activity Pre Intervention	7.0	6.4
NPRS Activity Post Intervention	2.6	4.3
NPRS Activity Mean Change	4.4	2.1
SPADI Pre Intervention Score	37.9	38.5
SPADI Post Intervention Score	15.1	21.4
SPADI Mean Change	22.8	17.1
Updated Swimmer Pain Scale Difference	5.2	2.7

In conclusion, this data analysis substantiates that rhythmic stabilization exercises are more effective than conventional strengthening in alleviating pain and improving functional outcomes in swimmers with shoulder pain. These findings provide strong evidence for recommending rhythmic stabilization as a key component in rehabilitation protocols tailored to competitive swimmers. This quantitative analysis forms a critical part of the research thesis, offering robust statistical validation of the clinical findings.

RESULTS

Figure 1. Age distribution of participants

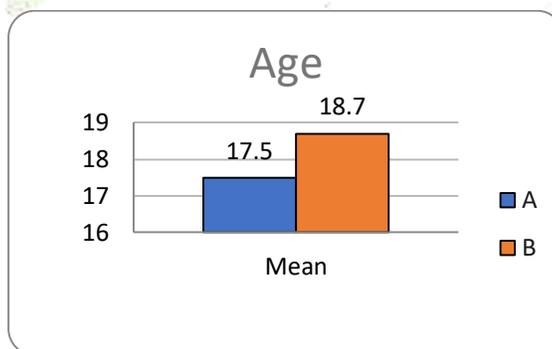


Table no 2. A comparison between the ages of both the groups

	Group	Mean	Median	SD	Minimum	Maximum
Age (in years)	A	17.5	16	4.4	8	25
	B	18.5	19	4.99	9	25

Study included voluntary participation of total 70 swimmers, with their age ranging from 10-25 years. The age distribution between Group A and Group B was descriptively analysed. Group A had a mean age of 17.5 years (SD = 4.4), while Group B had a slightly higher mean of 18.7 years (SD = 4.99). Given the non-normality suggested by the mean–median discrepancy, the Mann–Whitney U test was employed to compare age differences between groups. This non-parametric test confirmed whether the observed variation was statistically significant.

Figure 2. Gender and group distribution

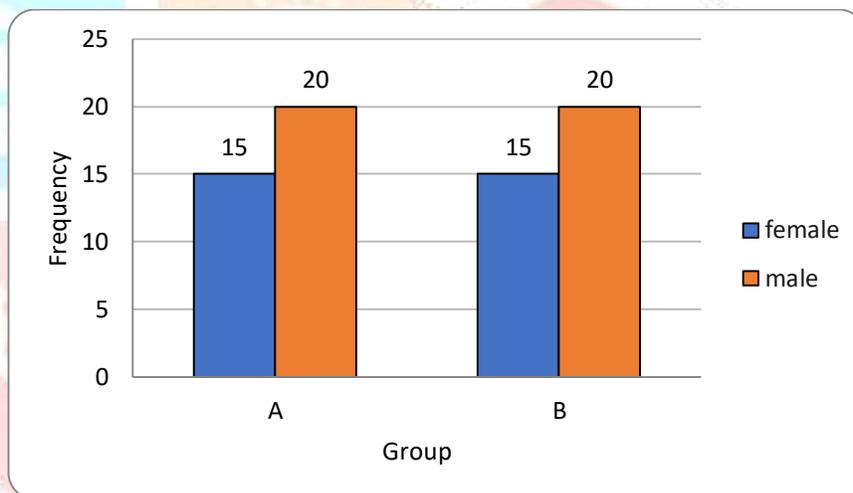


Table no 3. A comparison between genders of both the groups

Frequencies of Gender	Group	Counts	% of total
Female	A	15	21.40%
	B	15	21.40%
Male	A	20	28.60%
	B	20	28.60%

The gender distribution across Groups A and B was balanced, with each group comprising 15 females and 20 males. Females represented 42.9% of the total sample, while males accounted for 57.1%. Group-wise, both genders were equally distributed, indicating no sampling bias. These proportions were consistent across cumulative percentages, supporting the representativeness of the cohort for gender-based analysis.

Table no 4. Comparison between pain, disability and updated swimmer shoulder pain scale

Outcome Measure	Group	Wilcoxon W	p-value	Mean Difference	Effect Size (Rank biserial)
SPADI Score	A	630	<0.001	23.8	1
	B	630	<0.001	17.7	1
NPRS on Activity	A	630	<0.001	4.5	1
	B	595	<0.001	2	1
NPRS at Rest	A	595	<0.001	4	1
	B	595	<0.001	2	1
Updated Swimmer Shoulder Pain Scale	A	630	<0.001	5	1
	B	630	<0.001	3	1

It summarizes the within-group changes in clinical outcome measures for Groups A and B using the Wilcoxon Signed-Rank Test. Both groups exhibited statistically significant improvements ($p < 0.001$) across all parameters, including SPADI scores, NPRS at rest and during activity, and the Updated Swimmer Shoulder Pain Scale. Group A demonstrated greater mean reductions in SPADI (23.8 vs. 17.7) and shoulder pain scores (5.3 vs. 4.8), suggesting a more pronounced therapeutic effect. Uniform effect sizes of 1 across all measures indicate large treatment effects within both groups. These findings underscore the efficacy of both rehabilitation protocols, with Group A showing comparatively superior clinical gains.

Figure 3 Comparison between the pre and post assessment pain scale (NPRS) in the participants of Group A

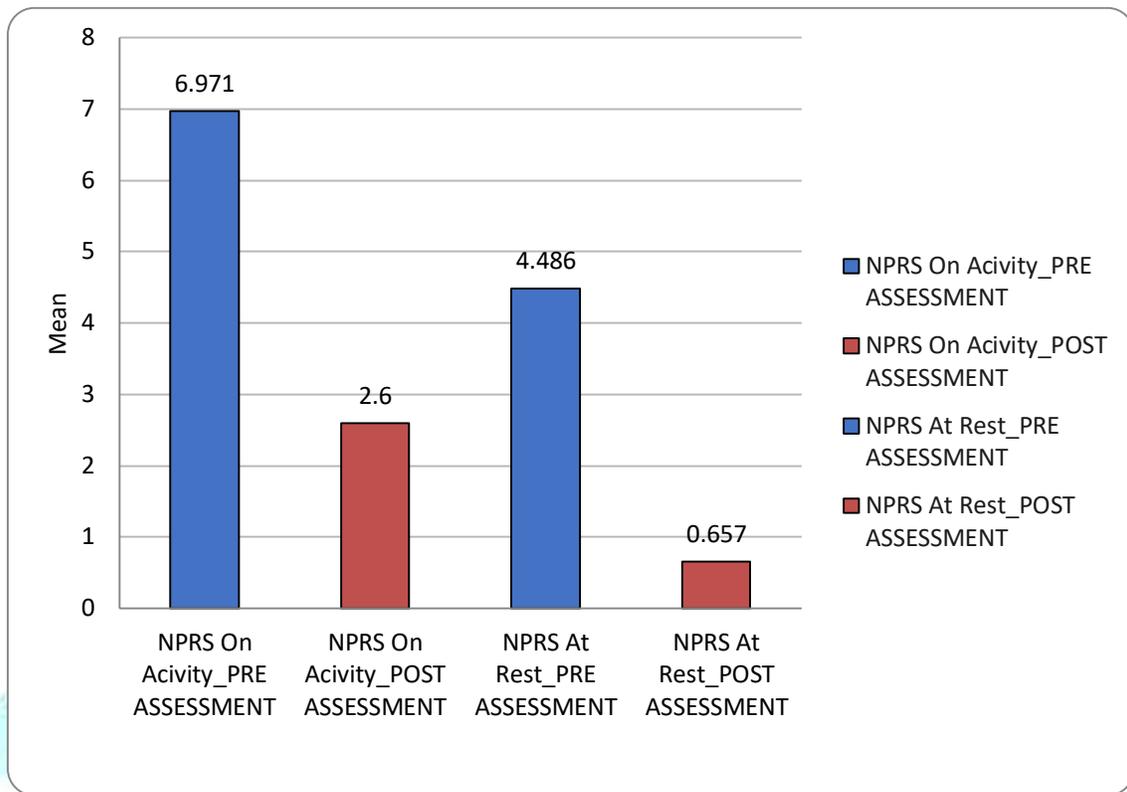


Figure 4 Comparison between the pre and post assessment of SPADI Score in the participants of Group A

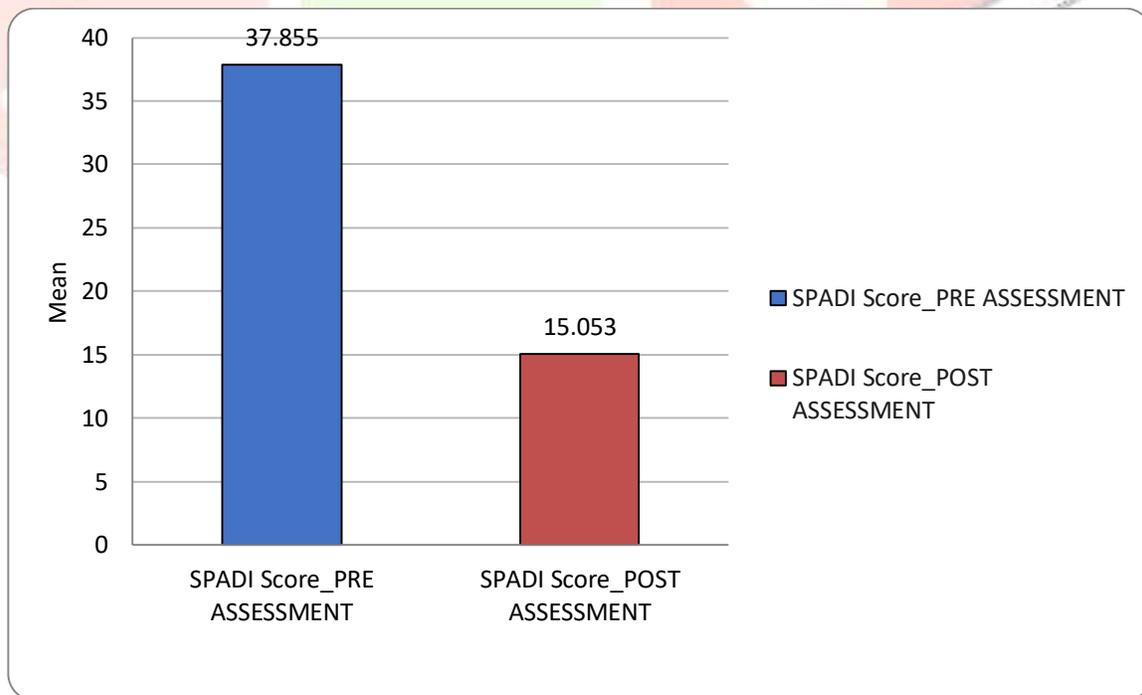


Figure 5 Comparison between the pre and post assessment of Updated Swimmer Shoulder Pain Scale Score among the participants of Group A

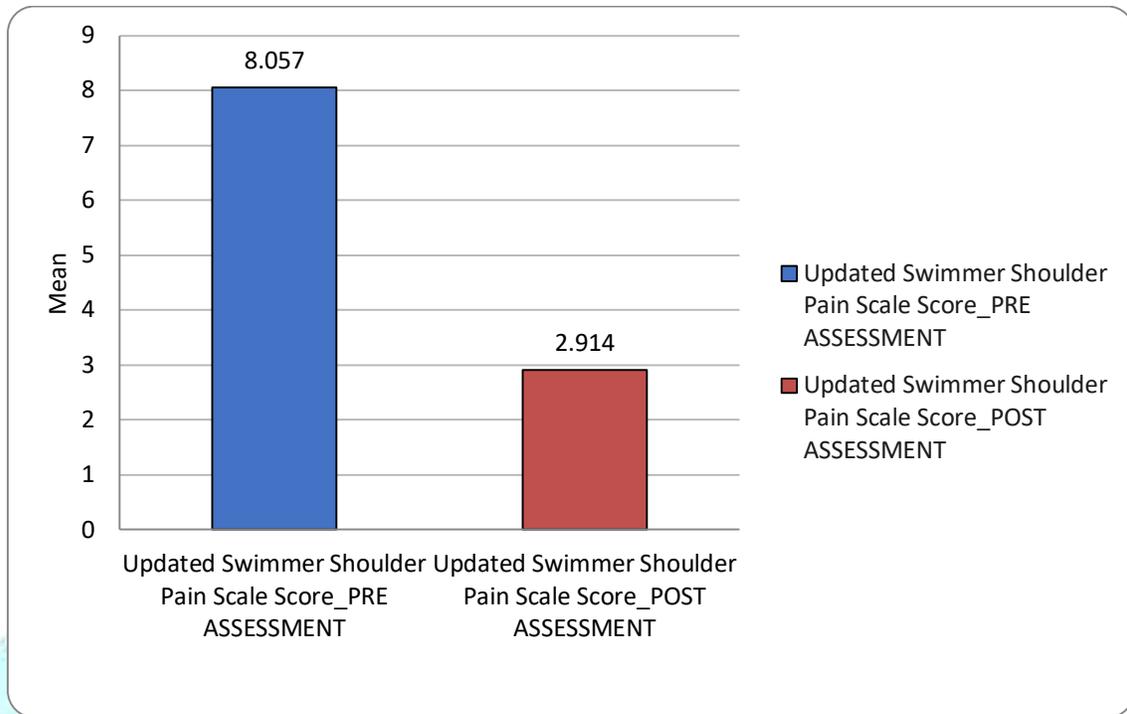


Figure 6 Comparison between the pre and post assessment pain scale (NPRS) in the participants of Group B

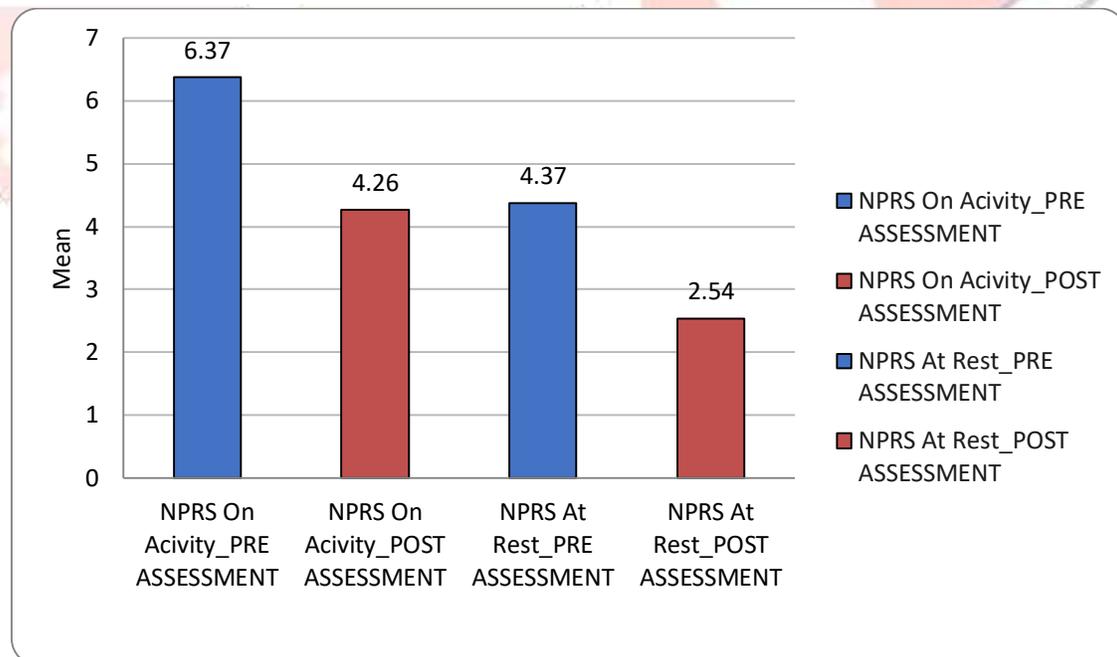


Figure 7 Comparison between the Pre and Post assessment of SPADI Score in the Participants of Group B

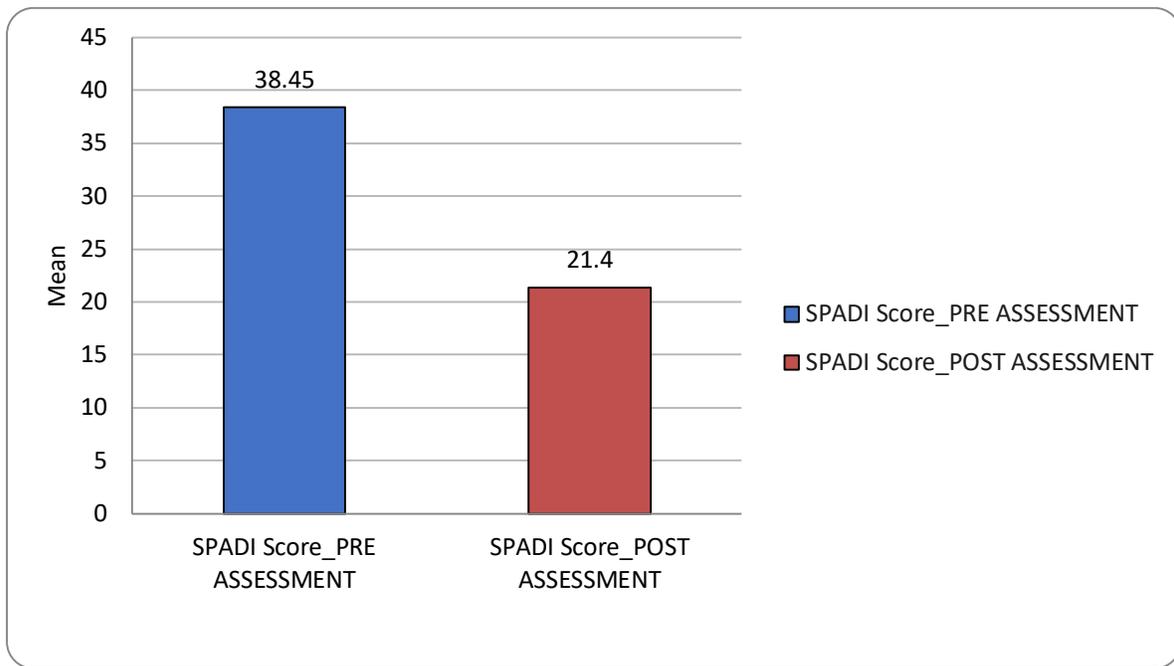


Figure 8 Comparison between the pre and post assessment of Updated Swimmer Shoulder Pain Scale Score among the participants of Group B

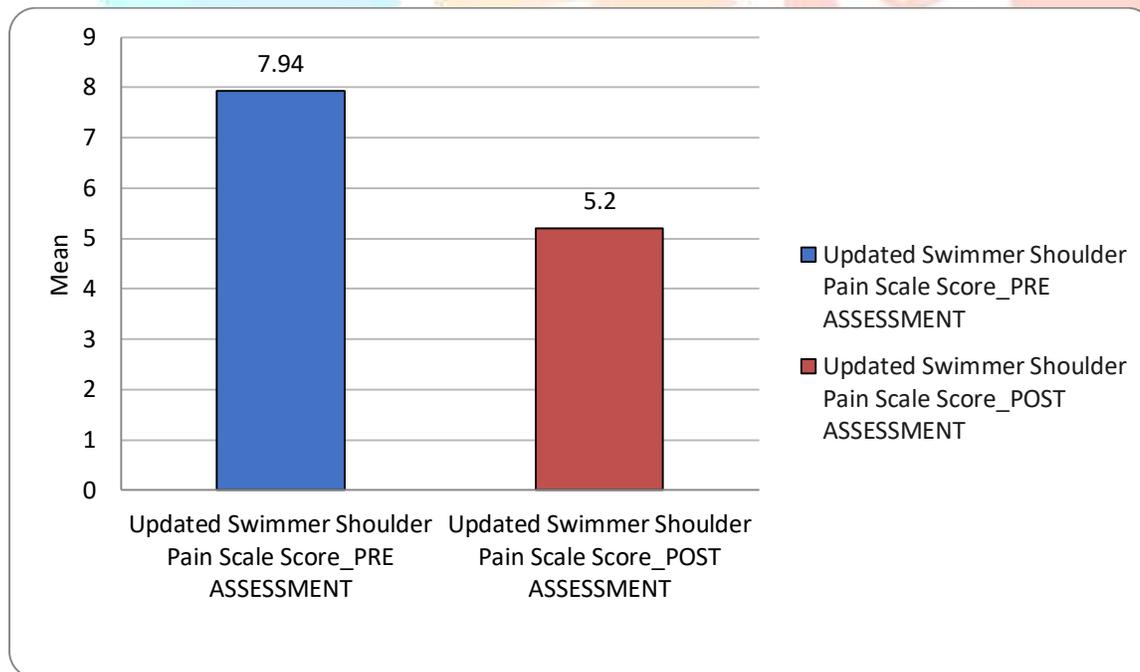


Table no 5. Between- group comparisons of clinical outcomes using Krushal-

Wallis and Pairwise Wilcoxon Tests

Outcome Measure	Kruskal-Wallis χ^2	p-value	Effect Size (ϵ^2)	Pairwise W (A vs B)	Pairwise p-value
NPRS on Activity	48.5	<0.001	0.703	-9.85	<0.001
NPRS at Rest	29.9	<0.001	0.434	-7.74	<0.001
SPADI Score	12.8	<0.001	0.186	-5.07	<0.001
Updated Swimmer Shoulder Pain Scale	47.5	<0.001	0.688	-9.74	<0.001

This table presents the results of non-parametric between-group comparisons evaluating the efficacy of Rhythmic Stabilization (Group A) versus Strengthening Exercises (Group B) in 70 competitive swimmers with shoulder dysfunction. Four outcome measures were analysed: Numeric Pain Rating Scale (NPRS) during activity and at rest, Shoulder Pain and Disability Index (SPADI), and the Updated Swimmer Functional Scale. The Kruskal-Wallis test revealed statistically significant differences across all measures ($p < 0.001$), with large effect sizes observed for NPRS on activity ($r = 0.703$) and the Updated Swimmer Scale ($r = 0.688$), indicating superior clinical improvement in Group A. Pairwise Wilcoxon tests further confirmed these differences, with consistently significant p-values (<0.001) and negative W statistics, suggesting greater reductions in pain and functional limitations in the Rhythmic Stabilization group.

DISCUSSION

Shoulder pain is a frequent and often disabling concern among competitive swimmers, with up to 73% affected due to the repetitive overhead motions required by various strokes. These repetitive movements exert continuous pressure on the shoulder complex, frequently leading to conditions such as impingement syndrome, supraspinatus tendinopathy, and scapular dyskinesis. Factors like muscular imbalance, fatigue of stabilizing muscles, and inefficient stroke technique further contribute to the development of these issues, underscoring the need for effective prevention and rehabilitation strategies in both clinical and sports settings.

This research fills a notable gap in physiotherapy literature by evaluating the effectiveness of rhythmic stabilization exercises—grounded in proprioceptive neuromuscular facilitation (PNF)—in comparison to traditional strengthening programs. A randomized sample of 70 competitive swimmers aged 10 to 25 was divided into two groups: one received rhythmic stabilization training (Group A), while the other followed conventional strengthening routines (Group B). Both groups also engaged in posterior capsule

stretching and standardized warm-up and cool-down activities. Ethical protocols were strictly followed, including institutional approval and informed consent.

Pain and function were assessed using validated tools such as the Shoulder Pain and Disability Index (SPADI), Numeric Pain Rating Scale (NPRS), and the Updated Swimmer Shoulder Pain Scale, measured before and after a four-week intervention. Group A demonstrated significantly greater improvements across all indicators: SPADI scores decreased by 23.8 points compared to 17.1 in Group B; NPRS scores at rest dropped from 4.5 to 0.7 in Group A versus 4.4 to 2.5 in Group B; and pain during activity was reduced more substantially in Group A. These statistically significant outcomes, coupled with large effect sizes and the absence of adverse events, affirm the safety and superior efficacy of rhythmic stabilization.

The study ensured demographic parity between groups, confirming that observed differences stemmed from the interventions themselves. These findings highlight the complex nature of swimmer's shoulder and suggest that rhythmic stabilization is particularly effective in enhancing neuromuscular coordination and joint stability. While traditional strengthening remains beneficial for scapular endurance, its impact may be amplified when integrated with proprioceptive techniques.

Despite promising results, limitations such as the small sample size and short duration restrict broader applicability and long-term conclusions. Future studies should incorporate biomechanical evaluations, extended follow-up periods, and subgroup analyses based on stroke type and training intensity to refine therapeutic approaches.

From a clinical perspective, the study supports early identification and targeted rehabilitation using rhythmic stabilization, especially for athletes with scapular dysfunction or proprioceptive impairments. For sports organizations, the findings present a strong case for investing in preventive physiotherapy and structured athlete education. Incorporating rhythmic stabilization into standard rehabilitation protocols can enhance recovery, minimize recurrence, and improve overall performance.

In summary, rhythmic stabilization exercises proved more effective than conventional strengthening in alleviating shoulder pain and improving function among competitive swimmers. These results advocate for their integration into rehabilitation and injury prevention strategies, with further research needed to confirm long-term benefits and optimize their application across varied athletic populations.

SUMMARY

This study investigated the comparative impact of rhythmic stabilization and conventional scapular strengthening exercises on swimmer's shoulder in 70 competitive swimmers aged 10–25. Both interventions led to notable improvements, but rhythmic stabilization produced significantly greater reductions in pain and disability, as measured by SPADI, NPRS, and the Updated Swimmer Shoulder Pain Scale ($p < 0.001$, ϵ^2 up to 0.703). These enhanced outcomes are likely due to improved proprioception and neuromuscular coordination achieved through PNF-based techniques. The exercises were well-tolerated, versatile, and effective in restoring shoulder function. Although the study was limited by its short duration and absence of biomechanical analysis, rhythmic stabilization proved to be a promising, sport-specific rehabilitation strategy for swimmers.

LIMITATIONS AND RECOMMENDATIONS

The study had certain limitations, including the absence of long-term follow-up, reliance on subjective outcome measures, lack of biomechanical assessment, and limited control over external training factors, while performance-related outcomes were not evaluated. Despite these limitations, the findings support the clinical value of rhythmic stabilization exercises in reducing shoulder pain and disability in competitive swimmers, particularly for those with scapular instability and impaired proprioception. Incorporating these exercises into early rehabilitation and return-to-play programs, along with coordinated efforts between therapists, coaches, and athletes, and the use of standardized outcome measures, may enhance long-term shoulder function, injury prevention, and overall athletic performance.

CONCLUSION

In conclusion, both rhythmic stabilization and strengthening exercises were effective in reducing shoulder pain and improving functional performance in competitive swimmers; however, rhythmic stabilization demonstrated significantly superior outcomes across all measured parameters. Greater reductions in pain intensity and disability scores in the rhythmic stabilization group highlight the importance of neuromuscular control and joint stability in managing swimmer's shoulder. These findings suggest that incorporating rhythmic stabilization exercises into rehabilitation and training programs may enhance recovery, improve shoulder function, and reduce the risk of recurrent injury in overhead athletes. Further research with long-term follow-up and sport-specific performance measures is recommended to strengthen and expand these conclusions.

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