RESEARCH PAPER

Comparative Efficacy of Scapular Strengthening and Core Stability on Pulmonary Function and Postural Alignment in Individual with Rounded Shoulder

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ABSTRACT
Background - Rounded shoulders are among the most prevalent aberrant postures in the upper quarter. The prevalence of rounded shoulder posture in India for age group (18-24 yrs) is 84 %.
Aims of the study - To study the Comparative efficacy of scapular strengthening and core stability on pulmonary function and postural alignment in individuals with rounded shoulders.
Procedure- Ethical clearance was obtained from Institution Ethical Committee. Total 72 participants were included in this study according to the inclusive criteria; participants were allocated by randomization method into two groups. GROUP A included 36 participants (Scapular strengthening exercise) and GROUP B included 36 participants (Core stability exercise) for 5 days in a week.
Outcome measures- Chest expansion, pectoralis minor length test
Result- Effect of GROUP A was assessed by using Paired t Test /Wilcoxon's Signed Rank Test. Effect of GROUP B was assessed by using Paired t Test / Wilcoxon's Signed Rank Test. Comparison Between both GROUP was done by using unpaired t Test / Mann-Whitney Test. Results indicated statically significant difference within the group for all parameters and statistically significant between group difference were found for PMLT.
Conclusion- Both interventions were equally effective in enhancing Pulmonary function However, scapular strengthening exercise demonstrated greater superiority in improving chest expansion. Scapular strengthening exercise were found to be more effective in improving Chest expansion values and reducing pectoralis minor tightness compared to the other intervention.
Keyword's – RSP, Scapular strengthening Exercise, Core stability Exercise, Chest expansion, Pectoralis minor length test
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INTRODUCTION
Modern civilization is seeing an increase in musculoskeletal disorders and discomfort due to improper work posture and repeated employment.[1] Poor relationships between various body components are typically the source of bad posture, and these imprecise relationships result in tense muscles and incorrect shortening and lengthening. One of the most common yet underappreciated health issues in adolescents is poor body posture. Untreated wrong body posture can lead to a variety of problems, including changes in cardiorespiratory fitness (CRF), decreased lung vital capacity, low back pain, and altered internal organ movement.[2]
Round shoulders are among the most prevalent aberrant postures in the upper quarter.[3]
The acromion process is most anteriorly positioned in relation to the mastoid process when seen laterally, which is known as forward shoulder posture (FSP).[4] Among young adults aged 18 to 24, eighty-four percent have rounded shoulders.[5] The prevalence of rounded shoulder syndrome among females aged 19-24 years has been reported to be 8.4[6]
Numerous daily tasks, such as carrying a backpack, mouth breathing, repetitive overhead movements and the use of mobile phones, laptops, or computers, as well as extended study sessions. It may be explained the fact that prolonged and repetitive back flexion gradually shortens the pectoral muscle, fixing the shoulder in this forward posture.[4] Women who have breast hypertrophy, also known as macromastia, which is defined by an unequal increase in breast size relative to body size, may also have rounded shoulders.[7]

The scapula plays vital role in shoulder biomechanics, forming the scapulothoracic (ST) joint which is supported by various muscles and ligaments. The glenohumeral (GH), acromioclavicular (AC), and sternoclavicular joints all work together to provide ST movement. Both habitual postures and functional activity of the upper extremities may have a direct effect on the scapula's resting positions.[8]

Changes in the position of the scapula produce adaptive aberrant posture and misalignment in the shoulder joint, which puts a lot of strain on the muscles and ligaments surrounding the shoulder joint and causes discomfort and impairment. Among the complications are impingement, instability, muscular imbalance, tendinitis, bursitis, shoulder pain, and insufficient scapulohumeral rhythm.[7]

The body's posture and relative alignment are affected by muscle weakening and shortening.[9]

A forward shoulder posture causes the posterior shoulder muscles, including the middle and lower trapezius, rhomboids, and rotator cuff muscles, to lengthen and weaken, while the anterior muscles, including the pectoralis major and minor, upper trapezius, serratus anterior, and intercostals, become tight because they are shortened. Due to a number of causes, it is evident that FSP may have an impact on pulmonary function by causing a noticeable drop in respiratory parameters including FEV1, FVC, and FEV1/FVC. In FSP, shortening of the accessory breathing muscles, such as the pectoralis minor, intercostal muscle, and serratus anterior, may result in lower respiratory values and increased energy consumption.

FSP also reduces the respiratory system's compliance and the lung's ability to expand

Furthermore, FSP gradually progresses into a slouched posture marked by an increase in forward head posture and thoracic kyphosis (TK), which leads to respiratory dysfunction and dyspnoea. These slouched sitting positions increase intra-abdominal pressure and the proximity of the ribs to the pelvis, which restricts the diaphragm's movement during inspiration [10]

The greatest force or tension that a muscle or set of muscles can Generate with a single contraction is define as strength. Reduced muscle volume and poor neuromuscular activation determine the amount muscle strength is lost with age, inactivity, injury, and immobilization.[11]

A systematic process of lifting, lowering, or managing resistance for a comparatively small number of repetitions or over a brief period of time is known as strengthening exercise. Both open and closed kinematic chains can be used for strengthening exercise. exercise programs intended to improve the weak scapular stabilizing muscles.[9] To restore the normal strength of periscapular muscles and the correct placement of the scapula, exercised aimed at strengthening the scapula have been suggested. [12]

According to Nordin, muscle strengthening occurs through active contraction of the agonist while the antagonist undergoes relaxation. Through this action, both elements of the muscular system- the agonist and the antagonist are functionally engaged.[13]

Sufficient muscle activity is essential for maintaining healthy posture; therefore, preserving the optimal length- tension relationship of muscles is important for proper postural alignment. evidence from multiple studies indicates that correcting muscle imbalance requires strengthening elongated and weakened muscles along with stretching shortened muscles. This approach helps to restore balance between agonist and antagonist muscle groups, thereby improving posture and reducing postural deviations such as forward head posture and rounded shoulder posture.[13]

The back, abdomen, pelvic floor, diaphragm, hip, and gluteus muscles are all part of the core, which is the functional term for the trunk muscles and connects the upper and lower limbs. These muscles are in charge of transmitting forces from the proximal to the most distal part of the body and stabilizing the spine.[14]

"The state of a joint remaining or quickly returning to proper position through an equalization of forces" is the definition of stability.[11]

In order to stabilize the posture and movement of the trunk above the pelvis, the diaphragm, the abdominal muscles, the spinal and hip muscles, and the pelvic floor muscles must all contract in unison anteriorly, posteriorly, superiorly, and inferiorly. This is known as core stabilization.[14]

MATERIALS AND METHODOLOGY

An Experimental study, a randomized clinical trial conducted on individuals with rounded shoulders at D. Y. Patil college of physiotherapy. Simple random sampling method was used. The Minimum sample size was 72 (36 in each group). The study started after getting ethical approval from institutional Ethics Committee. Duration of study is of 6 months

Inclusion Criteria

Age 18-24, Both males and females

Exclusion Criteria shoulder surgery, Recent Childhood asthma, Shoulder fractures, Rib fracture, Chest wall deformities, Shoulder deformities other than FSP.

PROCEDURE

The study protocol will be present for approval in front of institutional ethical committee and protocol committee of D.Y. Patil Education society, deemed to be university Kolhapur and D.Y. Patil College of Physiotherapy, Kolhapur. After concerning subjects will be taken from subjects willing to participate.

Considering the inclusion and exclusion criteria subjects will be requested to in study. The nature of

study will be explained. A brief demographic data including name, age, gender as per data collection sheet will be recorded.

The study will be consisting of Group A (scapular strengthening) and Group B (core stability exercises).

GROUP A

Y to W: Arms stretched 4-5 inches, flexed and abducted to a 120° angle, scapular retraction maintained, thumbs facing upward. Then the elbows flexed and the shoulders spread.[12]

L to Y: The arms are externally rotated when the scapula retracts and the elbows are 90 degrees flexed. By lifting the arms over the head and fully extending the elbows, the letter Y was formed.[12]

Scapular retraction against handheld resistance in prone position: patient is in prone lying position with a

	Mean	Std. Deviation
Age	22.28	1.38

Gender	Frequency	Percentage
Female	33	45.80%
Male	39	54.20%
Total	**72**	**100%**

weight in the hand and the arm placing over the edge

	Parameters	Assessment Period	Mean	Std. Deviation	p-value
CE	Axillary	Pre	2.40	0.58	<0.001*
		Post	3.74	0.60	
	Nipple	Pre	1.94	0.54	<0.001*
		Post	2.85	0.55	
	Xiphoid	Pre	1.51	0.57	<0.001*
		Post	2.37	0.45	

of table. Instruct the patient to squeeze their scapula together.[20]

Corner press out: patient is standing with shoulder abducted to 90 degrees, elbows flexed to 90 degree and back toward a corner. Tell the patient to shift their body weight away from the corner and push their elbows onto the walls.[20]

GROUP B

Bridge exercise: the patient is in supine lying. Both hand at the side, hip and knee flexed, feet placed on the floor. Patient is instructed to lift the pelvis from the floor.

Diagonal curl ups: the patient is in supine lying. Both hand at the side, hip and knee flexed, placed on the floor. instruct the patient to extend their fingers toward their knees, and their trunk raised to the acromion by raising their head and shoulders and then stretching their arms diagonally.

Back extension: Patient is in prone lying, hand at the side, palms facing upwards, forearm supinate, the upper and lower body raised, the spine extended, and the tips of the fingers reaching toward the toes with the scapular depression and retraction.

Quadruped with alternate arm and leg raise: patient is in quadruped position. Patient is instructed to lift the alternate arm and leg.

RESULT

The comparative study of scapular strengthening Exercise and core stability Exercise revealed that pectoralis minor length test improved more significantly in the scapular strengthening Exercise group than the core stability exercise. However, both exercises equally enhanced pulmonary function, as measured by the chest expansion at various levels (axillary, nipple, xiphoid). These findings suggest that while the scapular strengthening Exercise is more effective for improving pulmonary function parameters and postural alignment, but both exercises offer similar benefits in enhancing pulmonary function.

GENDER DISTRIBUTION

Table 1 presents the gender distribution of the total participants. Among the 72 participants, 39 were male and 33 were female.

Graph 1 illustrates the percentage distribution, showing that males are accounted for 54.20% of the total, while females comprised 45.80%.

Table No.1 Gender distribution

Graph No.1 Gender distribution

AGE WISE DISTRIBUTION

Table 2 presents the age-wise distribution of participants in **Group A** (scapular strengthening exercise) and **Group B** (core stability Exercise). The mean age of the study population was 22.28 years (S.D. 1.38).

Table no. 2 Age wise distribution

A. PRE & POST CHEST EXPANSION (CE) IN GROUP A

Table 3 presents the pre- and post-intervention values

of **Chest expansion** for **Group A** (scapular strengthening Exercise). The results show a significant improvement, with **Chest expansion** at different levels. At axillary level increasing from a mean of **2.40 to 3.74** (P-value**: <0.001***), at nipple level rising from **1.94 to 2.85** (P-value: **<0.001***) and at xiphoid level rising from **1.51 to 2.37** (P-value: **<0.001***)

Graphs **3** visually depict the pre- and post-intervention mean values of **Chest expansion** for Group A.

Table No. 3 Pre-Post Intervention of chest expansion in Group A

Graph No. 4 Pre-Post Intervention of chest expansion in Group A

PRE & POST PECTORALIS MINOR LENGTH TEST (PMLT) IN GROUP A

Tables **4a, 4b and 4c** represent the pre- and post-intervention of pectoralis minor length test for **Group A**. The results indicate that the median difference between pre- and post-intervention scores is **zero**, with a significance level of **0.050**, leading to the rejection of null hypothesis.

Graphs **4** visually represent the pectoralis minor length test scores before and after the intervention, demonstrating a significant reduction of scores following the intervention.

Table 4a

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The median of differences between Pre and Post equals 0.	Related-Samples Paired t Test	<0.001*	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Table 4b

Table No. 4c pre post intervention of pectoralis minor

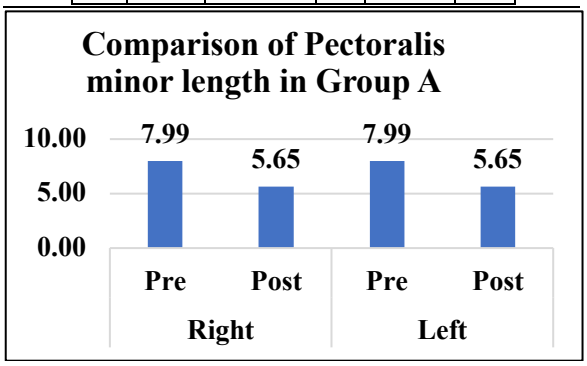
Related samples paired t test summary

		Parameters	**Assessment Period**	**Mean**	**Std. Deviation**	**p-value**
Total N	**PMLT**	Right	Pre	7.99	1.25	<0.001*
			Post	5.65	1.07	
		Left	Pre	7.99	1.25	<0.001*
			Post	5.65	1.07	
	36					
Test Statistic	8.54					
Standard Error	0.274					
Standardized Test Statistic	8.54					
Asymptotic Sig. (2-sided test)	<0.001*					

length test in group A

Related samples paired t test summary	
Total N	36
Test Statistic	2.51
Standard Error	0.305
Standardized Test Statistic	2.51
Asymptotic Sig. (2-sided test)	<0.001*

	Parameters	Assessment Period	Mean	Std. Deviation	p-value
PMLT	Right	Pre	7.99	1.25	<0.001*
		Post	7.20	1.33	
	Left	Pre	7.99	1.25	<0.001*
		Post	7.20	1.33	



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The median of differences between Pre and Post equals 0.	Related-Samples Paired t Test	<0.001*	Reject the null hypothesis.

a. The significance level is <0.001*

b. Asymptotic significance is displayed.

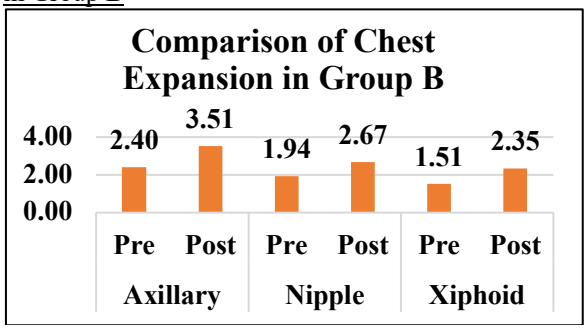
Graph 4

PRE & POST CHEST EXPANSION (CE) IN GROUP B

Table 5 presents the pre- and post-intervention values of **Chest expansion** for **Group B** (Core stability Exercise). The results show a significant improvement, with **Chest expansion** at different levels. At axillary level increasing from a mean of **2.40 to 3.51** (P-value**: <0.001***), at nipple level rising from **1.94 to 2.67** (P-value: **<0.001***) and at xiphoid level rising from **1.51 to 2.35** (P-value: **<0.001***)

Graphs **3** visually depict the pre- and post-intervention mean values of **Chest expansion** for Group A.

Table No. 5 Pre-Post Intervention of chest expansion in Group B



graph No. 5 Pre-Post Intervention of chest expansion in Group B

PRE & POST PECTORALIS MINOR LENGTH TEST (PMLT) IN GROUP B

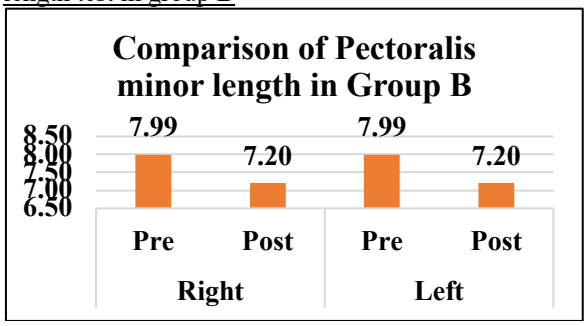
Tables **6a, 6b and 6c** represent the pre- and post-intervention of pectoralis minor length test for **Group A**. The results indicate that the median difference between pre- and post-intervention scores is **zero**, with a significance level of **0.050**, leading to the rejection of null hypothesis.

Graphs **6** visually represent the pectoralis minor length test scores before and after the intervention, demonstrating a significant reduction of scores following the intervention.

Table 6a

Table 6b

Table No. 6c pre post intervention of pectoralis minor length test in group B



Graph No. 6c pre post intervention of pectoralis minor length test in group B

B. GROUP WISE COMPARISON OF CHEST EXPANSION (CE)

Table **7** represents a group-wise comparison of post-intervention **Chest expansion** at the axillary, nipple and xiphoid levels between group A and group B.

At the axillary level, the mean chest expansion in Group A was 3.74 (S.D- 0.60), while Group B showed 3.51 (S.D- 0.60). the difference between the groups

was not statistically significant (P=0.123)

At the nipple level, the mean chest expansion in Group A was 2.85 (S.D- 0.55), whereas Group B showed 2.67 (S.D -0.53). The difference between the groups was not statistically significant (P =0.160)

	Parameters	Group	Mean	Std. Deviation	p-value
CE	Axillary	A	3.74	0.60	0.123
		B	3.51	0.60	
	Nipple	A	2.85	0.55	0.160
		B	2.67	0.53	
	Xiphoid	A	2.37	0.45	0.834
		B	2.35	0.44	

At the xiphoid level, the mean chest expansion in Group A was 2.37(S.D – 0.45), while Group B showed 2.35 (S.D-0.44). The difference between the groups was not statistically significant (P =0.8354)

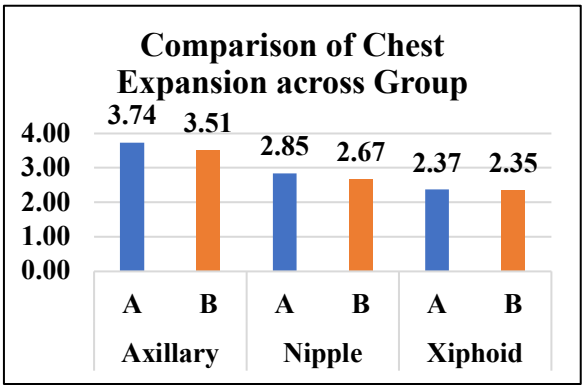
Overall, although Group A showed slightly higher chest expansion values than Group B at all three levels, the differences were not statistically significant.

Graphs **7** visually illustrate the group-wise comparison of **Chest expansion** between Group A and Group B at Axillary, Nipple, and xiphoid levels demonstrating that **Group A exhibited slightly greater improvement than Group B** at all three anatomical levels.

However, the difference between the groups was not statistically significant.

Table no 7 – Group wise comparison of chest expansion

	Parameters	Assessment Period	Mean	Std. Deviation	p-value
CE	Axillary	Pre	2.40	0.58	<0.001*
		Post	3.51	0.60	
	Nipple	Pre	1.94	0.54	<0.001*
		Post	2.67	0.53	
	Xiphoid	Pre	1.51	0.57	<0.001*
		Post	2.35	0.44	



Graph no 7 – group wise comparison of chest expansion

C. GROUP WISE COMPARISON OF PECTORALIS MINOR LENGTH TEST (PMLT)

Tables **8** represent a group-wise comparison of Pectoralis minor length test scores between **Group A** and **Group B** for both the Right and Left sides.

For the right side, the mean value for Group A was 5.65 ± 1.07, whereas Group B showed a higher mean value of 7.20 (S.D - 1.33). The difference between the groups was statistically significant ($p < 0.001$).

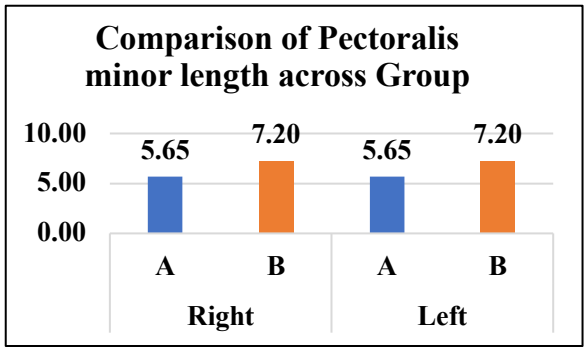
Similarly, for the left side, the mean value for Group A was 5.65 ± 1.07, while Group B demonstrated 7.20 (S.D - 1.33). This difference was also statistically significant ($p < 0.001$).

Overall, the results indicate that Group A showed significantly greater improvement in pectoralis minor length compared to Group B on both sides

Graphs **8** visually illustrate the group-wise comparison of **Pectoralis minor length test** between Group A and Group B for both right and left sides. demonstrating that **Group A exhibited significantly greater improvement than Group B** for both RIGHT and LEFT sides.

Table no 8a – group wise comparison of pectoralis minor length test

	Parameters	Group	Mean	Std. Deviation	p-value
PMLT	Right	A	5.65	1.07	<0.001*
		B	7.20	1.33	
	Left	A	5.65	1.07	<0.001*
		B	7.20	1.33	



Graph no 8 – groupwise comparison of pectoralis minor length test

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Score is the same across categories of Group.	Unpaired -t - Test	<0.001*	Reject the null hypothesis.
a. The significance level is <0.001*				
b. Asymptotic significance is displayed.				
c. Exact significance is displayed for this test.				

Table No. 8b

UNPAIRED t TEST	
Total N	72
Test Statistic	-5.45
Standard Error	0.284
Standardized Test Statistic	-5.45
Asymptotic Sig.(2-sided test)	<0.001*
Exact Sig.(2-sided test)	<0.001*

Table No. 8c Group wise comparison of PMLT

DISCUSSION

The aim of this study is analyse the effects of core stability and scapular strengthening exercises on postural alignment and pulmonary function in those with rounded shoulders. A total 72 subjects were recruited in the study age group of 18 – 24 yrs, divided into two group with 36 in each group.

Group A will receive scapular strengthening exercise for 5 days/week for four week and Group B will receive core stability exercise for 5 days/week for four week.

Evidence from previous studies indicates that the prevalence of rounded shoulders is 84% in individuals with age group 18-24. This age group is typically prone to have rounded shoulder posture because of changes in lifestyle, carrying large backpacks, and using laptops and cell phones, all of which cause muscular imbalance.

In the previous study, a pectoralis minor length test was used to asses rounded shoulder posture by measuring the distance between shoulder girdle and table of which it is raised. The raised shoulder shows tightness of pectoralis minor which is the cause of rounded shoulder.

A previous study conducted by Janvhi Singh et.al in 2023 investigated the corelation of rounded shoulder posture with cardio – respiratory fitness and psychosocial health status among adolescents. According to this study, pulmonary function may be impacted by rounded shoulders, and respiratory values clearly decreased as rounded shoulder degree decreased. the study shows that there is negative correlation between rounded shoulder posture and cardiorespiratory fitness. This indicates that individuals with increased rounded shoulder posture are prone to have decreased cardiorespiratory fitness.

Previous study conducted by Reethu Elsa et.al on the effect of scapular retraction exercise on shoulder alignment, pulmonary function and aerobic capacity in subjects with forward shoulder posture. In this study there is shortening of anterior muscles like, pectoralis major, pectoralis minor, upper trapezius, serratus anterior and intercostals muscles and lengthening of posterior muscles like, middle and lower trapezius, rhomboids and rotator cuff muscles. Due to this muscle imbalance, there is reduce pulmonary function. This study shows that there is significant improvement in shoulder alignment, pulmonary function and aerobic capacity among rounded shoulder posture. Scapular retraction exercises help in restoring muscle balance and reduce mechanical restriction on the thoracic cage.

Previous study investigated by Sheetal Kalra et.al on effect of scapular strengthening exercises on rounded shoulder and neck disability among college students of Delhi NCR. The study shows that during COVID 19 pandemic due to safety reasons the traditional

educational system is replaced by online educational system. The excessive use of cell phones and laptops and maintaining same posture for prolong period leads to the postural misalignment. Two instances of postural misalignment include forward head posture and rounded shoulder posture. In this study 30 participants were divided into two groups one experimental group (scapular strengthening and conventional treatment) and another one is control group (conventional treatment) the study concludes that the experimental group is more effective in pain reduction and scapular position improvement.

Similarly, study conducted by Ankita Patil et.al on effect of scapular stabilizers in treatment of rounded shoulder posture in dental students shows that strengthening of scapular stabilizers is more effective in correcting rounded shoulder posture among male dental students

Another study conducted by Khushboo Jangid et.al on effect of elastic band exercises for rounded shoulders on chest expansion in young adults at the end of 6 weeks: an experimental study. This study was done to see the effect of elastic band exercises on individuals with rounded shoulders to improve chest expansion. Chest wall measurements were used to assess the pre and post intervention values of chest expansion at different levels (axillary, nipple). the study concludes that there is significant improvement in pre post intervention chest expansion values at axillary and nipple levels.

Previous study conducted by A A I Ayesa Febrina Adyasputri et.al on modified scapular stabilization better than shoulder strengthening in pectoralis minor stretching improving scapular alignment in tailors with rounded shoulder posture. This study shows that due to continuous working for 4 hours or more can cause postural adaptation in tailors and are more prone to develop rounded shoulders. This study concludes that both interventions show improvement in scapular alignment; however, modified scapular stabilization combined with pectoralis minor stretching

Shows better improvement than the shoulder strengthening combined with pectoralis minor stretching.

In the same way, Mi-Kyung Kim's study contrasted core stability exercises and shoulder stabilization exercises for young people with rounded shoulder posture. According to their research, all workout regimens enhanced shoulder posture, but shoulder stabilization exercises showed a stronger increase in breathing. Shoulder height and respiratory function measurements were the main outcome measures, even though their study examined two distinct intervention regimens. In contrast, the current study uses measurements of chest expansion to evaluate pulmonary function and the pectoralis minor length test to evaluate postural alignment. Further insight into which intervention may be more effective in improving both respiratory and postural parameters is provided by the current study's larger sample size and specific focus on the relative efficacy of scapular strengthening and core stability exercises.

Overall, most prior research has focused on a single treatment strategy or few end measures, even when it has examined the connection between rounded shoulder position and respiratory function or assessed the efficacy of particular exercise programs. In contrast to earlier studies, this one uses a comparison design to assess the effects of two distinct exercise regimens on postural alignment and pulmonary function: scapular strengthening and core stability exercises. Additionally, objective evaluation of respiratory and musculoskeletal improvements is possible through the use of outcome measures like the pectoralis minor length test and chest expansion. Therefore, the findings of this study may offer crucial information for selecting the appropriate physiotherapy techniques for those with rounded shoulder posture.

CONCLUSION

The present study aimed to compare the effects of scapular strengthening Exercise and core stability Exercise on pulmonary function and postural alignment in individuals with rounded shoulder. The findings showed a significant improvement in chest expansion post intervention in both exercise groups, the scapular strengthening exercise demonstrated greater effectiveness in improving chest expansion values at various levels (Axillary, Nipple, Xiphoid), suggesting its superiority in improving pulmonary function in individuals with rounded shoulders.

Scapular strengthening exercises demonstrated greater significance in improving pectoralis minor length, whereas core stability exercises showed greater improvement in chest expansion.

These findings highlighted the importance of scapular strengthening exercises in improving postural alignment and chest expansion in individuals with rounded shoulder.

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