International Journal of Recent Advances in Multidisciplinary Topics
Volume 6, Issue 3, March 2025
https://www.ijramt.com | ISSN (Online): 2582-7839

Effectiveness of Resistance Band Training on Quadriceps Muscle Strength in Young Adults

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***Abstract*: According to the global status report on physical activity, 2022, more than 80% of adolescents and about 27% of adults do not meet WHO's recommended level of physical activity. Such physically inactive individuals are targeted in our study. Resistance Band Training is a common resistive training method that is used for strengthening the muscles. These bands have a unique advantage that the resistance can be developed in any direction that the band is elongated and provide variable resistance as compared to dumbbells. It produces a curvilinear tension profile and increases eccentric muscle activity, strength, and power. Objective: to find out the effectiveness of Resistance band exercises on Quadriceps muscle strength in young adults. Method: 30 young adults who are physically inactive are taken into consideration. The individuals are selected by proper screening, fulfilling the inclusion and exclusion criteria and are then taken for an experimental study. They are divided into two groups of 15 each. Group A receives strength training with free weights and dumbbells, while Group B receives strength training with the use of resistance bands. The exercise program is for a total period of four weeks. Pre and post are analyzed based on the outcome measure i.e., Modified sphygmomanometer. Results: the statistical analysis shows that both conventional strength training and resistance band training improved the strength of Quadriceps muscle, with the conventional training method being slightly more effective. Conclusion: the Conventional Strength Training method proved to be more effective in increasing the strength of Quadriceps muscle than Resistance Band Training.**

***Keywords*: Eccentric training, Modified sphygmomanometer, physically inactive individuals, Quadriceps muscle strength, Resistance band.**

1. Introduction

The document starts here. Copy and paste the content in the paragraphs. A recent survey reveals that less than 10% of Indians participate in leisure physical activity, with most of the population being sedentary [1]. According to the global status report on physical activity, it is not met by more than 80% of teenagers and roughly 27% of adults. Their inactivity levels are high because they don't exercise frequently [1]. Physical activity continues to be the biological stimulus required for the maintenance of organ and system functions and structures so that they can carry out their physiological duties as effectively as possible [3]. Physical activity is crucial for prevention of diseases. Inactive lifestyles are prevalent, with young people often leading sedentary lives and consuming calorie-heavy diets, leading to increased body weight and fat mass [3].

Lack of physical activity of the patient contributes to increased fatigability. Deconditioning brought on by inadequate exercise results in loss in muscular mass and strength. Additionally, alterations in muscle metabolism might also enhance fatigability. Conversely, consistent exercise training increases muscular strength and function, as well as fatigue tolerance [2] In addition to shortening life expectancy, physical inactivity can exacerbate several diseases, including obesity, type 2 diabetes, cardiovascular disease and others [5].

The quadriceps femoris are a group of muscles that cover the anterior and lateral aspects of the thigh. The Latin term "quadriceps femoris muscle" translates to "four-headed muscle." [6]. It consists of four individual muscles: rectus femoris, vastus medialis, vastus lateralis, and vastus intermedius as its constituents. The entire muscle is inserted into the smooth portion of the tibial tuberosity through the patella's common tendon [6].

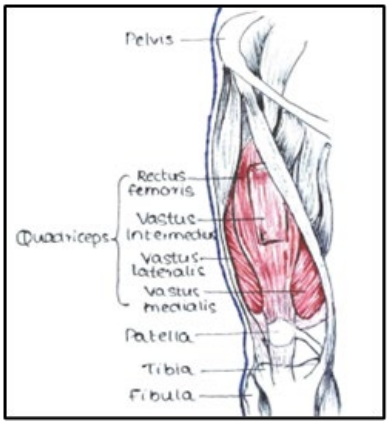

Fig. 1. Anatomy of quadriceps

The rectus femoris muscle spans both hip and knee joints, with the quadriceps femoris being the only strong knee extensor. It drags the patella along the lower leg's mechanical axis, while other muscles pull in proximally and laterally. Its horizontally oriented fibres resist the pull of the Vasti muscles, stabilizing the knee during extension and preventing patellar

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dislocation [6]. The rectus femoris muscle extends the knee by crossing both hip and knee joints, facilitating thigh flexion and anterior pelvis flexion. It can also bend the hip and extend the knee simultaneously. The eccentric contraction of the quadriceps muscles controls knee flexion during walking [4].

Weakness of the quadriceps muscle can cause rapid fatigue, impair neuromuscular control and result in abnormal movement at the knee joint. The quadriceps' weakening may lead to early degenerative alterations, reducing shock absorption and strain on the knee joint [3].

Strength training is the application of methodical repetitions that can modify the structure and functionality of tissues. Such trainings can improve a person's functionality, balance, cardiovascular fitness, attitude, and quality of life. As a result, there is a decreased chance of chronic injury [7]. Progressive strength training significantly increases muscle mass and maximum strength. Neurological changes contribute to this strength gain. Muscle hypertrophy also aids in strength development. However, hormonal imbalances can disrupt strength training. High-intensity weight training can lead to notable increases in muscle strength, size, and functional mobility [8].

The purpose of this study was strength training of the quadriceps using resistance bands. Resistance bands are cost-effective, accessible, and portable, making them ideal for home, hospital rehabilitation, and jobsite training. Studies show that young adults respond well to resistance band training, revealing skeletal muscle adaptations within a short period. However, training weaker muscles may be challenging, especially when the muscle is at its maximum range of motion and the resistance provided by the band is higher [3].

2. Methodology

Source of data: The patients for the study were scouted from Dr. B.R. Ambedkar College of physiotherapy, Bangalore

Study type: Experimental study.

Sampling technique: convenient sampling technique

Sample size: 30 subjects

Duration of study: 6 months

Inclusion criteria:

- *Participants in the age range*: 18-25 yrs old (young adults)
- Both male and female participants
- No history of any regular resistance type training for 2 months before the study
- Lower extremity MMT as grade 3

Exclusion criteria:

- Any history of surgery <2 years ago.
- Participants >25 years of age
- Fitness enthusiasts
- Recent fractures & ligament injuries in the past 6 months
- Cardiorespiratory problems
- History of musculoskeletal disorders

Outcome measures:

- MMT scale (MRC grading)
- Modified sphygmomanometer

Materials used:

- Resistance bands (yellow, green, blue)
- Dumbbells
- Ankle cuffs
- Quadriceps table
- Treatment table

A. Screening Test

1) Modified Sphygmomanometer Test

- *Purpose*: The Modified sphygmomanometer test was a method used to measure the Quadriceps muscle strength.
- *Position*: Participants were lying down on a plinth, with their legs straight in approximately 30o of flexion and the hands placed at the side.
- *Procedure*: A brief warm-up was required of the participants before the strength test. To prevent the tested muscle group from moving, the sphygmomanometer was positioned parallel to the segment. The cuff bag was inflated to 40mm/Hg and placed between the plinth and the popliteal fossa. The participants were instructed to perform a maximal isometric contraction and hold for 5 seconds. Three maximal contractions were performed on each leg and the best attempt was recorded; participants were provided with a 15s rest-interval between repetitions.

Fig. 2. Modified sphygmomanometer test

Table 1
Grades of MMT

Grades	Interpretation
Grade 0: (Zero)	No contraction can be felt.
Grade-1: (Trace)	Flicker of contraction felt at the quadriceps muscle.
Grade 2: (Poor)	Full range of Knee Extension in gravity minimized position
Grade 3: (Fair)	Full range of Knee extension against gravity
Grade 4: (Good)	Full range of Knee extension against gravity with minimal resistance applied to the distal tibia
Grade 5: (Normal)	Full range of Knee extension against gravity with maximal resistance applied to the distal tibia

2) Manual Muscle Test

- Patient position:
  Grades 0-2: Side lying,
  Grades 3-5: High sitting
- Therapist Position:
  Kneel Beside the Patient in order to stabilize the femur and to provide resistance.

3. Procedure

Physically inactive young adults without any prior exercise experience were taken into consideration. The individuals were selected by proper screening, fulfilling inclusion and exclusion criteria. Informed consent was taken from each individual prior to participation. Instructions were given about the techniques. A total of 30 subjects were divided into two groups of 15 each. Group A received strength training with the conventional use of free weights and dumbbells, while Group B received strength training with the use of resistance bands. Each exercise program included a 30–40-minute training session that lasted for a regular period of 3 days per week until a cumulative total of four weeks.

A. Conventional Strength Training

Warm up for up to ten minutes in general before beginning any exercise. Self-stretches, spot jogging, arm, hips, and neck rotations, were all part of the warm-up. Exercises include:

1) Closed Kinematic Chain Exercises

- Squats
- Wall Slides

Fig. 3. Squats

Fig. 4. Wall slides

2) Open Kinematic Chain Exercises

- Seated knee extension exercise
- Seated Resisted Knee Extension Exercise
- Isometric quadriceps
- Straight Leg Raises with use of Ankle cuffs

Fig. 5. Seated knee extensions

Fig. 6. Knee extension in quadriceps chair

Fig. 7. Isometrics of quadriceps

Fig. 8. Straight leg raises

Table 2
Exercise intervention for conventional strength training

Weeks	Repetitions / Sets	Frequency	Duration	Rest time
Week 1	5-6 reps / 2sets	3 days / week	4 weeks	60 sec
Week 2	6-7 reps / 2sets	3 days / week	4 weeks	60 sec
Week 3	8-10 reps / 3sets	3 days / week	4 weeks	60 sec
Week 4	10-12 reps / 3sets	3 days / week	4 weeks	60 sec

Exercise Intervention:

B. Resistance Band Strength Training

In this group, participants worked with resistance bands, completed exercises and advanced through the color hierarchy. Each resistance band has different color coding according to the level of resistance. Initially begin with the less resistive bands, which was then consequently progressed to the higher resistance bands.

Resistance provided by Yellow Band (3-10 kg), Green Band (7-20 kgs), Blue Band (15-30 kgs).

Exercises include:

- Straight leg raise exercise
- Eccentric knee extension exercise
- Short arc quadriceps
- Long arc quadriceps

Fig. 9. SLR with green resistance band

Fig. 10. SLR with blue resistance band

Fig. 11. Knee extension (Green resistance band)

Fig. 12. Seated knee extension (Blue resistance band)

Fig. 13. Long arc quadriceps

4. Data Analysis

Statistical analysis of the data was performed using SPSS 20.0. The Categorical variables were presented as frequency and percentage. The continuous variables were presented as

Table 3
Exercise intervention for resistance band training

Weeks	Monday	Tuesday	Thursday	Saturday	Repetitions /Sets
Week 1	Yellow Resistance band	Yellow Resistance band	Yellow Resistance band	Strength measurement	10-12 reps/3 sets
Week 2	Yellow Resistance band	Green Resistance band	Green Resistance band	Strength measurement	10-12 reps/3 sets
Week 3	Green Resistance band	Green Resistance band	Blue Resistance band	Strength measurement	10-12 reps/3 sets
Week 4	Blue Resistance band	Blue Resistance band	Blue Resistance band	Final modified sphygmomanometer assessment	10-12 reps/3 sets

mean ± SD. Pre and post comparison was done using paired t-test and between group comparisons was done using unpaired t test. A p value <0.05 was considered statistically significant.

In Group A, the average pre-intervention Modified Sphygmomanometer (Right) value was 83.33±15.26, increased to 128.33±16.88 post-intervention with average improvement of 45.00, with p-value < 0.001.

In Group B, the pre-intervention value was 89.80±13.60, increasing to 126.53± 22.04 post-intervention with average improvement of 36.73 and p-value <0.001.

The analysis shows a significant improvement in the Modified Sphygmomanometer (Right) measurement after the intervention in both Groups.

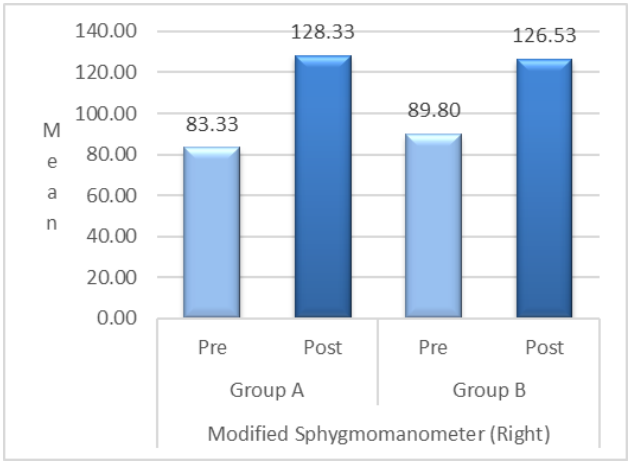

Fig. 14. Representation of modified sphygmomanometer (Right) in group A and group B

In Group A, the average pre-intervention Modified Sphygmomanometer (Left) value was 82.73 ± 14.24, which increased to 128.60± 13.70 post-intervention with average improvement of 45.87, with p-value < 0.001.

In Group B, the pre-intervention value was 89.80± 14.15, rising to 126.87± 24.14 post-intervention with average improvement of 37.07 and p-value < 0.001.

The analysis indicates a significant improvement in the Modified Sphygmomanometer (Left) measurement after the intervention in both Group A and Group B.

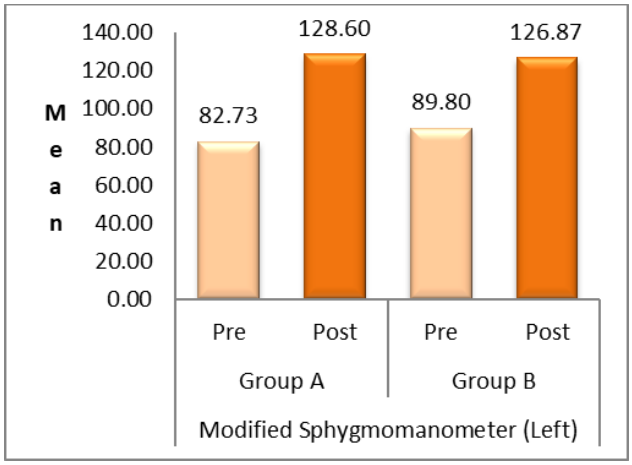

Fig. 15. Representation of modified sphygmomanometer (Left) in group A and group B

In Group A, the average pre-intervention MMT value was 4.27 ± 0.70, which increased to 5.00 post-intervention with an average improvement of 0.73, with p-value of 0.001. In Group B, the pre-intervention value was 4.07 ± 0.70, rising to 5.00 post-intervention with average improvement of 0.93 and p-value < 0.001.

The analysis shows a significant improvement in MMT scores after the intervention in both Group A and Group B.

Table 4
Showing pre and post comparison of modified sphygmomanometer (Right) in group A and group B

Modified Sphygmomanometer (Right)		Mean	Std. Deviation	Mean difference	t-value	p-value
Group A	Pre	83.33	15.26	45.00	12.80	0.000 (p<0.001)
	Post	128.33	16.88			
Group B	Pre	89.80	13.60	36.73	8.25	0.000 (p<0.001)
	Post	126.53	22.04			

Table 5
Showing pre post comparison of modified sphygmomanometer (Left) in group A and group B

Modified Sphygmomanometer (Left)		Mean	Std. Deviation	Mean difference	t-value	p-value
Group A	Pre	82.73	14.24	45.87	15.16	0.000 (p<0.001)
	Post	128.60	13.70			
Group B	Pre	89.80	14.15	37.07	8.01	0.000 (p<0.001)
	Post	126.87	24.14			

Table 6
Showing pre post comparison of MMT in group A and group B

MMT		Mean	Std. Deviation	Mean difference	t-value	p-value
Group A	Pre	4.27	0.70	0.73	4.04	0.001
	Post	5.00	0.00			
Group B	Pre	4.07	0.70	0.93	5.14	0.000 (p<0.001)
	Post	5.00	0.00			

Table 7
Comparison between group A and group B: Modified sphygmomanometer (Right)

Group		Mean	Std. Deviation	t-value	p-value
Modified Sphygmomanometer (Right)	Group A	45.00	13.62	1.46	0.156 (p>0.05)
	Group B	36.73	17.25		

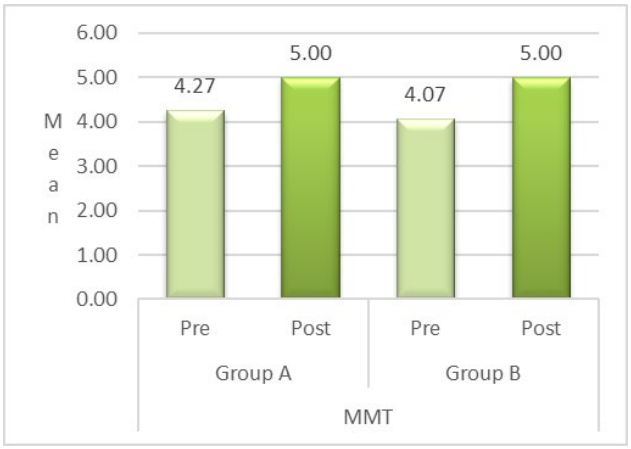

Fig. 16. Representation of MMT in group A and group B

In Group A, the average Modified Sphygmomanometer (Right) value was 45.00 ± 13.62, while in Group B, it was 36.73 ± 17.25 with t-value of 1.46 and p-value 0.156 (p>0.05).

The analysis shows that there is no significant difference in the Modified Sphygmomanometer (Right) values between Group A and Group B.

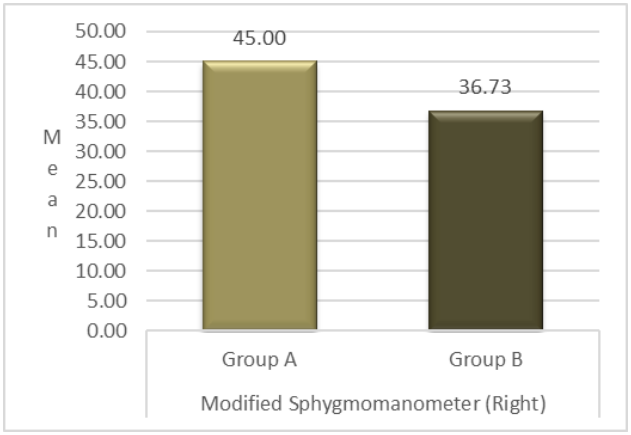

Fig. 17. Representation of comparison between group A and group B: modified sphygmomanometer (Right)

In Group A, the average Modified Sphygmomanometer (Left) value was 45.87 ± 11.72, while in Group B, it was 37.07 ± 17.93 with t-value of 1.59 and p-value 0.123(p>0.05).

The analysis shows that there is no significant difference in the Modified Sphygmomanometer (Left) values between Group A and Group B.

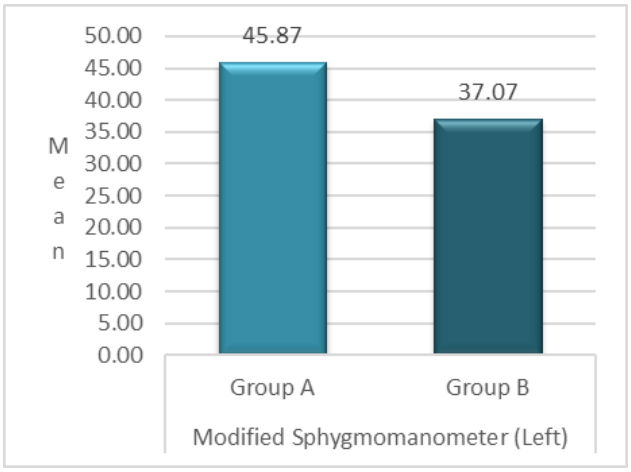

Fig. 18. Representation of comparison between group A and group B: Modified Sphygmomanometer (Left)

In Group A, the average MMT improvement was 0.73 ± 0.70, while in Group B, it was 0.93 ± 0.70 with t-value of 0.78 and p-value of 0.443(p>0.05).

The analysis shows that there is no apparent difference in MMT improvement between Group A and Group B.

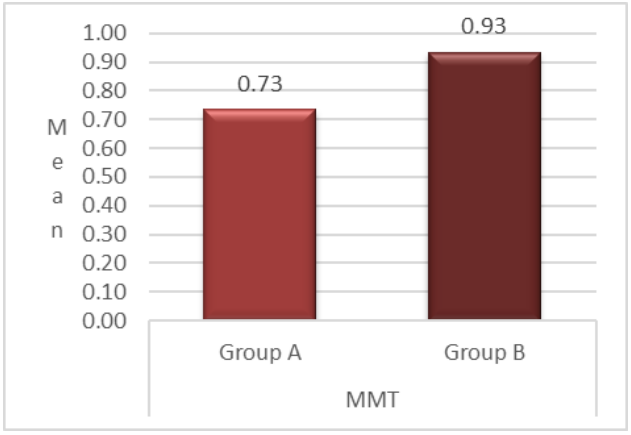

Fig. 19. Representation of comparison between group A and group B: MMT

Comparing pre-intervention and post-intervention outcomes, significant improvements were observed in both MMT and Modified Sphygmomanometer Test Results. In Group A, the average pre-intervention MMT value was 4.27 ± 0.70, which increased to 5.00 ± 0.00 post-intervention with average improvement was 0.73. In Group B, the pre-intervention value was 4.07 ± 0.70, rising to 5.00 ± 0.00 post-intervention with average improvement of 0.93.

The analysis shows a significant improvement in MMT

Table 8
Comparison between group A and group B: Modified sphygmomanometer (Left)

Group		Mean	Std. Deviation	t-value	p-value
Modified Sphygmomanometer (Left)	Group A	45.87	11.72	1.59	0.123 (p>0.05)
	Group B	37.07	17.93		

Table 9
Comparison between group A and group B: MMT

Group		Mean	Std. Deviation	t-value	p-value
MMT	Group A	0.73	0.70	0.78	0.443 (p>0.05)
	Group B	0.93	0.70		

scores after the intervention in both Groups, all participants transitioned from Fair or Good grade to a Normal Grade by the end of four weeks. Similarly, The Modified Sphygmomanometer test results in Group A, the average strength of the Right quadriceps was 45.00±13.62 and of the Left quadriceps was 45.87±11.72. While in Group B, the average strength of Right quadriceps was 36.73±17.25, and of the Left quadriceps was 37.07±17.93.

The analysis shows that there is no significant difference in the Modified Sphygmomanometer (Right and Left) values between the two groups. Overall, the findings suggest that exercise intervention effectively improved the muscle strength of Quadriceps. The study highlights the potential of Resistance Band training techniques as an effective method for improving the quadriceps muscle strength.

5. Discussion

The study aimed to evaluate the impact of resistance band training and traditional strength training on young adults' quadriceps muscle strength. It suggested combining exercise with resistance bands to improve quadriceps muscular strength. After four weeks of training, both resistance and conventional training showed improvement in quadriceps muscular strength. The majority of research indicated that elastic resistance training is a useful technique for boosting quadriceps strength.

A study on Effectiveness of resistance band training on muscle strength of quadriceps. Focuses on the use of resistance bands with varying resistance for strength training. The study involved 30 subjects from Dr. B.R. Ambedkar College of Physiotherapy, aged 18-25, who had no prior history of resistance training. They were selected through screening using modified sphygmomanometer, and MMT grade 3 or above. After their informed consent was obtained, Participants were instructed on the techniques.

A total of 30 subjects were divided into two groups of 15 each. Group A (Control-Group) received strength training with the conventional use of free weights and dumbbells, with progressively increasing resistance over the period of 4 weeks. While Group B (Experimental-Group) received strength training with the use of resistance bands of varying resistance ranging from Yellow, Green and Blue. Each exercise program included a 30–40-minute training session that lasted for a regular period of 3 days per week until a cumulative total of four weeks.

The outcome measures used include Manual Muscle Testing (MMT) to measure the muscle strength and Modified Sphygmomanometer test to measure the strength of quadriceps during an isometric contraction. Each of the Assessments were taken initially on the first day prior to beginning the exercise program and after four weeks of strength training. Statistical analysis reveals that In Group A, the average Modified Sphygmomanometer values were 45.87±11.72, while in Group B, it was 37.07±17.93 with t-value of 1.59 and p-value 0.123($p>0.05$). The analysis shows that there is no significant difference in the Modified Sphygmomanometer values between Group A and Group B.

6. Conclusion

The purpose of this study was to examine the effectiveness of Resistance Band Training on the Quadriceps muscle strength of Young Adults. The individuals were given exercise intervention incorporating the use of resistance bands which gradually progressed to higher resistance. While the control group received conventional strength training methods for quadriceps muscle.

Results showed that the resistance band training method demonstrated a significant improvement in the muscle strength of quadriceps as given by the modified sphygmomanometer test respectively after four weeks of training. Yet it was less effective than the conventional resistance training methods. The study's limitations include a small sample size, short duration, limited age range, and manual measurements, potentially affecting generalization and reliability. To establish greater efficacy of the training, the study should have been conducted in a large randomized clinical trial with a larger sample size and longer follow-up to assess the effectiveness of these techniques on other muscles as well.

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