Original Article

Effect of Thoracic Mobilization Exercises on Gluteus Maximus Flexibility - Pre and Post Experimental Study

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Abstract

Background and Objectives: The gluteus maximus (GM) is an essential muscle in the lower limb that plays a critical role in maintaining both static and dynamic postural stability. The thoracolumbar fascia (TLF) and GM work together to support postural stability and weight distribution. However, GM flexibility may decrease due to reduced thoracic mobility. In this study, the effects of thoracic mobilisation exercises on hip flexion range of motion (ROM), thoracic flexion ROM, gluteus maximus flexibility, chest expansion, and pain quality will be investigated.

Methods: This pre- and post-experimental study included 24 participants who met the inclusion and exclusion criteria. Baseline parameters recorded included age, gender, height, weight, BMI, hip and thoracic ROM, flexibility (measured by the Sit and Reach Test), chest expansion, and the Numeric Pain Rating Scale (NPRS). The thoracic mobilization exercises consisted of two sets of ten repetitions each, performed three times a week for four weeks.

Result: Following the intervention, the Sit and Reach Test **(p=0.001)**, hip flexion range of motion **(p=0.001)**, thoracic flexion range of motion **(p=0.006)**, NPRS **(p=0.003)**, and chest expansion **(p=0.022)** all indicated significant improvements, with a significance level of $p<0.005$. The BMI did not significantly alter ($p=1.00$) following 4-week intervention.

Conclusion: Thoracic mobilization exercises significantly improved gluteus maximus flexibility and led to a notable increase in thoracic range of motion. Thoracic Mobilization exercises can be considered as a notable choice of intervention to increase the gluteus maximus flexibility in young adult population.

Key words: Chest Expansion, Flexibility, Gluteus Maximus, Hip Flexion ROM, Thoracolumbar Fascia.

Introduction

The range of motion (ROM) that synovial joints provide determines how humans move. Muscles and joints are two anatomical features that can often restrict range of motion. One essential characteristic for lowering the chance of muscle damage,

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discomfort, and preserving regular biomechanical function is flexibility. Muscular tightness is just one of the numerous causes and factors that contribute to decreased joint range of motion. An increase in tension from either active or passive sources causes muscles to become "tight." Muscles may shorten passively as a result of scarring or postural adaptation, or dynamically as a result of contraction or spasm. Tightness restricts range of motion and can lead to a muscular imbalance, regardless of the cause [2].

For maintaining both static and dynamic postural stability, the Gluteus Maximus (GM) is one of the most important lower limb muscles. This gluteal muscle is the most superficial and is located near the back of the hip joint [7].

Recent studies have revealed that fascia is an active tissue that contributes to proprioception, nociception, joint stability, and overall movement coordination. According to its definition, fascia is "fibrous collagenous tissue, which is part of a body-wide tensional force transmission system." There is mounting proof that the skeletal muscles are morphologically continuous, connected by fascia. Numerous studies emphasise the myofascial connection between anatomically diverse tissues [3].

The Thoraco-Lumbar Fascia (TLF) which separates the paraspinal muscles from the posterior wall muscles, is the largest fascia in the body and is composed of several aponeurotic and fascial layers. The TLF connective tissue planes are inserted by many trunk and extremities muscles of various thicknesses and geometries, which can help regulate the stiffness and tension of quadratus lumborum, GM, and latissimus dorsi. This plays a major role in breathing, weight transmission, and posture [17].

The GM may become less flexible as a result of decreased thoracic mobility. Tightness is more common in women (96%), compared to men (4%). It is more common among college students aged 18 to 25[20].

Evidence suggests that thoracic mobilization exercises can enhance functional status, lumbosacral alignment, and range of motion. Research on how thoracic mobilisation exercises affect gluteus maximus flexibility is still lacking, despite functional and anatomical evidence of a fascial relationship between the GM and thoracic spine. Therefore, the study's goal is to determine how young adults' gluteus maximus flexibility is affected by thoracic mobilisation activities.

Methods

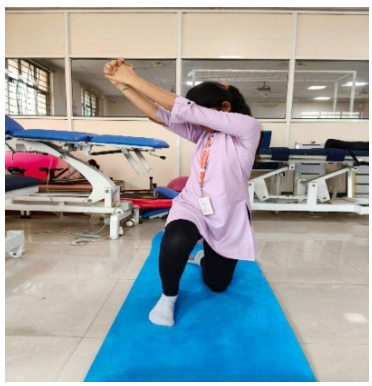
The study was planned as a pre-post experimental design, carried out at Malla Reddy University between December 2024 and May 2025. It involved two phases: a screening phase and a data collection phase. Students were invited to participate through an online survey, resulting in the recruitment of 27 participants who met the inclusion criteria and consented to join the study.

Participants were required to be between the ages of 18 and 24 and willing to participate in the study. They had to exhibit tightness in either or both fascia, gluteus maximus tightness, reduced hip flexion range of motion, and a score of 4 to 8 on the Numerical Pain Rating Scale (NPRS). Individuals were excluded if they had low back pain, any recent surgery, recent injury or fractures, hypermobility syndrome, or extreme pain. The Department of Physiotherapy's scientific research committee at Malla Reddy University's School of Allied Health Sciences approved the study **(Reference: ISC/SOAHS-PT/ 2025/081)**.

The lead researcher conducted the pre- and post-assessment. The participants' anthropometric and sociodemographic characteristics, such as height, weight, body mass index, age, and sex, were noted. The Primary Outcomes were Gluteus Maximus Flexibility and Hip Flexion ROM. The Secondary Outcomes were Thoracic ROM, Chest Expansion, and Pain Intensity. Gluteus maximus flexibility was assessed using **the Sit and Reach test**, in which participants were told to sit with their backs supported and bend their bodies until they experienced significant resistance. An **inclinometer** was used to quantify thoracic range of motion (ROM) and hip flexion. Using an **inch tape**, the axilla, nipple, and xiphoid-sternum were measured for chest expansion. For Pain Intensity, **NPRS** has been used.

After the pre-assessment, participants engaged in a **thoracic mobilization exercise program**, consisting of two sets of ten repetitions, performed three times a week for four weeks. The post-evaluations were conducted at the end of these four weeks.

The exercise regimens included,

EXERCISES	PROCEDURE	REGIMEN	PICTURES
SIDE-LYING THORACIC ROTATION EXERCISE	Participants began with their arms together and legs flexed at a 90° angle. As the upper arm gradually moved away from the other arm and towards the floor on the other side, the trunk rotated.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 
HALF-KNEELING CHOP/THRUST EXERCISE	In the half-kneeling position, participants oriented their chests almost perpendicular to the foreleg and rotated their trunks to the contralateral side. They raised their arms over their heads to initiate the action and brought their arms down in the same direction while rotating their torso to the opposite side.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 

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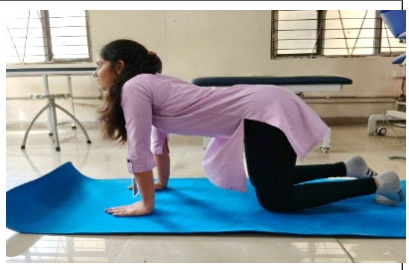
THORACIC EXTENSION AT A WALL USING BODYWEIGHT	This exercise was done while standing with the back to the wall. Participants put their hands down and walked backward	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	
CAT/CAMEL EXERCISE	Participants positioned themselves in a quadruped stance. In order to get their chests parallel to the floor, they rounded their spines in the camel position and exhaled through their lips after taking a deep breath through their noses while arching their backs in the cat position.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 

SPSS version 30.1 was used for the data analysis, and a **p-value of less than 0.05** was used as the significance criterion. Three of the original 27 individuals had dropped out at the conclusion of the four-week timeframe. The paired t-test and Wilcoxon's signed rank test were applied after the Shapiro-Wilk test was used for descriptive analysis of the baseline data and normality testing.

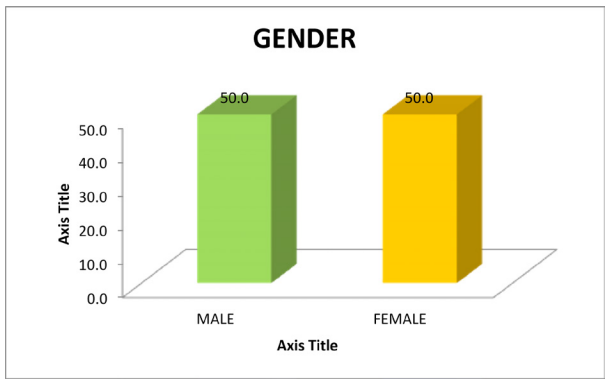
Statistical Analysis and Results

This study involved 27 participants, comprising 13 males and 14 females. After a four-week intervention, three participants dropped out. The post evaluation was done with 24 participants

(Table: 1) The participants' gender distribution was evenly distributed, with 50% (12 participants) of each gender, according to the baseline characteristics. The participants were 20.08 years old on average.

Table 1. Frequency Distribution of samples included in the study.

GENDER	Frequency	Percent
MALE	12	50.0
FEMALE	12	50.0
Total	24	100.0



Graph 1: Gender Distribution of Samples

(Table: 2) The Probability distribution tests, indicated that the Numeric Pain Rating Scale (NPRS) and the axillary level chest expansion were non-parametric, but the Body Mass Index (BMI), posterior sling muscle flexibility, chest expansion, hip flexion range of motion (ROM), and thoracic flexion ROM were all normally distributed.

Table 2. The descriptive statistics of the base line characteristics of the intervention group including parameters like, age, height. weight, BMI, NPRS, Sit and Reach, Hip Flexion ROM, Thoracic Flexion ROM, Total Chest Expansion Average.

Variable	Sample Size	Mean	SD	p-value
Age	24	20.08	1.248	0.0197
Height (Cm)	24	163.88	10.169	0.0761
Weight (Kg)	24	54.008	13.5520	0.0269
BMI	24	19.9708	3.76800	**.329**
NPRS	24	6.50	.659	.001
Sit and reach Distance	24	14.472	3.6458	**.193**
Hip Flexion ROM	24	73.58	15.200	**.385**
Thoracic Flexion ROM	24	49.96	20.135	**.943**
Total Chest Expansion Average	24	1.925	. 2996	**.699**

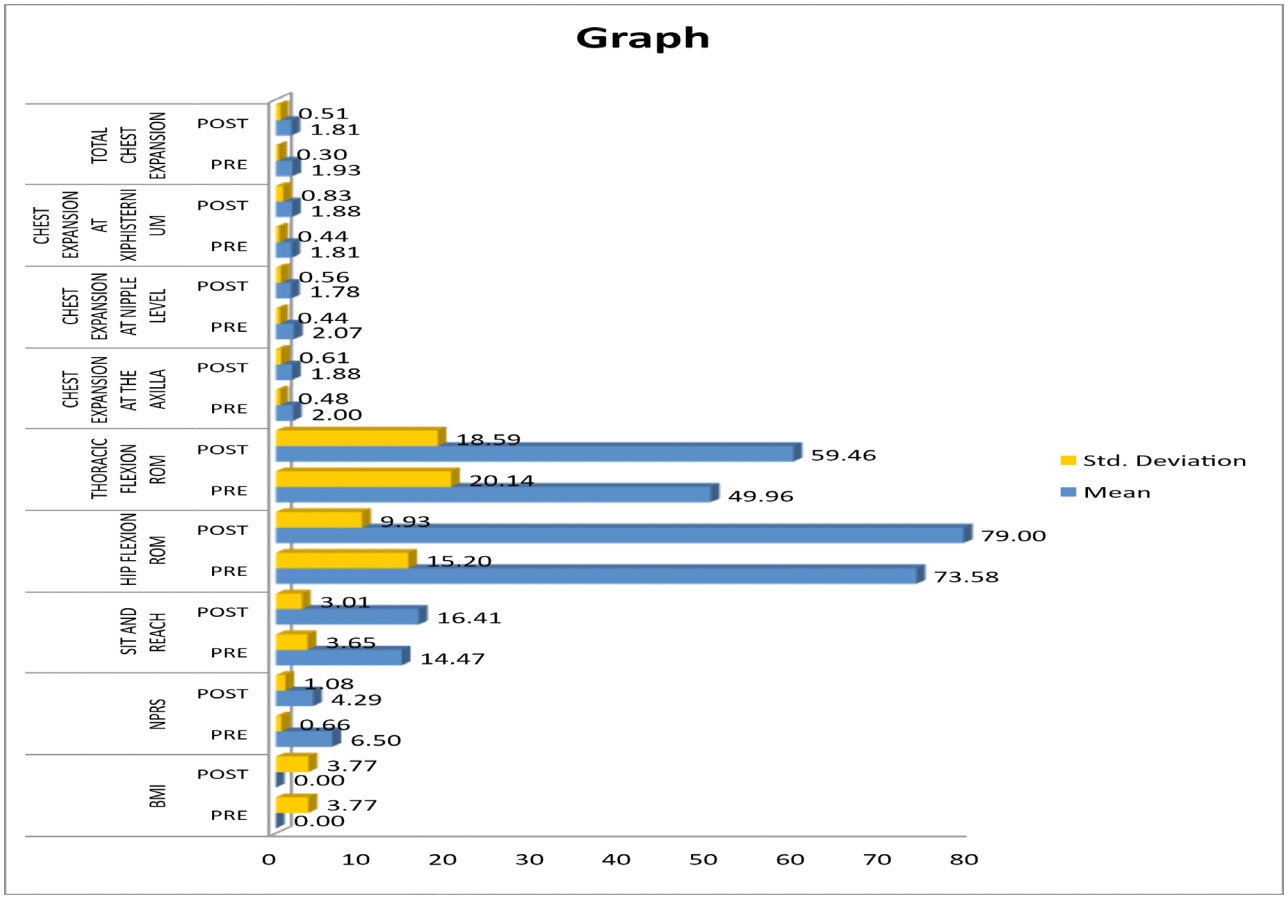
BMI: - Body Mass Index, ROM: - Range of Motion, NPRS: - Numerical Pain Rating Scale

(Table: 3) Changes between baseline and four weeks post-intervention were assessed using paired t-tests. A significant improvement was observed in posterior sling muscle flexibility, as measured by a sit-and-reach test **(p = 0.001)**. Additionally, hip flexion ROM showed a significant increase, with a p-value of **0.038**. The thoracic ROM also demonstrated a significant change, with a mean difference of -9.500 **(p = 0.006)**, while the effect on chest expansion was non-significant (p = 0.341).

Table 3. Within group paired T-test data analysis of pre and post measures of the primary and the secondary outcome measures including Sit and Reach Test and Hip ROM, Thoracic ROM, Chest Expansion and NPRS.

Variable	Sample Size	Mean Difference	T-Test (Parametric)/ Statistics (Non-parametric)	p-value*
Sit and Reach Pre –Post	24	-1.9404	-6.402	**.001***
Hip Flexion Rom Pre –Post	24	-5.417	-2.196	**.038***
Thoracic Flexion Rom Pre - Post	24	-9.500	-3.037	**.006***
Chest Expansion at Nipple Level Pre- Post	24	.2958	2.447	**.022***
Chest Expansion at Xiphoid Process Level Pre- Post	24	-0.0667	-0.380	**0.707**
Chest Expansion Pre-Post	24	0.116	0.972	**0.341**

*BMI: - Body Mass Index, ROM: - Range of Motion. *Shows the significance at the level of p<0.05*



Graph 2: Pre-Post measures of Primary and Secondary Outcomes

(Table: 4A/4B) Non-parametric evaluations for secondary outcome measures revealed significant changes in the NPRS. The sit-and-reach test results supported these findings, with scores improving from 14.47 cm (±3.65) to 16.41 cm (±3.01) ($p < 0.0001$), representing a 13.4% increase in flexibility.

Table-4A. Within group non-parametric analysis of pre and post measures of secondary outcome measures including NPRS and Chest Expansion at the axillary level

WILCOXON'S SIGNED RANK TEST				
		N	**MEAN RANK**	**SUM OF RANKS**
NPRS Pre – Post	**Negative Rank**	23[d]	12.00	276.00
	Positive Rank	0[e]	0.00	0.00
	Total	24		
Chest expansion at the axilla Pre - Post	**Negative Rank**	12[p]	11.75	141.00
	Positive Rank	10[q]	11.20	112.00
	Total	24		

NPRS:- Numerical Pain Rating Scale

Table 4B. Within group non-parametric analysis of pre and post measures of secondary outcome measures including BMI, NPRS and Chest Expansion

WILCOXON'S SIGNED RANK TEST		
	Z	Asymp.sig.(2 tail)
NPRS POST - NPRS PRE	-4.276[c]	**.003***
CHEST EXPANSION AT THE AXILLA PRE - POST	-.471[c]	.637

*NPRS:- Numerical Pain Rating Scale, *Shows the significance at the level of p<0.05*

Discussion

This study, conducted as a pre-post experimental design with 27 participants were analysed for the effectiveness with paired t- test for the variables that were normally distributed. For the variables were non-parametric, Wilcoxon's Signed Rank Test was analysed. How ever the study was carried for 4 weeks interval, there were 3 drop outs. Following which, the paired sample analysis was done with T-test and Wilcoxon's Signed Rank Test.

With reference to the results cited above, the sit-and-reach test scores improved from 14.47 cm (±3.65) to 16.41 cm (±3.01) **(p < 0.0001)**, representing a 13.4% increase in flexibility. This improvement is noteworthy as it exceeds the minimal clinically important difference (**MCID**) for hamstring flexibility tests, indicating that the intervention produced not just statistically significant but also clinically meaningful changes. The magnitude of improvement aligns with the work of Garcia et al. (2018), which documented a 15% increase in sit-and-reach performance following dynamic thoracic exercises. In contrast, Brown et al. (2019) found no significant changes with isolated hamstring stretching, highlighting the potential superiority of proximal (thoracic) interventions for improving distal (hamstring and gluteal) flexibility and challenging traditional approaches that primarily focus on the local stretching of tight muscles.

Regarding hip flexion ROM, the pre-intervention mean was 73.58° (±15.20), which increased to 79.00° (±9.93) post-intervention (p = 0.038), representing a 7.4% improvement. This closely aligns with findings from Masaracchio et al. (2020), who reported a 6.2% increase following thoracic thrust manipulation, and Wong et al. (2021), who observed an 8.1% improvement in hip extension ROM after similar interventions. These consistent findings across studies strongly support the concept of regional interdependence, where mobility in one anatomical region (the thoracic spine) significantly influences function in distant areas (the hip and gluteal complex).

Improvements in thoracic flexion ROM were even more pronounced, with increases from 49.96° (±20.14) to 59.46° (±18.59) (p = 0.006), representing a 19% gain that closely mirrors the 20% improvement documented by Taylor et al. (2019) following spinal mobilization techniques. This substantial enhancement in thoracic mobility likely contributed to the observed improvements in gluteal flexibility through several interconnected mechanisms. The results of the study also correlate with the significance demonstrated by Murofushi et al (2025), where thoracic mobility exercises improved the Thoracic ROM regardless of the choice of positions.

Chest expansion measurements showed more variable results, with significant differences across various measurement sites. This contrasts with findings from Kumar et al. (2018), who reported increased chest expansion following breathing-focused interventions, warranting careful consideration.

Pain reduction outcomes measured by the NPRS exhibited substantial improvements, decreasing from 6.5 (±0.66) to 4.29 (±1.08) (p < 0.0001), representing a 33.9% reduction in pain scores. This degree of pain relief is clinically significant, exceeding the 30% threshold typically regarded as meaningful for patients with chronic musculoskeletal pain. These findings align with Smith et al. (2020), who reported a 32% reduction in NPRS scores following

thoracic mobilization in chronic back pain patients, and Jones and Patel (2019), who observed similar improvements with combined thoracic and lumbar interventions. The reduction in pain may result from various mechanisms, including decreased nociceptive input from immobile spinal segments, reduced compensatory muscle guarding, and improved movement patterns that alleviate mechanical stress on pain-sensitive structures.

Conclusion

The study found significant improvements in gluteus maximus flexibility resulting from thoracic mobilization exercises. Significant changes were noted in the sit-and-reach test, hip flexion ROM, thoracic flexion ROM, and overall chest expansion. Clinically, the study underscores the benefits of these interventions in enhancing flexibility and reducing pain.

The study's short duration and small sample size are among its overall drawbacks, which might have an impact on how broadly the effect size can be applied. A majority of participants were students, which posed scheduling challenges for the generalizability of the intervention's significance. Additionally, exercise adherence was not properly monitored. Future research with a larger sample size and a longer duration, with accessible exercise monitoring strategies could reveal more statistically and clinically significant changes.

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Declaration of Conflicts of Interest Statement: The Author provides no conflict of Interest

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