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EFFECTIVENESS OF THORACIC MOBILITY EXERCISES VERSUS FOAM ROLLER TRAINING ON INDEX OF KYPHOSIS AND THORACIC EXPANSION AMONG YOUNG ADULTS WITH HYPERKYPHOSIS – A COMPARATIVE STUDY

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Abstract

Background: Postural thoracic hyperkyphosis is increasingly observed among young adults and may be associated with reduced thoracic mobility, altered sagittal alignment, and restricted chest expansion. Conservative physiotherapy interventions, including thoracic mobility exercises and foam roller training, may improve these impairments; however, direct comparative evidence in young adults is limited.

Objectives: To evaluate and compare the effectiveness of thoracic mobility exercises and foam roller training on the Index of Kyphosis and Thoracic Expansion in young adults with postural hyperkyphosis.

Methods: A comparative study was conducted among 80 young adults aged 18–27 years with thoracic hyperkyphosis. Participants were randomly allocated into Group A (thoracic mobility exercises, n=40) and Group B (foam roller training, n=40). Both groups received intervention 3 days per week for 3 weeks. The Index of Kyphosis was assessed using a flexicurve ruler, and Thoracic Expansion was assessed using a measuring tape. Within-group changes were analysed using the Wilcoxon signed-rank test, while between-group comparisons were performed using the Mann–Whitney U test. Statistical significance was set at $p<0.05$.

Results: Both groups demonstrated statistically significant improvement following intervention. In Group A, the Index of Kyphosis decreased from 40.75 ± 0.78 to 39.38 ± 1.03 ($p=0.001$; effect size=2.19), while Thoracic Expansion increased from 1.83 ± 0.34 cm to 2.75 ± 0.33 cm ($p=0.001$; effect size=2.76). In Group B, the Index of Kyphosis decreased from 40.98 ± 0.97 to 38.53 ± 0.99 ($p=0.001$; effect size=4.10), and Thoracic Expansion increased from 2.23 ± 0.52 cm to 3.43 ± 0.47 cm ($p=0.001$; effect size=4.34). Post-intervention between-group differences favoured foam roller training for both outcomes (Index of Kyphosis: $p=0.001$; Thoracic Expansion: $p<0.001$).

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Conclusions: Both thoracic mobility exercises and foam roller training improved kyphotic posture and thoracic expansion in young adults with postural hyperkyphosis. Foam roller training demonstrated greater improvement and larger effect sizes for both outcomes.

Keywords*: Foam Roller, Hyperkyphosis, Posture, Thoracic Expansion, Thoracic Mobility*

1. Introduction:

Musculoskeletal disorders (MSDs) are among the leading causes of disability worldwide, affecting approximately 1.71 billion people, according to the World Health Organization (1). These disorders include conditions affecting bones, joints, and soft tissues. Thoracic kyphosis, an abnormal anterior–posterior curvature of the thoracic spine, is a common spinal deformity. Although kyphosis is frequently associated with ageing, postural kyphosis is increasingly observed in young adults, adolescents, and children due to sedentary lifestyles, prolonged screen time, poor ergonomics, and slouched sitting postures. Kyphosis may be postural, structural, or pathological. Postural kyphosis is commonly associated with muscular imbalance, reduced thoracic mobility, and prolonged poor posture. Shortening of the anterior chest muscles and weakness of the posterior thoracic muscles can contribute to excessive thoracic curvature. Heavy backpack loads exceeding 10% of body weight have also been associated with altered sagittal spinal alignment, particularly in children and adolescents (2).

Thoracic mobility is essential for maintaining spinal alignment, respiratory function, and neuromuscular coordination. Reduced thoracic mobility can affect chest expansion, cervical posture, scapular mechanics, and lumbar biomechanics. Therefore, accurate assessment of the Index of Kyphosis and Thoracic Expansion is important for clinical evaluation. The flexicurve ruler and thoracic expansion measurements have demonstrated good inter- and intra-rater reliability (ICC = 0.86–0.94) (3).

Physiotherapy interventions such as thoracic mobility exercises and foam roller training are increasingly used as non-invasive approaches for postural kyphosis. Thoracic mobility exercises use extension-based movements to improve spinal mobility, postural alignment, and thoracic expansion. Foam roller training uses self-myofascial release and sustained thoracic extension to improve soft-tissue extensibility, reduce fascial restrictions, and enhance thoracic mobility and chest expansion (4,6).

Although both interventions have shown beneficial effects (4–6), comparative evidence in young adults with postural kyphosis is limited. Therefore, the present study aims to compare the effectiveness of thoracic mobility exercises versus foam roller training on the Index of Kyphosis and Thoracic Expansion among young adults aged 18–27 years with postural kyphosis. Early management of postural hyperkyphosis may help prevent progression and associated problems such as musculoskeletal pain, impaired respiratory function, and postural dysfunction (7,8). Thus, evidence-based and cost-effective interventions such as thoracic mobility exercises and foam roller training may contribute to improved spinal health and functional outcomes in young adults.

2. Material and Methodology:

After getting approval from the institutional ethical committee the comparative study was started the study was conducted in tertiary hospital, Latur. Individuals in the age group of 18-27 were enrolled in the study and the duration of the study was 18 months, the sample size of the study was 80 (40 in each group) and the duration of the intervention is three times a week for three weeks.

Study Design and Sample

Sample size Calculation:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where Z = 1.96; P = proportion of the young adult population affected by hyperkyphosis = 20% (0.20); d = desired margin of error = 9% (0.09). Applying these values, n = $1.96^2 \times 0.20 \times (1–0.20) / 0.09^2$ = 75.88 ≈ 80 participants (40 per group). Formula reference: Cochran WG et al. (1977).

the inclusion criteria for the study were individuals between age group 18 to 27 both males and females, individuals with kyphosis angle greater than 40 degrees and altered thoracic expansion ratio in 1:2:1. The exclusion criteria for the study was any traumatic injury to the spine, fracture of the spine and recent surgeries and vertebral artery insufficiency.

Outcome Measures

Index of Kyphosis: A malleable, plastic-covered metal band approximately 50 cm long, known as a flexicurve ruler, was used to measure thoracic kyphosis. The subject was instructed to stand upright, and the ruler was aligned along the spinal curve from C7 to T12. The ruler was then placed on paper and its outline traced. A straight line connecting C7 and T12 represented the thoracic kyphosis length (L). The height (h) was measured as the perpendicular distance from the highest point of the curve to this line. The Index of Kyphosis (IK) was calculated as (h/L) × 100. The flexicurve demonstrated good validity and reliability, with values of 0.94 and 0.86, respectively (3).

Thoracic Expansion Test: Thoracic expansion was measured using a measuring tape at two levels of the rib cage. Upper chest expansion was defined at the level of the third intercostal space at the clavicular line and the spinous process of the fifth thoracic vertebra. Lower chest expansion was measured using the tip of the xiphoid process and the spinous process of the tenth thoracic vertebra as anatomical markers. The reliability of the Thoracic Expansion Test is 0.81 (11).

Procedure

Approval for the research study was obtained from the Institutional Ethical Committee, Department of Musculoskeletal Physiotherapy, Maharashtra Institute of Physiotherapy, Vishwanathpuram, Latur (Approval no. MUHS/Acad/E-6/56/2024). The purpose of the study was explained to each participant, and written informed consent was obtained in a language they understood. Participants were screened and recruited based on predefined inclusion and exclusion criteria. Participants were randomly divided into two groups of 40 each, using a simple random sampling method (odd and even numbers). Outcome measurements were taken pre-treatment. The intervention was administered 3 days per week for a duration of 3 weeks.

Group A: Thoracic Mobility Exercises

Extension in sitting: The participant sat on the treatment table with hands clasped behind the neck for support, and was asked to extend the thoracic spine by lifting the elbows upward as far as possible. The extended position was held briefly before returning to the starting position. This was repeated for 10 repetitions in a single set, with 30 seconds of rest after each repetition, progressively increasing the range of motion.

Extension in sitting with overpressure (Fig. 1): The participant sat with hands clasped behind the neck. The therapist stood facing the participant, with one arm under the participant's elbow and the heel of the other hand placed against the spinous process at the appropriate level. The participant actively

extended the upper thoracic spine as far as possible; the therapist then applied brief overpressure by lifting the elbow and pressing at the appropriate level before the participant returned to the starting position. This was performed as a single set of 10 repetitions with 30 seconds of rest between repetitions.



Figure 1. Extension in sitting with overpressure.

Mid and lower thoracic sustained prone lying in extension: The participant lay prone on the treatment table, leaning on the elbows, and relaxed to allow the trunk to sag, applying passive overpressure to the thoracic spine. This position was sustained for up to three minutes as a single set; if the participant was unable to hold the position, a 30-second rest interval was given.

Cat and camel pose: The participant assumed a hands-and-knees position, inhaling while lifting the back toward the ceiling with the cervical spine flexed, then tucking the back with neck extension during exhalation. This was performed as a single set of 10 repetitions with 30 seconds of rest between repetitions.

Group B: Foam Roller Training for the Thoracic Spine

Sustained extension in supine: The participant lay supine with a foam roller positioned under the thoracic spine and was encouraged to increase the depth of exhalation to achieve greater thoracic extension; placing the hands above the head achieved further extension. This position was held for 15–20 minutes, with a 30-second rest if discomfort occurred, before returning to the starting position.

Sustained extension to flexion in spine (Fig. 2): With the foam roller under the thoracic spine in supine, the participant increased the depth of exhalation to achieve greater thoracic extension, then lifted the back up to scapular level and returned to the starting position with exhalation. This was performed as a single set of 10 repetitions with 30 seconds of rest between repetitions.



Figure 2. Sustained extension to flexion in spine using a foam roller.

Foam Roller Self-Mobilization (FRSM) in supine: In supine, participants performed two sets of 10 cephalocaudal rolls using the dorsal aspect of the trunk against the floor, along the central and lateral surfaces of the thoracic spine. Each set lasted 30 seconds with a 15-second rest between sets, performed for 3 minutes, twice daily.

Foam Roller Self-Mobilization (FRSM) in standing: With the foam roller placed between a wall and the thoracic spine along the paravertebral muscles, the participant performed cephalocaudal movements while standing, for 3 minutes, twice daily (two sets of 10 rolls, 30 seconds per set, 15-second rest between sets).

3. Data Analysis:

Data were analyzed using SPSS software (version 27.0). Within-group changes were analysed using the Wilcoxon signed-rank test, and between-group comparisons were performed using the Mann–Whitney U test. Statistical significance was set at $p<0.05$.

Results:

Eighty participants completed the study, with 40 participants in each group. Group A comprised 9 males and 31 females, while Group B comprised 7 males and 33 females. The mean age was 22.73 ± 2.81 years in Group A and 21.93 ± 2.91 years in Group B; the between-group age comparison was not statistically significant (p=0.248).

Table 1. Within- and between-group comparison of Index of Kyphosis and Thoracic Expansion.

Outcome	Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	p-value	Effect size
Index of Kyphosis	Thoracic mobility	40.75 ± 0.78	39.38 ± 1.03	0.001	2.19
Index of Kyphosis	Foam roller	40.98 ± 0.97	38.53 ± 0.99	0.001	4.10
Thoracic Expansion (cm)	Thoracic mobility	1.83 ± 0.34	2.75 ± 0.33	0.001	2.76
Thoracic Expansion (cm)	Foam roller	2.23 ± 0.52	3.43 ± 0.47	0.001	4.34

Within-group analysis showed statistically significant improvement in both outcomes for both groups (p=0.001). The reduction in Index of Kyphosis was greater in the foam roller group (mean change 2.45) than in the thoracic mobility group (mean change 1.38). Similarly, the increase in Thoracic Expansion was greater in the foam roller group (mean change 1.19 cm) than in the thoracic mobility group (mean change 0.93 cm).

Between-group analysis showed no significant pre-intervention difference in the Index of Kyphosis (p=0.369), indicating comparable baseline values for this outcome. Post-intervention Index of Kyphosis differed significantly between groups (p=0.001), favouring foam roller training.

For Thoracic Expansion, the reported between-group comparisons were statistically significant at both pre-intervention ($p<0.001$) and post-intervention ($p<0.001$), with larger post-intervention values in the foam roller group. The reported effect sizes favoured foam roller training for both Index of Kyphosis and Thoracic Expansion.

5. Discussion:

The present study compared thoracic mobility exercises and foam roller training in young adults with postural hyperkyphosis. Both interventions produced statistically significant improvements in the Index of Kyphosis and Thoracic Expansion after the 3-week intervention period. However, the magnitude of improvement and reported effect sizes were greater in the foam roller group.

Thoracic mobility exercises reduced the Index of Kyphosis from 40.75 ± 0.78 to 39.38 ± 1.03 and increased Thoracic Expansion from 1.83 ± 0.34 cm to 2.75 ± 0.33 cm. These changes may be related to

repeated thoracic extension, improvement in segmental mobility, stretching of shortened anterior structures, activation of posterior thoracic musculature, and improved postural awareness (4,5,8).

Foam roller training reduced the Index of Kyphosis from 40.98 ± 0.97 to 38.53 ± 0.99 and increased Thoracic Expansion from 2.23 ± 0.52 cm to 3.43 ± 0.47 cm. The larger reported effect sizes may reflect the combined influence of self-myofascial release and sustained passive thoracic extension. The foam roller provides an external mechanical stimulus that may reduce perceived soft-tissue stiffness and facilitate greater thoracic extension (6,12,13).

The findings are consistent with previous literature. Previous work has reported that thoracic extension and postural exercises can improve kyphotic posture (4,5,8), while studies of foam roller-based thoracic extension have reported improvements in thoracic alignment and chest expansion (6,16). Systematic reviews have also supported exercise-based approaches for management of hyperkyphotic posture (7,8).

The superior outcome observed with foam roller training may be explained by its ability to provide sustained passive extension in addition to self-myofascial stimulation. Compared with active mobility exercises, the roller may permit prolonged low-load extension and provide tactile and proprioceptive feedback. These mechanisms may help explain the larger changes observed in both outcome measures (14–16).

Clinical Implication:

The findings suggest that both interventions may be useful in the physiotherapy management of young adults with postural hyperkyphosis, with foam roller training demonstrating greater improvement in the outcomes assessed in this study.

6. Conclusion:

Both thoracic mobility exercises and foam roller training were effective in reducing the Index of Kyphosis and improving Thoracic Expansion in young adults with postural hyperkyphosis following a 3-week intervention.

Foam roller training demonstrated superior improvement in both outcomes, with a larger reduction in the Index of Kyphosis and a greater increase in Thoracic Expansion than thoracic mobility exercises. The reported effect sizes were 4.10 versus 2.19 for the Index of Kyphosis and 4.34 versus 2.76 for Thoracic Expansion, favouring foam roller training.

Therefore, foam roller training may be considered an effective, low-cost adjunct or intervention within physiotherapy rehabilitation for young adults with postural hyperkyphosis, while thoracic mobility exercises remain a useful component of postural and mobility-based rehabilitation.

7. Footnotes:

- Conflict of Interest: The authors declare that there is no conflict of interest.
- Data Availability Statement: The data generated and/or analysed during the present study are available from the corresponding author on reasonable request, subject to applicable ethical and confidentiality requirements.
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- Author's Contribution: Not stated in the source manuscript — to be completed by the authors.

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