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4-WEEK INTERVENTION IN IMPROVING THORACIC KYPHOSIS USING GYROTRONIC METHOD

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Abstract

This study explores innovative physiotherapeutic and biomechanical approaches aimed at improving the thoracic kyphotic angle. Healthy thoracic curvature contributes to appropriate spinal alignment, shock absorption, load distribution, and efficient movement. Excessive or reduced thoracic kyphosis may contribute to back pain, muscular fatigue, restricted mobility, impaired balance, and postural dysfunction. The study included 30 patients aged 18–40 years who had experienced back pain for at least three months and were not receiving treatment for this condition during the study period. Patients whose symptoms were related to systemic diseases, as well as pregnancy, significant motor impairments, or mental disorders affecting participation, were excluded. Participants completed a Gyrotonic exercise program focused on thoracic mobility, trunk stability, core activation, and postural control. The intervention lasted four weeks and consisted of three sessions per week. Each session lasted 45–60 minutes and was supervised by a certified Gyrotonic instructor and physiotherapist. Thoracic kyphosis and spinal alignment were assessed before and after the intervention using the DIERS formetric 4D system, a non-invasive, radiation-free method of three-dimensional surface topography. Following the four-week Gyrotonic exercise program, all 30 participants moved closer to the prespecified ICT–ITL reference range of 42°–55°. The mean distance from this range decreased from 8.10° (SD = 2.89°) before the intervention to 1.33° (SD = 1.45°) afterward. The reduction was statistically significant (Wilcoxon signed-rank test, $W = 0.00$, $p < .001$), and 13 participants (43.3%) reached the reference range after treatment. Through controlled multidirectional movements, spinal elongation, coordinated breathing, and core activation, the method may promote more physiological spinal alignment and improve postural stability. These findings suggest that Gyrotonic exercise may be a valuable component of rehabilitation programs for postural deviations such as hyperkyphosis or hypokyphosis. Further studies involving larger samples, control groups, and longer follow-up periods are recommended to confirm the durability and clinical relevance of these outcomes.

Keywords: *thoracic kyphosis, Gyrotonic, DIERS formetric 4D, spinal alignment, postural control, physiotherapy*

Introduction

Back pain is a prevalent musculoskeletal condition that can significantly restrict movement, occupational performance, and daily functioning (Tom et al., 2022). The increasing prevalence of sedentary behavior, prolonged sitting, and reduced physical activity associated with modern lifestyles has been linked to postural alterations and a greater incidence of spinal discomfort (Fritz et al., 2008). A key structural component of sagittal spinal alignment is thoracic kyphosis, the natural posterior curvature of the thoracic spine. This curvature contributes to the distribution of mechanical loads across the vertebral column, supports upright posture, and helps maintain the body's center of gravity within the base of support. Thoracic kyphosis is the physiological posterior curvature of the thoracic spine in the sagittal plane. It contributes to spinal load distribution, upright postural control, and the mechanical relationship between the thoracic spine, rib cage, cervical and lumbar regions, shoulder girdle, and pelvis. Although thoracic kyphosis is a normal anatomical feature, an excessive curvature commonly termed thoracic hyper kyphosis may alter sagittal alignment and negatively influence movement and physical function.

The magnitude of thoracic kyphosis varies according to age, sex, spinal morphology, body composition, habitual posture, physical activity, and the method used for measurement. Hyper kyphosis may result from structural alterations, such as vertebral wedging, Scheuermann's disease, osteoporotic vertebral fractures, and degenerative changes, or from modifiable postural and neuromuscular factors. These may include reduced thoracic mobility, impaired postural control, weakness or reduced endurance of the spinal extensor muscles, and prolonged flexed postures. Importantly, marked hyper kyphosis does not always result from vertebral compression fractures, indicating that muscular, degenerative, and postural factors can also contribute to its development (Katzman et al., 2010; Roghani et al., 2017). A distinction should therefore be made between structural and non-structural or postural hyper kyphosis. Structural hyper kyphosis is associated with relatively fixed anatomical changes and may demonstrate limited correction during active movement. Postural hyper kyphosis is generally more flexible and may be partially corrected through active extension, postural adjustment, or therapeutic intervention. This distinction is clinically relevant because the potential response to exercise depends on the cause, rigidity, severity, and duration of the curvature. Thoracic alignment is maintained through the interaction of the vertebral column, intervertebral discs, spinal ligaments, rib cage, and surrounding musculature. The erector spinae and multifidus muscles contribute to the control of gravitational flexion moments and support an upright trunk position. The abdominal muscles and scapular stabilizers also influence thoracic posture through their effects on trunk stability, rib-cage position, and scapular orientation. Reduced strength or endurance of the spinal extensors may impair the ability to maintain an upright posture, while limited thoracic extension mobility and altered control of the shoulder girdle may reinforce a flexed thoracic position.

Thoracic hyperkyphosis should consequently be understood as more than an isolated change in vertebral curvature. It may involve interactions among spinal mobility, muscular performance, scapular positioning, breathing mechanics, and habitual postural behavior. An anterior displacement of the trunk may also be accompanied by compensatory changes, including forward head posture, cervical extension, altered lumbar lordosis, and adjustments in pelvic position. These compensations can influence balance, movement strategies, and mechanical loading in adjacent spinal regions. In older populations, greater hyperkyphosis has been associated with reduced physical performance and limitations in activities of daily living (Katzman et al., 2010b). Because the thoracic vertebrae articulate with the ribs, changes in thoracic posture may also affect rib-cage mobility and respiratory mechanics. A pronounced or rigid kyphotic posture may restrict thoracic expansion and reduce the mechanical efficiency of breathing. However, the extent of respiratory

involvement varies according to the severity and structural characteristics of the deformity; therefore, respiratory impairment should not be assumed in every individual with an increased kyphotic angle.

Conservative management of postural hyper kyphosis commonly includes thoracic mobility exercises, strengthening of the spinal extensors and scapular stabilizers, stretching of shortened anterior structures, postural education, breathing exercises, and, where clinically indicated, manual therapy or bracing. Systematic reviews and meta-analyses indicate that structured exercise can reduce thoracic kyphosis, although the certainty of the evidence varies because of differences in participant characteristics, intervention duration, exercise content, measurement methods, and methodological quality (González-Gálvez et al., 2019). A more recent review of exercise interventions in adolescents similarly reported improvements in thoracic kyphosis but highlighted substantial heterogeneity among the included programs (Yang et al., 2024). Corrective interventions generally seek to improve thoracic extension mobility, spinal-extensor performance, scapular control, and awareness of sagittal alignment. Targeted spinal strengthening and postural training have produced improvements in kyphosis-related outcomes in controlled studies, although most established evidence relates to conventional corrective-exercise programs rather than to the Gyrotonic method specifically (Katzman et al., 2017). This distinction is important because findings from one exercise modality should not automatically be generalized to another.

The Gyrotonic method is a movement-based exercise approach that incorporates spinal elongation, coordinated breathing, trunk stabilization, and multiplanar movement patterns. Sessions may include controlled flexion, extension, lateral flexion, rotation, and circular or spiral movements of the spine and shoulder girdle. These characteristics provide a plausible therapeutic basis for addressing factors associated with postural hyper kyphosis, particularly restricted thoracic mobility, reduced postural control, and impaired coordination of the trunk and shoulder girdle. Nevertheless, direct evidence regarding the effect of Gyrotonic® exercise on thoracic kyphosis remains limited. Its potential effectiveness should therefore be treated as the research question of the present study rather than as an established clinical effect. Thoracic kyphosis can be assessed using radiographic and non-radiographic methods. Standing lateral spinal radiography, using the Cobb angle, is traditionally regarded as the reference method for quantifying thoracic curvature and identifying structural vertebral changes. However, radiography involves exposure to ionizing radiation, which limits its suitability for repeated measurements during short-term exercise-intervention studies. Moreover, the resulting Cobb angle may vary according to the vertebral levels selected for measurement.

Non-radiographic methods include in clinometry, the Flex curve ruler, photographic postural analysis, ultrasound-based assessment, and optical surface topography. These approaches provide indirect measurements of spinal curvature and should not be considered interchangeable with radiographic Cobb measurements. In particular, surface topography evaluates the external contour of the back and uses mathematical modelling to estimate the underlying spinal alignment rather than directly visualizing the vertebral endplates.

Figure 1.



In the present study, thoracic kyphosis was evaluated using the DIERS Formetric 4D

system (DIERS International GmbH, Schlangenbad, Germany). This non-invasive, radiation-free rasterstereographic system projects a pattern of parallel light lines onto the participant's back. A digital camera records their deformation across the body surface, enabling a three-dimensional reconstruction of the trunk. The principal outcome was the DIERS kyphotic angle ICT–ITL, expressed in degrees. ICT and ITL refer to the cervicothoracic and thoracolumbar transition points, respectively. The angle is derived from tangents at these inflection points along the reconstructed sagittal spinal profile. Because it is based on surface topography, the ICT–ITL angle is methodologically different from and not directly interchangeable with the radiographic Cobb angle (Frerich et al., 2012). DIERS Formetric 4D permits repeated assessment without ionizing radiation, although measurements may be influenced by breathing, postural sway, repositioning, and standing posture. Accordingly, baseline and post-intervention assessments followed the same procedure (Degenhardt et al., 2020). The study aimed to determine whether a four-week Gyrotonic® exercise program moved altered ICT–ITL angles toward the prespecified reference range of 42°–55°. It was hypothesized that the distance from this range would decrease after the intervention.

Methodology

This pre–post intervention study evaluated the effects of a four-week Gyrotonic® exercise program on thoracic kyphosis. The primary objective was to determine whether the program moved the DIERS Formetric 4D ICT–ITL angle toward the prespecified reference range.

Participants

The study included 30 participants aged 18–40 years with an altered thoracic kyphotic angle. Participants were recruited mostly as students University of Sports of Tirana and the treatment was done right there in the school clinics and fitness centers. The inclusion criteria were:

- No spinal surgery or acute spinal injury during the previous six months;
- No participation in another structured postural or spinal rehabilitation program during the study.

Participants with structural scoliosis, symptomatic disc herniation, vertebral fractures, serious neurological conditions, or systemic musculoskeletal disorders were excluded.

Exercise intervention

Participants completed a four-week GYROTONIC® exercise program. The sessions were conducted three times per week, for a total of 12 sessions. Each session lasted approximately 30–45 minutes and was supervised by a certified GYROTONIC® practitioner. The program focused on improving thoracic mobility, strengthening the back and shoulder-girdle muscles, stretching shortened chest muscles, and increasing awareness of upright posture.

Session structure

1. Warm-up: 5–10 minutes

The warm-up prepared the spine and shoulder girdle for the main exercises and included:

- Controlled breathing exercises;
- Gentle shoulder movements;
- Scapular retraction and depression;
- Gentle thoracic rotation;
- Thoracic extension and spinal elongation; and
- Slow arch-and-curl movements.

2. Main exercise phase: 20–30 minutes

The main part of each session included:

- **Arch-and-curl exercises** to improve controlled movement of the thoracic spine;
- **Thoracic-extension exercises** to encourage a more upright posture;
- **Spinal-elongation exercises** to reduce compression and improve postural alignment;
- **Circular and spiral spinal movements** to improve thoracic mobility;
- **Scapular-retraction exercises** to strengthen the muscles between the shoulder blades;
- **Shoulder-opening exercises** to reduce rounded shoulder posture;
- **Chest and pectoral stretching** to lengthen shortened anterior muscles;
- **Back-extensor strengthening exercises** to improve the ability to maintain an upright trunk position;
- **Trunk-stabilization exercises** to support spinal control; and

- **Breath-coordinated movements** to improve rib-cage mobility and movement control.

3. Cool-down: approximately 5 minutes

The cool-down included:

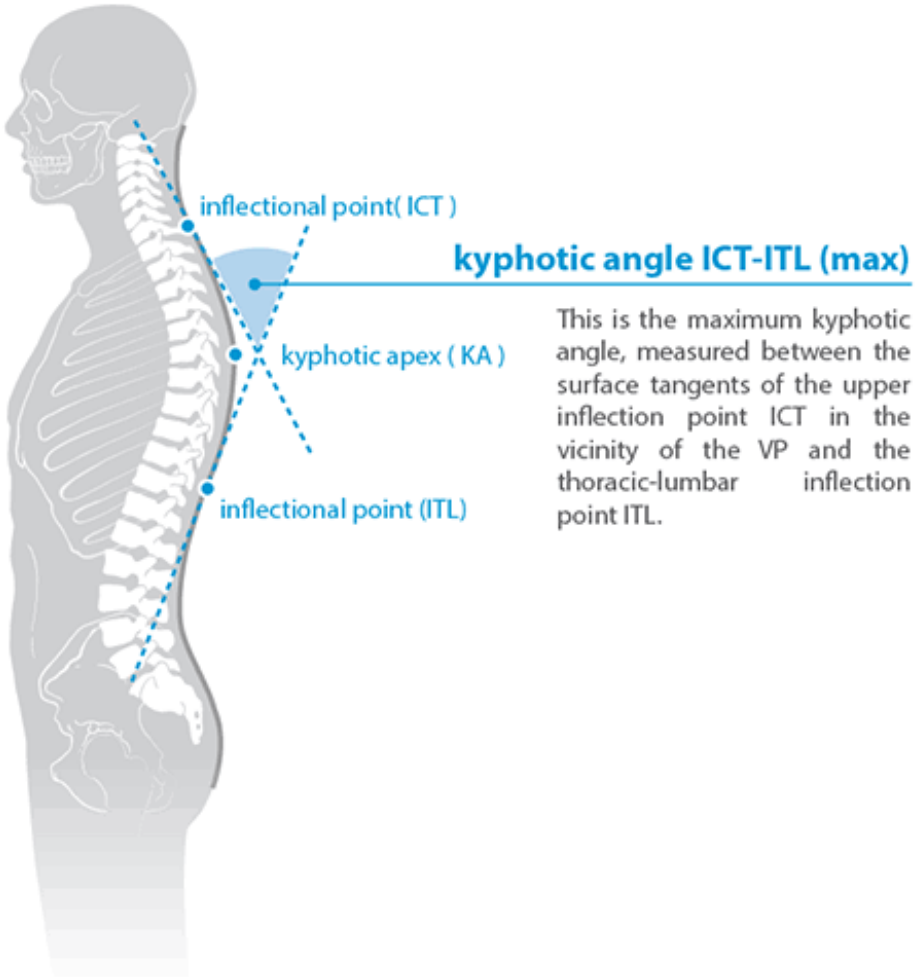
- Slow, controlled breathing;
- Gentle stretching of the chest and shoulders;
- Gentle thoracic mobility exercises;
- Relaxed spinal elongation; and
- Practice of an upright and comfortable standing posture.

The difficulty of the exercises was gradually increased according to each participant's mobility, postural control, and tolerance. All exercises were performed slowly and within a comfortable, pain-free range.

Outcome measurement

The primary outcome was the thoracic kyphotic angle ICT–ITL, measured in degrees using the DIERS Formetric 4D system. The DIERS Formetric 4D is a non-invasive and radiation-free surface-topography system. It projects parallel light lines onto the participant's back and uses their deformation to create a three-dimensional representation of the trunk and estimate spinal alignment (Degenhardt et al., 2017). The ICT–ITL angle represents the thoracic curvature between the cervicothoracic transition point and the thoracolumbar transition point. It is a surface-topography measurement and is different from the Cobb angle measured using radiography.

Figure 2.



Data collection

Measurements were performed twice:

- Before the first exercise session, at week 0; and
- After completion of the program, at week 4.

The same DIERS equipment, measurement procedure, and examiner were used

during both assessments to improve consistency.

Data analysis

The participants' ICT–ITL angles before and after the intervention were compared. Descriptive statistics were used to summarize the measurements, and a paired statistical test was used to evaluate the change following the intervention. Statistical significance was set at $p < .05$.

Because some participants initially had a reduced kyphotic angle and others had an increased angle, improvement was defined as movement of the ICT–ITL angle toward the study's prespecified reference range of 42°–55°, rather than only as a reduction in the angle.

Table 1.

Patient Nr	Kyphotic angle before treatment	Kyphotic angle after treatment
Nr1	33°	40°
Nr2	60°	55°
Nr3	65°	59°
Nr4	60°	54°
Nr5	30°	38°
Nr6	59°	53°
Nr7	28°	37°
Nr8	32°	40°
Nr9	34°	41°
Nr10	30°	39°
Nr11	32°	40°
Nr12	36°	42°
Nr13	38°	44°
Nr14	38°	46°
Nr15	30°	39°
Nr16	60°	55°
Nr17	60°	54°
Nr18	33°	40°
Nr19	32°	41°
Nr20	34°	42°
Nr21	32°	40°
Nr22	31°	40°
Nr23	35°	42°
Nr24	38°	54°
Nr25	34°	40°
Nr26	60°	54°
Nr27	31°	40°
Nr28	35°	42°
Nr29	32°	40°
Nr30	34°	41°

Interpretation

All 30 participants showed improvement, defined as movement of the ICT–ITL angle toward the prespecified reference range of 42°–55°. Before treatment, 23 participants had angles below the reference range and seven had angles above it; none were within the reference range. After treatment, 13 participants (43.3%) were within the reference range, 16 remained slightly below it, and only one remained above it. The mean distance from the reference range decreased from 8.10° (SD = 2.89°) before treatment to 1.33° (SD = 1.45°) after treatment. This reduction was statistically significant using the paired Wilcoxon signed-rank test ($p < .001$). The average improvement toward the reference range was 6.77° (SD = 1.74°).

The findings demonstrate a consistent normalization of thoracic kyphosis following the intervention. Although not every participant reached the 42°–55° reference range, all participants moved closer to it, and almost half achieved values within the range. The reduction in variability after treatment also indicates that participants' measurements became more concentrated around the reference values.

Table 2. *Descriptive statistics for ICT–ITL angles*

Measurement	N	Mean	SD	Median	Minimum	Maximum
Before treatment	30	39.53°	12.07°	34.00°	28°	65°
After treatment	30	44.40°	6.62°	41.00°	37°	59°

The mean ICT–ITL angle increased from 39.53° before treatment to 44.40° after treatment. The standard deviation decreased from 12.07° to 6.62°, indicating that the post-treatment measurements were less dispersed and more concentrated around the prespecified reference range. However, the change in the raw mean should be interpreted cautiously because the sample included participants with both reduced and increased initial angles.

Table 3. *Distribution of ICT–ITL angles relative to the prespecified reference range*

ICT–ITL classification	Before treatment, n (%)	After treatment, n (%)
Below 42°	23 (76.7%)	16 (53.3%)
Within 42°–55°	0 (0.0%)	13 (43.3%)
Above 55°	7 (23.3%)	1 (3.3%)
Total	**30 (100%)**	**30 (100%)**

Table 4. *Distance from the prespecified ICT–ITL reference range*

Measure	Mean	SD	Median	Minimum	Maximum
Before treatment	8.10°	2.89°	8.00°	4°	14°
After treatment	1.33°	1.45°	1.00°	0°	5°
Improvement toward range	6.77°	1.74°	7.00°	4°	9°

Table 5. *Paired comparison of distance from the reference range*

Comparison	Statistical test	Test statistic	p-value
Before vs. after treatment	Wilcoxon signed-rank test	W = 0.00	< .001

The Wilcoxon signed-rank test showed a statistically significant reduction in distance from the prespecified reference range (W = 0.00, p < .001). All participants improved according to this criterion; no participant was unchanged or moved farther from the range.

Conclusion

This study examined the short-term effect of a four-week, 12-session Gyrotonic® exercise program on thoracic curvature in 30 adults aged 18–40 years with altered DIERS ICT–ITL angles. Following the intervention, every

participantmovedclosertotheprespecified42°––55° reference range. The mean distance from the range decreased from 8.10° to 1.33°, representing an average improvement of 6.77°. Thirteen participants (43.3%) reached the reference range, and the paired analysis confirmed that the reduction in distance was statistically significant (W = 0.00, p < .001).

These findings suggest that supervised Gyrotonic® exercise may be a useful short-term approach for improving thoracic alignment in individuals with either reduced or increased ICT–ITL angles. The program's emphasis on multidirectional spinal mobility, elongation, trunk stabilization, scapular control, and coordinated breathing provides a plausible basis for the observed change. Nevertheless, the findings apply specifically to the surface-topography-derived ICT–ITL angle and should not be interpreted as equivalent to a change in the radiographic Cobb angle.

The results should be interpreted in light of the study's limitations. The single-group pre–post design cannot establish that the intervention alone caused the observed changes, and the convenience sample limits its generalizability. The study did not include a control group, assessor blinding, longer-term follow-up, or reported adherence and adverse-event data. In addition, functional outcomes such as pain, mobility, disability, and quality of life were not formally measured. Future research should use a controlled design, justify the selected ICT–ITL reference range with an authoritative source, report standardized measurement procedures and intervention adherence, and include validated clinical outcomes and follow-up assessments to determine whether the postural changes are durable and clinically relevant.

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