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Research Article / Araştırma Makalesi

Effect of Physiotherapy on Thoracic Rotation in Individuals with Spinal Pathology

Spinal Patolojisi Olan Bireylerde Fizyoterapinin Torasik Rotasyon Üzerindeki Etkisi

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ABSTRACT

Objective: Spinal pathologies are common musculoskeletal disorders in industrialized societies, often leading to impaired thoracic rotation, which is crucial for spinal stability and weight transfer during movement. This study aimed to investigate the effects of a physiotherapy program on thoracic rotation in individuals with spinal pathologies.

Method: The study group consisted of 56 patients with spinal pathologies, including 32 with lumbar and 24 with cervical involvement, while the control group comprised 34 healthy individuals without spinal pathologies. Pain was assessed using the Visual Analog Scale and the Short-Form McGill Pain Questionnaire; disability was evaluated with the Oswestry Disability Index and the Neck Disability Index; physical performance was measured using the Five-Repetition Sit-to-Stand Test; and quality of life was assessed with the Short-Form 36 Health Survey. Thoracic rotation degree was measured using a goniometer. The physiotherapy program, prescribed by a physical medicine and rehabilitation specialist, was implemented by a physiotherapist for the study group. It consisted of 15 sessions, conducted five days per week, with each session lasting 45-60 minutes. The entire program spanned three weeks. Assessments were performed once for the control group and both before and after physiotherapy for the study group.

Results: The baseline assessments revealed that the study group had significantly lower thoracic rotation degrees and higher disability levels compared to the control group ($p<0.05$). Following the physiotherapy intervention, the study group demonstrated statistically significant improvements in thoracic rotation, pain reduction, quality of life, and sit-to-stand test performance ($p<0.05$).

Conclusion: Physiotherapy effectively reduces pain and improves quality of life in individuals with spinal pathologies. However, despite improvements, thoracic rotation remains lower than in healthy individuals. Incorporating targeted exercises for thoracic rotation into physiotherapy programs may enhance clinical outcomes in this population.

Keywords: *Spine, rotation, pain, exercise, physiotherapy*

ÖZ

Amaç: Spinal patolojiler, sanayileşmiş toplumlarda yaygın görülen kas-iskelet sistemi hastalıklarıdır ve hareket sırasında spinal stabilite ile ağırlık transferi açısından kritik öneme sahip olan torakal rotasyonun bozulmasına neden olabilir. Bu çalışmanın amacı, spinal patolojisi olan bireylere uygulanan fizyoterapi programının torakal rotasyon derecesi üzerindeki etkilerini incelemektir.

Yöntem: Çalışma grubunu 32 lomber ve 24 servikal olmak üzere toplam 56 spinal patolojili hasta oluştururken, kontrol grubunda spinal patolojisi olmayan 34 sağlıklı birey değerlendirildi. Ağrı, Görsel Analog Skala ve Kısa Form McGill Ağrı Ölçeği ile; disabilite, Oswestry Disabilite İndeksi ve Boyun Disabilite İndeksi ile; fiziksel performans, beş tekrarlı otur-kalk testi ile; yaşam kalitesi ise Kısa Form-36 Sağlık Anketi ile değerlendirildi. Torakal rotasyon derecesi, gonyometre kullanılarak ölçüldü. Çalışma grubundaki bireylere, haftada beş gün, her biri 45-60 dakika süren, fiziksel tıp ve rehabilitasyon uzmanı hekim tarafından reçete edilmiş toplam 15 seans fizyoterapi programı fizyoterapist tarafından uygulandı. Tüm program 3 hafta sürdü. Değerlendirmeler, kontrol grubu için bir kez, çalışma grubu için ise fizyoterapi öncesi ve sonrası gerçekleştirildi.

Bulgular: Başlangıç değerlendirmelerinde çalışma grubunun torakal rotasyon derecelerinin belirgin şekilde daha düşük, disabilite düzeylerinin ise kontrol grubuna kıyasla anlamlı derecede daha yüksek olduğu tespit edildi ($p<0.05$). Fizyoterapi müdahalesi sonrasında çalışma grubunda torakal rotasyon, ağrı düzeyi, yaşam kalitesi ve beş tekrarlı otur kalk testinin sonuçlarında istatistiksel olarak anlamlı iyileşmeler gözlendi ($p<0.05$).

Sonuç: Fizyoterapi, spinal patolojisi olan bireylerde ağrıyı azaltmada ve yaşam kalitesini artırmada etkili bir yaklaşımdır. Bununla birlikte, elde edilen iyileşmelere rağmen torakal rotasyon sağlıklı bireylerle kıyaslandığında daha düşük seviyede kalmaktadır. Spinal patolojisi olan bireyler için uygulanan fizyoterapi programlarına torakal rotasyonu artırmaya yönelik egzersizlerin eklenmesi, klinik sonuçları daha da iyileştirebilir.

Anahtar Sözcükler: *Omurga, rotasyon, ağrı, egzersiz, fizyoterapi*

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INTRODUCTION

The thoracic spine plays a crucial role in spinal mobility, functional movement, and weight transfer in the musculoskeletal system (1). Thoracic rotation occurs as the vertebrae rotate around their own axis, contributing to essential movements required for daily activities and sports (2). The range of thoracic rotation can be influenced by various factors, including age, general health status, and physical activity levels (3). Studies indicate that thoracic rotation range decreases with age, while regular physical activity positively affects mobility (4). A restriction in thoracic mobility can lead to spinal deformities and degenerative changes, particularly when rotation is limited to 20-25 degrees or less (5,6).

Thoracic rotation is vital for spinal stability and the efficient execution of functional movements (3). When rotation remains symmetrical between the right and left sides, normal spinal alignment and function are preserved. However, a reduction in thoracic rotation can lead to asymmetric postures, difficulty with weight transfer, joint range of motion limitations, and muscle weakness. Additionally, restricted thoracic mobility is associated with pain, motor dysfunction, and sensory impairments (7). In industrialized societies, low back and neck pain represent major public health concerns, with prevalence rates of 38% for neck pain and 84% for low back pain in the adult population (8). These conditions can arise from physiological, somatic, or nonspecific sources, often leading to secondary restrictions in thoracic mobility (9). Given its essential role in spinal function, restoring thoracic mobility is a key component of physiotherapy interventions. Various rehabilitation strategies, including pain management techniques, mobility and flexibility exercises, core stabilization training, and posture education, are widely utilized in the treatment of spinal pathologies (10, 11). Evaluating thoracic rotation range of motion can provide clinicians with insights into pain severity, physical activity levels, and overall spinal health, particularly in individuals with cervical and lumbar spinal pathologies (9). Despite its clinical significance, most studies on spinal disorders have primarily focused on flexion, lateral flexion, and extension, while thoracic rotation has received limited attention (12). Although physiotherapy interventions are widely used in the management of spinal pathologies, their specific impact on thoracic rotation remains unclear. Thoracic mobility plays a crucial role in spinal stability, functional movement, and weight transfer, and its restriction can lead to postural asymmetries, joint mobility limitations, and increased pain, particularly in individuals with cervical and lumbar spinal disorders (7-10). Understanding how targeted physiotherapy interventions influence thoracic mobility, pain levels, disability, and functional performance is essential for optimizing rehabilitation strategies and improving clinical outcomes. Therefore, this study aims to evaluate the effects of a structured physiotherapy program on thoracic rotation in individuals with spinal pathologies. The intervention includes pain management techniques, flexibility and mobility exercises, core stabilization training, and posture education (11). We hypothesize that the physiotherapy program will lead to significant improvements in thoracic rotation, reduce pain levels, decrease disability, and enhance functional performance in individuals with spinal pathologies.

MATERIAL and METHODS

Participants

The study was designed as a case-control study involving individuals with chronic spinal pathologies. Participants who voluntarily enrolled and met the inclusion criteria from individuals seeking treatment at a specialized physical therapy and rehabilitation center were included in the study. Individuals with diagnosed cervical and lumbar spinal pathologies who applied on an outpatient basis formed the study group, while healthy volunteers without any complaints in the spinal regions constituted the control group.

Sample Size & Power Analysis

The sample size was determined based on a power analysis using thoracic rotation range of motion as the primary outcome measure. A large effect size (Cohen's d = 0.8) was considered clinically meaningful, with a power of 0.80 (80%) and a significance level of $\alpha = 0.05$. Based on this calculation, a minimum of 26 participants per group was required to detect statistically significant differences.

A total of 357 individuals were assessed for eligibility, and after applying the exclusion criteria, 92 participants were enrolled in the study. The study group consisted of 58 individuals with chronic spinal pathologies (32 with lumbar pathology and 26 with cervical pathology), while 34 healthy individuals were included in the control group.

During the study, 2 participants from the study group discontinued treatment and were excluded from the final analysis. Thus, the final sample included 56 participants in the study group and 34 participants in the control group, all of whom completed the study and were included in the statistical analysis. The flow of participants through the study is detailed in Figure 1 (Flowchart).

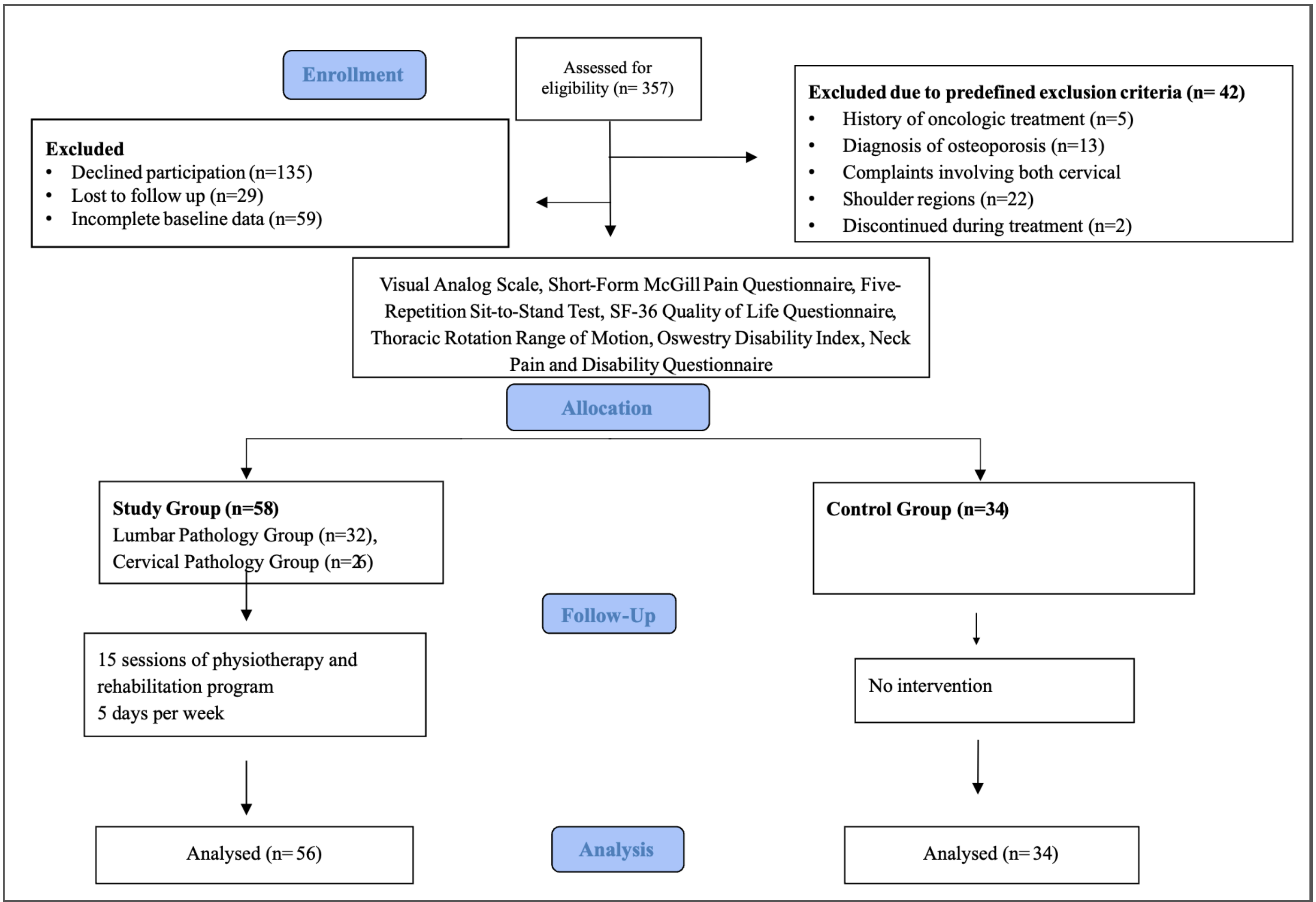

Figure 1. Flow chart of study

Inclusion and Exclusion Criteria

The inclusion criteria for the study group were: Being diagnosed with a chronic cervical or lumbar spinal pathology (symptom duration >3 months) (2); being over 18 years old; being able to read and write in Turkish at a proficient level

The exclusion criteria for the study group included: Systemic inflammatory spinal diseases, such as spondyloarthropathies (e.g., ankylosing spondylitis, psoriatic arthritis, reactive arthritis) (3); other conditions affecting spinal mobility, including tumors and scoliosis; neurological diseases impacting the musculoskeletal system (e.g., cerebrovascular diseases, Parkinson's disease, neuropathy); A history of spinal surgery

For the control group, the inclusion criteria required participants to be over 18 years old; have proficiency in reading and writing Turkish. The exclusion criteria for the control group included: any spinal deformity; neurological, oncological, rheumatological, or cardiopulmonary diseases that could affect thoracic rotation range of motion

The control group consisted of healthy individuals without spinal pathologies, serving as a reference to comparing functional differences and the extent of improvement after rehabilitation. The inclusion of a healthy control group allowed for a clearer understanding of how spinal pathologies impact movement, pain, and functional outcomes (13). Additionally, comparing post-rehabilitation outcomes with those of healthy individuals provided a more objective assessment of the clinical significance of the intervention. This approach has been widely utilized in similar studies evaluating spinal rehabilitation outcomes (5,13,14).

This study was approved by the Dokuz Eylül University Non-Interventional Medical ResearchEthics Committee (Approval number: 2014/12-18, Protocol number: 1400-GOA, Date: 27.03.2014).

Participant Recruitment

Participants were recruited through a specialized physical therapy and rehabilitation center. Potential candidates were screened based on their medical history, clinical voluntarily, and informed consent was obtained before enrollment. The control group consisted of healthy individuals who were recruited through community advertisements and referrals, ensuring they met the exclusion criteria.

Assessment

Thoracic Rotation Degree Measurement: The measurement was conducted in a seated position. Participants sat with their hips and knees at 90 degrees of flexion, holding a 21 cm diameter ball between their knees. A bar, 105 cm in length and 2.5 cm thick, with its midpoint marked, was used to standardize the position of the upper extremities (Figure 2).

Figure 2. The measurement of thoracic rotation degree

The bar was held with arms crossed in front of the chest. The participant was instructed to rotate to the right and then to the left. Using a goniometer, the measurement was taken with the pivot point positioned at the thoracodorsal junction (T7-T9 region) to ensure alignment with the natural spinal rotation axis (4). Right and left thoracic rotation measurements were assessed separately. The best value from three attempts, conducted with 30-second intervals, was recorded. The method's intra- and inter-rater reliability has been previously reported (12).

Physiotherapy Plan: The physiotherapy program consisted of: Transcutaneous Electrical Nerve Stimulation (TENS) (15); therapeutic ultrasound (16); superficial heat modalities (17) ,exercise routines based on the Williams and McKenzie methods (16,17) (Figure 3).

These interventions were selected based on their evidence-based effectiveness in reducing pain, improving soft tissue flexibility, enhancing spinal mobility, and correcting postural misalignments, all of which contribute to improving thoracic rotation (10). TENS was applied to modulate neuromuscular activity and alleviate pain, thereby facilitating movement initiation (15). Therapeutic ultrasound was used to enhance tissue elasticity and reduce muscle stiffness, promoting better spinal flexibility. Superficial heat modalities were incorporated to increase blood circulation and improve tissue extensibility, further supporting mobility (14-15). Williams and McKenzie exercises were included to optimize spinal mobility and segmental control while improving postural alignment, which are crucial for thoracic rotation (16-17). Each session, the patient's perceived exertion intensity was assessed. When the patient reported a score of 7 or below on a 10-point scale, the exercise duration was increased to the pain threshold by adding appropriate exercises and increasing the number of repetitions (14). The selection of these interventions was based on their established role in musculoskeletal rehabilitation and their potential to enhance thoracic rotation range of motion (ROM) by addressing pain, stiffness, and postural dysfunctions (9).

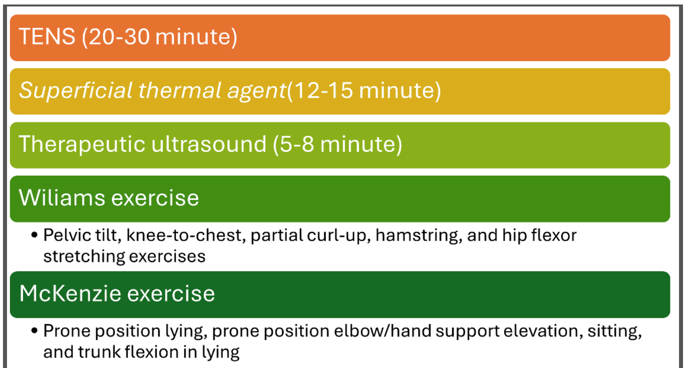

Figure 3. The physiotherapy plan for the patients

Post-Intervention Assessment Timing: All post-intervention assessments, including thoracic rotation range of motion, pain, disability, functional performance, and quality of life evaluations, were conducted one day after the final physiotherapy session. This approach was chosen to minimize the immediate effects of acute fatigue and temporary post-exercise changes, ensuring that the observed improvements reflect actual functional and physiological adaptations rather than transient effects of the last session (17).

Statistical Analysis

All results were analyzed using IBM SPSS Statistics, with statistical significance set at $p < 0.05$. Group distribution homogeneity was assessed based on demographic variables (age, gender, occupation, complaint duration, body mass index, height, weight, medical and family history). Pearson chi-square test was used for qualitative comparisons between independent groups. Wilcoxon Signed Rank test was used to evaluate pre- and post-treatment differences within the study group. Mann-was used to analyze relationships between thoracic rotation degree and other measured parameters.

RESULTS

The mean age for the lumbar pathology group (LPG) was 45.47 ± 13.19 years, for the cervical pathology group (CPG) 47.75 ± 9.58 years, and for the control group (CG) 48.12 ± 11.49 years. The mean body mass index (BMI) for the LPG was 26.48 ± 3.65 kg/m², for the CPG 28.16 ± 5.17 kg/m², and for the CG 27.20 ± 3.36 kg/m². There was no statistically significant difference between the demographic and clinical characteristics of the study and control groups ($p > 0.05$). The demographic and clinical data of the participants are presented in Table 1. Baseline comparisons between lumbar pathology, cervical pathology, and control groups were conducted. No significant differences were observed among the groups in terms of sex distribution, age, BMI, occupation, history of spinal pathology, diabetes mellitus, hypertension, and other diseases ($p>0.05$ for all comparisons).

Table 1. Demographic and clinical characteristics of the spinal pathology and control group

	Lumbar pathology group (LPG) (n=32)	Cervical pathology group (CPG) (n=24)	Control group (CG) (n=34)	p value (comparison p-value)[a]
Sex				
F	17 (%53.1)	18 (%75)	21 (%66.7)	0.67[b]
M	15 (%46.9)	6 (%25)	13 (%29.6)	
Age (years)	45.47±13.19	47.75±9.58	48.12±11.49	0.39
BKI (kg/m²)	26.48±3.65	28.16±5.17	27.20±3.36	0.87
Occupation				
House wife	10 (%31.3)	14 (%58.3)	16 (%47.1)	0.78[c]
Working	12 (%37.5)	9 (%37.5)	11 (%32.4)	
Not working	8 (%25)	1 (%17.6)	6 (%17.6)	
Student	2 (%6.3)	0 (%2.9)	1 (%2.9)	
History				
1 year and less	12 (%37.5)	5 (%20.8)		0.23[d]
1-3 years	3 (%9.4)	8 (%33.3)		
3-10 years	7 (%21.9)	7 (%29.2)		
10 years and more	10 (%31.3)	4 (%16.7)		
DM				
Yes	5 (%15.6)	6 (%25)	5 (%14.7)	0.44[e]
No	27 (%84.4)	18 (%75)	29 (%85.3)	
HT				
Yes	12 (%37.5)	10 (%29.2)	15 (%44.1)	0.38[e]
No	20 (%62.5)	14 (%70.8)	19 (%55.9)	
Other disease				
Yes	7 (%21.9)	3 (%21.5)	6 (%17.6)	0.41[e]
No	25 (%78.1)	21 (%87.5)	28 (%82.4)	

DM: Diabetus Mellitus, HT: Hypertension, BMI: Body Mass Index
* Age and BMI values are expressed as mean ± SD (Standard Deviation)
[a] Group comparisons conducted with independent sample t-tests for quantitative variables and chi-square tests for categorical variable.
[b] Group comparisons examined distributions between 'Male' and 'female' only as all participants self-identified with these two categories.
[c] Group comparisons examined distributions between 'housewife', 'working', 'not working' and 'student'.
[d] Group comparisons examined distributions between '1 year and less than 1 year', 'between 1-3 years', 'between 3-10 years' and '10 years and over'.
[e] Group comparisons examined distributions between 'yes' and 'no'.

It was observed that, among participants with lumbar pathology, a negative correlation existed between thoracic rotation and the 5-times sit-to-stand test both before and after treatment (pre-treatment right: $r = -0.504$, $p < 0.05$; left: $r = -0.362$, $p < 0.05$; post-treatment right: $r = -0.511$, $p < 0.05$; left: $r = -0.492$, $p < 0.05$). For those with cervical pathology, a positive correlation was found post-treatment between SF-36 physical function and thoracic rotation (right: $r = 0.462$, $p< 0.05$; left: $r = 0.424$, $p < 0.05$) (Table 2). In participants with lumbar pathology, a positive correlation was also identified between left thoracic rotation and SF-36 physical health post-treatment ($r = 0.396$, $p<0.05$) (Table 3).

Table 2. Correlation between thoracic rotation and the five-repetition sit-to-stand test, pain assessment, disability status, and quality of life scale

	STST	McGill	VAS	ODI	NDI	SF-36 physical function	SF-36 physical health	SF-36 pain	SF-36 health	SF-36 fatique	SF-36 Social function	SF-36 emotional health	SF-36 mental health
LPG													
BT													
TR	**-.504**	.035	-.072	-.261		.072	.017	.123	.025	.037	.103	.108	.180
R	**.003**	.849	.697	.148		.697	.926	.501	.893	.842	.573	.557	.323
TR	**-.362**	.026	-.137	-.184		.030	-.068	.002	.021	.095	.049	.153	.124
L	**.042**	.890	.453	.314		.872	.710	.002	.910	.605	.789	.402	.498
AT													
TR	**-.511**	.022	-.129	-.121		.228	.224	.157	-.010	.124	-.020	0.75	-.049
R	**.003**	.906	.482	.509		.209	.218	.392	.957	.500	.913	.682	.788
TR	**-.492**	.056	-.040	-.027		.298	**.038**	.020	.135	.055	-.050	.184	-.164
L	**.004**	.759	.826	.885		.098	**.038**	.914	.462	.766	.785	.314	.369
CPG													
BT													
TR	-.244	-.005	-.118		.028	.222	.020	.089	.076	-.108	.086	.050	.129
R	.250	.982	.581		.896	.296	.928	.678	.725	.614	.689	.816	.548
TR	-.124	-.008	-.214		-.039	.058	-.168	-.119	-.025	-.037	-.021	-.003	.088
L	.562	.970	.316		.855	.786	.431	.579	.907	.864	.923	.987	.663
AT													
TR	-.365	.020	-.253		.174	**.462**	.238	.208	.053	.076	-.053	.226	-.146
R	.076	.926	.233		.417	**.023**	.263	.329	.806	.725	.807	.288	.497
TR	-.287	.135	-.128		-.002	**.424**	.351	-.041	.073	-.009	-.075	.213	-.237
L	.173	.530	.551		.994	**.039**	.092	.848	.735	.968	.976	.318	.264

BT: Before treatment, AT: After treatment, TR: Thoracic Rotation, STST: Sit-to-Stand Test, VAS: Visual Analog Scale

Table 3. Results of thoracic rotation degree, functional performance, and pain assessment

	LPG (n=32)	P*	CPG(n=24)	P**	CG (n=34)	P***
TR (R)						
BT	34.03±6.15	.082	34.50±7.25	.000	43.09±7.42	.000
AT	35.97±5.81		36.13±7.03		43.35±4.56	.000
TR (L)						
BT	34.16±6.74	.007	33.79±7.46	.003	42.65±6.05	.000
AT	37.19±5.89		37.54±6.20		43.01±5.45	.000
STST (sn)						
BT	17.42±4.85	.001	17.25±3.06	.001	12.35±2.72	.000
AT	16.85±4.43		14.98±4.22		10.45±3.45	.000
SF McGill Q.						
BT	11.97±7.85	.016	16.50±10.03	.025	2.18±3.20	.000
AT	8.47±8.29		10.25±6.40		2.04±3.25	.000
VAS						
BT	6.22±2.02	.000	7.25±1.67	.000	0.76±1.75	.000
AT	3.56±2.10		4.25±1.42		0.26±0.45	.000
NPDS						
BT			61.88±15.54	.000	1.78±0.56	
AT			41.96±13.32	.000	1.02±1.23	
ODI						
BT	19.90±11,87	.000			1.56±2.34	.000
AT	12,67±8,12	.000			1.77±3.25	.000

BT: before treatment, AT: after treatment, TR: thoracal rotation, R: right, L: left, STST: sit to stand test, SF McGill Q: Mcgill short form, VAS: visual analog scale
P: The p-value between pre- and post-treatment of LPG*
*P**: The p-value between pre- and post-treatment of CPG*
*P***: The p-value between the study group and the control group*

In the CPG1 group, 31.3% of the 32 cases had severe disability according to the Oswestry Disability Index. Post-treatment, a significant improvement was observed on this scale ($p < 0.05$). Quality of Life, as measured by SF-36, was lower in the CPG1 and CPG2 groups compared to the control group ($p < 0.05$). No statistically significant difference was found between the CPG2 group and the control group regarding the SF-36 Emotional Role Limitation parameter ($p > 0.05$). In participants with spinal pathologies, a statistically significant improvement was observed in body pain, vitality, and emotional role limitations subparameters of the quality of life (Figure 4) questionnaire following physiotherapy ($p < 0.05$). Thoracic rotation degrees were lower in individuals with spinal pathologies. Although an increase in the degree of right thoracic rotation was observed in CPG1 participants pre- and post-treatment, this result was not statistically significant ($p > 0.05$). However, the mean increase in left thoracic rotation degree was statistically significant ($p < 0.05$). CPG2 participants demonstrated an increase in the degree of right thoracic rotation joint movement post-treatment ($p<0.05$). Additionally, a decrease in time on the sit-to-stand chair test was noted post-treatment in those with spinal pathologies ($p<0.05$). Across the entire physiotherapy group, pain complaints and scores were reduced ($p<0.05$)

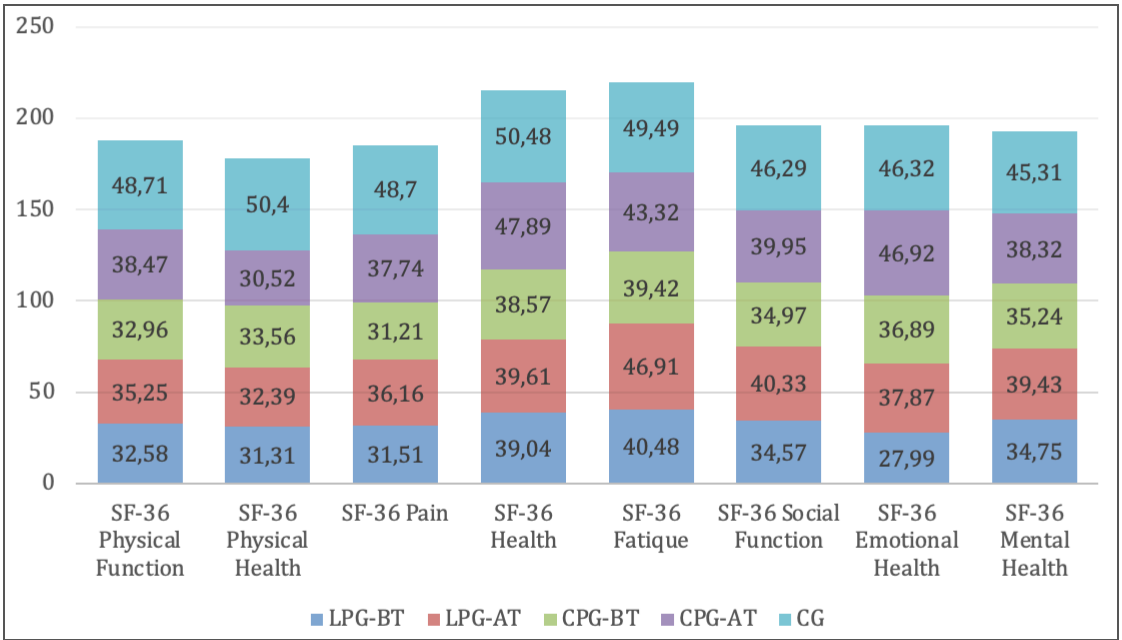

Figure 4. Measurements of participants' quality of life using the SF-36 questionnaire

DISCUSSION

This study investigated the effects of a physiotherapy program on thoracic rotation in individuals with spinal pathologies. It was observed that thoracic rotation decreased in both the lumbar and cervical spinal pathology groups compared to the control group. Although improvements in pain and other parameters were noted after physiotherapy, the degree of thoracic rotation in the treatment group remained lower than in the control group. A reduction in thoracic rotation was associated with decreased functional performance and physical health, as seen in the functional performance and quality of life measures (12). These findings indicate that thoracic mobility should be carefully monitored during the treatment process, as a decrease in thoracic rotation could be a significant factor influencing functional outcomes.

The degree of thoracic rotation is affected in individuals with spinal pathologies (4). Al-Eisa et al. examined thoracic spine movements in individuals with lumbar pain complaints and found that unilateral pathologies resulted in restricted thoracic rotation on the opposite side (3). In individuals with symptomatic lumbar pain, bilateral thoracic rotation restriction has also been observed (18). Various studies have emphasized the importance of assessing thoracic rotation joint range of motion in individuals with cervical region complaints (13,14). The results of our study align with previous findings, demonstrating significantly lower thoracic rotation in individuals with lumbar pathology. Despite improvements in left thoracic rotation after the physiotherapy program, the range of motion remained inadequate compared to healthy individuals (19). Similarly, while an increase in right thoracic rotation was noted in the lumbar pathology group, it was not statistically significant. These observations suggest that limitations in thoracic rotation may persist despite physiotherapy intervention.

The biomechanical relationship between spinal regions is well documented, with any restriction in one segment potentially affecting adjacent areas (20). Kim et al. emphasized that biomechanical restrictions in one part of the body can significantly impact other anatomical segments (6). Our findings further support this, as thoracic rotation degrees were bilaterally reduced in individuals with cervical spinal pathology, even though improvements were noted post-treatment. Kaya et al. (20) also reported decreased thoracic mobility and flexibility in individuals with neck pain, reinforcing the interdependent nature of spinal mobility.

Sitting and standing movements are fundamental daily activities, and spinal pathologies can negatively impact functional performance (21). A decrease in thoracic rotation may contribute to reduced functional capacity, influencing an individual's ability to perform daily tasks (22). This study which corresponded with reduced thoracic rotation angles. However, functional performance improved across all groups following physiotherapy, suggesting a beneficial relationship between physiotherapy intervention and spinal mobility. This emphasizes the importance of incorporating targeted mobility exercises into rehabilitation programs to optimize functional performance and stability (24).

Pain is another critical factor influencing thoracic rotation (7). Brigg et al. (13) reported that lumbar pain affects trunk rotation and functionality, with a high prevalence in the general adult population. However, our study did not find a direct correlation between thoracic rotation and pain, possibly due to the relatively short duration of symptoms in our participants. Prior research suggests that the impact of pain on thoracic mobility may become more pronounced in chronic cases persisting beyond three years (25-26). These findings highlight the need for longitudinal studies to explore the long-term effects of pain on thoracic movement patterns.

Disability is characterized by the loss or restriction of specific movement patterns (27), and thoracic rotation may be influenced by an individual's disability level (8). In this study, lumbar pathology patients were classified as having 'severe disability' before physiotherapy, which improved to 'moderate' and 'minimal' disability post-treatment according to the Oswestry Disability Questionnaire. Similarly, individuals with cervical pathology exhibited higher disability scores compared to the control group, with improvements observed post-treatment. However, no direct relationship was found between thoracic rotation range and disability scores (28). This may be attributed to the moderate disability levels observed in our study cohort, suggesting that more severe impairments may be necessary to establish a significant correlation.

Quality of life is another essential measure, with thoracic mobility potentially playing a role in overall well-being (24). While our study found an association between left thoracic rotation and physical health in individuals with lumbar pathology, a relationship between thoracic rotation and physical function was noted only in individuals with cervical spine pathology post-treatment. Notably, the SF-36 scores for the control group were lower than normative Turkish population values (29), potentially confounding our ability to assess treatment effects accurately. This indicates that external factors may have influenced the quality of life assessments in our study population, warranting further investigation (29).

Our findings suggest that small changes in thoracic rotation may not produce significant effects on pain, disability, or quality of life. For a clearer understanding of these relationships, future studies should focus on interventions that induce more substantial changes in thoracic mobility. Additionally, modifications to treatment protocols and follow-up processes may yield different outcomes in quality of life scores. A biopsychosocial approach, recently emphasized in spinal pathology management, has shown promise in improving quality of life and daily activity competence (30-32). Future studies should explore this approach further, integrating holistic rehabilitation strategies to enhance patient outcomes.

Limitations

This study provides valuable clinical outcome data and insights into the impact of thoracic rotation range of motion. However, several limitations should be noted. The relatively small sample size may limit the generalizability of the findings, and a larger cohort would enhance statistical power. Additionally, the lack of long-term follow-up restricts conclusions regarding the sustainability of improvements in thoracic mobility and pain reduction. While a standardized physiotherapy program was implemented, individual adherence may have varied. Furthermore, the use of a goniometer, though practical in a clinical setting, has inherent measurement variability compared to advanced motion analysis techniques.

Another methodological limitation concerns the thoracic rotation measurement method. The goniometric approach used in this study, validated by Johnson et al. (4), has demonstrated reliability in healthy individuals aged 18-45 years. However, its validity for individuals with spinal pathologies remains uncertain. Using this method in a clinical population may introduce measurement bias and limit the generalizability of the findings. Future studies should incorporate advanced motion analysis techniques, such as three-dimensional motion analysis or digital inclinometers, to improve measurement accuracy and applicability.

Another potential limitation is the ceiling effect, as some participants may have reached maximal possible scores in certain outcome measures due to the short intervention period and rapid reassessment timeline. Consequently, additional improvements in thoracic mobility might not have been fully captured. Future research should extend follow-up periods and utilize more sensitive measurement tools to better evaluate long-term functional outcomes.

CONCLUSION

The findings of this study suggest that thoracic rotation is significantly reduced in individuals with spinal pathologies, and despite improvements following mobility, functional performance, and physical health highlights the importance of targeted interventions to optimize rehabilitation outcomes. Future research should explore long-term effects, refine measurement techniques, and integrate holistic rehabilitation approaches to enhance spinal mobility and overall patient well-being.

Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Dokuz Eylul University University Non-Interventional Clinical Research Ethics Committee, İzmir, Türkiye (Decision no:2014/12-18, Date: 23/03/2014).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept/Design: GE; Design: GE, AKV; Supervision/Consultancy: BK; Funding and Resources: AKV; Materials: AKV; Data Collection and/or Processing: AKV; Analysis and/or Interpretation: AKV; Literature Review: GE, AKV; Writing: GE, AKV; Critical Review: BK. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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