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The Relationship Between Posture, Sense of Position, Musculoskeletal Discomfort, and Anxiety in Asymptomatic Individuals: A Cross-Sectional Study

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ABSTRACT

Objective: Increased thoracic curvature may cause cosmetic deformities, sensory issues, musculoskeletal pain, and adverse effects on psychological health. This study aims to investigate the relationships among the degree of thoracic kyphosis, trunk position sense, musculoskeletal discomfort, and anxiety in asymptomatic individuals.

Materials and Methods: In this cross-sectional study, young volunteers aged between 18 and 30 years were included. A dual digital inclinometer was used to assess the thoracic kyphosis angle and trunk position sense. Musculoskeletal discomfort was evaluated using the Cornell Musculoskeletal Discomfort Scale, and anxiety levels were evaluated using the Generalized Anxiety Disorder-7 Scale.

Results: The analysis of the postures of asymptomatic individuals revealed a very weak positive correlation between the degree of kyphosis and both trunk position sense and musculoskeletal discomfort ($p<0.05$); no correlation was found with the other parameters ($p>0.05$). There was also a weak positive correlation between musculoskeletal discomfort and anxiety ($p<0.05$). However, no correlation was found between other parameters ($p>0.05$).

Conclusion: As a result, it was determined that an increase in the degree of kyphosis in asymptomatic individuals negatively affects the sense of trunk position and musculoskeletal disorders, and that musculoskeletal disorders increase the level of anxiety. We think that multiple factors should be evaluated in the protection and promotion of health in asymptomatic individuals.

Keywords: Anxiety, kyphosis, pain, posture, proprioception.

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INTRODUCTION

The vertebral column serves several functions, including supporting body weight, protecting the spinal cord from injury, and absorbing shock in daily life. Kyphosis refers to the posterior curvature of the thoracic and sacral spine, which can also manifest as a lateral curvature of the spine.[1–3] In a healthy population, the typical range for thoracic kyphosis is between 20° and 40°. Values above 45° are indicative of hyperkyphosis.[4,5] It is stated that the increase in the degree of kyphosis, which

can be caused by many factors, may also result from poor postural habits in individuals.[6,7] Increased thoracic curvature may cause cosmetic deformities, postural problems, and musculoskeletal pain, thereby negatively affecting the physical and psychological health of individuals.[7,8] Furthermore, it has been postulated that musculoskeletal discomforts and psychosocial factors may contribute to an increase in the extent of thoracic kyphosis.[9]

It is thought that disorders in proprioception, a basic element of sensorimotor control, and position sense, a subcomponent of proprioception, may increase the degree of thoracic kyphosis.[10,11] The spine receives proprioceptive information from different structures, including ligaments, the thoracolumbar fascia, intervertebral discs, and paraspinal muscles.[12,13] Proprioception plays a role in maintaining proper posture by providing information on the three-dimensional position of the functional units of the spine.[10] Moreover, it has been posited that an elevated thoracic kyphosis may facilitate the progression of degenerative processes, increasing the spinal load in an upright position, which could lead to dysfunction and pain.[14] Musculoskeletal discomforts may damage the proprioceptive feedback mechanism, affecting receptors in the capsule, ligaments, and muscular structures.[15,16] Furthermore, it has been documented that the presence of pain from musculoskeletal disorders can result in alterations to proprioception at the periphery, within the spinal cord, as well as during supraspinal integration.[17] According to this data, it appears that postural disorders, musculoskeletal discomforts, and pain may affect proprioception. In addition, it is also stated that proprioceptive information and musculoskeletal changes affect emotional experience.[18,19] Changed posture is also thought to affect conditions such as psychological stress and anxiety through receptors.[20]

The correlation between kyphosis and position sense has been the subject of investigation in numerous studies, which have included individuals with thoracic hyperkyphosis, those experiencing musculoskeletal discomfort and/or pain, and geriatric populations suffering from various issues.[11,21,22] As a result, the cause-and-effect relationship between kyphosis and proprioception cannot be clearly expressed. It is unclear whether an increase in the degree of thoracic kyphosis causes a deterioration in proprioceptive information, or whether a decrease in proprioceptive information leads to an increase in the degree of thoracic kyphosis. This research aims to investigate whether there is a correlation between the degree of thoracic kyphosis, trunk position sense, musculoskeletal discomfort, and anxiety in asymptomatic individuals.

KEY MESSAGES

- It was determined that an increase in the degree of kyphosis in asymptomatic individuals negatively affects the sense of trunk position and musculoskeletal disorders.
- Musculoskeletal disorders were found to increase the level of anxiety.

MATERIALS AND METHODS

Ethical Approval

The study was granted ethical approval by the Ankara Yildirim Beyazit University Health Sciences Ethics Committee (2022-874/08). The content of the study was presented to each participant, and their written and verbal consent was obtained prior to commencing the study. The study is registered as a clinical trial registered on the Clinical Trials platform with the identifier number NCT06360198.

Study Design and Setting

This cross-sectional study was conducted at the University Department of Physiotherapy and Rehabilitation, between June and November 2022. Young volunteer individuals aged between 18 and 30 years participated. The study excluded individuals with any systemic or neurological chronic diseases, severe visual or hearing impairments, orthopedic issues (such as scoliosis or lower extremity postural problems), recent orthopedic injuries or surgeries within the past six months, and individuals with mood or psychotic disorders receiving treatment for these conditions.

Data Collection

In the study, the age, body mass index, gender, and dominant limb of the participants were recorded. All individuals were then assessed for thoracic kyphosis angle, position sense, musculoskeletal discomfort, and anxiety. A dual digital inclinometer was used to assess the thoracic kyphosis angle and trunk position sense. Musculoskeletal discomfort was evaluated using the Cornell Musculoskeletal Discomfort Scale, while anxiety levels were assessed with the Generalized Anxiety Disorder-7 Scale (GAD-7).

Thoracic Kyphosis Angle

The kyphosis angle was determined using a dual digital inclinometer (ACUMAR™, Lafayette Instrument, USA). During the measurement, participants were instructed to assume a comfortable posture while standing. For the thoracic kyphosis angle assessment, the inclinometer was placed at the T1-T2 and T12-L1 vertebral processes. The displayed

value was then recorded in degrees of thoracic kyphosis. The measurement was repeated three times, and the mean value was used for analysis.[23]

Trunk Position Sense

Trunk position sense assessment was conducted using the dual digital inclinometer (ACUMAR™, Lafayette Instrument, USA). During the test, participants stood on a hard surface. They were instructed to position their feet shoulder-width apart and keep their eyes closed throughout the entire test. Before starting the test, both verbal and practical exercises were conducted to minimize the error rate. To assess trunk flexion movement in the standing position, the inclinometer was placed on the T1 and S1 spinous processes, which were located and marked by palpation. The subjects were asked to perform 30° trunk flexion movements. They were instructed to fully perceive the precise angle and then return to the neutral position. They were then asked to identify the target angle. The value displayed on the inclinometer at the moment the individual indicated they had found the target angle was recorded. The discrepancy between the target and actual angles was quantified in absolute terms and recorded in degrees. The measurements were repeated three times and then averaged.[24]

Musculoskeletal Discomfort

Musculoskeletal discomfort was evaluated using the Cornell Musculoskeletal Discomfort Scale, which consists of three sections assessing the frequency, severity, and work interference of musculoskeletal discomfort in 20 different body parts over the last week. In the frequency section assessing musculoskeletal discomfort, the frequency for each body part is scored as follows: "never felt (0), felt 1–2 times during the week (1.5), felt 3–4 times during the week (3.5), felt once every day (5), and felt many times every day (10)." In the section evaluating the severity of musculoskeletal discomfort, the severity for each body part is scored as "mildly severe (1), moderately severe (2), very severe (3)." The work interference caused by the musculoskeletal disorder is scored as "not at all interfered (1), a little interfered (2), very much interfered (3)." The scores for each body part are multiplied, with total scores for each category ranging from 0 to 90. A lower score indicates a reduced level of musculoskeletal discomfort.[25]

Anxiety

Anxiety was evaluated using the GAD-7 scale, designed for screening and measuring the severity of generalized anxiety disorder. The scale evaluates experiences over the last 2 weeks using 7 items on a four-point Likert scale (0–3). The GAD-7 is a self-report instrument. Its Turkish validation and reliability were evaluated by Konkan et al.[26]

Table 1. Demographic and clinical characteristics of the cases (n=67)

Age, years [median (min-max)]	21 (19.00–29.00)
BMI, kg/m^2 (Mean±SD)	22.69±3.65
Gender, female/male, n (%)	54 (80.6)/13 (19.4)
Dominant limb, right/left, n (%)	62 (92.5)/5 (7.5)
Kyphosis [median (min–max)]	39 (19.00–59.00)
Trunk position sense [median (min–max)]	3.33 (0.33–9.33)
Cornell Musculoskeletal Discomfort Questionnaires, [median (min–max)]	16.50 (0.00–552.00)
Anxiety [median (min–max)]	20 (0.00–105.00)

BMI: Body mass index; kg: Kilogram; m: Meter; SD: Standard deviation; n: Number; Min: Minimum; Max: Maximum.

Statistical Analysis

The variables obtained from the evaluation were analyzed using the Shapiro-Wilk test, normality graphs, and skewness/kurtosis statistics. All quantitative variables were reported in terms of median (minimum; maximum), mean, and standard deviation (SD). All qualitative variables were expressed as frequency (%). Due to the non-parametric nature of the variables, Spearman's correlation test was used to analyze the relationships between variables. According to the correlation coefficient, the significance levels were defined as follows: very high between 0.90 and 1.00, high between 0.70 and 0.90, moderate between 0.50 and 0.70, weak between 0.30 and 0.50, and very weak below 0.30. All analyses were conducted using the SPSS (Statistical Package for the Social Sciences) version 22.00, with a 95% confidence interval and a 0.05 significance level.

Sample Size

The sample size was determined using the software program G*Power, version 3.1. A correlation coefficient of 0.50 was anticipated, with an alpha level of 0.05 and a desired power level of 95%. This led to the estimation of a minimum sample size of 46 individuals.[27]

RESULTS

The study included 67 asymptomatic young individuals (54 females, 13 males). Descriptive characteristics of the individuals are presented in Table 1. Hyperkyphosis was found in 14 (20.89%) of the individuals.

When analyzing the postures of asymptomatic individuals, a very weak positive correlation was found between the degree of kyphosis and trunk position sense (r=0.279, p=0.022) and musculoskeletal discomfort (r=0.245, p=0.045); no correlation

Table 2. Investigation of the relationship between kyphosis, lordosis, trunk position sense, musculoskeletal discomfort, and anxiety level of asymptomatic individuals

	Kyphosis		Trunk position sense		Musculoskeletal discomfort		Anxiety	
	r	p	r	p	r	p	r	p
Kyphosis	–	–	0.279	0.022*	0.245	0.045*	0.045	0.718
Trunk position sense	0.279	0.022*	–	–	0.106	0.392	0.012	0.925
Musculoskeletal discomfort	0.245	0.045*	0.106	0.392	–	–	0.329	0.007*

r: Spearman Correlation Coefficient; *: P<0.05.

was found with the other parameters (p>0.05). There was also a weak positive correlation between musculoskeletal discomfort and anxiety (r=0.329, p=0.007). However, no correlation was found with other parameters (p>0.05) (Table 2).

DISCUSSION

This study aimed to investigate posture, position sense, musculoskeletal discomfort, and anxiety levels in asymptomatic individuals and to determine the relationships among these parameters. It was found that there was a very weak positive relationship between the degree of kyphosis and position sense and musculoskeletal discomfort, and a weak positive relationship between anxiety and musculoskeletal discomfort in asymptomatic individuals, while no relationship was found with other parameters.

The spine is a mechanically stable structure that withstands compressive loading through stabilizing muscular force. It is known that a decrease in the capacity of the paraspinal muscles to stabilize the spine will lead to an increase in the forward curvature of the thoracic spine.[11,28] Hyperkyphosis, or a greater than normal increase in thoracic curvature, is one of the most common disorders of the spine. Biomechanical analyses suggest that an increase in kyphosis may be associated with significantly increased spinal load and trunk muscle strength in the upright position,[29] which may increase degeneration, leading to decreased physical function and pain in the spine.[30] Studies accept that the kyphosis angle in an adult individual is between 20–40 degrees, and anything above 45 degrees is considered hyperkyphosis.[4] In our study, where we evaluated the kyphosis angle with an inclinometer, it was found that the kyphosis angles of the individuals averaged 39°, which is within normal limits. However, 14 individuals (20.89%) exhibited hyperkyphosis. Griegel-Morris et al.[31] examined the postural abnormalities of healthy individuals divided into age groups of 20–35 and 36–50 and reported that 38% of all individuals had hyperkyphosis issues, with no differences in postural abnormalities between the groups. It was also reported that although no correlation was found between the severity of postural abnormalities and the severity and frequency of pain, the incidence of pain increased in individuals with more severe postural abnormalities. Eman et al.[32] investigated the relationship between thoracic hyperkyphosis, neck pain, the range of motion of the cervical region, and functional abilities of the neck and reported that the degree of hyperkyphosis affected the severity of neck pain and decreased the extension movement of the neck. In contrast, Barret et al.[33] reported that increasing the degree of kyphosis does not adversely affect shoulder pain. Unlike other studies, our research evaluated the frequency and severity of musculoskeletal disorders in various body parts and their interference with work performance. Although the individuals included in our study do not have hyperkyphosis, we believe that musculoskeletal discomfort will occur as the degree of kyphosis increases.

The sense of position is a fundamental element of sensorimotor control, determining the ability to perceive body positions in space without visual inputs. As it plays an important role in the control of movement and posture, its deficiency or impairment reduces the ability to maintain a neutral spine posture.[11] Although it is known that postural disorders negatively affect the sense of position, it is also known that disorders in the sense of position can affect posture. In the literature, it has been investigated that hyperkyphosis, especially common in geriatric individuals, may adversely affect individuals' sense of position,[11,22] but this has not been sufficiently investigated in asymptomatic young individuals. Keshavarzia et al.[22] reported that trunk position sense can be impaired by thoracic kyphosis in geriatric individuals with hyperkyphosis. Granito et al.[11] reported that the degree of thoracic kyphosis may negatively affect the trunk position sense in geriatric individuals. In our study, which evaluated asymptomatic individuals, we think that an increase in the degree of kyphosis, albeit at a low rate, may adversely affect the afferent inputs in the trunk, disrupt the sense of position, and cause musculoskeletal disorders in individuals.

When examining the literature, although it has been investigated that a disorder in proprioceptive input leads to many problems, the effects of trunk position sense on musculoskeletal discomfort and psychological states have not been sufficiently investigated. Reddy et al.[21] reported that cervical position sense was impaired in individuals with neck pain. In our study, the frequency and severity of musculoskeletal discomfort and work performance were evaluated using the Cornell Musculoskeletal Discomfort Questionnaire. As a result, no relationship was found between trunk position sense, musculoskeletal discomfort, and anxiety. In conclusion, although problems with proprioceptive input are important in posture and movement control, we believe that multiple factors can influence musculoskeletal discomfort and anxiety.

In addition to physical disorders due to spinal problems, the psychological status of individuals is also adversely affected as cosmetic appearance may be impacted. Moslehi et al.[34] investigated the relationship between kyphosis and depression, anxiety, and aggression in male high school students and found that 126 (53.1%) out of 327 students had kyphosis problems. Gulsun et al.[35] reported that anxiety disorders were higher in male individuals with thoracic deformity compared to the healthy control group. They noted a relationship between kyphosis angle and psychological conditions such as anxiety, depression, and aggression. In contrast to these findings, Samadi et al.[36] investigated the relationship between the degree of kyphosis and psychological factors in male students and reported no relationship between the degree of kyphosis and anxiety or depression. In our study, which was similar to those conducted by Samadi et al.,[36] we did not find a relationship between degrees of kyphosis and anxiety. Considering that 20.3% of asymptomatic individuals in our study had hyperkyphosis and that anxiety is influenced by many factors, we believe that the degree of kyphosis alone does not affect anxiety. As a result of musculoskeletal discomfort, individuals may develop conditions such as muscle tension and pain. Although these symptoms are usually alleviated as recovery occurs, in some individuals, this condition can become chronic. This results in significant emotional disorders and impairment of occupational and social functioning.[37] In many studies investigating anxious and healthy individuals, it has been reported that muscle tension increases during or immediately after a mild stress situation in anxious individuals, but such a situation dissipates upon relaxation.[38,39] Based on these studies, increased muscle tension appears to be a consistent physiological finding associated with anxiety. There are also studies showing the co-occurrence of chronic pain and post-traumatic stress disorder.[39,40] Altındağ et al.[39] reported that depression symptoms increase with the duration of pain in participants with low back and neck pain. Castro et al.[40] noted that psychiatric symptoms and disorders are common in individuals with chronic pain. In our study, a positive correlation was found between musculoskeletal disorders and anxiety, aligning with the literature. Considering that musculoskeletal discomfort and anxiety mutually exacerbate each other, we think that these confounding factors should not be overlooked during evaluations.

This study has several limitations. We found a relationship between posture, position sense, and musculoskeletal discomfort, but trunk muscle strength and endurance were not analyzed. Additionally, not evaluating the physical activity levels of asymptomatic individuals and the non-homogeneous distribution of gender are further limitations of our study. Therefore, future research should include individuals with different physical activity levels, evaluate trunk muscle strength and endurance, and ensure a homogeneous gender distribution.

CONCLUSION

Although the correlation found in this study was low, it demonstrated that an increase in the degree of kyphosis in asymptomatic individuals would negatively affect the trunk position sense and musculoskeletal disorders. It was also found that musculoskeletal disorders would increase the level of anxiety. We think that multiple factors should be considered in the protection and promotion of health in asymptomatic individuals. In light of these results, it is recommended to create and implement educational programs that will increase and improve the knowledge of individuals about healthy lifestyle behaviors.

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