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RIGHT LEFT DISCRIMINATION PERFORMANCE OF BODY PARTS IN INDIVIDUALS WITH SCOLIOSIS

Skolyozlu Bireylerde Vücut Parçalarının Sağ Sol Ayrım Performansı

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ABSTRACT

This study aimed to examine the right-left discrimination of hands, feet and back in individuals with scoliosis. In the study, right-left discrimination performance was evaluated with the mobile application called Recognize, radiographic features of scoliosis were evaluated with X-ray, degree of rotation was evaluated with the mobile application called Scoliodetector, and back pain was evaluated with the Visual Analog Scale. 25 individuals with idiopathic scoliosis were included in the analysis. In the comparison made according to the thoracolumbar and lumbar curve, no difference was found between the groups in the lateralization performances (p>0.05). In the comparison according to the type of curve, no significant difference was observed in the reaction time and accuracy rate between the groups (p>0.05). When comparing the lateralization performance according to the direction of the curve, a significant difference was found between the groups in the left foot and back reaction times (p<0.05). Weak or very weak correlations were shown between Cobb and rotation angle and lateralization measurements of the back, hand and foot. It has been shown that the location and type of the curve (C or S) does not have a significant effect on lateralization performance in individuals with idiopathic scoliosis, however, the direction of the curve may affect the discrimination of right and left.

Keywords: Cobb angle, Lateralization, Reaction time, Right-left discrimination, Scoliosis.

ÖZ

Bu çalışma; skolyozlu bireylerde el, ayak ve sırtın sağ-sol ayrım performansının incelenmesi amaçladı. Çalışmada sağ-sol ayrım performansı Recognize adlı mobil uygulama, skolyozun radyografik özellikleri röntgen, rotasyon derecesi Scoliodetector adlı mobil uygulama, sırt ağrısı Visual Analog Skala ile değerlendirildi. Analize idiyopatik skolyozlu 25 kişi dahil edildi. Torakolomber ve lomber eğriye göre yapılan karşılaştırmada gruplar arasında lateralizasyon performanslarında fark bulunmadı (p>0.05). Eğri tipine göre yapılan karşılaştırmada gruplar arasında reaksiyon süresi ve doğruluk oranı açısından anlamlı bir fark gözlenmedi (p>0.05). Eğri yönüne göre lateralizasyon performansı karşılaştırıldığında sol ayak ve sırt reaksiyon sürelerinde gruplar arasında anlamlı fark bulundu (p<0.05). Cobb ve rotasyon açısı ile sırt, el ve ayağa ait lateralizasyon ölçümleri arasında zayıf ya da çok zayıf korelasyon gösterildi. İdiyopatik skolyozlu bireylerde eğriliğin yeri ve tipinin (C ya da S) lateralizasyon performansı üzerinde anlamlı bir etkisinin olmadığı ancak eğriliğin yönünün sağ-sol ayrımını etkileyebildiği gösterilmiştir.

Anahtar Kelimeler: Cobb açısı, Lateralizasyon, Reaksiyon süresi, Sağ sol ayrımı, Skolyoz.

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INTRODUCTION

Three-dimensional deformity of the spine is called scoliosis (Altaf, Gibson, Dannawi & Noordeen, 2013; Kotwicki et al., 2009). Scoliosis Research Society (SRS) examines scoliosis etiologically in two groups: structural and non-structural (functional or non-structural). 80% of scoliosis cases consist of the idiopathic form classified under structural scoliosis (Negrini et al., 2018). Despite numerous studies in the literature, the etiopathogenesis of idiopathic scoliosis has not been fully elucidated. Various views have been proposed regarding the etiology of idiopathic scoliosis, including metabolic, biomechanical, bone metabolism, central nervous system, genetic and other factors, but the exact factor or factors that cause the onset of scoliosis are not fully known (Barton & Weinstein, 2018; Cheng et al., 2015). In idiopathic scoliosis, different neuromorphological and neurophysiological anomalies related to the central nervous system are observed. Neuromorphologically; there are differences in brain volume ratios and symmetry indices in patients with idiopathic scoliosis (Joly, Rousié, Jissendi, Rousié & Frankó, 2014), there is vestibular system dysfunction and a decrease in the spinal cord / vertebral height ratio (Chu et al., 2006). Neurophysiologically, postural instability, proprioceptive dysfunction (Lao, Chow, Guo, Cheng & Holmes, 2008) visuo-oculomotor and vestibular dysfunction (Simoneau et al., 2009), and abnormal somatosensory evoked potentials have been reported (Chen, Qiu, Ma, Qian & Zhu, 2014). Right-left discrimination performance (lateralization) is an implicit motor imagery task that tests a person's ability to recognize a depicted body part as belonging to the right or left side of the body. These tasks use similar brain areas as imagined and actual movements (Schmid & Coppieters, 2012; Szameitat, Shen & Sterr, 2007). It is suggested that accurate left/right discrimination performance depends on the integrity of the representation of the body in subcortical and cortical motor and somatosensory areas (Schmid & Coppieters, 2012). In diseases characterized by cortical changes for parkinsons and hemiplegia (Helmich, de Lange, Bloem & Toni, 2007; Steenbergen, van Nimwegen & Crajé, 2007) deficits in the right-left discrimination performance task have been observed. It has been stated in the literature that some cortical changes, especially somatosensory dysfunction, are observed in patients with scoliosis (Cheng et al., 2015).

As a result, this study aimed to investigate the effect of body schema, which is disrupted due to cortical changes seen in individuals with scoliosis and abnormal alignment of the vertebralis column, on the right-left discrimination performance of hands, feet and back.

MATERIAL AND METHOD

Study design, setting

This study was designed as a single-center, cross-sectional study. Before starting the research, permission was obtained from the Inonu University Clinical Research Ethics Committee with approval code 2021/192. The study was conducted according to the principles of the Declaration of Helsinki. Informed consent was obtained from individuals over the age of 18 and from the guardians of children under the age of 18. Study data was collected between November 2021 and November 2022.

Participants

Participants were selected by non-probability random sampling method among patients with idiopathic scoliosis who applied to the orthopedics outpatient clinic of Turgut Özal Medical Center. It was planned to include a healthy control group in the study, but since a sufficient number of patients and control groups could not be reached due to the ongoing pandemic conditions, only scoliosis-specific analysis was performed. Individuals between the ages of 10 and 25 who were diagnosed with idiopathic scoliosis by an orthopedist and did not have any other joint deformities or cognitive disorders were included in the study. Exclusion criteria were severe hearing and visual impairment other than scoliosis, surgical history in the last 6 months, hand deformity, and inability to use the hand actively. Individuals who could not comply during the evaluation were excluded from the study.

Measurements

First of all, sociodemographic information (age, gender, height, weight) was obtained from all participants. Additionally, orthosis use and dominant hand information were also recorded. Pain intensity in the thoracic region was evaluated using the Visual Analog Scale. A horizontal line of 10 cm in length was used. The starting point on this line was determined as 0=no pain and 10=unbearable pain (Carlsson, 1983). If the participants had pain in the back region, they were asked to describe its severity on the line. Lateralization performance was evaluated through the application called Recognise™ developed by the Neuro Orthopedic Institute. Back, Hand, and Foot versions of this application were used on the tablet. The test was carried out with the Vanilla section in the right-left distinction section of the application. In this section, images of the back, hands, and feet were shown every 5 seconds. A total of 20 visuals were evaluated for each region. Reaction times and accuracy rates obtained from the application were recorded (Pelletier, Higgins & Bourbonnais, 2018). The degree of rotation was evaluated using the mobile application ScolioDetector. The participant was asked to lean forward and keep the body parallel to the ground. The highest point of the bump on the spine was determined and the smartphone was placed perpendicular to the spine. Degree of rotation recorded. (Bottino, Settino, Promenzio & Cannataro, 2023; Bunnell, 1986). The localization of scoliosis (thoracolumbal- lumbal curvature), direction (right-left) and type (C-S Scoliosis) of the curve were evaluated through routine radiography taken by the orthopedist. In addition, the Cobb angle was also measured by the orthopedist by measuring the angle between the vertical lines drawn between the upper part of the upper vertebra and the lower part of the lower vertebra (Whittle & Evans, 1979).

Statistical Analysis

Data analysis was carried out with Statistical Package for the Social Sciences (SPSS) version 25.0. Normality was assessed with the Shapiro-Wilk Test. Categorical data regarding gender, orthosis use and dominant hand were compared with the Chi-square test. Among descriptive statistics, mean and standard deviation were used. Independent sample t test was used to compare normally distributed data in groupings based on the localization of the curve, its type, and the direction of the gap. Analysis of data that did not show normal distribution was performed with the Mann-Whitney U test. For the relationship between rotation and Cobb angle and lateralization performance, the Pearson Correlation Test was used for normally distributed data, and Spearman correlation analysis was used for non-normally distributed data. Correlation coefficient (r); 0.00–0.20 was interpreted as fair, 0.21–0.40 as moderate, 0.41–0.60 as good, 0.61–0.80 as very good, and 0.81–1.0 as excellent. $p<0.05$ was considered statistically significant.

RESULT

A total of 27 patients were evaluated. Analysis was performed with 25 participants with idiopathic scoliosis. A total of 2 participants were not included in the analyses (n = 1, missing data; n = 1 with short limbs). In the comparison made according to the thoracolumbar and lumbar scoliosis curve, there was no difference between the groups in terms of age, BMI, gender, orthosis use and dominant hand ($p>0.05$). There was no difference between the groups in terms of pain intensity ($p = 0.806$). There were no differences in right and left accuracy rates and reaction times in terms of back, hand, and foot regions in both groups ($p>0.05$). Data on the lateralization performance of scoliosis patients with thoracolumbar and lumbar curves are included in Table 1.

Table 1. Comparison of Lateralization Performance According to the Location of the Scoliosis Curve

	Thoracolumbal Curvature (n=18)	**Lumbal Curvature (n=7)**	***p***
Age, year	15.66±2.78	14.42±1.81	0.290a
BMI, kg/m2	19.19±3.26	18.51±3.03	0.639a
Gender (F/M)	13/5	5/2	1.000b
Orthotic (Y/N)	4/14	1/6	1.000b
Dominant hand (R/L)	18/0	6/1	0.280b
Pain severity, VAS	3.27±3.15	2.32±2.50	0.806c
Back Accuracy, R	88.88±9.00	90.00±10.00	0.676c
Back Accuracy, L	87.22±10.74	87.14±9.51	0.900c
Back Response Time, R	1.58± 0.50	1.70±0.80	0.667a
Back Response Time, L	1.60± 0.49	1.60±0.52	0.981a
Hand Accuracy, R	76.11±16.49	64.28±20.70	0.147a
Hand Accuracy, L	71.11±16.04	65.71±22.25	0.505a
Hand Response Time, R	2.32±0.76	1.87±0.74	0.191a
Hand Response Time, L	1.98±0.49	2.05±0.48	0.748c
Foot Accuracy, R	87.77±13.08	80.00±25.16	0.705c
Foot Accuracy, L	88.88±11.31	81.42±28.53	0.726c
Foot Response Time, R	1.77±0.49	1.80±0.71	1.000c
Foot Response Time, L	1.86±0.53	1.77±0.46	0.855c

BMI: Body Mass Index; F: Female, M: Male; Y: Yes; N: No; R: Right, L: Left, VAS: Visual Analog Skala
[a]Independent Sample T test, [b]Chi square test, [c]Mann Whitney U test, *p<0.05

In the grouping made according to the type of curve, there was no difference between the groups in terms of BMI, gender, orthosis use and dominant hand (p>0.05), except for the age parameter (p=0.015). There was no difference in pain intensity in the C and S scoliosis groups (p = 0.658). There was no difference between the groups in terms of accuracy and reaction time of the back, hand and foot regions (p>0.05). Comparison of lateralization performance according to curve type is given in Table 2.

Table 2. Comparison of Lateralization Performance According to the Type of Scoliosis Curve

	C Scoliosis (n=13)	**S Scoliosis (n=12)**	***p***
Age, year	14.15±1.99	16.58±2,60	0.015a
BMI, kg/m2	18.67±3.35	19.35±3.02	0.599a
Gender (F/M)	8/5	10/2	0.378b
Orthotic (Y/N)	2/11	3/9	0.645b
Dominant hand (R/L)	12/1	12/0	1.000b
Pain severity, VAS	3.11±2.93	3.00±3.04	0.658c
Back Accuracy, R	89.23±7.59	89.16±10.83	0.931c
Back Accuracy, L	87.69±8.32	86.66±12.30	0.910c
Back Response Time, R	1.51±0.60	1.72±0.57	0.313c
Back Response Time, L	1.60±0.40	1.60±0.59	0.970a
Hand Accuracy, R	69.23±18.00	76.66±18.25	0.316a
Hand Accuracy, L	70.76±18.46	68.33±17.49	0.739a
Hand Response Time, R	2.04±0.95	2.36±0.50	0.302a
Hand Response Time, L	2.13±0.48	1.87±0.45	0.191a
Foot Accuracy, R	86.15±19.80	85.00±14.45	0.552c
Foot Accuracy, L	87.69±21.66	85.83±12.40	0.178c
Foot Response Time, R	1.62±0.51	1.95±0.55	0.140a
Foot Response Time, L	1.83±0.55	1.84±0.48	0.785c

BMI: Body Mass Index; F: Female, M: Male; Y: Yes; N: No; R: Right, L: Left; Visual Analog Skala
[a]Independent Sample T test, [b]Chi square test, [c]Mann Whitney U test, *p<0.05

In the comparison made according to the direction of the curve, age, BMI, gender, orthosis use, dominant hand and pain intensity were similar between the groups (p>0.05). The right and left back accuracy rates were not different between the groups (p>0.05). The right back reaction time in the group with a left-facing curve was borderline significantly higher than in the group with a right-facing curve (p=0.057). Conversely, the right reaction time was greater in the right-facing group than in the left-facing group (p=0.027). There was no difference between the groups in terms of left and right hand accuracy and reaction time (p>0.05). There was no difference between the groups in the accuracy rate of both feet and the reaction time of the right foot (p>0.05). In the group with a left curve, the left foot reaction time was significantly higher than in the group with a right curve (p=0.022). The comparison made according to the direction of the opening of the curve is given in Table 3.

Table 3. Comparison of Lateralization Performance According to the Direction of the Opening of the Curve

	Right (n=16)	**Left (n=9)**	p
Age, year	15.43±2.73	15.11±2.42	0.768[a]
BMI, kg/m^2	19.35±3.37	18.38±2.78	0.472[a]
Gender (F/M)	12/4	6/3	0.673[b]
Orthotic (Y/N)	5/11	11/9	0.123[b]
Dominant hand (R/L)	15/1	9/0	1.000[b]
Pain severity, VAS	3.03±3.01	3.11±2.93	0.818[c]
Back Accuracy, R	87.50±8.56	92.22±9.71	0.141[c]
Back Accuracy, L	86.25±10.87	88.88±9.27	0.596[c]
Back Response Time, R	1.46±0.59	1.87±0.52	0.057[a]
Back Response Time, L	1.45±0.44	0.87±0.47	**0.027[c]**
Hand Accuracy, R	73.12±17.40	72.22±20.48	0.908[a]
Hand Accuracy, L	67.50±16.53	73.33±20.00	0.437[c]
Hand Response Time, R	2.24±0.77	2.12±0.81	0.715[c]
Hand Response Time, L	1.95±0.54	2.11±0.36	0.434[a]
Foot Accuracy, R	85.62±15.90	85.55±20.06	0.813[c]
Foot Accuracy, L	86.87±16.62	86.66±20.00	0.766[c]
Foot Response Time, R	1,63±0.50	2.03±0.55	0.083[a]
Foot Response Time, L	1.66±0.37	2.14±0.59	**0.022[a]**

BMI: Body Mass Index; F: Female, M: Male; Y: Yes; N: No; R: Right, L: Left; Visual Analog Skala
[a]Independent Sample T test
[b]Chi square test
[c]Mann Whitney U test, *p<0.05

A fair positive correlation was found between Cobb angle and back accuracy rate (right) and back reaction time (left) (r=0.309; r=0.307, respectively). There was a fair positive correlation between rotation angle and back reaction time (right) and hand reaction time (right) (r=0.380; r=0.366, respectively). Apart from these, there was a poor correlation between the Cobb angle and rotation angle and the reaction time and accuracy rates of the back, hand and foot. The relationship between Cobb and rotation angle and lateralization performance is given in Table 4.

Table 4. Relationship Between Cobb and Rotation Angle and Lateralization Performance

		Cobb Angle	**Rotation Angle**
Back Accuracy, R	r	0.309	0.219
	p	0.133[b]	0.294[b]
Back Accuracy, L	r	0.121	0.138
	p	0.566[b]	0.512[b]
Back Response Time, R	r	0.141	0.380
	p	0.503[a]	0.061[b]
Back Response Time, L	r	0.307	0.148
	p	0.135[a]	0.479[b]
Hand Accuracy, R	r	0.096	0.051
	p	0.649[a]	0.810[b]
Hand Accuracy, L	r	-0.134	-0.129
	p	0.522[a]	0.540[b]
Hand Response Time, R	r	0.260	0.366
	p	0.209[a]	0.072[b]
Hand Response Time, L	r	-0.129	0.051
	p	0.540[a]	0.808[b]
Foot Accuracy, R	r	-0.076	0.034
	p	0.718[b]	0.873[b]
Foot Accuracy, L	r	0.128	0.011
	p	0.542[a]	0.958[b]
Foot Response Time, R	r	-0.035	0.125
	p	0.867[b]	0.553[b]
Foot Response Time, L	r	0.241	0.197
	p	0.245[b]	0.346[b]

R: Right, L: Left
[a]Pearson korelasyon testi
[b]Spearmen korelasyon testi

DISCUSSION

In the study investigating the effect of the body schema, which is distorted due to the cortical changes seen in individuals with scoliosis and the abnormal alignment of the vertebral column, on the right-left discrimination performance of the hands, feet and back, a comparison made according to the thoracolumbar and lumbar scoliosis curve showed similarity between the groups in the lateralization of the hands, feet and back. When the curve type (C or S) was compared, it was seen that the accuracy rate and reaction times were similar in the groups. When lateralization was compared according to the direction of the curve (right and left), differences were found between the groups in terms of left back and foot reaction time. Additionally, a weak or very weak correlation was observed between rotation and Cobb angle in lateralization measurements.

Previous studies on individuals with scoliosis have shown a positive correlation between the laterality of the curve and hand dominance. However, it has been reported that further studies are needed to confirm this situation (Yang & Li, 2011). Deviations in abdominal muscle thickness were examined while performing the active straight leg raise test at rest in children with idiopathic scoliosis, whose type of curvature was >5° relative to the Cobb angle and generally had a primary left thoracolumbar arc of curvature. It has been stated that in children with idiopathic scoliosis, the muscle thickness is smaller in the muscles on both sides (left and right) during rest. Regardless of which leg was lifted when performing the straight leg raise test, all muscles on the right side showed higher activity in children with scoliosis compared to the control group. It was stated that this is due to changes in balance and proprioception, regardless of the location and direction of scoliosis. It has been stated that it is difficult to decide what effect lateralization has in this case, that it may be due to functional asymmetry in the abdominal muscles and that further studies are needed (Linek, Saulicz, Kuszewski & Wolny, 2017). In a case-control study examining the direction and strength of lateralization in individuals with juvenile and adolescent idiopathic scoliosis, patients with scoliosis with Cobb angle ≥10° and vertebral rotation and healthy individuals were included. In the study, the area of curvature (thoracic-thoracolumbar-lumbar) of individuals with scoliosis was not specified. In the study, it was seen that the age, weight and height ratios of the patient group were higher than the control group. However, it is seen that the direction of lateralization and hand and foot preferences tend to the left in individuals with scoliosis, but this is not statistically significant. Similarly, there was weaker lateralization in the hand, leg, eye and ear lateralization strength in the scoliosis group, but it was not statistically significant (Dobies-Krześniak, Werblińska & Tarnacka, 2022). Parallelism in hand preference and cerebellar lateralization has generally been reported in patients with scoliosis with a predominant right thoracic curve pattern (Keane, 2001). In light of the information in the literature, these situations raise the question of whether the dominant side causes scoliosis or whether scoliosis determines side dominance (Arienti et al., 2019; Catanzariti et al., 2014). The individuals with scoliosis in our study appear to be generally right-dominant in the direction of the curve pattern and hand preference. In the findings of our study, when compared according to the thoracolumbar and lumbar curves, there is a similarity between the lateralization performance of the hands, feet and back regions between the groups. When looking at the studies in the literature, there are conflicting results and hypotheses (Catanzariti et al., 2014; Grivas, Vasiliadis, Polyzois & Mouzakis, 2006; Keane, 2001; Park et al., 2021). Studies in the literature and our findings considering we assume that the location of the scoliosis curve does not affect lateralization performance.

In a study involving 77 children with idiopathic scoliosis between the ages of 9-19, muscle activation was evaluated according to the curve type of scoliosis. The patients were divided into five groups: single thoracic, thoracolumbar, lumbar, double thoracic and double major curve pattern. The 7th and 12th thoracic erector spines, the 3rd lumbar erector spina and the multifidus muscles were evaluated with superficial EMG in the superman position. While

EMG amplitudes were observed to be higher on the convex side than the concave side in double major, thoracolumbar and lumbar curve patterns, similarity was reported in thoracolumbar and lumbar curve patterns (Park et al., 2021). It is stated that in individuals with idiopathic scoliosis, the primary curve is dominant during movement and the smallest movement begins at the apex where the primary curve is located. It has been reported that the changes occurring in the paravertebral muscles begin around the apex (Fernandez-Bermejo, García-Jiménez, Fernandez-Palomeque & Munuera, 1993). In the findings of our study, it was observed that there was no significant difference in reaction time and accuracy rate between groups when compared according to the type of curve. In light of the information in the literature, we think that the primary curve is dominant in the patients in our study and that their muscle activations and lateralizations show similar patterns.

Structural changes are observed in the spine with scoliosis. Loads on the upper extremities are transferred to the pelvis and then to the lower extremities. This situation plays a major role in the formation of postural disorders (Mahaudens, Banse, Mousny & Detrembleur, 2009; Mahaudens, Thonnard & Detrembleur, 2005). EMG studies have reported that asymmetries in muscle activation occur in individuals with idiopathic scoliosis (Ford, Bagnall, Clements & McFadden, 1988). Additionally, in biomechanical studies, it is seen that there is an increase in the pressure-mass centers and postural sway of patients with scoliosis (Nault et al., 2002; Sahlstrand, Ortengren & Nachemson, 1978). One study examined neuroanatomical changes in children with idiopathic scoliosis and healthy children. In the study, it was observed that the corpus callosum genus and left internal capsule white matter in children with left thoracic scoliosis were statistically weaker compared to the healthy group. It has been reported that there is no statistically significant difference in children with right thoracic scoliosis (Shi et al., 2009). 57 patients between the ages of 10 and 16 were included in a study examining posture balance in patients with adolescent idiopathic scoliosis. At the end of the study, it was reported that children with scoliosis had poorer postural control than healthy individuals, and left convex patients had quantitatively more significant reaction times than right convex patients (Sahlstrand et al., 1978). In a study including children with adolescent idiopathic scoliosis and healthy children; EEG and balance data were examined in 4 different standing positions. While no difference was observed in balance control between the two groups, higher EEG alpha power in the sensorimotor areas on the same side of the direction of the curve and a statistically significant increase in theta power over the central areas were reported in individuals with scoliosis (Formaggio et al., 2022). When comparing the lateralization according to the direction of the curve, a significant difference was found between the groups in the left foot and back reaction time. We assume that the observed differences in left back and foot reaction times in our findings may affect lateralization by neuroanatomical changes that occur depending on the direction of the scoliosis curve and compensatory mechanisms that occur.

In the study examining hand-eye laterality in patients with idiopathic scoliosis between the ages of 10-18, a total of 130 people (65 patients and 65 healthy children) with single and double curvatures (average Cobb angle 32.8°) were included. In order to examine the relationship between hand and eye laterality and gravitational force in individuals with idiopathic scoliosis, the Cobb angle in the patient group was divided into two subgroups: ≤ 30° and >30°. In the comparison of the two groups created according to the Cobb angle, it was reported that there was no difference in any parameters evaluated for laterality (Catanzariti et al., 2014). In another study examining the movement characteristics of healthy individuals and patients with idiopathic scoliosis, dynamic balance tests and Cobb angle were evaluated. Statistically significant differences were reported in left step tests when individuals with idiopathic scoliosis were compared with healthy individuals. It has also been reported that there is no statistical difference when comparing patients with different Cobb angles in individuals with idiopathic scoliosis. It was concluded that lateralization will affect dynamic balance in individuals with idiopathic scoliosis (Filipovic & Viskic-stalec, 2006). Our findings showed weak or very weak correlations between Cobb and rotation angle and lateralization measurements. Further studies are needed to clearly express the relationship between Cobb angle and lateralization. The strengths of the study are that it is the first study to evaluate lateralization in individuals with scoliosis and the use of mobile applications for evaluations. The lack of a control group and the small number of samples are among the limitations of the study.

CONCLUSION

Lateralization performance is a versatile parameter and can be affected by various factors. It has been shown that the location and type of the curve does not have a significant effect on lateralization performance in individuals with idiopathic scoliosis, however, the direction of the curve may affect the performance of right and left discrimination. Although it contributes to the literature by being the first study to evaluate lateralization performance in individuals with idiopathic scoliosis, further studies are needed to interpret the results.

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