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Evaluation of Balance and Core Endurance in Patients with Fibromyalgia Syndrome

Songul Baglan Yentur[1], Muhammet Sahin Elbasti[2], Bekir Dagdeviren[1], Derya Cetintas[2]

[1]Fırat University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Elazığ, Türkiye
[2]Elazığ Fethi Sekin City Hospital, Clinic of Physical Medicine and Rehabilitation, Elazığ, Türkiye

ABSTRACT

Introduction: This study was designed to examine disparities in core endurance and balance among patients with fibromyalgia syndrome (FMS) relative to healthy controls.

Methods: A case-control design was used, including 44 FMS patients and 44 matched controls. Assessments included the McGill tests for core endurance; the HUR BTG4 Balance Master System and the Berg Balance Scale (BBS) for balance; and the Fibromyalgia Impact Questionnaire for functional status.

Results: There were no significant demographic differences between the groups (p>0.05). However, FMS patients exhibited significantly lower scores on the BBS (p=0.017), trunk extension (p<0.001), and prone bridge tests (p<0.001) than controls. Significant impairments were observed in all static and dynamic balance parameters, including SP-COG-EO area (p<0.001) and USP-COG-EC velocity (p<0.001). A moderate negative correlation was found between the right-side bridge test and velocity during the eyes-closed balance test (r: -0.309, p=0.042).

Conclusion: Core endurance and balance are significantly impaired in patients with FMS. While individual deficits exist, the lack of strong correlation between most endurance and balance measures suggests these impairments may stem from independent pathophysiological mechanisms in FMS.

Keywords: Balance, core endurance, fibromyalgia syndrome

Introduction

Fibromyalgia syndrome (FMS) is a long-term condition of unknown origin, primarily affecting women aged 40 to 60. The exact causes and underlying mechanisms of FMS remain uncertain (1). Pain, stiffness, subjective soft-tissue swelling, fatigue, sleep disturbance, and psychiatric and cognitive disorders are among the symptoms observed in patients with FMS (2). However, balance problems are among the most frequent and disturbing symptoms in patients with FMS (3). A study of 2596 FMS patients reported that balance impairment was one of the 10 most distressing symptoms in patients' self-reported statements (4). A significant proportion of patients (45%) experience balance problems which may be attributable to multiple factors, including sensory and cognitive deficits and symptoms such as pain, poor sleep, fatigue, and muscle weakness (5,6). In a study investigating balance in FMS, 68% of 486 patients reported balance problems (7).

Balance is crucial for performing everyday tasks, such as walking, running, and climbing stairs (8). Postural problems affecting the vertebral column seen in FMS affect the spatiotemporal parameters of walking and increase the risk of falls (9). The core is a musculoskeletal structure conceptualized as a cylinder (10). Studies demonstrated that core stabilization training improved static and dynamic balance (11,12). In addition, balance training should also include core stabilization exercises as it improves body awareness and acts as a muscular corset that stabilizes the trunk with or without limb movement (13). Generally, the purpose of the core muscles is to stabilize the spine during functional movements while the body seeks to maximize balance. It has been claimed that improving core stability will increase dynamic stability. The body's ability to maintain dynamic stability requires neuromuscular control of all segments, including both proximal and distal joints. The body's core responds to disturbances in dynamic stability by utilizing the core musculature and transferring forces through the trunk (14). To the best of our knowledge, research specifically assessing core stability in individuals with FMS is extremely limited. The primary contribution of this study is its comprehensive approach: it is the first to evaluate both static and dynamic core endurance alongside objective balance metrics measured using the HUR BTG4 Balance Master System. By using an

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Address for Correspondence: Assoc. Prof., Songül Bağlan Yentür, MD, Fırat University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Elazığ, Türkiye
E-mail: songulbaglan23@hotmail.com **ORCID ID:** orcid.org/0000-0001-9394-4817
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objective platform to measure sway area, length, and velocity, this study fills a critical gap in the literature by examining the direct relationship between trunk stabilization and balance impairments in FMS. This objective data is vital for determining whether core endurance is a primary driver of balance dysfunction or other sensory-cognitive factors play a dominant role, thereby guiding more targeted rehabilitation interventions.

While previous research has explored the connection between balance issues and core stability, there appears to be a lack of studies specifically assessing core stability in individuals with FMS, to the best of the authors' knowledge. The main objective of this study was to examine and compare core stability and balance in FMS patients and healthy individuals. A secondary goal was to explore the potential relationship between core stability and balance impairments in individuals with FMS.

Methods

This study enrolled 44 patients diagnosed with FMS from the outpatient clinic of Elazığ Fethi Sekin City Hospital and 44 age- and sex-matched healthy volunteers. The sample size was determined a priori using G*Power software (version 3.1.9.4). Based on the effect size (d: 0.60) derived from the mean difference in eyes closed-center of gravity (EC-COG) velocity scores reported by Tas et al. (15), a power analysis with α: 0.05 and power (1-β): 0.80 indicated that were required to detect an effect size of d: 0.60. The study protocol received approval from the Fırat University Non-Interventional Clinical Research Ethics Committee (decision number: 2022/11-24, date: 06.10.2022), and written informed consent was obtained from all participants prior to their inclusion. Inclusion criteria encompassed individuals who were aged between 18 and 65, who met the clinical diagnostic criteria for FMS, who had been on a stable medication regimen for at least three months, and who were able to follow complex motor instructions required for the assessments. Exclusion criteria included severe spinal stenosis, concurrent systemic inflammatory rheumatic conditions, pregnancy, cancer, active infections, surgical procedures within the past three months, or any physical limitations that could interfere with the administration of core endurance assessments.

Outcome Measurements

The demographic details of participants—including age, height, weight, occupation, medication use, and smoking status—were collected at the outset. To assess core endurance, both static and dynamic tests were administered. Static core endurance was evaluated using the side bridge, trunk flexion, trunk extension, and prone bridge tests. To assess dynamic core endurance, participants performed modified push-up and sit-up tests. Functional capacity in individuals with fibromyalgia was measured using the Fibromyalgia Impact Questionnaire (FIQ). Balance, both static and dynamic, was assessed using the HUR BTG4 Balance Master System and the Berg Balance Scale (BBS).

McGill Core Endurance Tests

Prior to actual testing, participants performed a single familiarization trial for each McGill test to ensure correct technique. Each assessment were performed once to prevent fatigue. The test completion criterion (end-point) was defined as the moment when the participant could no longer maintain the required isometric position or when they deviated from the neutral spinal alignment despite verbal cues.

Side-bridge test: Participants were asked to lift their hips off the floor in a side-lying position, supported on the elbow and forearm. After the patients positioned their whole bodies in a straight line, supported on their feet and elbows, timing began with a stopwatch. The time maintained for the right and left sides was recorded as a score (16).

Trunk flexion test: Participants were asked to position the upper trunk at 60º flexion, with the hips and knees at 90º flexion. The duration for which patients could maintain this angle while standing was recorded (16).

Trunk extension test: Participants were asked to lie prone with the upper part of the iliac crest positioned beyond the edge of the bed, with their hips and knees fully extended. The time that the horizontal position with their arms in the inverted-T position was maintained was measured with a stopwatch and recorded (16).

Prone bridge test: Participants were asked to support themselves on their elbows and toes while lying prone and to maintain a horizontal position on the floor. The duration for which the position was maintained was recorded (16).

Modified push-ups test: Participants were asked to assume the prone position, cross their feet, and place their hands on an exercise mat. They were then asked to lift their trunk by extending their elbows, without disturbing the straight alignment of the trunk and hips. The number of repetitions performed within 30 seconds was recorded as a score (16).

Sit-ups test: Participants were asked to place their hands at the sides of their heads and perform trunk flexion while in the supine position with their knees at 90° of flexion. The number of repetitions performed within 30 seconds was recorded as a score (16).

Balance Assessments

Balance was assessed using the HUR BTG4 Balance Master System® (HUR International, Finland) on both stable and unstable platforms, as well as the BBS. The system utilizes HUR Smart Balance Software, which is specifically developed for balance evaluation and training purposes. Before each assessment, the stability of both platform types was confirmed. Data were recorded at a sampling rate of 100 Hz and then filtered. The primary focus of this study was the 95% confidence ellipse area of the center of pressure for analyzing balance. This equipment is particularly useful for evaluating postural control and developing individualized rehabilitation strategies (Figure 1) (17).

Before starting the assessment, participants stood still for at least five seconds. They then stood upright with their arms relaxed at their sides. Measurements were obtained under two visual conditions—eyes open (EO) and EC, the latter eliminating visual input, and on a foam surface to reduce proprioceptive feedback, allowing the evaluation of static balance. Body sway was analyzed to assess the contributions of the visual, vestibular, and proprioceptive sensory systems (see Figures 2-4). During testing, participants stood barefoot on the platform with their heels positioned 2 cm apart and

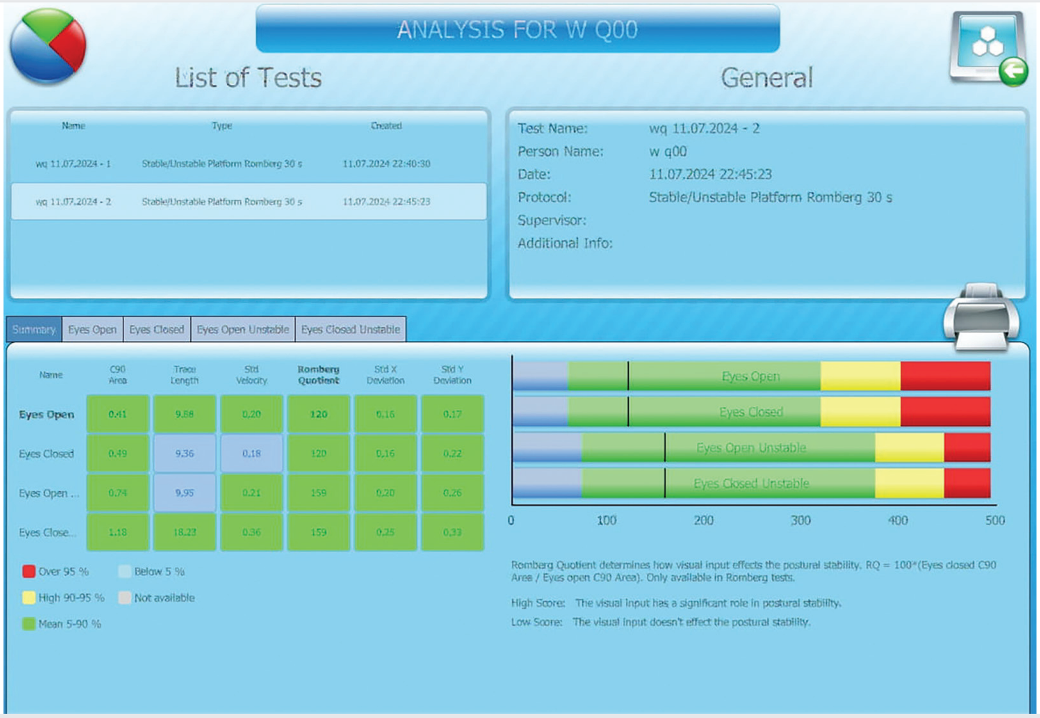

Figure 1. Balance assessments on stable an unstable platforms

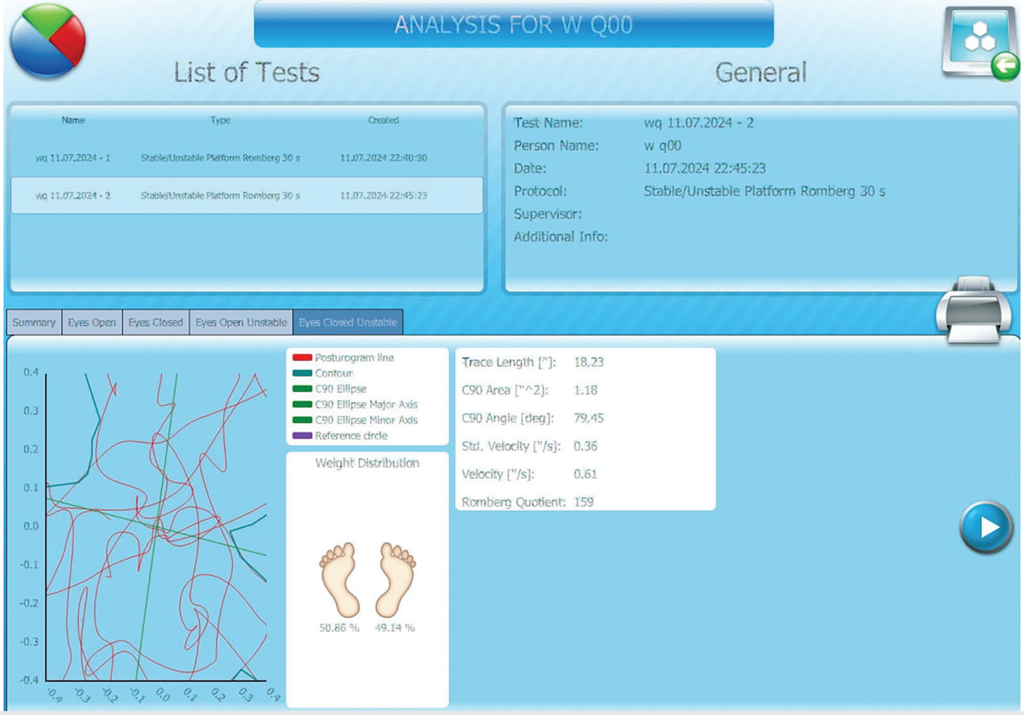

Figure 2. Eyes closed balance evaluation on stable platform

arms at their sides for 30 seconds. Each test was followed by a 60-second rest period. This protocol examines proprioceptive function, recognizing that when proprioception is impaired, balance relies more heavily on the visual and vestibular systems. However, in cases of proprioceptive dysfunction, closing the eyes disrupts this compensatory process, resulting in balance difficulties.

To assess dynamic balance, participants experienced controlled perturbations from the right, left, and horizontal directions, with peak accelerations reaching 9.6 m/s². Each individual's leaning angle was determined by considering their height and the shift in their COG from a neutral stance. The evaluation involved asking participants to lean forward, backward, to the right, and to the left to assess their balance responses.

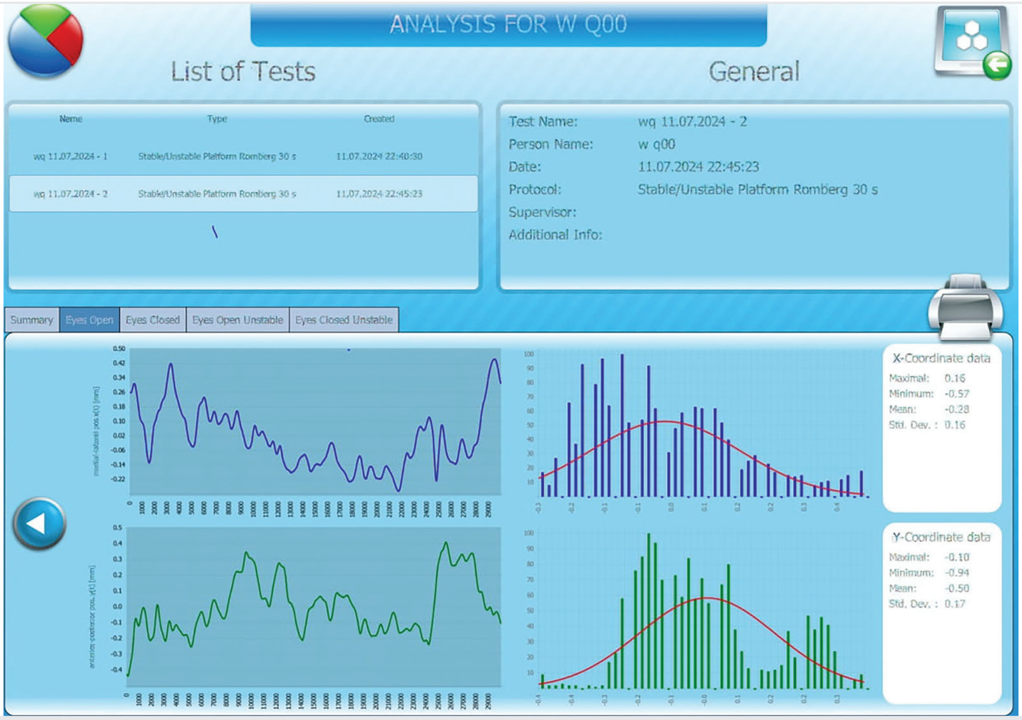

Figure 3. Balance assessments with eyes open positions on stable platform

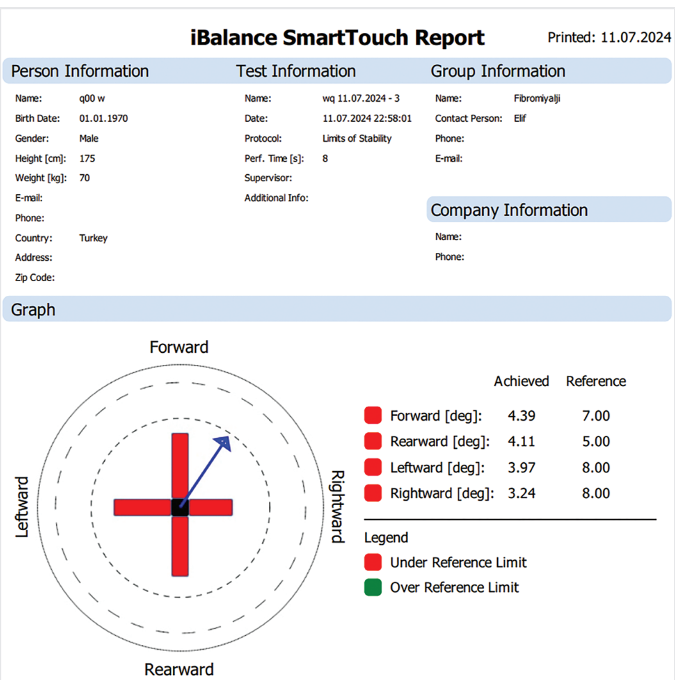

Figure 4. Dynamic balance assessment

Berg Balance Scale

Balance was assessed using the BBS. The BBS is a reliable and precise tool designed to evaluate balance. It comprises 14 tasks that assess an individual's capacity to maintain stability during various movements and postural shifts. Each task is designed to assess how well an individual can complete it independently and within a specified time or over a specified distance. Scores for each item range from 0 to 4 points (18).

Functional Evaluation

Patient function was evaluated using the FIQ. The total FIQ score is derived from the sum of its ten items. Item one assesses daily activities using a Likert scale anchored at 0 ("always able to do") and 3 ("never able to do") (19).

Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 22.0. Descriptive statistics were presented as frequencies, percentages, medians, and interquartile ranges. The normality of continuous data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For data that were not normally distributed, the nonparametric Mann-Whitney U test was applied. Categorical variables were compared between groups using the Pearson chi-square test. Correlations were examined using the Spearman correlation coefficient. Statistical significance was set at $p<0.05$.

Results

This study compared 44 patients with FMS to 44 age- and sex-matched healthy controls. The groups were statistically similar in their sociodemographic profiles (Table 1).

Significant differences were observed in several measures. The FMS group demonstrated markedly lower performance on the BBS ($p=0.017$) and specific static core endurance tests, including trunk extension ($p<0.001$) and the prone bridge ($p<0.001$) (Table 2). Furthermore, both static and dynamic balance metrics (e.g., SP-COG-EC area, $p<0.001$; USP-COG-EC velocity, $p<0.001$) were significantly impaired in the patient group compared to controls (Table 3). However, not all tests showed

Table 1. Demographics and characteristics of FMS patients and healthy controls

Parameters [median (IQR: 25/75)]		FMS group (n=44)	Healthy controls (n=44)	p
Age/year		45.00 [43.25; 51.00]	45.00 [39.25; 51.00]	0.538
Weight/kg		70.00 [63.00; 74.75]	72,00 [65.00; 77.00]	0.448
Height/cm		160.00 [160.00; 163.00]	160.50 [154.25; 165.00]	0.285
BMI/kg/cm^2		27.34 [24.40; 27.82]	26.99 [25.42; 31.20]	0.324
Disease duration/year		2.00 [2.00; 4.00]		
FIQ		66.44 [62.05; 74.86]		
Medication (%)	Myorelaxan	6 (50%)	1 (25%)	0.313
	HT	3 (25%)	1 (25%)	
	Diabetes	2 (16.7%)	0 (0%)	
	Antidepressant	1 (8.3%)	1 (25%)	
	Goiter	0 (0%)	1 (25%)	
Smoking (%)	Yes	14 (31.8%)	10 (22.7%)	0.338
	No	30 (68.2%)	34 (77.3%)	
Occupation (%)	Yes	12 (27.3%)	13 (29.5%)	0.813
	No	32 (72.7%)	31 (70.5%)	

IQR: Interquartile range, FMS: Fibromyalgia syndrome, BMI: Body mass index, FIQ: Fibromyalgia Impact Questionnaire, HT: Hypertension

Table 2. Comparison of BBS and core endurance tests between FMS group and healthy controls

Parameters [median (IQR: 25/75)]	FMS group (n=44)	Healthy controls (n=44)	p
BBS	48.00 [48.00; 49.75]	51.50 [46.25; 55.00]	**0.017**
Side bridge test-R	6.64 [3.25; 9.75]	8.00 [4.00; 10.00]	0.366
Side bridge test-L	6.09 [3.00; 8.50]	6.85 [3.25; 10.00]	0.402
Trunk flexion test	11.37 [3.00; 17.75]	14.00 [10.25; 16.00]	0.137
Trunk extension test	8.38 [5.25; 9.75]	16.00 [11.50; 19.75]	**<0.001**
Prone bridge test	6.37 [4.00; 7.00]	13.00 [9.25; 18.00]	**<0.001**
Push-ups test	6.00 [5.00; 8.46]	7.00 [5.00; 8.00]	0.956
Sit-ups test	7.00 [3.50; 8.85]	8.00 [6.00; 9.00]	0.339

IQR: Interquartile range, FMS: Fibromyalgia syndrome, BBS: Berg Balance Scale, R: Right, L: Left

differences; performance on dynamic core endurance tests and certain static tests (side bridge and trunk flexion) was comparable between the groups (Table 2).

Within the FMS group, correlation analyses revealed specific relationships. A moderate inverse correlation was found between performance on the right-side bridge test and velocity during the eyes-closed balance test on a stable platform(r: -0.309, p=0.042) (Table 4). Positive correlations were identified between the BBS and two parameters of EC balance on an unstable platform: sway area (r: 0.328, p=0.030)and sway length (r: 0.329, p=0.029) (Table 5).

Discussion

This study aimed to compare core endurance and balance between individuals with FMS and a healthy control group. A secondary objective was to examine the relationship between core endurance and balance in those with FMS. The findings revealed that self-perceived balance differed significantly between FMS patients and healthy controls matched for age and gender. Additionally, the trunk extension and prone bridge assessments showed notable differences in static core endurance. Significant group differences were also identified in balance tests conducted with EO and with EC on both stable and unstable surfaces using the HUR BTG4 Balance Master System® (HUR International, Finland). Analysis of the association between core endurance and balance parameters revealed a significant correlation between the eyes-closed velocity test and the right-side bridge test, performed on a stable surface. When the relationship between balance tests performed on an unstable surface and core endurance tests was evaluated, a relationship was observed between the self-reported balance measurement and the EC area and EC length measurements. It was concluded that FMS patients had impaired balance and performed worse on some static core endurance tests than an age- and gender-matched healthy control group.

Many studies have concluded that FMS patients have impaired balance. It was observed at a frequency between 45% and 68% and reported to be among the ten most challenging symptoms. Balance impairment in FMS patients may also increase the risk of falls (20). The incidence of falls has been reported as 1.75 per 6-month period (9). Falls are associated with postural instability, balance, and executive function and processing speed (21). Collado-Mateo et al. (9) found that FMS may cause fear of falling, balance problems, an increased number of falls.

Table 3. Comparison of static and dynamic balance tests between FMS group and healthy controls

Parameters [Median (IQR: 25/75)]	FMS Group (n=44)	Healthy controls (n=44)	p
SP-COG-EO-area	0.41 [0.27; 0.41]	0.19 [0.12; 0.26]	**<0.001**
SP-COG-EO-length	13.34 [7.64; 13.53]	7.05 [5.85; 7.76]	**<0.001**
SP-COG-EO-velocity	0.19 [0.14; 0.19]	0.15 [0.13; 0.16]	**0.004**
SP-COG-EC-area	0.96 [0.37; 0.96]	0.23 [0.12; 0.35]	**<0.001**
SP-COG-EC-length	13.53 [13.07; 14.71]	9.29 [7.24; 11.08]	**<0.001**
SP-COG-EC-velocity	0.30 [0.25; 0.30]	0.20 [0.17; 0.26]	**<0.001**
USP-COG-EO-area	0.66 [0.48; 0.66]	0.42 [0.24; 0.62]	**0.003**
USP-COG-EO-length	11.48 [10.19; 11.48]	10.13 [7.90; 10.80]	**0.003**
USP-COG-EO-velocity	0.27 [0.24; 0.27]	0.23 [0.17; 0.25]	**0.007**
USP-COG-EC-area	1.31 [0.77; 1.31]	0.67 [0.33; 0.85]	**<0.001**
USP-COG-EC-length	22.35 [17.48; 22.35]	14.85 [10.66; 16.35]	**<0.001**
USP-COG-EC-velocity	0.82 [0.42; 0.82]	0.30 [0.22; 0.38]	**<0.001**
Forward	2.63 [1.80; 3.80]	3.64 [2.69; 4.49]	**0.009**
Backward	2.86 [2.53; 3.10]	4.48 [3.64; 5.02]	**<0.001**
Left	2.99 [2.89; 3.34]	4.25 [3.45; 4.89]	**<0.001**
Right	2.84 [2.45; 3.45]	4.85 [3.86; 5.84]	**<0.001**

FMS: Fibromyalgia syndrome, IQR: Interquartile range, SP: Stable platform, COG: Center of gravity, EO: Eyes open, EC: Eyes closed, USP: Unstable platform

Table 4. Correlations between static balance measurements and core endurance tests and BBS in FMS group

Parameters		BBS	FIQ	Side bridge test-R	Side bridge test-L	Trunk flexion test	Trunk extansion test	Prone bridge test	Push-ups test	Sit-ups test
BBS	r	1	-0.263	0.255	0.112	-0.051	0.148	0.231	-0.182	-0.188
	p		0.085	0.095	0.470	0.743	0.339	0.131	0.237	0.223
SP-COG-EO-area	r	0.060	-0.002	-0.184	-0.166	-0.094	0.126	-0.121	-0.124	-0.003
	p	0.700	0.992	0.232	0.281	0.544	0.416	0.433	0.424	0.986
SP-COG-EO-length	r	0.258	-0.025	-0.072	0.034	-0.168	0.284	0.076	0.023	-0.047
	p	0.090	0.874	0.641	0.826	0.276	0.062	0.622	0.881	0.761
SP-COG-EO-velocity	r	0.221	-0.063	-0.218	-0.151	-0.237	-0.070	-0.112	0.010	-0.130
	p	0.149	0.686	0.156	0.328	0.122	0.652	0.468	0.947	0.401
SP-COG-EC-area	r	0.018	-0.040	-0.058	0.016	-0.088	-0.011	-0.007	0.020	0.220
	p	0.908	0.796	0.709	0.918	0.570	0.942	0.963	0.193	0.151
SP-COG-EC-length	r	0.034	0.082	-0.276	-0.203	-0.225	-0.230	-0.279	0.028	-0.006
	p	0.827	0.595	0.070	0.185	0.142	0.133	0.067	0.856	0.970
SP-COG-EC-velocity	r	0.039	-0.014	-0.309	-0.225	-0.236	-0.119	-0.216	0.005	-0.020
	p	0.804	0.926	**0.042**	0.141	0.124	0.441	0.158	0.974	0.897

FMS: Fibromyalgia syndrome, BBS: Berg Balance Scale, COG: Center of gravity, SP: Stable platform, EO: Eyes open, EC: Eyes closed, FIQ: Fibromyalgia Impact Questionnaire, R: Right, L: Left

It has also been argued that balance problems may be associated with fear of falling (9). Cognitive functions are known to be affected in patients with FMS. Increased cognitive problems may elevate the risk of balance impairment and falls (22). In our study, we evaluated the balance of patients with FMS on both stable and unstable surfaces and found significant differences compared with healthy controls. Evaluating balance using the HUR BTG4 Balance Master System allowed us to obtain more objective results. Visual, vestibular, and proprioceptive sensations were also evaluated using this test. Area, length, and velocity measurements were evaluated on stable and unstable platforms with EO and EC. Across all evaluated parameters, patients had higher values than healthy subjects, suggesting greater oscillation to maintain balance and, therefore, poorer postural control. In addition, we found a significant difference on the BBS, which is a performance-based measure of balance administered by an examiner. Consistent with the literature, these results demonstrate that patients with FMS may have impaired balance. Tas et al. (15) evaluated balance in patients with FMS and in healthy controls using the same device; however, unlike our study, they did not find significant differences across many balance parameters. The same study found a significant difference in BBS scores between patients with FMS and healthy controls, which is similar to our findings.

Table 5. Correlations between dynamic balance measurements and core endurance tests and BBS in FMS group

Parameters		BBS	FIQ	Side bridge test-R	Side bridge test-L	Trunk flexion test	Trunk extansion test	Prone bridge test	Push-ups test	Sit-ups test
USP-COG-EO-area	r	-0.224	0.151	-0.195	-0.121	-0.016	0.175	-0.041	0.051	0.183
	p	0.143	0.328	0.205	0.435	0.918	0.255	0.791	0.743	0.235
USP-COG-EO-length	r	-0.075	0.017	-0.002	-0.003	0.115	0.185	0.034	0.079	0.064
	p	0.630	0.913	0.991	0.982	0.459	0.229	0.827	0.610	0.682
USP-COG-EO-velocity	r	0.003	-0.137	0.034	0.019	0.085	0.250	0.023	0.033	-0.060
	p	0.983	0.376	0.827	0.902	0.583	0.102	0.883	0.833	0.698
USP-COG-EC-area	r	0.328*	-0.244	-0.005	0.059	-0.064	0.070	0.055	0.067	0.019
	p	**0.030**	0.110	0.974	0.703	0.680	0.652	0.722	0.665	0.905
USP-COG-EC-length	r	0.329*	-0.272	0.018	0.074	-0.074	0.057	0.013	0.113	-0.091
	p	**0.029**	0.074	0.906	0.634	0.635	0.713	0.935	0.466	0.555
USP-COG-EC-velocity	r	0.091	-0.144	-0.032	0.091	-0.133	0.186	0.110	0.104	-0.032
	p	0.559	0.350	0.837	0.555	0.388	0.227	0.478	0.502	0.834

FMS: Fibromyalgia syndrome, BBS: Berg Balance Scale, COG: Center of gravity, USP: Unstable platform, EO: Eyes open, EC: Eyes closed, R: Right, L: Left

In this study, dynamic and static core endurance tests were performed on patients with FMS. The results of the study showed a significant difference between FMS patients and healthy controls in the prone bridge test and the trunk extension test. Although no significant difference was obtained, dynamic and static core endurance test scores were lower in patients. This indicated that core endurance was lower in patients with FMS than in healthy controls. In this study, symptoms such as pain, exercise intolerance, and decreased functional capacity in patients with FMS may cause a decrease in core endurance. Increased pain during activity can lead to pain-induced reflex inhibition of muscles, limiting the duration for which a patient can sustain a muscle contraction. Our study assessed muscle endurance by requiring participants to sustain a muscle contraction for an extended period (20). Therefore, the decreased performance observed on extensor and side-bridge endurance tests among FMS patients may be related to impaired muscle microcirculation during both static and dynamic activities. Previous research has suggested that reduced aerobic endurance in individuals with fibromyalgia may result from reduced blood flow and impaired oxygen delivery to muscle tissue. These changes may be associated with atrophy of type-II muscle fibers and increased mitochondrial content in type-I fibers, leading to disrupted oxidative metabolism and reduced ATP synthesis, both of which manifest as muscle weakness and fatigue (23). Additionally, in FM muscles, the combination of decreased phosphorylation potential, low oxidative capacity, and an inefficient work-to-energy-cost ratio may lead to a noticeable decline in endurance (23). This may be the mechanism by which core endurance was lower in patients with FMS than in healthy controls in our study. Studies that evaluate all symptoms are needed to determine the cause of decreased core endurance. This study focused on core endurance and balance in patients with FMS and healthy controls. Significant differences in trunk extension and prone-bridge tests were found in our study. High levels of fatigue are observed in the multifidus muscle during the trunk extension test. This is because the multifidus muscle is overactive. The flexed posture seen in patients with FMS may have led to a greater weakening of the back muscles. More detailed investigations can be conducted to yield clearer results. To the authors' knowledge, only one study has evaluated core endurance in FMS patients: Sindwani and Kaur (24). However, balance and its relationship with core endurance were not evaluated in their study. In addition, static core endurance tests were evaluated in their study, whereas dynamic core endurance tests were not. However, similar to our study, it was concluded that core endurance test scores were lower than those of healthy controls.

The relationship between dynamic and static core endurance tests and balance tests on stable and unstable platforms was investigated in this study. On the stable surface, the eyes-closed velocity test and the right side-bridge test showed a moderately significant negative relationship, but no significant relationships were found among the other parameters. This result is surprising. It was concluded that core endurance did not seem to be among the causes of impaired balance in FMS patients, whose core endurance tests and balance were found to be worse than those of the healthy control group. More patients and more detailed studies are needed. Similarly, no significant relationship was found between core endurance and balance in female athletes (25). Gordon et al. (26) also did not find a significant relationship between balance and core endurance in their study of lacrosse players. In both studies, balance was evaluated with the Star Excursion Balance Test. However, a weak relationship was found between core endurance and balance in dancers. The reason was attributed to a possibly greater proportion of type II fibers in dancers (27). More research is needed to clarify the relationship between core endurance and balance in patients with FMS.

The functional status of patients with FMS was evaluated using the FIQ in this study. Based on the evaluation results, no significant relationship was observed between FIQ and the balance and core endurance tests. Although this study concluded that patients who participated in our study had balance impairment, it was predicted that the impairment was not at a level that would affect independence in daily life.

Study Limitations

Our study had some limitations. That we did not evaluate pain and activities of daily living is a limitation. However, functional assessment was performed, including pain, blood parameters, vitamin levels, and activities of daily living. Nevertheless, different results can be obtained with a more detailed evaluation. Secondly, our study included only women and did not include men, which is a limitation. Third, we did not evaluate the fall frequency or fear of falling among the patients who participated in the study. If future studies are designed to include these parameters, more comprehensive results can be obtained.

Conclusion

In conclusion, this study aimed to compare core endurance and balance between individuals with FMS and healthy controls, as well as to explore the potential relationship between these two factors. The findings indicated that patients with FMS exhibited both balance impairments and reduced core endurance relative to the control group, consistent with existing literature. However, no significant correlation was observed between core endurance and balance. This research is noteworthy as it represents the first attempt to specifically investigate the connection between core endurance and balance in FMS patients. Further research is recommended to explore this relationship in greater depth and to emphasize the role of balance and core stability exercises in managing FMS.

Ethics

Ethics Committee Approval: The study protocol received approval from the Fırat University Non-Interventional Clinical Research Ethics Committee (decision number: 2022/11-24, date: 06.10.2022).

Informed Consent: The written informed consent was obtained from all participants prior to their inclusion.

Footnotes

Authorship Contributions: Concept - S.B.Y.; Design - S.B.Y.; Data Collection or Processing - B.D., D.Ç.; Analysis or Interpretation - S.B.Y., M.Ş.E., B.D., D.Ç.; Literature Search - S.B.Y., M.Ş.E., B.D., D.Ç.; Writing - S.B.Y., M.Ş.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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