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Comparison of the effects of core stabilization exercises on muscle strength and balance in women and men

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ABSTRACT

The aim of this study was to investigate the effects of core stabilization exercises on balance and core muscle strength in healthy male and female individuals and to determine whether these effects differ by gender. The study was conducted at the Physiotherapy and Rehabilitation Laboratory of Istanbul Yeni Yüzyıl University. Thirty university students, aged between 18 and 30, voluntarily participated in the study. The participants were divided into two groups: 15 women and 15 men. The static balance of the participants was measured using the Flamingo Balance Test, and their dynamic balance was assessed using the Y-Balance Test. The core muscle strength evaluations were performed using the "Core Muscle Strength and Stability" test, which consists of 9 stages. Both groups were provided with a 6-week core stabilization exercise program, which was applied three days a week. At the end of the study, the final test results of the women and men were compared to examine the effects of core stabilization exercises, which were applied for the same duration and intensity, on balance and muscle strength. The results showed significant differences in the static and dynamic balance measurements in women ($p<0.05$), while no such difference was observed in men ($p>0.05$). No significant difference in muscle strength tests was found between women and men ($p>0.05$). It is important to consider gender-specific differences in the planning and implementation of core stabilization programs.

KEYWORDS

Exercise; Static Balance; Dynamic Balance; Core Stabilization; Muscle Strength

1. INTRODUCTION

The core region is characterized as the region that is described as the weight point of the body and covers the middle part of the human body (Gür, 2015). The core region consists of vertebrae, pelvis region, abdominal regions, proximal lower and upper extremities. It also provides stability in the vertebrae (Barr et al., 2005). In order to increase efficiency for athletes, to increase the strength and endurance levels of the core muscles, the muscles in the core region should be known and taken into consideration. These muscles are transverse abdominis, external obliques, internal obliques, latissimus dorsi, erector spinae, rectus abdominis, and quadratus lumborum (Axel, 2013).

The purpose of core stabilization is to prevent overloading of the pelvis, vertebrae and kinetic chain. With the healthy functioning of this system, the loads on the body of the person are distributed in an even pattern and the kinetic chain minimizes the excessive load on the joints (Barr et al., 2005). The core stabilization segment is accepted as the motor and power point of all body limb movements because it is the center of central stabilization and power transfer in body movements (Willardson, 2007)

Core strengthening and stabilization exercises have gained importance in recent years and have taken their place in athlete training and rehabilitation exercises (Chan et al., 2017). For athletes, it generally deals with the development of the abdominal muscles and core area, while applications for rehabilitation are generally used for spinal stabilization and treatment of chronic low back pain (Günay et al., 2019). However, the core and the balance factor are interconnected. The strength of an athlete's core is an important indicator in determining the level of balance. The balance factor is handled under two different concepts, static and dynamic. Static balance is characterized as maintaining the balance of the organism in a determined position, while dynamic balance refers to the ability to maintain and maintain the balance of the body while moving (Tan & Çolak, 2021).

When looking at the content of core exercises, it is possible to exercise with the athlete's own body weight, as well as exercise with various balance tools (Dilber et al., 2016). Static and dynamic stretching exercises have a positive contribution to the speed, strength and flexibility of the body (Akyüz et al., 2017).

Strength is generally referred to as the output created by muscle strength and refers to the resistance created by the human body. Although there are many exercise programs to ensure strength development, we can state that core training exercises are widely used today (Miyaç & Göktepe, 2023). The aim of this study is to investigate the effects of core stabilization exercises on balance and

core muscle strength in healthy male and female individuals, and to test whether these effects differ based on gender.

2. METHODS

2.1. Participants

This research was conducted with 15 female and 15 male university students between the ages of 18-30. The application period of the research was limited to a 6-week period and the measurements were carried out in the Physiotherapy and Rehabilitation laboratory of T.C. Istanbul Yeni Yüzyıl University. The group participating in the study was included in the study by filling out the "Informed Voluntary Consent Form".

2.2. Instruments and Procedures

Participants' ages were determined based on their Republic of Turkey identity cards. Anthropometric characteristics were measured too: body weight (kg), height (cm) and body mass index. Flamingo Balance Test was used to measure the static balance abilities of the subject group (Tan & Çolak, 2021). The Y Balance Test was used to measure the dynamic balance ability of individuals (Chimera et al., 2015). Regarding the assessment of trunk muscle strength, the core strength and stability of the subject group were measured with the Core Muscle Strength and Stability test developed by MacKenzie (2005); this test consists of 9 stages (Günaydın & Eliöz, 2020).

With regard to the exercise program, the exercise practices were organized as 2 sets of 20 repetitions, 3 days a week. The following exercises were performed: abdominal corsetry, including heel strikes, leg lift rotation, bridging position, standing posture, and walking; quadratus lumborum and obliques through side plank with knees extended; and paraspinals and multifidi through four-point contact arm and leg lifts.

Warm-up exercises were performed before the measurements, followed by cool-down exercises. In addition, the pre- and post-test measurements were performed in the same time periods.

2.3. Data Analyses

The statistical analyses of the study were performed using SPSS IBM software, version 25. Descriptive statistics, frequency (f), percentage (%), mean ($\bar{X}$), standard deviation (SD), and minimum and maximum expressions were presented in the analysis. Whether the variables were normally distributed or not was examined with the Kolmogorov-Smirnov test and parametric tests

were preferred. For normally distributed variables, independent sample t-test was used for comparisons between two groups, and paired sample t-test was used for pre and post-test comparisons of subject groups.

3. RESULTS

In the demographic findings of the study, it was determined that half of the participants, who were between the ages of 19-25 years with an average age of 22.20 (years), were female, 96.7% were bachelor's degree graduates and all of the subject group were single. It is seen that 76.7% of the participants are not working, 70.0% do not smoke, 66.7% do not drink alcohol, 83.3% do not have chronic diseases, 70.0% do not exercise, 73.3% are normal weight, 20.7% are overweight and 6.7% are underweight. Table 1 shows the independent samples t-test results for differences in core muscle strength and stability between groups at pretest.

Table 1. Pretest differences in core muscle strength and stability between groups

Measurement	Group	N	X̄	SD	t	p
Core muscle strength and stability	Male	15	.27	.46	.894	.379
	Female	15	.13	.35		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

There was no significant difference between core muscle strength and stability pretest mean scores of male participants and core muscle strength and stability pretest mean scores of female participants (p>0.05) (Table 1). In the following, table 2 presents the independent samples t-test results for differences in flamingo test subcomponents between pretest and posttest in male participants.

Table 2. Independent samples t-test results for differences in flamingo test subcomponents between pretest and posttest in male participants

Measurement	Male Group	N	X̄	SD	t	p
Flamingo test Right lower ext.	Pre-test	15	11.93	1.79	1.293	.217
	Final test	15	11.67	1.80		
Flamingo test Left lower ext.	Pre-test	15	12.40	1.80	1.417	.178
	Final test	15	11.87	1.46		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

When table 2 was analyzed, it was found that there was no significant difference between the Flamingo Test right lower extremity pre-test mean scores and Flamingo Test right lower extremity post-test mean scores of male participants (p>0.05).

It was determined that there was no significant difference between the Flamingo Test left lower extremity pre-test mean scores and Flamingo Test left lower extremity post-test mean scores of male participants (p>0.05). Below, table 3 presents the independent samples t-test results for differences in flamingo test subcomponents between pretest and posttest in female participants.

Table 3. Independent samples t-test results for differences in flamingo test subcomponents between pretest and posttest in female participants

Measurement	Female Group	N	X̄	SD	t	p
Flamingo test Right lower ext.	Pre-test	15	11.67	1.40	7.643	.000*
	Final test	15	10.20	1.52		
Flamingo test Left lower ext.	Pre-test	15	12.07	1.53	6.205	.000*
	Final test	15	10.60	1.59		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

When table 3 was examined, it was determined that there was a significant difference of 10.20 between the Flamingo Test right lower extremity pre-test mean scores of 11.67 and the Flamingo Test right lower extremity post-test mean scores of the female participants and that this difference was in favor of the Flamingo Test right lower extremity post-test (p<0.05).

It was determined that there was a significant difference between the Flamingo Test left lower extremity pre-test mean scores of 12.07 and the Flamingo Test left lower extremity post-test mean scores of 10.60 and that this difference was in favor of the Flamingo Test left lower extremity post-test (p<0.05). Table 4 presents the independent samples t-test results for differences in pretest and posttest core muscle strength and stability in male participants.

Table 4. Independent samples t-test results for differences in pretest and posttest core muscle strength and stability in male participants

Measurement	Male Group	N	X̄	SD	t	p
Core muscle strength and stability	Pre-test	15	.27	.46	-2.256	.041*
	Final test	15	.53	.52		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

There was a significant difference between core muscle strength and stability pre-test scores of male participants 0.27 and core muscle strength and stability post-test mean scores 0.53 and this difference was determined in favor of core muscle strength and stability post-test (p<0.05) (Table 4). However, table 5 shows that there is no significant difference between core muscle strength and stability pre-test mean score of 0.13 and core muscle strength and stability post-test mean score of

0.33 for female participants (p>0.05) (Table 5).

Table 5. Independent samples t-test results for differences in pretest and posttest core muscle strength and stability in female participants

Measurement	Female Group	N	X̄	SD	t	p
Core muscle strength and stability	Pre-test	15	.13	.35	-1.382	.189
	Final test	15	.33	.49		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

Table 6 presents the independent samples t-test results for differences in posttest Flamingo Test subcomponent scores between overall participants.

Table 6. Independent samples t-test results for differences in posttest Flamingo Test subcomponent scores between participants

Measurement	Group	N	X̄	SD	t	p
Flamingo test Right lower ext.	Male	15	11.67	1.80	2.411	.023*
	Female	15	10.20	1.52		
Flamingo test Left lower ext.	Male	15	11.87	1.46	2.271	.031*
	Female	15	10,60	1,59		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

Table 6 showed that there is a significant difference of 11.67 between the Flamingo Test right lower extremity post-test mean scores of female participants 10.20 and the Flamingo Test right lower extremity post-test mean scores of male participants 10.20 and that this difference is in favor of the Flamingo Test right lower extremity post-test of female participants (p<0.05). It was also determined that there was a significant difference between the Flamingo Test left lower extremity posttest mean scores of female participants 10.60 and the Flamingo Test left lower extremity posttest mean scores of male participants 11.87 and that this difference was in favor of the Flamingo Test left lower extremity posttest of female participants (p<0.05). However, it was also found that there was no significant difference between the core muscle strength and stability posttest mean scores of male participants and the core muscle strength and stability posttest mean scores of female participants (p>0.05) (Table 7).

Table 7. Independent samples t-test results for differences in participants' posttest core muscle strength and stability

Measurement	Group	N	X̄	SD	t	p
Core muscle strength and stability	Male	15	.53	.52	1.090	.285
	Female	15	.33	.49		

Note. *N; Sample Number: X̄; Mean: SD; Standard Deviation: p; probability value*

4. DISCUSSION

In this study, the effects of a 6-week core stabilization exercise program on balance and core muscle strength were examined in healthy young men and women. It was also evaluated whether these effects differed according to gender.

When the pre-tests of 15 female and 15 male participants included in the study were compared, there was no significant difference between both groups in static and dynamic balance measurements and core muscle strength evaluations ($p>0.05$). In other words, the individuals participating in the study had similar static and dynamic balance and core muscle strength.

It was also observed that there was no significant difference between the pre-test and post-test averages of men in the right and left lower extremity flamingo balance test application ($p>0.05$), but there was a significant difference between the pre-test and post-test averages of the female participants in the right and left lower extremity flamingo balance test in favor of the post-test, that is, the static balance performance increased ($p<0.05$).

According to the y balance test findings, it was determined that there was no significant difference between the pre-test and post-test averages in the anterior, posterolateral, posteromedial directions of the right and left lower extremities of the men ($p>0.05$). However, there was a significant difference between the pre-test and post-test averages in the anterior, posterolateral, posteromedial directions in both extremities of the y balance test in favor of the post-test ($p<0.05$).

According to the core muscle strength and stability test, there was a significant difference between the pre-test and post-test averages of the male subject group on behalf of the post-test ($p<0.05$), but there was no significant difference between the pre-test and post-test data of the female participants, that is, it was observed that core muscle strength improved more rapidly in men than in women ($p>0.05$).

Based on the data obtained by Yıldırım et al. (2021), core stabilization applications have a positive effect on balance. The positive effect was observed in both gender factors. Positive results were obtained on behalf of balance performance after core stabilization exercises applied to improve balance performance in the female and male subject group. In the study, there was statistical significance in the comparison of core performance measurement before and after exercise for both genders. It is thought that the difference may be due to the hereditary body structure and muscle fiber density of men and women being different from each other (Yıldırım et al., 2021).

Etefagh et al. (2017) reported that backward walking exercises in a six week (3 days a week)

exercise program positively increased dynamic balance performance in female high school athletes. They used YDT to evaluate dynamic balance and Modified Romberg Test to evaluate the measurement of semi-dynamic balance. As a result of the research, it was suggested that backward walking exercises in female athletes can be applied as a complementary exercise program in order to improve sports performance and prevent trauma due to the positive effects of backward walking exercises on balance performance (Etefagh et al., 2017). Oh et al. (2017) applied core stabilization exercises to a group of 19 female subjects without health problems for 4 weeks and found that positive results occurred in the static balance of the female subject group in the evaluation (Oh et al., 2017).

Another study investigating the relationship between core stabilization and balance was conducted by Sever (2017). In the study, the effect of static and dynamic core exercise movements on core stabilization and balance performance was examined in a group of football players. In the study, which included 38 football players, 3 groups were determined as dynamic, static and control group. It was determined that core stabilization increased in the two teams in which core exercises were applied. Therefore, in the light of these findings, it was determined that increasing core stabilization with dynamic and static core exercise applications created a positive effect for balance (Sever, 2017).

In the study by Günaydın and Eliöz (2020), the effect of sports habits on core stabilization strength and balance abilities was investigated. A total of 100 participants aged 18–30 years were included in the study, consisting of 25 female athletes, 25 female sedentary individuals, 25 male athletes, and 25 male sedentary individuals. Core stabilization and strength tests, the Flamingo Balance Test, and the Y Balance Test were administered to the participants. At the end of the study, it was found that individuals with higher core stabilization strength demonstrated better static and dynamic balance and overall strength.

In a study conducted by Koumantakis et al (2005), core stabilization exercises were found to increase the strength of the lower extremity muscles. Similarly, in a study conducted by Parkhouse and Ball (2011), it was shown that core training also improves the strength of the upper extremity muscles. These results reveal that core stabilization contributes to the strengthening of all body muscles (Koumantakis, 2005; Parkhouse et al., 2011).

On the other hand, some studies also report that the effects of core stabilization exercises on muscle strength are limited. For example, Wirth et al. (2017) found that core training did not improve maximal leg muscle strength in a study on leg asymmetry in different league football players. They

reported that muscle strength balance in the lower extremity was positively affected according to the league level.

In a different study, it was found that 6 weeks of core stabilization training significantly improved the static and dynamic balance performance of young adults. The researchers emphasized that strengthening the core muscles improves balance skills by increasing proprioception (Granacher et al., 2010). Similarly, a study by Kang et al. (2012) showed that core stabilization exercises improved balance and postural control in stroke patients. The researchers reported that increased activation of core muscles improved both static and dynamic balance.

According to the results of the literature review, the existing literature suggests that core stabilization exercises have positive effects on muscle strength, but these effects may be limited and should be supported by other strength training programs. Therefore, it can be said that core training alone may not be sufficient to increase muscle strength, but can be used as a supportive component of strength development. At the same time, most research shows that core stabilization exercises improve balance skills. In particular, strengthening the core improves static and dynamic balance by increasing proprioception and postural control. However, some studies have also reported that the effects of core training on balance are limited. Therefore, it should be taken into consideration that the benefits of core stabilization exercises on balance performance may show individual differences.

5. CONCLUSIONS

In conclusion, the findings of this study showed that a 6-week core stabilization exercise program had positive effects on balance and core muscle strength in healthy young men and women. However, it was determined that women showed better improvement than men in terms of static balance and dynamic balance, while men showed better improvement than women in terms of muscle strength. The reason for this situation is the innate differences between men and women and the differences in muscle fiber density as well as body structure. Therefore, it is important to consider gender-specific differences in the planning and implementation of core stabilization programs.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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