

Comparison of static and dynamic balance performances of sports science students by gender

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Abstract

Background and Study Aim Static and dynamic balance performance are fundamental skills that can exhibit significant differences between genders and are critically important in motor skills and sports science. The aim of this study was to compare the static and dynamic balance performance of sports science students by gender.

Material and Methods Ten male students (age: 22.70 ± 1.33 years) and ten female students (age: 23.00 ± 1.05 years) studying in the sports science faculty voluntarily participated in the study. The Biodex Balance System (BBS, Biodex Medical Systems Inc., Shirley, NY) was utilized to assess balance performance. Independent samples t-test and paired t-test were conducted for analysis using SPSS.

Results In intergroup comparisons, static and dynamic balance performances were similar between genders, with a significant difference found only in the S-APSI parameter ($p = 0.021$). Among male participants, a significant difference was observed in the S-MLSI parameter ($p = 0.015$), while no significant differences were found in the other parameters. For female participants, dynamic balance performance significantly outperformed static performance (OSI $p = 0.018$, APSI $p = 0.035$, MLSI $p = 0.046$). Apart from anterior-posterior balance outcomes, no significant differences were observed between males and females in the other parameters. It was also evident that female participants exhibited significantly superior dynamic balance performance compared to static performance.

Conclusions Understanding gender differences in balance performance is crucial for creating effective training programs in sports education. By recognizing these differences, trainers can develop strategies that better meet the specific needs of male and female athletes. This approach can help enhance overall athletic performance.

Keywords: balance, gender, static, dynamic.

Introduction

In sports science, balance performance, both static and dynamic, is a critical component of motor skills. Despite its importance, there is a gap in understanding how these balance performances differ between genders. Such differences, if significant, could have implications for how training programs are designed and implemented in sports education.

In this context, balance in sports performance depends on the development of various fitness components, including balance itself [1]. Balance is achieved by keeping the body's center of gravity aligned vertically with its base of support. This process relies on rapid and ongoing feedback from the visual, vestibular, and somatosensory systems, enabling smooth and coordinated neuromuscular movements [2], which is also referred to as postural control [3]. While the connection between balance ability and the risk of sports injuries is well-

documented [4], the link between balance ability and athletic performance is less clear [5]. In the realm of sports science, understanding gender-specific disparities in balance performance assumes significant importance, as it offers insights into optimizing athletic capabilities and tailoring training strategies to account for specific physiological and biomechanical variations [6, 7].

Gender differences in balance performance have garnered substantial interest due to potential influences stemming from biomechanical and physiological factors [2, 6, 7]. Dynamic balance, essential for tasks involving rapid changes in direction and propulsion, requires real-time adjustments to external forces and proprioceptive feedback [8]. Conversely, static balance, crucial for maintaining stability during static poses and weight-bearing activities, demands meticulous postural control and precise distribution of body weight [9].

The impact of anthropometric variables on body stability presents conflicting findings in specialized research. Some studies have noted weak positive and negative correlations, or even the absence of correlations, between anthropometric measurements

and outcomes in static and dynamic balance tests among female university students, suggesting that no single anthropometric measure can fully explain variations in balance [8]. In contrast, another study found strong correlations between static balance scores and trunk muscle endurance levels among male university students in Tehran [10]. Despite the influence of lower limb muscle strength on body balance, research indicates that toe flexor strength may not significantly affect static standing posture [11]. Patlar and Yilmaz [12] found a correlation between body weight and balance performance. Football training has a clear positive impact on the postural stability and balance of young females. Compared to sedentary females, female participants demonstrate improved utilization of the vestibular system and better asymmetrical distribution of body weight [13]. Examining the balance performances of men and women with diverse anthropometric characteristics, strength, and body weight levels is considered crucial in this context.

Several neurophysiological and mechanical factors significantly impact balance. These factors include characteristics such as an individual's height, weight, body composition, and base of support. Additionally, the distance of the center of mass from the ground, the length and weight of each limb, muscle torque arm length, and the distribution of mass across different body points also play crucial roles [14]. Despite the importance of these factors, the field of balance research remains underexplored, particularly concerning healthy, young, physically active women. Specifically, there is a scarcity of studies directly focusing on the balance of female students [15].

Despite numerous studies investigating balance performance, the influence of gender-specific factors on static and dynamic balance remains inadequately addressed. This is especially true in the context of young, physically active populations. In this context, there is a clear need for more effective solutions to address this problem. The aim of this study was to compare the static and dynamic balance performance of sports science students by gender.

Material and Methods

Participants

Ten male sport science faculty students participated in the study. Participants were briefed on the study's goals and any potential risks involved. Each volunteer signed a consent form, and the study protocol received approval from the Ethics Committee of Selçuk University Faculty of Sports Sciences (Protocol number 59/31.05.2024).

Research Design. Procedure

Participants were asked to undergo the test three times one week prior to the experiment to become

familiar with the experimental equipment. In the study, participants' dynamic and static balance performances were examined in the dominant leg. Participants were advised to abstain from heavy exercise for 48 hours leading up to the experiment. On the day of the experiment, participants arrived at the laboratory at 10:00 AM and underwent a standard warm-up. Immediately afterward, their balance performances were measured. The measurements were recorded in a computer environment.

Balance Performance Test

The Biodex Balance System (BBS, Biodex Medical Systems Inc., Shirley, NY) was used to evaluate the subjects' dynamic balance (with eyes open) and static balance (with eyes closed). Each participant completed two practice trials to become accustomed to the testing equipment. Subsequently, the balance test was performed on the dominant leg. Participants were asked to balance on one foot with their hands crossed on their shoulders while standing on the BBS's mobile platform. The difficulty setting was adjusted to "Level 5" for the eyes-open condition and set to a static level for the eyes-closed condition. The non-dominant leg was held off the ground, and participants were instructed not to look at the BBS monitor. After the test automatically concluded, three balance scores were recorded: Overall Stability Index (OSI), Anterior-Posterior Stability Index (APSI), and Medial-Lateral Stability Index (MLSI). Lower scores represented better balance performance [16].

Statistical Analysis

The Shapiro-Wilk test was used to assess normality. For datasets not normally distributed, skewness and kurtosis values were also evaluated, with values within the ± 2 range considered indicative of a normal distribution. Homogeneity of variances was tested using Levene's test. To compare dynamic and static balance outcomes between male and female participants, an independent samples t-test was performed. For within-group balance performance comparisons, a paired samples t-test was applied. All statistical analyses were conducted using SPSS software, version 24.0 (SPSS Inc., Chicago, IL, USA), with a significance level set at < 0.05 .

Results

The results of the study are summarized in Tables 1, 2, and 3, which present the descriptive statistics and balance performance comparisons between male and female participants. In Table 1, significant differences were found between males and females in height and body weight, while their ages and BMI did not differ statistically. In Table 2, a significant difference in favor of males was found in the Static APSI parameter. No statistical differences were found in the other parameters. Table 3

Table 1. Descriptive of participants

Parameters		Mean	Std. Deviation	t	df	95% CI		P
						Lower	Upper	
Age (year)	Male	22.70	1.33	-.557	18	-1.431	.831	.584
	Female	23.00	1.05					
Height (cm)	Male	176.40	7.30	3.728	18	4.016	14.384	*.002
	Female	167.20	2.74					
Body Weight (kg)	Male	71.90	6.88	5.184	18	8.148	19.252	*.000
	Female	58.20	4.73					
BMI (kg/m ²)	Male	22.50	2.22	2.004	18	-.086	3.686	.060
	Female	20.70	1.76					

*: p<0.05.

Table 2. Comparison of static and dynamic balance performances by gender

Parameters		Mean	Std. Deviation	t	95% CI		P
					Lower	Upper	
Dynamic-OSI (score)	Male	2.32	.59	.906	-.3036	.7636	.377
	Female	2.09	.54				
Dynamic-APSI (score)	Male	1.70	.55	1.040	-.2652	.7852	.312
	Female	1.44	.56				
Dynamic-MLSI (score)	Male	1.26	.43	.111	-.3602	.4002	.913
	Female	1.24	.37				
Static-OSI (score)	Male	2.58	.43	-1.530	-.7594	.1194	.143
	Female	2.90	.50				
Static-APSI (score)	Male	1.64	.33	-2.535	-.9510	-.0890	*.021
	Female	2.16	.55				
Static-MLSI (score)	Male	1.65	.34	.957	-.1554	.4154	.351
	Female	1.52	.25				

*: p<0.05; OSI - Overall Stability Index; APSI - Anterior-Posterior Stability Index; MLSI - Medial-Lateral Stability Index.

Table 3. Comparison of static and dynamic balance performances among male participants

Parameters	Mean	Std. Deviation	95% CI		t	P
			Lower	Upper		
Dynamic-OSI (score)	2.32	.59	-.6908	.1708	-1.365	.205
Static-OSI (score)	2.58	.43				
Dynamic-APSI (score)	1.70	.55	-.3560	.4760	.326	.752
Static-APSI (score)	1.64	.33				
Dynamic-MLSI (score)	1.26	.43	-.6829	-.0971	-3.012	*.015
Static-MLSI (score)	1.65	.34				

*: p<0.05; OSI - Overall Stability Index; APSI - Anterior-Posterior Stability Index; MLSI - Medial-Lateral Stability Index.

Table 4. Comparison of static and dynamic balance performances among female participants

Parameters	Mean	Std. Deviation	95% CI		t	P
			Lower	Upper		
Dynamic-OSI (score)	2.09	.54	-1.4476	-.1724	-2.874	*.018
Static-OSI (score)	2.90	.50				
Dynamic-APSI (score)	1.44	.56	-1.3755	-.0645	-2.485	*.035
Static-APSI (score)	2.16	.55				
Dynamic-MLSI (score)	1.24	.37	-.5535	-.0065	-2.316	*.046
Static-MLSI (score)	1.52	.25				

*: $p < 0.05$; OSI - Overall Stability Index; APSI - Anterior-Posterior Stability Index; MLSI - Medial-Lateral Stability Index.

indicates that there was a significant difference in the Static-MLSI parameter for static and dynamic balance performances among male participants. No significant differences were found in the other parameters. When comparing the dynamic and static balance performances of female participants, it was found that dynamic performance was significantly higher than static performance (Table 4).

Discussion

The aim of this study was to compare the static and dynamic balance performances of male and female sports science students. The results indicated significant gender differences in certain balance parameters, with males showing superior performance in the Static APSI parameter and females demonstrating better dynamic balance compared to static balance. These findings suggest that gender-specific factors may influence balance performance in different ways.

It is well documented that athletic performances required in sports, such as strength, speed, agility, endurance, balance [17], and flexibility, vary according to gender, with physical and physiological differences being very evident [18]. The literature on gender-related differences in athletic performance reveals that male athletes generally outperform female athletes in all maximal anaerobic and aerobic performances due to physical and physiological gender-based differences. From a physiological perspective, men have more red blood cells, larger heart and lung capacity, which provide greater aerobic performance, while greater muscle mass, lower body fat, and higher levels of certain hormones contribute to better anaerobic performances [19]. While these physiological advantages dominate in physical efforts, they may be less influential in performances requiring cognitive skills such as flexibility and dynamic balance [20]. In fact, women's balance ability may even be better than men's in some cases [21, 22]. Although some evidence suggests that these differences may be linked to anthropometric variations [23], Nolan and

Grigorenko [24] argued that gender differences were not dependent on anthropometrics. In light of this literature, it remains a debatable issue whether, and to what extent, gender-related differences in balance ability exist.

Hageman and Leibowitz [25], Wolfson et al. [26], and Fujiwara and Toyama [27] reported non-significant differences between genders. Similarly, Demura and Yamaji [20] measured four stepping tests requiring dynamic balance ability and found no gender-related differences in the number of steps or the average time taken to transition between stepping right and left. However, they observed significant differences between genders in the total connecting time during bilateral stepping (right and left) and in the number of steps during unilateral right/left stepping. This suggests that females might be more adept at maintaining stability during the phase when both feet are on the ground, while males may be more effective at sustaining stability during the leg-raising phase.

Balance can be categorized into various types: static steady-state balance (the ability to maintain a stable position while standing or sitting), dynamic steady-state balance (the ability to remain stable while walking), proactive balance (anticipating and preparing for a predicted postural disturbance), and reactive balance (compensating for an unexpected postural disturbance) [23, 28]. Considering this information alongside the literature mentioned above, it appears that there are no major differences between men and women in terms of dynamic balance skills. However, it is important to note that the sample groups in these studies consist of older individuals compared to the sample group in our study.

While many studies have shown a decrease in balance ability with aging, gender-related differences in dynamic balance may also be age-dependent [20]. For this reason, further studies should consider our findings in relation to theirs.

Schedler and Kiss [23] reported that balance performance develops from early childhood,

with physical factors such as growth and weight gain having only a minimal impact on balance performance in youth. Era et al. [29] found that males exhibited more pronounced sway, as evidenced by the speed and amplitude of center of pressure movements during force platform measurements, with these differences being more pronounced in older age groups. Among children, girls may demonstrate better postural control than boys of the same age [30, 31], which is attributed to enhanced sensory integration, more advanced neuromuscular development, and the use of more mature postural control strategies. Additionally, it has been suggested that girls tend to be less hyperactive and more attentive during balance tasks compared to boys [23].

Studies investigating gender-related dynamic balance differences within the age range of our study sample are very limited. Schedler and Kiss [23] highlighted this issue and emphasized the need for more research on this subject, particularly with well-designed and large cohort studies. Given the limited research in this area, our findings provide valuable insights but should be interpreted with

caution. Another limitation of our study is the relatively small sample size, which may affect the generalizability of the results. Additionally, the cross-sectional design does not allow for observations of balance performance changes over time. Incorporating more advanced biomechanical analysis and exploring other potential influencing factors, such as hormonal fluctuations and training regimens, could further enhance the depth of understanding in this field.

Conclusions

The study demonstrated a significant superiority of dynamic balance performance over static balance in men, with some elements of balance performance being more successful in women. Our findings also confirmed significant differences between static and dynamic balance when considering the Medio-Lateral Stability Index. Although this finding was not the primary focus of our research, it suggests that further studies exploring the differences between static and dynamic balance could benefit from this information.

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