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Factors affecting Y-Balance Test in elite adolescent soccer players

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Abstract
Introduction. **The ability of soccer players to maintain dynamic balance is crucial for their performance in physical tasks and matches. Therefore, it is essential to examine the factors influencing the dynamic balance of these players.** Aim of Study. **This study aimed to analyze the factors affecting the Y-Balance Test scores of elite adolescent soccer players, including the dominant and non-dominant leg, leg length, and muscle strength.** Material and Methods. **In 2024, a study was carried out on 40 elite male adolescent soccer players who competed at an advanced level and trained at a professional center. The study involved taking measurements for the Y-Balance Test – leg length measurements, and knee flexor and extensor muscle measurements. Statistical analyses, including an independent t-test and Pearson correlation analysis, were performed to examine the relationship between the Y-Balance Test, leg length, and knee strength.** Results. **The study found that there is no significant difference in the Y-Balance Test results between the dominant and non-dominant legs of elite adolescent soccer players. Additionally, the Y-Balance Test results for dominant and non-dominant sides were not affected by leg length. However, the flexors and extensors of the knee showed a positive correlation with the Y-Balance Test.** Conclusions. **The Y-Balance Test results of elite adolescent soccer players show a connection between their dominant and non-dominant legs. Additionally, the test score seems to be influenced by knee strength to some extent. Implementing a systematic approach to managing knee strength and conducting the Y-Balance Test to enhance players performance and lower the risk of injury.**

KEYWORDS: soccer, Y-Balance Test, strength, players, leg length.

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Introduction

Soccer is one of the most popular ball sports globally [18]. It is a complex sport in which players can improve, with psychological factors, their chances of success by focusing on various physical health and performance factors such as agility, aerobic and anaerobic power, rapid acceleration, and deceleration [3]. Meanwhile, balance plays a crucial role in enhancing sports performance and preventing falls during technical and tactical training [4]. Static balance refers to the ability to maintain a stable position with minimal movement using one or both legs [11]. On the other hand, dynamic balance involves performing active tasks while staying stable [21]. Balance is maintained through dynamic integration of internal and external forces, which are regulated by visual, vestibular, and somatic sensory stimulation. In other words, various neuromuscular control strategies are employed to maintain balance, making it a vital aspect of soccer skill performance [22]. Therefore, dynamic balance of soccer players is crucial for various physical development tasks and matches, and it is closely linked to the risk of injury [9]. Passing and kicking are the most commonly used techniques during soccer practice and matches. It is recommended to execute these techniques with the dominant leg and to use the non-dominant leg as the standing leg [8]. As a result, posture control in standing legs can be better than in kicking legs [9]. This difference in single-balancing performance can be improved by a soccer player's experience and training [19]. Posture control involves mastering body position in space for stability and direction [1, 23]. Postural stability means being able to keep the body's center of mass within a support base and maintaining the right relationship between body parts and the environment to perform tasks [8, 23]. The Y-Balance Test (YBT) is used to evaluate dynamic posture control [17]. This test assesses muscle strength, flexibility, neuromuscular control, stability, range of motion, balance, and proprioception [5]. There have been many research studies emphasizing the significance of postural stability in the physical development of soccer players and its connection to specific tasks in matches [2, 5, 7]. Additionally, there is substantial evidence regarding the biomechanical aspects of postural stability [26]. However, while most balance studies have been carried out in clinical settings, there is a lack of research on the factors influencing balance [26]. Therefore, there is a need to analyze the factors affecting dynamic balance [1]. With that in mind, the purpose of this study was to analyze the factors of leg length and muscle strength in the YBT, which is a dynamic balance evaluation in elite adolescent soccer players. These results could be integrated into programs to improve the performance of elite soccer players and to prevent future injuries.

Aim of Study

Numerous studies have shown that dynamic balance plays a crucial role in the physical development of soccer players and is linked to specific tasks within the matches. However, while most studies on balance have been conducted in clinical settings, there is a lack of studies examining the factors that influence balance. Therefore, this study aimed to analyze the factors affecting the Y-Balance Test in elite adolescent soccer players, including the dominant and non-dominant legs, leg length, and muscle strength.

Material and Methods

Participants

In 2024, a study was carried out involving elite male adolescent soccer players who competed at an advanced level and trained at a specialized center. All the players were 14 years old or older, and a total of 43 players were initially chosen for the study (Table 1). Out of the 43 players, 40 were eventually included in the study, as three of them were unable to undergo the YBT and lower extremity strength measurements due to serious injuries. The study was conducted in accordance with the Declaration of Helsinki.

Table 1. General characteristics of the players

	Mean	SD
Age (years)	14.83	0.81
Height (cm)	167.56	6.68
Weight (kg)	54.79	7.66
BMI	19.47	1.60
Fat-free mass (kg)	48.52	7.19
Body fat mass (kg)	6.27	1.66

Note: BMI – body mass index, SD – standard deviation

Data collection and analysis

All measurements were taken on the day when the players did not undergo any training. This included the measurements for the YBT, leg length, and the flexor and extensor muscles of the knee. All players were instructed to drink at least 200 mL of water before the measurements were taken. The measurements were conducted after the players had rested comfortably for at least 30 minutes to ensure maximum stability.

Measure

Y-Balance Test

The players started by placing their stance leg on the starting table and used the opposite leg to push the reach mark box as far as possible in the anterior, posteromedial, and posterolateral directions [24]. Attempts were not to be counted if any of the following conditions were met: the players failed to maintain a single-leg stance throughout the entire movement, rested the foot on top of the indicator box while reaching kicks forward to gain extra distance, or did not return to the center while maintaining balance [24]. All players completed six practice attempts and then performed three times in each direction on each leg before data was collected with the average value. They took a short break between repetitions to prevent fatigue.

Leg length

The players' leg lengths were measured from the most protruding part of the anterior-superior iliac spine (ASIS) of the pelvis to the distal end of the ipsilateral medial malleolus of the ankle [13].

Measurement of muscle strength

The knee flexor and extensor muscles of the players were measured using Computer Sports Medicine, INC (Cybex, HUMAC, USA) in a concentric/concentric manner. All players were normalized based on peak torque/body weight (PT/BW) to provide an objective assessment, as there may be variations in muscle strength based on individual weight differences [16]. This is defined as the maximum force generation on the joint divided by the weight [6]. Researchers trained the players to exert maximum muscle strength through the pre-training during the evaluation. The strength of the knee was measured three times at a load speed of 60% based on the dynamic strength assessment study of elite players [14]. The knee operating range was set from 0° to 90°. To prevent target activity, the body and pelvis were fixed in an X-shape with straps attached to both shoulders and the measuring equipment. Additionally, the flexor/extender muscles ratio of the flexor and extensor muscles of the knee was calculated as flexor/extender muscles × 100.

Statistical analyses

We analyzed the general characteristics of the players using descriptive statistics. An independent t-test was conducted to assess the difference in the YBT between the dominant and non-dominant legs. We used Pearson correlation to determine the association between the YBT, leg length, and knee strength. Variables with significant correlation were then used in a simple linear regression model to identify those predicting the YBT score. All statistical analyses were conducted using SPSS ver. 27.0 (IBM Corp., Armonk, NY, USA), and the statistical significance level was set at $\alpha \leq 0.05$.

Results

The study found that the YBTs for both the dominant and non-dominant sides of elite adolescent soccer players

Table 2. Comparison of the Y-Balance Test results between the dominant and non-dominant legs

		Mean (SD)	t	p
Anterior	dominant	69.18 (7.96)	–0.316	0.752
	non-dominant	69.74 (7.94)		
Posteromedial	dominant	75.25 (9.28)	0.296	0.768
	non-dominant	74.59 (10.68)		
Posterolateral	dominant	84.26 (7.02)	1.496	0.139
	non-dominant	81.96 (6.73)		

Note: SD – standard deviation

Table 3. Y-Balance Test and correlation with other variables

Dominant Y-Balance Test			
	Anterior	Posteromedial	Posterolateral
Dominant posteromedial	0.556**		
Dominant posterolateral	0.061**	0.650**	
Non-dominant anterior	0.440**	0.574**	0.340*
Non-dominant posteromedial	0.489**	0.593**	0.593**
Non-dominant posterolateral	0.544**	0.634**	0.771**
Dominant flexors strength	0.453**	0.264	0.531**
Dominant extensor strength	0.365*	0.304	0.329*
Non-dominant flexors strength	0.322*	0.137	0.180
Non-dominant right extensor strength	0.329*	0.401	0.267
Non-dominant Y-Balance Test			
	Anterior	Posteromedial	Posterolateral
Non-dominant flexors strength	0.346*	0.252	0.121
Non-dominant extensor strength	0.338*	0.245	0.070
Dominant flexors strength	0.384*	0.286	0.315*
Dominant extensor strength	0.415**	0.311	0.073

* $p < 0.05$; ** $p < 0.01$

Table 4. Simple linear regression between the dominant Y-Balance Test and muscle strength

	B	t	Beta	p
Dominant flexor strength	0.165	3.130	0.453	0.003
Dominant extensor strength	0.077	2.419	0.365	0.020
Non-dominant flexor strength	0.094	2.100	0.322	0.042
Non-dominant extensor strength	0.062	2.151	0.329	0.038
Dependent variable: anterior				
Dominant flexors strength	0.157	3.445	0.488	0.001
Dominant extensor strength	0.061	2.149	0.329	0.038
Dependent variable: posterolateral				

Table 5. Simple linear regression between the non-dominant Y-Balance Test and muscle strength

	B	t	Beta	p
Non-dominant flexor strength	0.100	2.273	0.346	0.029
Non-dominant extensor strength	0.064	2.215	0.338	0.033
Dominant flexor strength	0.140	2.567	0.384	0.014
Dominant extensor strength	0.087	2.811	0.415	0.008
Dependent variable: anterior				
Dominant Flexor strength	0.097	2.049	0.315	0.047
Dependent variable: posterolateral				

were similar. This means that there was no significant difference in the YBT results between the dominant and non-dominant legs (Table 2). Additionally, the study found that the YBT results for the dominant and non-dominant sides were not influenced by the leg length (Table 3). The flexor and extensor muscles of the knee exhibited a positive correlation with the YBT (Table 3). However, it affects only certain directions, not all three directions of the YBT. For each 1-point increase in flexor and extensor muscles on the dominant side, the anterior directions score of the dominant YBT increases by 0.165 and 0.077, respectively (Table 4). Additionally, for each 1-point increase in flexor and extensor muscles on the non-dominant side, the anterior directions score of the dominant YBT increases by 0.094 and 0.062, respectively (Table 4). For each 1-point increase in flexor and extensor muscles on the dominant side, the posterolateral directions score of the dominant YBT increases by 0.157 and 0.062, respectively (Table 4). For each 1-point increase in flexor and extensor muscles on the non-dominant side, the anterior directions score of the non-dominant YBT increases by 0.100 and 0.064, respectively (Table 5). Additionally, for each 1-point increase in flexor and extensor muscles on the dominant side, the anterior directions score of the non-dominant YBT increases by 0.140 and 0.087, respectively (Table 5). Lastly, for each 1-point increase in flexor muscles on the dominant side, the posterolateral directions score of the non-dominant YBT increases by 0.097 (Table 5). Apart from that, the YBT is not affected by knee flexors, extension muscles, and the flexor/extender muscles ratio.

Discussion

The study aimed to assess the dynamic balance of elite male adolescent soccer players using the YBT and analyze the factors influencing it. This information can enhance exercise performance and develop injury prevention programs.

In our study, there were no differences in the YBT results between the dominant and non-dominant sides of soccer players; that is, the dominant and non-dominant legs. Previous research has indicated that the YBT results of soccer players vary between their dominant and non-dominant sides, increasing the risk of sports injuries [25]. However, it is important to note that the findings of our study may differ from these results because we excluded players who were unable to perform the YBT and muscle strength tests due to serious injuries. In soccer, players typically use their dominant legs for passing and kicking, and their non-dominant legs for posture control while standing [8]. This posture control helps improve stability and spatial awareness, which may have led to improvements in the YBT scores for both dominant and non-dominant legs. These pieces of evidence suggest a strong correlation between the YBT of the dominant and non-dominant legs. Additionally, research by Haddad et al. [12] showed that there was a significant difference in the YBT scores between the dominant and non-dominant legs in professional soccer players, but not in amateur players. It is worth noting that our study participants were adolescent soccer players, not professional soccer players, which may explain why our findings are similar to those of previous studies.

In our study, we found that leg length did not have an impact on the YBT. Meanwhile, Hébert-Losier [13] pointed out that the YBT can be affected by hand position rather than leg length and measurement methods. It was noted that the leg length measuring method in the YBT had little effect in comparison to the leg length from ASIS to the lateral malleolus vs the medical malleolus-affected comparisons. However, the YBT performs better when the players move freely than when their hands are placed on hips. Therefore, it should be considered that the hand position during the YBT may significantly affect the score and its interpretation, and induce other neuromuscular control strategies.

In our study, we found a positive correlation between the flexor and extensor muscles of the knee and the YBT scores. Additionally, we observed that the strength of the dominant and non-dominant knees had a significant impact on the anterior directions, but not on the posteromedial directions. Previous studies have mainly focused on the relationship between hip joint strength and the YBT, and have found a correlation between hip joint strength and YBT performance [15, 24]. However, there is limited research on the relationship between knee strength and the YBT. When standing, the hamstrings become more active as the trunk angle increases [20]. During the YBT, the body sways back and forth to maintain balance, and the knee flexors and extensors need to contract eccentrically to resist trunk movement [20]. As a result, the knee flexors and extensors can contribute to improved performance in the YBT when the body transitions from swaying forward and back to swaying from side to side. However, it is not yet clear whether the strength of these knees is strongly correlated with only the anterior direction among the three directions of the YBT. According to a study by Gribble et al. [10], it was suggested that hip and knee sagittal kinematics did not significantly affect the medial orientation performance. In addition, Gribble et al. [10] reported that the most significant amount of knee flexion range occurred during the anterior direction reach performance, similar to our study. However, additional studies are required to clarify this.

Our study has several advantages. We assessed the YBT, which measures dynamic posture control, in elite adolescent soccer players. Additionally, we examined leg length and muscle strength measurements to analyze the factors influencing the YBT. However, there are also some limitations to our study. Firstly, it was only conducted on adolescent male soccer players, so the findings may not be applicable to female and adult soccer players. Additionally, while the YBT assesses strength, endurance, balance, flexibility, and neuromuscular control, we only measured knee strength in an isokinetic manner, which may not fully represent the YBT. Finally, the YBT score was not normalized according to leg length.

Conclusions

It seems that elite adolescent soccer players have a connection between the YBT results of their dominant and non-dominant legs. This indicates that the YBT score of one leg may affect the other leg as well. Additionally, the YBT score is not influenced by leg length, but it is somewhat influenced by knee strength. Therefore, it is important to systematically manage knee strength and the YBT to enhance players' performance and reduce the risk of injuries.

Conflict of Interest

The authors have no conflicts of interest to report.

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