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Comparison of the Relationship Between Hamstring Muscle Group Flexibility and Selected Biomotor Skills in Soccer Players

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ORIGINAL ARTICLE

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Abstract

Soccer is a complex sport involving various dynamic activities in which such characteristics as speed, agility, acceleration, flexibility, jumps, and balance directly affect performance. As in many sports activities, it is known that limited muscle flexibility, which restricts the range of motions in soccer, causes muscles to be prone to injury, impairing performance. This study aimed to compare the relationship between hamstring muscle group flexibility and selected biomotor skills in soccer players. This study was conducted with the participation of a total of 28 male soccer players with an average age of 16.50±0.50 years, an average body weight of 61.92±8.16 kg, an average height of 1.74±0.06 cm, an average training age of 5.96±1.40 years, and an average BMI of 20.31±1.72 kg.m^{-2}. The "Personal Information Form," "Active Knee Extension Test (AKET)," "Illinois Agility Test," "20-M Sprint Test," "Standing Long Jump Test," and "Y Dynamic Balance Test (YDBT)" were used as data collection tools. The data were collected by Pearson Correlation Test and Independent Samples T-Test from among descriptive statistics in the SPSS package program. In all analyses, p<.05 was set as the significance level. Based on the findings: a positive correlation was found between the average scores of balance and flexibility, especially when the left foot was the balance foot. Although no significant relationship was found between hamstring flexibility and long jump, agility, and sprint tests, the mean athletic performance values appeared to have increased as the flexibility increased. This indicates that hamstring flexibility had a positive effect on performance outcomes.

Keywords: Agility, Balance, Soccer, Hamstring Muscle Flexibility, Long Jump.

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Futbolcular da Hamstring Kas Grubu Esnekliği ile Seçili Biyomotor Beceriler Arasındaki İlişkinin Karşılaştırılması

Öz

Futbol; sürat, çeviklik, ivmelenme, esneklik, sıçramalar ve denge gibi özelliklerin performansı doğrudan etkilediği, çeşitli dinamik aktivitelerini içeren karmaşık bir spordur. Birçok spor aktivitesinde olduğu gibi futbolda da hareket açıklığını kısıtlayan sınırlı kas esnekliğinin kası yaralanmaya yatkın hale getirdiği ve performansı bozduğu bilinmektedir. Bu bilgiler doğrultusunda çalışmanın amacı; futbolcularda hamstring kas grubu esnekliği ile seçili biyomotor beceriler arasındaki ilişkinin karşılaştırılmasıdır. Araştırmaya yaş ortalaması 16.50±0.50 vücut ağırlık ortalaması 61.92±8.16 kg., boy uzunluğu ortalaması 1.74±0.06 cm., spor yaşı ortalaması 5.96±1.40 ve BKİ ortalaması 20.31±1.72 kg.m^{-2} olan 28 erkek futbolcu katılmıştır. Araştırmada "Kişisel Bilgi Formu," "Aktif Diz Ekstansiyon Testi (ADET)," "İllinois Çeviklik Testi," "20 Metre Sürat Testi," "Durarak Uzun Atlama Testi" ve "Y Dinamik Denge Testi (YDDT)" veri toplama aracı olarak kullanılmıştır. Çalışma verileri SPSS paket programında tanımlayıcı istatistiklerden Pearson Korelasyon Testi ve Bağımsız Örneklem T Testi ile elde edilmiştir. Analizlerin tamamında p<.05 anlamlılık düzeyi olarak kabul edilmiştir. Çalışmanın bulgularına göre; denge ve esneklik ortalamaları arasında özellikle sol ayak denge ayağı iken pozitif yönde ilişki tespit edilmiştir. Hamstring esnekliği ile uzun atlama, çeviklik ve sürat testleri arasında anlamlı düzeyde bir ilişki olmadığı belirlensede esneklik artıkça atletik performans değer ortalamalarının da artığı görülmektedir. Bu durumda hamstring esnekliğinin performans çıktıları üzerine olumlu yönde bir etkisinin olduğuna işaret etmektir. Bununla birlikte literatürde çelişkili sonuçların olduğu tespit edilmiştir.

Anahtar kelimeler: Çeviklik, Denge, Futbol, Hamstring Kası Esnekliği, Uzun Atlama.

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Introduction

To achieve the desired improvement in athletes, coaches should know the physical, physiological, and metabolic features required for any targeted sport. The trainers must prepare the exact training programs based on the necessary features so that the athletes can demonstrate the technical skills to increase their performance in a competition (Mercier et al., 1986).
Soccer is a sport that operates with aerobic and anaerobic exercises and in which strength, speed, flexibility, agility, and coordination closely affect motor skills and performance (Güneş et al., 2019). The features that make a soccer player stand out in the game depend on more than one factor. Some comprise aerobic and anaerobic endurance and locomotor features, including mobility (McMillan et al., 2005). Since soccer is a long-term and high-paced sport, basic biomotor skills such as strength, speed, and endurance and complementary skills such as agility, flexibility, balance, and coordination are critical. Moreover, both anaerobic and aerobic energy systems are used since turning, running fast, dribbling, keeping the ball under pressure, changing direction, and running at different speeds are essential in soccer (Stolen et al., 2005).

Flexibility is one of the most important physical fitness components that affect athlete performance. As in soccer, flexibility is essential to mobility in many sports branches. It is also a basic requirement for athletes to demonstrate their skills at wide angles comfortably (Bogalho et al., 2022). Likewise, soccer flexibility depends on the functional properties of the associated muscles, muscle-joint alignments, tendons, and ligaments. Improving the level of flexibility increases the ability to perform the movements necessary for the game and facilitates the prevention of injuries. Improving the level of flexibility increases the ability to perform the actions required for the game and helps prevent injuries. Due to the continuity of short sprints in soccer, the lack of improved mobility is likely to cause the athlete to be unable to exhibit high performance in speed and acceleration (Voight and Blackburn, 2000; Aşçı et al., 2005). In this connection, stretching exercises prevent athletes from getting injured and increase their range of motion and performance (Faigenbaum et al., 2005). Limited muscle flexibility is believed to restrict the range of motion, make muscles vulnerable to injury, and impair performance in sports where flexibility is essential (Rahnama et al., 2005). About 17% of soccer injuries are attributed to muscle tension and lack of flexibility (Ekstrand and Gillquist, 1982).

The factors affecting soccer performance have always been extensively studied. However, despite the hypothesis suggesting that restricted hamstring flexibility affects the risk of injury in soccer players, very few studies analyze the effects of limited lower extremity muscle flexibility and its impact on soccer-specific skills (García-Pinillos et al., 2015). Likewise, notwithstanding the well-known, acute effects of flexibility on sports performance (Thacker et al., 2004; Opplert and

Babault, 2018; Sands et al., 2013; Behm et al., 2015; Herbert et al., 2007; Torres et al., 2013), there are very few studies that analyze the impact of lower extremity muscle flexibility on skills such as vertical jump, speed, and balance (Rey et al., 2016; Bogalho et al., 2022). However, there is very limited on the effect of muscle flexibility on athletic performance; such information is quite controversial. Therefore, this study aimed to compare the relationship between hamstring muscle flexibility and selected biomotor skills in soccer players.

Materials and Methods

Research Model

In this study, the relational survey model was used. The relational survey model is designed to determine whether there is a change between two or more variables together or to determine the degree, if any (Karasar, 2011). The current study complied with the "Higher Education Institutions Scientific Research and Publication Ethics Directive" framework.

Study Sample

The sample consisted of volunteer male athletes aged 16 and 17, who played in the development league in the 2022/23 season, participated in soccer training 5 times a week, and played a match at least once a week. The exclusion criteria from the study were; a) ongoing knee, hip, and low back pain, b) the presence of cardiovascular disease, c) past medical history of hamstring muscle injury and d) the presence of a length difference between lower extremities. According to the G*Power analysis, the number of participants required to participate in the study was 28 athletes at a 95% confidence level and 80% difficulty level with a 5% of acceptable margin of error. All participants and coaches were informed about the protocol and experimental risks; the participants under 18 signed an information contract for participation in the study after parental consent. Table 1 below provides descriptive information about the participants.

Table 1
Complementary Information About The Participating Athletes

Variables	N	X̄	S	Min/ Max
Age (years)	28	16.50	.509	16.00-17.00
Weight (kg)	28	61.92	8.16	50.00-76.00
Height (cm)	28	1.74	.069	1.57-1.86
Training age (years)	28	5.96	1.40	4.00-9.00
BMI (kg.m^{-2})	28	20.31	1.72	17.31-22.94

X̄: Mean, **S:** Standard Deviation, **BMI:** Body Mass Index, **kg:** Kilogram, **m^{-2}:** Square meters, **Min:** Minimum, **Max**: Maximum, **N:** Number of Participants

As can be seen in Table 1, there are 28 male soccer players with a mean age of 16.50±0.50 years, mean body weight of 61.92±8.16 kg, mean height of 1.74±0.06 cm, mean training age of 5.96±1.40 years, and mean BMI of 20.31±1.72 kg.m^{-2}.

Research Procedure

The athletes were tested individually in a single session. First, anthropometric measurements were made. Weight (kg) was measured using a portable scale, and height was measured using tape. BMI was calculated by dividing the weight in kilograms by the square of height in meters. Before the test, the athletes' hamstring flexibility was measured. 2 maximal trials (left and right leg) for flexibility were performed randomly. The mean value between the two legs was taken (Ayala et al., 2012). 3 experienced physical education teachers conducted the tests. The athletes performed a typical soccer warm-up consisting of low-intensity running and general exercises. After the warm-up, the Illinois agility test, 20 meters sprint test, standing long jump test, and Y balance test were applied randomly.

Data Collection Tools

The "Personal Information Form," "Active Knee Extension Test (AKET)," "Illinois Agility Test," "20-M Sprint Test," "Standing Long Jump Test," and "Y Dynamic Balance Test (YDBT)" were used as data collection tools.

Active Knee Extension Test (AKET)

The athlete was asked to actively extend his knee while the hip was in 90˚ of flexion in the supine position. The maximum knee extension angle the participants could bring was measured with a goniometer. This test aimed to gather information about the flexibility of the muscle since the extension angle increases as the hamstring tension increases. For the flexibility measurement, the angle formed in the knee was determined and noted. Norris and Matthews (2005) marked the AKET as a valid and reliable measure of hamstring muscle length. To identify hamstring tightness, the reference value determined for healthy men regarding knee extension angles was reported to be 35.2° (144.8°) (Kuilart et al., 2005). In another study, the mean value of normal hamstring flexibility was reported to be 36.05° (143.95°) (Corkery et al., 2007). To ensure a homogeneous distribution of the groups, two groups were formed in the study, in which the flexibility average of 135-155° was the low average and the flexibility values of 156-180° were the high average.

Figure 1 Active Knee Extension Test

Illinois Agility Test

It assessed the athletes' ability to slalom between the designated funnels and change direction (Miller et al., 2006). The athletes were allowed to do two trials. A recovery period of 3 minutes was given between trials. The best test result was recorded in seconds.

20 Metre Sprint Test

The 20-meter running test was used to determine the maximum speed of the participants (Moir et al., 2004). One by one, the athletes were asked to run the entire distance quickly, starting from 1 meter behind the starting line. They were allowed to do two trials. A recovery period of 3 minutes was given between trials (Yanci et al., 2017). The best test result was recorded in seconds.

Standing Long Jump (SLJ)

To determine the functional strength of the lower extremities, the horizontal jump distance of the athletes was measured and recorded in centimeters. The athletes were not allowed to accelerate by coming from behind, and they were asked to make the best jump by swinging their arms back and forward, from behind the designated starting line, with their toes in the closest position to the line. The athletes were allowed to do two trials; the best score was recorded (Reiman and Manske, 2009).

Y Dynamic Balance Test (YDBT)

This test was used to collect data from the athletes through trunk rotation, extremity mobility, ankle instability, and lower extremity flexibility to obtain predictive information about balance asymmetry and injury susceptibility (Gribble et al., 2012). The athletes pushed the blocks with the tip of their toes in the anterior (0°), posterior-medial (45°), and posterior-lateral (45°) directions with the other foot while maintaining a stable stance on the Y dynamic balance test platform with their hands on the waist and one foot. After each measurement, the athlete was asked to return to the starting position without any feet touching the ground. The leg length of the participants was measured from the anterior, superior iliac spine to the most distal part of the medial malleolus. After the test was repeated three times in each direction (anterior, posteromedial, posterior-lateral), the following normalization formula was used (Shaffer et al., 2013).

$$\text{Composite score: } \frac{(\text{anterior+ posterior-lateral+ posteromedial})}{3 \text{ x length of the extremity}} \text{ x } 100$$

Figure 2 Y Dynamic Balance Test

Research Ethics

By the Decision No. 04 of the Scientific Research and Publication Ethics Committee of Erzurum Technical University Scientific Research and Publication Ethics Committee, taken at meeting No. 22 on 30.03.2023, the present study was carried out after obtaining the necessary official permissions for compliance with publication ethics.

Data Analysis

Whether or not the available data showed normal distribution was determined by applying skewness and kurtosis tests. In general, skewness and kurtosis values between +1.5 and -1.5 can be an acceptable range for normal distribution (Tabachnick and Fidell, 2007). Since the analyzed skewness and kurtosis values showed a normal distribution between +1.5 and -1.5 in this study, Pearson Correlation Test and Independent Samples T-Test were used in data analysis. In all analyses, p<.05 was set as the significance level. Table 2 presents the normality results of the tests.

Table 2
Normality Test Findings in The Tests Applied to The Athletes

		Skewness	**Kurtosis**
Mean Hamstring Muscle Flexibility		-.314	-.735
Dynamic Balance Score (cm)			
Right	**Anterior**	.157	-.494
	Posterior-medial	.333	-.953
	Posterior-lateral	.010	.241
	Composite	-.290	-.716
Left	**Anterior**	-.427	-.193
	Posterior-medial	-.330	-.395
	Posterior-lateral	.201	.090
	Composite	-.288	-1.03
Performance Tests			
	SLJ	.157	-1.03
	Speed	.292	-.869
	Agility	.670	-.581

As shown in Table 2, it was determined that parametric tests should be used in our study according to the results of normality distribution.

Results

Table 3

Comparative Findings Between The Groups With Higher Mean Flexibility and Lower Mean Flexibility Based on The Applied Tests (Agility, Speed, Standing Long Jump (SLJ), Balance)

		Hamstring Flexibility Groups		
		The group with the lower mean flexibility (n=15)	The group with the higher mean flexibility (n=13)	P
Dynamic Balance Score (cm)		X̄ ±S	X̄ ±S	
Right	**Anterior**	61.60 ±6.48	63.23 ±5.19	.474
	Posterior-medial	68.80 ±9.57	72.38±10.57	.355
	Posterior-lateral	64.53 ±9.56	73.00 ±8.54	**.021***
	Composite	66.75 ±7.29	68.84±4.69	384
Left	**Anterior**	59.46±5.04	63.00±4.76	.069
	Posterior-medial	65.26±7.77	72.61±8.10	**.022***
	Posterior-lateral	65.93±7.48	74.38±8.07	**.008***
	Composite	65.32±5.21	69.30±3.67	**.030***
Performance Tests				
	SLJ (cm)	2.01±.225	2.03±.165	.865
	Speed (sec)	2.99±.152	3.04±.158	.354
	Agility (sec)	18.93±.992	18.63±1.09	.454

*****p<.05

As can be seen in Table 3, while there were statistically significant differences (p<.05) between the right balance posterior-lateral (p .021), left balance posterior-medial (p .022), posterior-lateral (p .008), and composite (p .030) values in the group with higher mean flexibility, the average values in the performance tests (long jump and agility) were found to be insignificant. However, they rose in the group with higher mean flexibility.

Table 4

The Results Regarding The Relationship Between The Tests (Agility, Speed, Long Jump, Balance) Applied in The Study And The Average Scores In Hamstring Flexibility

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. MHMF	1											
2. RAP	.141	1										
3. RPM	.181	**.500****	1									
4. RPL	**.434***	**.530****	**.618****	1								
5. RCM	.171	**.588****	**.789****	**.814****	1							
6. LAP	.349	**788****	**.495****	**.562****	**.476***	1						
7. LPM	**.432***	.064	.352	**.540****	.267	**.408***	1					
8. LPL	**.491****	.338	**.516****	**.724****	**.483****	**.465***	**.598****	1				
9. LCM	**.411***	.167	**.381***	**.667****	**.550****	**.450***	**.803****	**.745****	1			
10. SLJ	.034	**.411***	**.394***	.347	.302	.220	-.058	**.375***	-.016	1		
11. Speed	.182	-.312	**-.439***	-.152	-.306	-.018	.175	-.108	.166	**-.784****	1	
12. Agility	-.147	-.100	-.104	-.259	-.135	-.055	-.099	-.291	-.153	**-.386***	**.482****	1

MHMF: Mean Hamstring Muscle Flexibility, **RAP:** Right Anterior Posterior, **RPM:** Right Posterior-medial, **RPL:** Right Posterior-lateral, **RCM:** Right Composite, **LAP:** Left Anterior Posterior, **LPM:** Left Posterior-medial, **LPL:** Left Posterior-lateral, **LCM:** Left Composite, **SLJ:** Standing Long Jump.

*****p <.05 ******p < .01

As is seen in Table 4, there is a significant (p<.05), moderate positive correlation between the mean of hamstring flexibility and right balance posterior-lateral (r: .434), left posterior-medial (r: .432) and left composite (r: .411) values. At the same time, there is a strong positive correlation with the left posterior-lateral direction (r: .491), but there is no significant correlation between performance values and average hamstring flexibility.

Discussion and Conclusion

This study aims to examine the relationship between hamstring flexibility, balance, long jump, speed, and agility skills used predominantly in soccer and the effect of flexibility on these skills. Flexibility is integral to an athlete's physical abilities and significantly affects their overall performance (Rey et al., 2016; Kartal, 2020). Clinicians and sports doctors are constantly evaluating hamstring flexibility. This is because tight hamstrings cause various lower extremity injuries (Croisier et al., 2008; Witvrouw et al., 2003) and a decline in sportive performance (Lehance et al., 2009). However, as mentioned before, the studies examining the impact of flexibility on the long jump, sprint speed, agility, and balance are limited in number, and there is no complete agreement in the findings.

According to the results obtained in the present study, no significant relationship was found between hamstring flexibility and sprint speed and agility. However, research shows significant differences in contrast to what was concluded in this study. For example, Favero et al. (2009) reported that changes in the elastic structure of the muscle might adversely affect force production in skills that require an extension-shortening cycle, such as jumping or sprinting, and that basic flexibility affects sportive performance. Moreover, Oliveira et al. (2013), found that the shooting performance of soccer players with tight hamstring muscles was negatively affected. Huang et al. (2022), reported a statistically significant correlation between sprint performance and flexibility. In the study conducted with young soccer players, Garcia-Pinillos et al. (2015), concluded that having more flexibility was an essential factor for such skills determining performance in soccer as jumping, sprinting, agility, and shooting (García-Pinillos et al., 2015). Research also shows that insufficient lower extremity flexibility may adversely affect skills such as speed, agility, and increased or decreased speed, which are used extensively in soccer (Arnason et al., 2004). Aside from that, it has also been reported that there is a positive and significant relationship between flexibility and speed (Çalık et al., 2019; Demir and Yüksel, 2022).

However, there are also other studies in the literature that support the results of the present study. Bogalho et al. (2022), for example, concluded that athletes with high flexibility were slower in the 20 m sprint, and there was no statistically significant correlation between the flexibility of knee extensors and speed. The authors also reported that the flexibility of the hamstring muscle group was not associated with improved sprint performance and that muscle stiffness may therefore be more advantageous. Similar to such results, Rey et al. (2016), reported the lack of a correlation between flexibility and speed. They indicated that soccer players with low flexibility performed better in all anaerobic performance tests. They also suggested that the reason for this could be that the professional soccer player group with low flexibility in their knee extensors had more muscle stiffness compared to the group with a higher flexibility level, and this could facilitate the generation and transmission of contraction force and energy release in relatively fast stretching-shortening activities such as jumping and sprinting (Rey et al., 2016). The results obtained in this study also support the above conclusions in that they point out that flexibility is unlikely to affect athletic performance. However, more research is needed to clarify the conflicting results.

The study found no significant correlation between the long jump and knee extension flexibility. Numerous studies have been conducted in the literature about different jump types (vertical, horizontal, and counterforce), supporting this study's results. Rey et al. (2016), revealed in their research that professional soccer players with low knee extensor flexibility performed better in the counter movement jump. Bogalho et al. (2022), reported no significant correlation between the flexibility of knee extensors (knee flexion angle) and vertical jump performance. Likewise, Rey et al. (2016), found no evidence regarding the likelihood of restricted flexibility in the knee flexors of professional soccer players to reduce jumping performance. In another study, García-Pinillos et al. (2015), reported that soccer players with more knee flexor flexibility proved better in all skills and gave better results, especially in the counter movement jump. Kirkini et al. (2019), stated that the countermovement jump performance was significantly better in the group of young elite soccer players with a higher level of knee flexor flexibility. Turki-Belkhiria et al. (2014), reported that the players in their study experienced a significant improvement in their vertical jump capacity after an 8-week stretching program, resulting in greater flexibility and better athletic performance (Turki-Belkhiria et al., 2014). Overall, the results indicate that it is necessary to determine the reasons for the contradictions to achieve unity in the literature. However, the presence of divergent results can be explained by the age of the participants (adults and youth) and their level of sporting status (amateurs, semi-professionals, professionals).

The present study found a significant correlation between flexibility and left foot balance measurements (excluding the anterior). Apart from that, there were substantial differences in the right foot balance values only in the group with a higher mean of flexibility in the posterior-lateral direction. The reason for this can be explained by the fact that the dominant foot of most of the participants (n:21) was the right foot, and they lay down with the right foot while the left foot was balanced. To determine the relationship between dynamic balance and flexibility, sprint, strength, and jumping in young soccer players, Kartal (2020) found positive, significant correlations between the flexibility of the knee flexors in the star balance test and anterior and anterior-medial directions. However, negative, considerable correlations exist in the posterior and posterior-medial directions. Bogalho et al. (2022), concluded that although players with more knee flexor flexibility could reach more on the right side, they could achieve a different result on the left side when evaluated in terms of balance. This was explained by the fact that all the study's players were right-footed (Bogalho et al., 2022). According to the findings of the study conducted by Overmoyer and Reiser (2015), the authors reported that the Y balance test could help to determine the flexibility insufficiency in the lower extremities and asymmetric flexibility in the ankle and hip regions, indicating a possible uncertain correlation between balance and flexibility in the knee region (Overmoyer and Reiser, 2015). Research shows that similar results cannot be obtained for both feet nor can a unity be achieved between balance and flexibility.

As a result, a positive correlation was found between the average scores of balance and flexibility, especially when the left foot was the balance foot. Although no significant relationship was found between hamstring flexibility and long jump and between agility and speed tests, average athletic performance seemed to increase as flexibility increased, indicating that hamstring flexibility positively impacted performance outcomes. However, there are still conflicting results reported in the literature. More research is needed better to explain the relationships between flexibility and performance testing. Despite this study's limitations, the presented results contribute to the literature and confirm the conflicting results found in the literature.

The main limitation of the current study is that it is observational, making it impossible to establish a causal relationship. In addition, the sample size and the status of the athletes prevented using more robust statistical procedures and limited the generalization of the study results. Moreover, performing anaerobic performance tests on all participants in the same time zones caused the effect of circadian rhythms to be ignored.

Ethics Committee Approval

Ethics Committee: Erzurum Technical University Scientific Research and Publication Ethics Committee

Date of ethics assessment document: 30.03.2023

Issue number of the ethics evaluation document: In meeting 04 and pursuant to Decision No. 22.

Author Contributions

The sole author of the study conducted the entire study.

Conflict of Interest

The author has no conflicts of interest to declare regarding the present study.

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