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Original Article

The relationship between FMS scores and lower body isokinetic strength in football players

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Abstract:
Objective of the Study: In football, one of the branches with a large audience in the world, it is thought that ever-increasing performance, the strengthening of competition and the desire to succeed as well as technical-tactical, psychological, and psychological needs and the improvement of physical and physiological characteristics at the most appropriate level will contribute positively to the performance of football players. Especially in football competitions, high-intensity actions may cause athletes to spend higher effort. Many qualities of football players should be improved to perform these actions at the most appropriate level and to protect them from injuries. For this purpose, the aim of this study is to investigate the relationship between FMS (Functional Movement Screen) scores and isokinetic lower body strength of football players. **Method:** The correlational survey model was preferred as the research model of the study. The sample group consisted of a total of 28 volunteer football players competing at the level of amateur league. The maximum strength of the knee extensor and flexor muscles of the participants was measured using an isokinetic dynamometer device (Cybex NORM®, Humac, CA, USA) that allows to record instantaneous isokinetic torque. The FMS test was applied to assess mobilisation and stabilisation of football players. SPSS 25.0 software was used for statistical analysis of the data and Spearman's correlation analysis was used to compare the relationship between isokinetic lower body strength and FMS scores. **Findings:** When the FMS scores and right and left knee flexion/extension degrees were analysed, no statistically significant correlation was found between the parameters. **Conclusion:** The results of the statistical analysis revealed no correlation between FMS scores and right-left knee flexion and extension parameters of the amateur football players. Accordingly, it is suggested to include FMS applications in the training programmes of the football players and contribute to their performance by minimising their injuries and providing neuromuscular coordination and thus to make contribution to the related literature and to guide future studies.
Key Words: **Football, Isokinetic lower body strength, Functional Movement Screen**

Introduction

Football can be considered as a sport branch that attracts the most attention in the world, has the largest audience population and provides both physical and psychosocial development compared to all other sports branches. In football, which is considered to be one of the branches with a significant audience in the world, the performance increases day by day, and the strengthening of competition and the desire to achieve success is thought to reveal the necessity of special studies. In addition to technical-tactical and psychological needs, it is thought that determining physical and physiological needs and planning training programmes according to these needs will contribute positively to the performance of football players.

While football is defined as a branch in which high levels of strength, endurance, agility, speed, flexibility, and balance performance are important, football players must repeatedly perform football-specific movements, such as passing and scoring goals, sudden changes in direction, and high-speed running during the game (Griffin et al., 2020; Marqués Jiménez et al., 2017). At the same time, it has been reported that the speed of force development and the capacity to produce external mechanical power, which is required for football-specific performances, are related to skills such as sprinting, sudden change of direction and jumping (Lehnert et al., 2017). For this reason, isokinetic muscle strength assessment (muscle strength estimation) is said to be very important in football as in other branches (Kabaciski et al., 2022). Ineffective movement patterns and inadequate neuromuscular control that may occur during high-intensity activities indicate the necessity for the correct application of movement patterns. Thus, tests of movement patterns are used to estimate the athlete's injury risk and to detect functional disorders that may limit performance and increase high-performance outcomes. Therefore, lower and upper isokinetic strengths are extremely important elements for football players to exhibit high performance against the actions they encounter during competitions and training. The FMS testlet is generally grouped into functional skill categories, consisting of locomotor, balance, and manipulative skills.

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In this direction, the FMS test developed by physical therapy and kinesiology specialists Gray Cook and Lee Burton in 1995 to evaluate the basic movement patterns of individuals is used (Cook, 2003; Galahue vd., 2011; Sermaxhaj vd., 2017). Functional movement skill test is an easy-to-apply screening system designed to evaluate the quality of basic movement patterns of mobilization and stabilization (including neuromuscular and motor control), testing the right and left sides of the body equally. In addition, research has shown that high-performance physical activities are functional movements. It has been stated that there is a connection with (FMS). The importance of the FMS is therefore supported by numerous studies investigating various aspects related to the teaching and learning process, such as the usefulness of various assessment methods (Sgrò, vd., 2019; Cook, 2010). In addition, while the FMS expresses the necessary knowledge to achieve proficiency in different sports branches and gymnastics, it also forms the basis of efficient and effective actions in terms of athletes discovering their environment and gaining knowledge about the world around them (Suherman and Nugroho, 2022).

Based on this information, many studies on isokinetic strength and FMS have been reported. However, few studies have examined the relationship between isokinetic strength and functional movement ability appear to be limited. This study aimed to examine the relationship between movement pattern, joint structure, and muscle strength in the football branch, where short-term, high-intensity activities are abundant.

Methods

Research Model:

The research model was determined as a relational survey model among the survey models. The relational survey model was a research model that aimed to determine the presence and/or degree of co-variance between two or more variables. Although the relational survey model cannot give a real cause-effect relationship, it allows the prediction of the other variable if the situation in one variable is known (Karasar, 2006).

Study Group:

In this study, a total of 28 volunteer male football players competing in amateur leagues in Turkey participated. The football players in the study were informed about the tests and were not included in the evaluation if they had any health problems during the test or if they wanted to leave the study. Ethics committee approval of the research was approved at Istanbul Gelişim University meeting dated 08.06.2023 and numbered 2023-05.

Data Collection

Body Weight and Height Measurement

Weight was measured with an electronic scale with a precision of 0.1 kg and height was measured with a digital height measuring device with a precision of 0.01 cm (Zorba, 1999).

Isokinetic Strength Test

The maximum strength of the knee extensor and flexor muscles of the football players in the study was measured using an isokinetic dynamometer device (Cybex NORM®, Humac, CA, USA) that allows the recording of instantaneous isokinetic torque (Impellizzeri et al., 2008). The football players who participated in the study were asked to warm up by doing a warm-up run for 5 minutes before starting the test and active stretching exercises for the lower extremities for 5 minutes afterwards. After warming up, the footballers were taken to the isokinetic dynamometer. During the evaluation with the isokinetic dynamometer, the footballers were kept in a sitting position and the evaluated leg was fixed with a belt from the distal thigh. The lower leg was connected to the dynamometer axis just proximal to the medial malleolus with a belt. The dynamometer angles were calibrated to 0° and 90° for each footballer.

Knee extension and flexion measurements of the footballers in the study were measured with concentric contractions as 4 main tests with 4 repetitions of 60°s-1 angular velocity followed by 15 seconds rest, 4 repetitions of 240°s-1 angular velocity followed by 15 seconds rest and then 20 main tests. A rest period of 45 seconds was given between the angular velocities. During the measurements, footballers were repeatedly warned about the basic push/pull, the number of repetitions remaining and rest periods. Verbal warnings and motivations were given throughout the tests for the participants to reveal their strength value in the best way. The test position was performed as recommended in the manufacturer's manual. As a result of the test, both side quadriceps and hamstring peak torque (PT) (Nm) values and H/K peak torque ratios were calculated (Alvares et al., 2015).

FMS Test

The FMS consisted of four separate scores ranging from 0-3, 3 was the best score that can be obtained. The 7 subtests result in a total score of 0-21, and in the calculation of the total score, the lower score of the subtests performed bilaterally reflects the result of that test (Cook, 2014). In practice, researchers have generally set a cut-off score of 14 points for those at greater risk of injury (Cook, 2006).

In the FMS test, each movement was performed 3 times by the participant. In the subtests (shoulder mobility, Trunk stability push-ups and rotation stability tests) a "Clearing Test" was performed, which was rated as positive or negative. These tests only consider pain, so if a person has pain during the scanning movement, that part of the test scored as positive, and if not, as negative. Control tests affected the total score for the specific tests they are associated with. If a person had a positive control test, their score for that test was considered zero (Cook, 2014).

An individual with pain anywhere on their body at any time during the test was given a score of zero and the location of the pain was noted. If the person cannot complete the movement pattern or cannot take the position to perform the movement, one point was given. Two points were awarded if the person was able to complete the movement but compensates in some way to perform the basic movement. Three points were given if the person perform the movement correctly, without any compensation, according to the standard movement expectations associated with each test. The tests assess both the right and left side and both sides needed to be scored. The lower score on either side was recorded and the total was counted. It was also important to note any imbalances that exist between the right and left sides (Okada 2005).

Deep Squat In this test, the person to be evaluated was asked to hold the bar with his hands above his head and perform the squat movement. If the person performed squats properly, three points were given. If he cannot complete the movement, he was asked to repeat the movement by placing an elevation under his heels. If the person completes the movement properly in this position, two points were given. One point was given if he completes the movement incorrectly. If he has pain during the movement, zero points were given (Ercan, 2018).

Hurdle Step In this test, the person to be evaluated was asked to step over an obstacle equal to the distance of the tibial plateau to the ground without losing his balance by holding the edges of the bar with both hands placed on the neck of the bar. Three points were given if the person performed the step in a smooth and balanced manner. Two points were given if the person performed the movement in a compensatory manner. One point was given if the person cannot perform the movement and got stuck in the obstacle (Ercan, 2018).

In-line lunge In this test, the person to be evaluated was asked to step a distance up to the height of the tibial plateau and bend the knees to a half-kneeling position. The movement should be performed in a straight line. If the person performed the movement in a straight line, three points were given. Two points were given if the person performed the movement in a compensatory manner. One point was given if the balance was broken and the person could not perform the movement (Ercan, 2018).

Shoulder mobility In this test, the palm length of the person to be evaluated was measured and he was asked to make fists and bring His hands together on the back of his head in such a way that one of his fists would approach or touch each other from above and the other from behind his back. Three points were given if the fists touch each other or come close to each other by half of the palm measurement. Two points were given if there was a distance of half or all of the palm. One point was given if the distance was more than the length of the palm. Zero points were given if the movement was painful (Ercan, 2018).

Active Straight Leg Raise In this test, the person to be evaluated was requested to lie on his back and a wooden column was placed under both knees. The person asked to flex the thigh up to the maximum distance he can do without the knee of one leg straight, without shifting to the right or left from the hip, and without the other knee lifting from the board. The person who was going to measure holds the attached bar at the level of the person's fingers respectively and if the person passes the bar with the flexed heel, three points were given. If the person cannot do this movement, the upper side of the wooden column was considered as the pivot point and if he passes the bar placed here, two points were given. If he cannot pass the two upper points, the bar was placed under the wooden column and considered as the pivot point, and one point was given if his heel passes this point (Ercan, 2018).

Trunk Stability Push Up In this test, the person to be tested was asked to come to the push-up position face down, open both hands at shoulder level and place them so that the thumbs were at the forehead level and lift himself by loading himself on his hands without disturbing his body. Three points were given if he succeeded. If he failed, he was asked to get up without disturbing his body by placing his hands so that his thumbs were at the chin level. If he can perform this, two points were given. In this position, one point was given if the body stood up in a distorted manner (Ercan, 2018).

Rotary Stability In this test, the person to be tested was asked to come to the crawling position with the wooden block between his knees and hands. In this position, three points were given if he can touch his knee and elbow on the same side without disturbing his balance and extend straight and maintain his balance. If he cannot do the previous movement, he was asked to touch his crossed knee and elbow to each other and extend them forward without losing his balance. If he does this properly, two points were given. If it was performed in a distorted pattern, one point was given (Ercan, 2018).

Statistical Analysis

The data obtained in the study were transferred to electronic media and given as mean and standard deviation. The Shapiro-Wilk test was applied to determine the normality analyses of the data. The significance level was determined as $p<0.05$ in the statistical evaluation applied. As a result of these analyses, Spearman correlation analysis, one of the non-parametric tests, was applied because the data did not show normal distribution. Statistical analysis of the data was performed in SPSS 25.0 package programme.

Results

Table 1. Demographic Statistics of the Participants

Variables	**n**	**Min**	**Max**	**X±Sd**
Age (years)	28	17,00	38,00	23,25±5,50
Height (cm)	28	170,00	192,00	181,14±6,18
Weight (kg)	28	60,00	90,00	74,46±7,20
BMI (kg/m^2)	28	17,72	26,15	22,70±2,00
Body fat ratio (%)	28	4,50	20,70	14,93±4,62

When Table 1 was analysed, the mean age (years) of the participants was 23.25±5.50, mean height (cm) was 181.14±6.18, mean body weight (kg) was 74.46±7.20, mean BMI was 22.70±2.00 and mean body fat percentage was 14.93±4.62.

Table 2. Descriptive Statistics of Participants

Variables	**n**	**min.**	**max.**	**X±Sd**
FMS test	28	11,00	17,00	14,28±1,30
60s. Flx Right	28	161,00	274,00	205,35±29,12
60s Flx Right %BW	28	162,00	355,00	273,03±40,30
60s Flx Left	28	102,00	258,00	193,60±32,36
60s Flx Left %BW	28	140,00	352,00	260,50±39,61
60s Ext Right	28	84,00	160,00	116,53±19,45
60s Ext Right %BW	28	107,00	274,00	161,89±33,03
60s Ext Left	28	16,00	149,00	106,85±25,53
60s Ext Left %BW	28	24,00	185,00	144,57±34,35
60s H/Q Right	28	46,00	69,00	56,89±7,05
60s H/Q Left	28	16,00	66,00	54,75±10,24
240s Flx Right	28	94,00	170,00	120,71±18,88
240s Flx Right %BW	28	131,00	206,00	162,57±24,04
240s Flx Left	28	18,00	155,00	116,53±25,22
240s Flx Left %BW	28	27,00	264,00	159,78±38,52
240s Ext Left	28	53,00	102,00	77,07±12,87
240s Ext Right %BW	28	69,00	143,00	104,50±19,53
240s Ext Left	28	12,00	98,00	71,21±17,65
240s Ext Left %BW	28	21,00	143,00	95,92±25,51
240s H/Q Right	28	48,00	97,00	64,14±13,11
240s H/Q Left	28	41,00	81,00	61,75±10,83

When Table 2 was analysed, the mean FMS test scores of the participants were 14.28±1.30, 60 s Flx Right mean was 205.35±29.12, 60 s Flx Right %BW mean was 273.03±40.30, 60 s Flx Left mean was 193.60±32.36, and 60 s Flx Left %BW mean was 260, 50±39.61. Moreover, 60 sec Ext Right mean was 116.53±19.45, 60 sec Ext Right %BW mean was 161.89±33.03, 60 sec Ext Left mean was 106.85±25.53, 60 sec Ext Left %BW mean was 144.57±34.35, 60 sec H/Q Right mean was 56.89±7.05, 60s H/Q Left mean was 54,75±10,24, and 240s Flx Right mean was 120,71±18,88. Besides, 240s Flx Right %BW mean was 162,57±24,04, 240s Flx Left mean was 116,53±25,22, 240s Flx Left %BW mean was 159,78±38,52, 240s Ext Right mean was 77, 07±12,87, 240s Ext Right %BW mean was 104,50±19,53, 240s Ext Left %BW mean was 71,21±17,65, 240s Ext Left %BW mean was 95,92±25,51, 240s H/Q Right mean was 64,14±13,11 and 240s H/Q Left mean was 61,75±10,83.

Table 3. Correlation Analysis Between FMS Test and Right Knee Flexion and Extension Degrees of the Participants

Variables		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
FMS	r	1										
	p											
60s Flx Right	r	-0,168	1									
	p	0,393										
60s Flx Right %BW	r	0,004	**,683****	1								
	p	0,984	0,000									
60sn Ext Right	r	-0,033	**,701****	**,520****	1							
	p	0,866	0,000	0,005								
60s Ext Right %BW	r	0,064	**,485****	**,607****	**,783****	1						
	p	0,745	0,009	0,001	0,000							
60s H/Q Right	r	0,202	-0,223	-0,107	**,497****	**,482****	1					
	p	0,304	0,255	0,588	0,007	0,009						
240s Flx Right	r	-0,216	**,767****	**,516****	**,521****	0,289	-0,195	1				
	p	0,270	0,000	0,005	0,004	0,135	0,319					
240s Flx Right %BW	r	-0,083	**,530****	**,741****	**,385***	**,423***	-0,099	**,786****	1			
	p	0,673	0,004	0,000	0,043	0,025	0,617	0,000				
240s Ext Right %BW	r	-0,044	0,271	0,309	**,648****	**,492****	**,588****	0,302	0,320	1		
	p	0,824	0,163	0,109	0,000	0,008	0,001	0,119	0,097			
240s Ext Right	r	0,094	-0,017	**,388***	**,386***	**,541****	**,591****	0,045	**,391***	**,800****	1	
	p	0,633	0,933	0,042	0,043	0,003	0,001	0,821	0,039	0,000		
240s H/Q Right	r	0,229	**-,486****	-0,183	-0,015	0,113	**,573****	**-,541****	-0,265	**,482****	**,614****	1
	p	0,241	0,009	0,351	0,938	0,568	0,001	0,003	0,172	0,009	0,001	

*p<0,05, **p<0,001

When Table 3 was analysed, no statistically significant correlation was found between the FMS test values and right knee flexion and extension values of the participants ($p>0.05$).

Table 4. Correlation Analysis Between FMS Test and Left Knee Flexion and Extension Degrees of the Participants

Variables		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
FMS	r	1										
	p											
60s Flx Left	r	-0,106	1									
	p	0,592										
60s Flx Left %BW	r	0,023	**,752****	1								
	p	0,908	0,000									
60s Ext Left	r	0,111	**,667****	**,726****	1							
	p	0,575	0,000	0,000								
60s Ext Left %BW	r	0,142	**,451***	**,816****	**,857****	1						
	p	0,470	0,016	0,000	0,000							
60s H/Q Left	r	0,267	-0,079	0,201	**,632****	**,705****	1					
	p	0,169	0,689	0,306	0,000	0,000						
240s Flx Left	r	-0,123	**,829****	**,552****	**,455***	0,238	-0,211	1				
	p	0,535	0,000	0,002	0,015	0,223	0,281					
240s Flx Left %BW	r	-0,030	**,559****	**,685****	0,371	**,437***	-0,087	**,743****	1			
	p	0,879	0,002	0,000	0,052	0,020	0,659	0,000				
240s Ext Left %BW	r	-0,315	**,488****	**,533****	**,558****	**,522****	0,247	**,514****	**,577****	1		
	p	0,103	0,008	0,003	0,002	0,004	0,205	0,005	0,001			
240s Ext Left	r	-0,205	0,248	**,505****	0,345	**,502****	0,236	0,290	**,571****	**,874****	1	
	p	0,296	0,202	0,006	0,072	0,006	0,226	0,134	0,002	0,000		
240s H/Q Left	r	-0,204	-0,194	0,147	0,239	**,420***	**,506****	-0,363	-0,120	**,540****	**,635****	1
	p	0,297	0,321	0,456	0,221	0,026	0,006	0,058	0,544	0,003	0,000	

*p<0,05, **p<0,001

When Table 4 was analysed, no statistically significant relationship was found between the FMS test values and the left knee flexion and extension values of the participants ($p>0.05$).

Dicussion

In today's football branch, it can be said that the competitions have become faster as the struggle during the competitions has reached the highest level. In addition to this situation, considering that football players perform many actions (sudden acceleration, deceleration, jumping, etc.) during competitions and training, it can be concluded that basic movement functions, as well as lower extremity strength, contribute significantly to their performance. For this reason, in the study conducted to determine the relationship between FMS scores and isokinetic lower body strength in football players, FMS scores and isokinetic lower extremity, 60s right-left, 240s right-left, 60s H/Q right-left and 240s H/Q right-left knee strength parameters were analysed.

According to the results of the statistical analyses, no relationship was found between the FMS scores and right-left knee flexion and extension parameters of the amateur football players in the study.

When the literature was examined, Willigenburg and Hewet (2017) did not find any statistically significant relationship between FMS scores and knee strength in their study on university football players. In a different study conducted by Willigenburg et al. (2014), no statistically significant relationship was found between FMS tests and knee strength of NCAA Division I football players. In another study, İbiş et al. (2023) investigated the relationship between functional movement scores and hamstring muscle strength in professional football players and found that there was no significant relationship between FMS scores and hamstring muscle strength. When the literature was examined, it was concluded that very few studies supported our study. Although this situation limits the discussion section of our research, it also suggests that it increases the importance of this study.

Bayrakdar and Boz (2020) examined the effect of 8-week FMS and lower extremity training on hamstring and quadriceps ratio in football players and found that the programme increased lower extremity strength. In another study, Baron et al. (2020) found that 12 weeks of functional training in young football players increased lower extremity strength. In another study, Apolinskiene et al. (2017) evaluated the 5-month functional movement patterns integrated into the training programmes of elite female and male youth basketball players. As a result of the study, it was determined that the FMS score of female basketball players increased from 15.89±2.0 to 17±1.23. In a different study, Baron et al. (2020) first evaluated the functional movements of young football players with the FMS test and then applied for a 12-week period of functional training programme. When the data obtained at the end of the study were evaluated, FMS 1 pre-test was 1,55±0,51 post-test was 2,25±0,55 (42,2%), FMS 2 pre-test was 1,85±0,49 post-test was 2,3±0,57 (24,3%) and FMS 3 pre-test was 1,65±0,59 post-test was 2,45±0,69 (48,5%). They also concluded that the lower body strength of football players improved significantly after the training programme. In a different study, Soyal et al. (2023) examined the effect of isokinetic lower extremity strength on vertical jump parameters in female football players. According to the findings of the study, they concluded that there was a moderate relationship between the vertical jump right 240 s %BW knee flexion and left knee 240 s %BW flexion and 240 s %BW extension parameters. In their study on female volleyball players, Soylu et al. (2020) concluded that there was a moderate positive relationship between FMS scores and lower extremity 600 s flexion, 60^0 s extension, 180^0 s flexion and 180^0 s extension peak torque. In a different study, Birben et al. (2017) investigated the relationship between FMS analyses and isokinetic lower-extremity muscle strength balance in Greco-Roman wrestling athletes. According to the results of this study, 60 s. and 180 sec. They found a relationship between flexor and extensor peak torque values at angular velocities, flexion/extension ratio, and the difference between right and left leg strength and FMS parameters related to the lower extremity on the dominant and non-dominant sides.

It was thought that the reason why there was no relationship between FMS tests and isokinetic lower body strength of amateur football players in our study was due to the fact that the athletes in the studies were professional athletes compared to other studies. In addition to the fact that the athletes were professionals, the FMS programme was integrated into the training periods before and during the season and applied for long weeks, which contributed positively to the lower extremity parameters of the athletes.

Conclusions

In conclusion, no statistical relationship was found between the FMS scores of the participants in our study and isokinetic lower-extremity knee strength. This situation creates the idea that proprioception, especially in the lower extremities, comes to the fore because of the limited force produced at a certain angle in the movement pattern of football players. It can be said that lower extremity strength, joint mobility and football-specific muscle memory play an important role, especially in situations where football players need to react suddenly. However, the training performed by football players, the fact that not only the lower extremity values but also the functions of all joints are active in the FMS score, and the limited past isokinetic force experience and level revealed that there was no relationship between the values measured in the study. Future studies should measure the FMS score, isokinetic strength, and proprioception parameters of the lower extremity joints. Applying a specific training program in line with the first tests, taking the final tests, and examining the relationship between the parameters and the effect of the training will contribute to sports science.

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