ORIGINAL ARTICLE

Investigation of the relationship between isokinetic lower extremity strength and the vertical jump parameter in elite women football players

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim It can be said that recently, with the popularity of women's football and playing at a professional level, physical and physiological needs have increased. In this context, this study was conducted to examine the relationship between isokinetic lower extremity strength and vertical jump parameters in elite female football players.

Material and Methods The model of the research was the relational survey model, one of the survey models. The research group consisted of 26 volunteer professional female football players competing at the Turkish women's super league level. The maximum strength of the knee extensor and flexor muscles of female soccer players was measured using an isokinetic dynamometer device (Cybex NORM®, Humac, CA, USA) that allows the recording of instant isokinetic torque. The vertical jump test data of the female football players were determined with the Fusion Sport-Smart Jump brand jump mat. While SPSS 25.0 package program was used for statistical analysis evaluation, correlation analysis was applied to compare the relationship between isokinetic lower extremity strength and vertical jump parameter.

Results When the participants' vertical jump, right knee flexion and extension degrees were examined, a moderate positive correlation was found between the vertical jump parameter and the 240s Flexion Right %Body Weight values, and no relationship was found between the other parameters and the vertical jump. A moderate positive correlation was detected between the vertical jump parameter and 240s Flexion Left %Body Weight. Another moderate positive correlation was found between the vertical jump parameter and 240s Extension Left %Body Weight values. At the same time, no relation was found between other parameters and vertical jumps.

Conclusions As a result, when the study results were evaluated, a positive relationship was determined between vertical jump and right knee flexion parameters and similarly left knee flexion-extension parameters. Based on this situation, it was concluded that the contraction levels of the lower extremity strength, which plays an important role in determining the performance in the football branch, contribute positively to the jump performance.

Keywords: football, isokinetic lower extremity strength, vertical jump, strength, football players

Introduction

Nowadays, women's football has become an increasingly popular sport in our country as well as all over the world. To maximize performance and be successful in this branch, the psychological, and technical-tactical needs of female football players as well as their physical and physiological characteristics should be well determined, and training programs should be applied systematically.

While football is defined as a sport that requires intermittently high agility, speed, endurance, strength and balance, and to become successful in this branch, football players must perform repetitive high-intensity activities, including football-specific skills such as high speed running, sudden changes of direction, passing and scoring [1, 2]. Besides, some motor skills of football players should be developed to perform these activities well and to gain an advantage over the opponent in the competition. The sudden change of direction, sprint and jump in the football branch are closely related to the concentric and eccentric work of the lower extremity muscles together with the trunk stabilization to accelerate and slow down the body mass in both horizontal, and vertical directions and to perform [3, 4]. It can be said that this situation reveals the fact that isokinetic lower extremity strength is important in football players.

Isokinetic force, it is expressed as the highest torque [rotation moment] value that can be developed during a certain contraction speed. At the same time, thanks to isokinetic devices, it is said that maximum loading is achieved in the muscle during the predetermined constant speed movement and dynamic movement [5].

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It can be said that jumps in football are important in terms of evaluating performance. Jumping is stated as an important parameter for athletes to gain superiority over their opponents and to assess their performance during football competitions. At the same time, a strong relationship is stated between jumping, which is an indicator of anaerobic power, and competition performance [6].

Regarding the vertical jump, it is stated that performance depends not only on the strength of the lower extremities, but also on the speed at which the muscle units can generate force, the speed of contraction, the ability to use the stretch-shortening cycle, and the intramuscular coordination ability [7]. This suggests that athletes may be injured from time to time due to insufficient muscle strength. In addition to muscle strength, the decrease in the functional integrity of the knee joint may disrupt the postural balance and accordingly may reveal the risk of anterior cruciate ligament injury [8]. Thus, it can be said that following the strength ratio between the lower extremity muscles is an important criterion for athletes to minimize this situation that may arise and to increase their performance of the athletes. Traditionally, the balance of force between the agonist and antagonist thigh muscles can be assessed by dividing the concentric peak torques from both the flexors and extensors [extensor-flexor ratio] [9]. This ratio is called the traditional balance ratio and it is stated that a healthy knee shows results between 55-77% [10]. Moreover, it has been reported that more power is associated with speed, sudden change of direction, jumping, and improved force-time characteristics [force development speed and the ability to generate external mechanical strength], a requirement of football-specific skills [11]. For this reason, it is that the evaluation of muscle strength, that is, isokinetic lower extremity strength [estimating muscle strength] is important in football, as other branches [12].

It can be said that the physical and physiological needs have increased with the popularity of women's football and being played at a professional level recently. In this context, this study aimed to examine the relationship between isokinetic lower extremity strength and vertical jump parameters in elite female football players.

Materials and Methods

Participants

The research group consisted of 26 volunteer professional female football players (mean age was 23.43±4.52), among whom were university students, competing at the Turkish women's super league level. Permits was taken from the authorized football clubs for the participants. No participants with any injuries or sports injuries were included in the study. Necessary information was given before the study and participation was provided on a voluntary basis.

Ethics committee approval was received from Istanbul Gelisim University Institute of Graduate Studies (meeting date: 30.11.2022- meeting no: 2022 17-52) for the purpose of conducting the research.

Research Design

The model of the research was the relational survey model, one of the survey models. Relational screening models are research models that aim to determine the existence and/or degree of co-variance between two or more variables. Although the relational screening model does not give a real cause-effect relationship, it allows the estimation of the other variable if the situation in one variable is known [13].

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 meter with a precision of 0.01 cm [14].

Isokinetic Force Test

The female soccer players participating in the study measured the maximum strength of the knee extensor and flexor muscles using an isokinetic dynamometer device [Cybex NORM®, Humac, CA, USA], which allows the recording of instant isokinetic torque [15]. The female football players in the study warmed up by running for 5 minutes before starting the test and doing active stretching for the lower extremities for 5 minutes. After the warm-up, the players were taken to the isokinetic dynamometer to be measured. During the evaluation with an isokinetic dynamometer, the participants were held in a sitting position and the evaluated leg was stabilized with a belt from the distal thigh. The lower leg is strapped to the axis of the dynamometer just proximal to the medial malleolus. Dynamometer angles were calibrated to 0° and 90° for each football player.

In the study, Knee extension and flexion of the female football players were measured by concentric contractions as 4 retrials at 60°s-1 angular speed followed by 4 main tests with 15 seconds rest, and 4 retests at 240°s-1 angular speed, and followed by 15 seconds rest and then 20 main tests. A rest period of 45 seconds was given between angular velocities. During the measurements, the participants were constantly warned about the basic push/pull, the number of repetitions remaining, and the rest time. Verbal warnings and motivations were given throughout the tests so that the participants could reveal their best strength values. The test position was performed as recommended in the manufacturer's manual. As a result of the test, both quadriceps and hamstring peak torque (PT) (Nm])values and H/K peak torque ratios were calculated [16].

Vertical Jump Test

Vertical jump status data of the athletes were determined with the Fusion Sport-Smart Jump brand jump mat. At the time of the test, the body positions of athletes were in an upright posture with their hands on the waist, and they were asked to jump upwards with maximal force immediately after a downward slump. The time scale was arranged to start with the upward jumping action performed by the athletes and was within the interval when they descend on the splash mat again. Thanks to the software in the device, the time spent by the athletes in the air, and the jump height data were calculated automatically and recorded as a score. The vertical jump test was applied by giving the athletes 2 rights and giving 30 seconds as a rest period between the rights, and the best result was recorded as the score [17].

Statistical Analysis

The data to be obtained in the study were transferred to the electronic environment and given as mean and standard deviation. For the normality test of the data, skewness and kurtosis values were checked with the Kolmogorov-Smirnov test. No deviations from normality were detected in the obtained data and the data showed a normal distribution within the range of ±1.5.

Results

When Table 1. was examined, it was determined that the mean age was 23.43±4.523, the mean height was 163.57±3.586, the weight mean was 57.10±5.881, and the mean body mass index value was 21.3400±2.1360.

Table 1. Descriptive Statistics of Participants

Variables	N	Min	Max	X±Sd
Age [year]	21	17	31	23.43±4.523
Height [cm]	21	156	172	163.57±3.586
Weight [kg]	21	45	68	57.10±5.881
Body mass index [BMI, %]	21	16.73	25.28	21.3400±2.11360

When Table 2 was examined, the minimum value seen as a 0 (zero), and the maximum value seen as a 316.

When Table 3 was examined, a moderate positive correlation was detected between the participants' vertical jump parameter and 240sec Flx Right %BW [p=.038; r=.455] values, while no relationship was found between other parameters and vertical jump.

When Table 4 was examined, a moderate positive correlation was detected between the vertical jump parameter of the participants and the values of 240sec Flx Left %BW (p=.019; r=.506) and 240sec Ext Left %BW (p=.030; r=.475). No relationship was detected between other parameters and vertical jump.

Table 2. Descriptive Statistics of Participants' Pre-Test Values

Variables	N	Min	Max	X±Sd
60sec Flx Right	21	99	183	129.86±20.553
60sec Flx Right %BW	21	170	316	228.95±37.677
60sec Flx Left	21	71	155	120.62±22.573
60sec Flx Left %BW	21	110	268	213.38±43.223
60sec Flx Deficit	21	0	37	11.57±9.479
60sec Ext Right	21	52	102	71.57±13.242
60sec Ext Right %BW	21	86	176	125.86±24.282
60sec Ext Left	21	52	95	70.43±13.083
60sec Ext Left %BW	21	92	164	123.86±23.497
60sec Ext Deficit	21	0	22	8.90±6.371
60sec H/Q Right	21	40	70	55.38±6.837
60sec H/Q Left	21	46	87	59.10±9.762
240sec Flx Right	21	54	98	77.52±11.961
240sec Flx Right %BW	21	104	170	136.14±21.216
240sec Flx Left	21	53	94	75.57±12.048
240sec Flx Left %BW	21	95	176	133.14±21.615
240sec Flx Deficit	21	0	22	7.90±6.441
240sec Ext Right	21	31	71	48.90±10,922
240sec Ext Right %BW	21	63	122	86,24±19.685
240sec Ext Left	21	31	66	45.29±8.990
240sec Ext Left %BW	21	51	116	79.71±15.624
240sec Ext Deficit	21	0	32	9.67±8.470
240sec H/Q Right	21	48	76	62.95±8.363
240sec H/Q Left	21	41	82	61.19±9.847
Vertical Jump	21	20.6	35.9	26.243±3.7282

Discussion

It can be said that the physical and physiological needs have increased with the popularity of women's football, and due to its professional level. In this context, our study was conducted to examine the relationship between isokinetic lower extremity strength and vertical jump parameters in elite female football players.

When the statistical analysis results were evaluated, a moderately positive correlation was determined between the vertical jump parameter, 240sec Flx Right %BW [p=.038; r=.455], 240sec Flx Left %BW [p=.019; r=.506] and 240sec Ext Left %BW [p=.030; r=.475] values.

Table 3. Correlation Analysis of Participants' Vertical Jump and Right Knee Flexion and Extension Degrees

Variables		1	2	3	4	5	6	7	8	9	10	11
Vertical Jump	r	1										
	p											
60sec Flx Right	r	.087	1									
	p	.707										
60sec Flx Right %BW	r	.404	**.801****	1								
	p	.069	.000									
60sec Ext Right	r	.098	**.751****	**.590****	1							
	p	.673	**.000**	**.005**								
60sec Ext Right %BW	r	.332	**.619****	**.755****	**.884****	1						
	p	.142	**.003**	**.000**	**.000**							
60sec H/Q Right	r	.007	-.145	-.158	**.540***	**.520***	1					
	p	.976	.530	.495	**.012**	**.016**						
240sec Flx Right	r	.127	**.724****	**.482***	**.773****	**.598****	.271	1				
	p	.584	**.000**	**.027**	**.000**	**.004**	.235					
240sec Flx Right %BW	r	**.455***	**.589****	**.738****	**.675****	**.795****	.269	**.803****	1			
	p	**.038**	**.005**	**.000**	**.001**	**.000**	.238	.000				
240sec Ext Right %BW	r	.407	**.463***	**.559****	**.746****	**.844****	**.521***	**.658****	**.810****	1		
	p	.067	**.034**	**.008**	**.000**	**.000**	.015	.001	.000			
240sec Ext Right	r	.202	**.574****	.410	**.827****	**.725****	**.514***	**.802****	**.696****	**.910****	1	
	p	.380	**.006**	.065	**.000**	**.000**	**.017**	**.000**	**.000**	**.000**		
240sec H/Q Right	r	.135	.088	.066	**.470***	**.482***	**.570****	.172	.189	**.722****	**.720****	1
	p	.560	.706	.776	**.032**	**.027**	**.007**	.457	.412	**.000**	**.000**	

*p<0.05, **p<0.001

Table 4. Correlation Analysis of Participants' Vertical Jump and Left Knee Flexion and Extension Degrees

Variables		1	2	3	4	5	6	7	8	9	10
Vertical Jump	r	1									
	p										
60sec Flx Left	r	.140	1								
	p	.544									
60sec Flx Left %BW	r	.395	**.865****	1							
	p	.076	**.000**								
60sec Ext Left	r	.007	**.723****	**.532***	1						
	p	.975	**.000**	**.013**							
60sec Ext Left %BW	r	.257	**.681****	**.740****	**.878****	1					
	p	.261	**.001**	**.000**	**.000**						
60sec H/Q Left	r	-.194	**-.487***	**-.566****	.228	.101	1				
	p	.398	**.025**	**.007**	.320	.665					
240sec Flx Left %BW	r	**.506***	**.665****	**.761****	**.523***	**.665****	-.227	1			
	p	**.019**	**.001**	**.000**	**.015**	**.001**	.322				
240sec Ext Left	r	.258	.425	.283	**.734****	**.620****	.354	**.539***	1		
	p	.258	.055	.214	**000**	**.003**	.116	**.012**			
240sec Ext Left %BW	r	**.475***	.392	**.473***	**.635****	**.740****	.240	**.655****	**.897****	1	
	p	**.030**	.079	**.030**	**.002**	**.000**	.294	**.001**	**.000**		
240sec H/Q Left	r	.008	-.112	-.135	.373	.337	**.568****	-.182	**.543***	**.532***	1
	p	.971	.628	.559	.096	.135	**.007**	.430	**.011**	**.013**	

*p<0.05, **p<0.001

When the literature was examined, found high correlations between isokinetic strength and jump performance in a study by Menzel et al. [18]. In another study [19] it was found that 8-week plyometric training applied to the lower extremity of adult female football players contributed positively to jumping ability. Śliwowski et al. [4] examined the relationship between jumping performance, isokinetic strength and dynamic postural control in elite young male soccer players. The authors found a statistically significant difference between isokinetic power indicators and dynamic jump performance in soccer players. In another study [20], the strength, speed and power profiles obtained during a unilateral jump and single-leg isokinetic training in basketball players were investigated. Was found that one-legged jump performance was moderately related to the force-generating ability of leg extensors. Rouis et al. [21] examined the relationship between isokinetic knee strength and vertical jump in elite young female basketball players. The authors found a mean of 2400/s knee extensor 133.96±20.75 in the dominant leg and 128.83±31.52 in the non-dominant leg, and knee flexor mean was determined as 94.43±12.92 in the dominant leg and 96.48±13.31 in the non-dominant leg. These results showed that a strong relationship could be obtained between the strength of the isokinetic knee extensors and the vertical jump height. In another study [22] it was found that 6-week plyometric training in elite male taekwondo players showed a significant improvement in maximum torque strength in the lower extremities, while there was a statistically significant difference in vertical jump performance. When some studies in the literature were examined, it was seen that they showed parallelism with our study.

Ikeda et al. [23] examined the effects of static stretching of knee extensors on flexibility, muscle strength and jump performance in young men, and found that there was no statistically significant difference in vertical jump, countermovement jump and backward jump performance. Carvalho et al. [24] evaluated the strength training combined with plyometric exercises and vertical jump performance in elite male handball players and concluded that combining general strength training with plyometric exercises could not only increase lower extremity strength and improve vertical jump performance.

In a different study [25] it was found that a 6-week plyometric exercise program for physical education students caused significant improvements in lower extremity muscles, but there was no significant increase in vertical jump performance. When the literature was examined, some studies did not show parallelism with our study. It can be concluded that this difference was due to the gender of the sample group, the training programs applied and the branch differences

Conclusions

When the results of the participants were evaluated, a moderate positive correlation was found between vertical jump and right knee flexion parameters. This situation reveals the idea that the state of the hamstring muscle contributes positively to flexion during vertical jumps. Similarly, a moderate positive correlation was found with a vertical jump in left knee flexion and extension parameters. When the biomechanics of the vertical jump was evaluated, it was concluded that the contraction levels of the hamstring and quadriceps femoris muscles were an important factor. The hamstring-quadriceps femouris ratio was considered more optimal in the support legs, especially assuming that the female football players participating in the research use their right feet dominantly, and this ratio was more limited in the dominant foot. Considering that the most common type of injury experienced by female football players was knee injuries, it can be stated that it was parallel with the result of the study. In future studies, examining the isokinetic strength by monitoring the nerve conduction levels of the neuromuscular structure will make an important contribution to sports science.

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Conflict of interest

The authors state no conflict of interest.

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