Analysis of isokinetic knee strength in soccer players in terms of selected parameters

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Abstract

Purpose: The aim of study is to analyse isokinetic knee strength in soccer players in terms of selected parameters.

Material: A total of 30 subjects, 15 soccer players and 15 controls, were included in the study. Isokinetic knee strength measurements at angular speeds of 60°sec⁻¹, 180°sec⁻¹ and 240°sec⁻¹ and pro-agility tests were conducted on the subjects. A body analyser was used for height, weight and body mass indexes (BMI) values. The training ages of the subjects and the positions of the soccer player group were recorded on personal information forms.

Results: When the agility parameters were compared between football and control groups, a statistical difference was found in favour of the soccer player group ($p < 0.05$). When the effects of body composition and isokinetic knee strength on agility were analysed, negative significant correlation was found between weight and agility, BMI and agility and 240° right knee extension strength and agility ($p < 0.05$). When the positions of soccer players and isokinetic knee strengths were compared, significance was found between 60° right extension strength of defenders and midfielders and 60° left extension-flexion strengths of defenders and midfielders and forwards in favour of defenders ($p > 0.05$).

Conclusions: In conclusion, it was found that isokinetic knee strength did not have an influence on agility in low angular speeds, except for 240°sec⁻¹ right extension. According to positions, as the isokinetic knee strength of defenders decreased, they showed higher results when compared with other positions.

Keywords: isokinetic, knee, strength, soccer player, agility.

Introduction

Football is a game that requires physical competence as well as top-level motor skills such as technical-tactical agility and speed because of the high number and intensity of matches it involves [1, 2]. Additionally, player position [3], the league that the player is in, and even the style of the game played [4] have significant effects on a soccer player's muscle profile. Studies have shown that soccer players cover long distances during a match and the distance they cover differs according to the levels and positions they play in [5, 6]. It is known that midfielders and defenders cover longer distances when compared with forwards, and offensive players are more exposed to moves that require slipping, jumping and man-to-man offence [7]. The basis of all these specific features is muscle strength [8].

Studies have shown that lower extremity strength has great significance of these specific moves in football like a strength [8], speed [9], acceleration [10], endurance [11]. In addition, isokinetic knee strength has been found to influence the speed of kicking the ball [12]. Lower extremity strength, which could previously be found with squat and vertical jump tests in general, can now be measured more objectively with isokinetic dynamometers and – thanks to dynamometers – dominant and non-dominant foot strengths can also be examined separately [13, 14]. Determining the lower extremity strength capacity of a player has great importance with respect to preventing injuries and determining the intensity of

training. Isokinetic strength values have also been found to be high as age and league levels increase [15, 16]. When studies conducted on soccer players were examined, it was found that dominant and non-dominant foot strengths generally did not show significant correlations [17]; however, low levels of significant differences were found as angular speed increased [18, 19].

The purpose of study is to analyse the effects of isokinetic knee strength of soccer players on selected physical parameters and motoric features and to compare all these parameters with respect to player positions. The subjects consisted of 15 soccer players in the Turkish Football Federation Regional Amateur League. The data were collected to compare isokinetic knee strengths of soccer players in terms of selected physical parameters, agility and positions, which is the hypothesis of the study.

Material and methods

Participants

The study included 15 soccer players (football group) who were trained five days a week for at least 2 hours each day in amateur leagues and 15 individuals (control group) who had a training history of 2–3 years out of football and who were not actively doing sports (Table 1). The study protocol was approved by the Ethics Committee for Ondokuz Mayıs University. (B.30.2.ODM.0.20.08/1596).

Research Design

The subjects were tested in a laboratory twice and indoor sports hall once. At the first laboratory visit, the subjects were informed about the test protocols, and their

heights, weights and body mass indexes (BMI) were measured. At the second one, the subjects' isokinetic knee strength measurements were done (at $60^{\circ}\text{sec}^{-1}$, $180^{\circ}\text{sec}^{-1}$ and $240^{\circ}\text{sec}^{-1}$ angular speeds, in order to find the peak torque values). Pro-agility tests were conducted in the indoor sports hall. Before the test started, the subjects were informed about the test and they were asked to perform the test with maximum effort. The subjects were warned about not doing any exercise or physical activity before the all test.

Warm-up procedure

Before the tests, the subjects undertook 5 minutes of low intensity aerobic run and 10 minutes of dynamic and static stretching of lower extremity muscles for general warm-up [20].

Determination of descriptive information

A Gaia 359 Plus BodyPass analyser was used to find out the height, weight and BMI parameters of the subjects. Before the measurements, the device was introduced to all the subjects and they were asked to stay as quiet and as immobile as possible during the test. An individual demonstrated the test on the analyser to help the subjects understand it. The subjects stood on the analyser with bare feet, wearing a t-shirt and shorts, and their height (cm), weight (kg) and BMI values were recorded. The subjects' age, position and training ages were obtained from the personal information form given to subjects.

Determination of isokinetic knee strength

The peak torque angular speeds that the subjects were to show in knee extension and flexion moves were determined as $60^{\circ}\text{sec}^{-1}$, $180^{\circ}\text{sec}^{-1}$ and $240^{\circ}\text{sec}^{-1}$. The tests were conducted with computer controlled isokinetic dynamometer (Humac Norm Testing and Rehabilitation System, CSMI, USA). For each test at the determined angles, the subjects were warned verbally to take into consideration the resting intervals in line with the fixed protocol of the dynamometer.

With the determination of resting intervals, subjects were asked to show five maximum efforts and the highest values displayed during five tries of all angular speeds were accepted as peak torque values. In order to ensure the adaptation of the subjects and to protect them from injuries, three practice repetitions of all angular speeds were made before the test and the test was started after 30 seconds of rest. During the whole test, each subject was encouraged about basic push/pull and the number of remaining repetitions and loud verbal encouragement

were given continuously to help the peak torque (PT) values of the subjects to be the highest level. Before starting the test, all the subjects were asked to use their knee strength in the maximal level for a positive test and to get maximal results [21]. In all angular speeds, PT values were recorded as Newton (Nm). Before isokinetic knee strength, isokinetic dynamometer was calibrated as advised by CSMI (2003).

Pro-agility test

A pro-agility test, also known as a 20 yard (18.2982 m) sprint, was conducted on the subjects. The test area was adjusted by placing pointers 4.57 m left and 4.57 m right of the start line. Tagheuer HL-232 photocell doors, which can record percentiles of a second, were placed at the start line and the area in which the study would be conducted was defined with pointers. The data from the photocell was directly transferred to the computer with a Tagheuer CP-540. After the photocell system was tested, the subjects were taken to the area. They were told that the participant had to be in place at the start line and, when he was ready, to touch the pointer on the right and then the one on the left at the same time with hands and feet and to end the test by passing the start line. After being shown how to do the test, each subject had to do a trial test three times and received feedback. At the beginning, the subjects to be tested were determined randomly and the test was predicted to be completed according to that order. All the subjects were tested three times with intervals of 1 minute. The subjects were given feedback to help them get the best results. The subjects' best times from these three tests were recorded in seconds (sec) and the test was concluded.

Statistical Analysis.

SPSS for Windows (version 16.0, 2008, SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. The data were presented as mean and standard deviation. Normal distribution of data was tested using the Shapiro-Wilk's test and a Levene test was used to test homogeneity. An independent t-test was applied in the comparison of two groups. A Pearson correlation was performed to control the association between variables. Statistical results were assessed within the 95% confidence interval and a $p < 0.05$ level of significance.

Results

Table 1 shows the descriptive information of the study. There were no significant difference between the soccer

Table 1. Comparison of descriptive information of the football and control groups

Variable	Group	N	Mean	Std. Dev.	t	p
Age	Soccer	15	22.80	2.14	1.813	0.082
(years)	Control	15	21.60	1.40		
Height	Soccer	15	177.00	4.90	0.645	0.524
(cm)	Control	15	175.73	5.81		
Weight	Soccer	15	75.95	6.91	1.601	0.123
(kg)	Control	15	72.63	4.07		
BMI	Soccer	15	24.22	1.61	1.016	0.319
(kg/m ²)	Control	15	23.57	1.84		

players and the control group with respect to descriptive information ($p > 0.05$).

When the agility parameters were compared between groups (Table 2), a statistically significant difference was determined in favour of the soccer group ($p < 0.05$).

There were no differences right and left isokinetic knee extension and flexion strength parameters between the groups ($p > 0.05$), (Table 3).

In the correlation test conducted to find out the effect of soccer players' body composition and isokinetic knee strength on agility (Table 4). When the pro-agility test time improved, weight, BMI and 240° right knee extension strength increase ($p < 0.05$).

Table 5 examines the correlation between soccer players' positions and their descriptive information, agility and isokinetic knee strength rates. When the results were analysed, significant differences were found as follows: in weight between defenders and midfielders and the control group; in training age between all positions and the control group; in agility test between defenders and

the control group; in 60° right extension strength between defenders and midfielders and also the control group and midfielders; in 60° left extension strength between defenders and midfielders and forwards and also between the control group and midfielders and forwards; and in 60° left flexion strength between defenders and forward midfielders and also the control group and forwards ($p < 0.05$).

Discussion

Football is a sport based on aerobic-anaerobic strength and muscle strength and at the same time it requires a top-level display of motoric features. In the studies conducted, the most commonly used moves include kick the ball, jumping and running, and all these moves are reported to be directly associated with knee joint muscles [22, 23].

In our study, when isokinetic knee strengths were examined, no significant difference was found between the two groups ($p > 0.05$). When compared with the literature, the results were found to be similar to results

Table 2. Comparison of pro-agility parameters of football and the control group

Variable	Group	N	Mean	Std. Deviation	t	p
Pro-Agility (sec)	Soccer	15	4,70	0,22	-2,189	0,037*
	Control	15	4,89	0,26		

* $p < 0,05$

Table 3. Comparison of isokinetic knee strength parameters of the football and the control group

Variable	Group	N	Mean	Std. Deviation	t	p
60° Right knee Ext. Strength (nm)	Soccer	15	165.00	24.83	0.779	0.445
	Control	15	154.40	46.51		
60° Right knee Flex. Strength (nm)	Soccer	15	105.60	17.70	1.272	0.214
	Control	15	94.93	27.22		
60° Left knee Ext. Strength (nm)	Soccer	15	169.73	29.57	1.485	0.151
	Control	15	148.60	46.50		
60° Left knee Flex. Strength (nm)	Soccer	15	94.73	10.65	0.838	0.414
	Control	15	87.20	33.16		
180° Right knee Ext. Strength (nm)	Soccer	15	106.60	25.12	1.070	0.295
	Control	15	98.20	17.11		
180° Right knee Flex. Strength (nm)	Soccer	15	68.73	20.80	0.597	0.555
	Control	15	64.27	20.17		
180° Left knee Ext. Strength (nm)	Soccer	15	101.93	21.34	1.097	0.282
	Control	15	93.27	21.93		
180° Left knee Flex. Strength (nm)	Soccer	15	61.67	16.41	0.192	0.849
	Control	15	60.60	13.84		
240° Right knee Ext. Strength (nm)	Soccer	15	88.07	17.84	1.262	0.218
	Control	15	81.07	11.98		
240° Right knee Flex. Strength (nm)	Soccer	15	56.40	13.83	0.635	0.531
	Control	15	53.00	15.46		
240° Left knee Ext. Strength (nm)	Soccer	15	83.33	14.31	0.540	0.594
	Control	15	80.27	16.71		
240° Left knee Flex. Strength (nm)	Soccer	15	49.47	10.15	0.018	0.985
	Control	15	49.40	9.72		

Table 4. The association between descriptive parameters and isokinetic knee strength and agility

Variable		Age	Height	Weight	BMI	60° Right Knee Ext. strength	60° Right Knee Flex. strength	60° Left Knee Ext. strength	60° Left knee Flex. strength	180° Right knee Ext. strength	180° Right knee Flex. strength	180° Left Knee Ext. strength	180° Left knee Flex. strength	240° Right Knee Ext. strength	240° Right Knee Flex. strength	240° Left Knee Ext. strength	240° Left knee Flex. strength
Pro-Agility	r	.062	-.247	-.577	-.578	-.342	.333	-.188	-.330	-.378	.172	-.249	-.076	-.586*	.028	-.437	-.434
	p	.825	.374	.024*	.024*	.212	.225	.503	.229	.165	.540	.371	.789	.022	.920	.103	.106
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

*p<0,05

Table 5. Analysis of positions in terms of descriptive information, agility and isokinetic strength rates

Variable		n	Mean	SD	F	P	Significant difference
Age (years)	1.Defender	6	23.00	2.45	1.412	0,262	-
	2.Midfielder	5	23.20	1.64			
	3.Forward	4	22.00	2.58			
	4.Control	15	21.60	1.40			
Height (cm)	1.Defender	6	179.67	3.44	2.106	0,124	-
	2.Midfielder	5	172.60	4.56			
	3.Forward	4	178.50	3.87			
	4.Control	15	175.73	5.81			
Weight (kg)	1.Defender	6	80.53	6.73	4.589	0,010	2-1 4-1
	2.Midfielder	5	70.84	2.69			
	3.Forward	4	75.45	7.18			
	4.Control	15	72.63	4.07			
BMI(kg/m ²)	1.Defender	6	24.91	1.45	0.876	0,466	-
	2.Midfielder	5	23.80	1.28			
	3.Forward	4	23.68	2.19			
	4.Control	15	23.57	1.84			
Sports age (years)	1.Defender	6	11.17	1.60	143.875	0,001	1-4 2-4 3-4
	2.Midfielder	5	10.80	1.64			
	3.Forward	4	9.75	0.96			
	4.Control	15	2.93	0.26			
Pro Agility (sec)	1.Defender	6	4.55	0.19	2.923	0,050	1-4
	2.Midfielder	5	4.78	0.14			
	3.Forward	4	4.80	0.27			
	4.Control	15	4.89	0.26			
Right extension 60° (nm)	1.Defender	6	185.83	55.05	3.768	0,023	1-2 4-2
	2.Midfielder	5	122.60	15.81			
	3.Forward	4	147.00	31.23			
	4.Control	15	165.00	24.83			
Right flexion 60°(nm)	1.Defender	6	100.67	38.06	1.030	0,396	-
	2.Midfielder	5	84.60	9.50			
	3.Forward	4	99.25	25.60			
	4.Control	15	105.60	17.70			
Left extension 60°(nm)	1.Defender	6	179.33	41.25	3.527	0,029	1-2 1-3 4-2, 4-3
	2.Midfielder	5	134.60	35.22			
	3.Forward	4	120.00	47.91			
	4.Control	15	169.73	29.57			

Cont. Table 5

Variable		n	Mean	SD	F	P	Significant difference
Left extension 60°(nm)	1.Defender	6	179.33	41.25	3.527	0,029	1-2
	2.Midfielder	5	134.60	35.22			1-3
	3.Forward	4	120.00	47.91			4-2, 4-3
	4.Control	15	169.73	29.57			
Left flexion 60°(nm)	1.Defender	6	110.33	35.76	5.076	0,007	1-2, 1-3
	2.Midfielder	5	79.40	19.71			4-3
	3.Forward	4	62.25	21.93			
	4.Control	15	94.73	10.65			
Right extension 180°(nm)	1.Defender	6	116.83	29.69	1.256	0,310	-
	2.Midfielder	5	96.40	23.73			
	3.Forward	4	104.00	18.28			
	4.Control	15	98.20	17.11			
Right flexion 180°(nm)	1.Defender	6	74.50	27.13	0.566	0,642	-
	2.Midfielder	5	60.20	6.57			
	3.Forward	4	70.75	23.27			
	4.Control	15	64.27	20.17			
Left extension 180°(nm)	1.Defender	6	103.00	25.67	1.090	0,371	-
	2.Midfielder	5	88.00	17.71			
	3.Forward	4	85.25	20.17			
	4.Control	15	101.93	21.34			
Left flexion 180°(nm)	1.Defender	6	66.17	17.60	0.549	0,653	-
	2.Midfielder	5	62.60	20.56			
	3.Forward	4	53.75	7.14			
	4.Control	15	60.60	13.84			
Right extension 240° (nm)	1.Defender	6	95.17	20.84	1.300	0,295	-
	2.Midfielder	5	82.00	19.70			
	3.Forward	4	85.00	8.37			
	4.Control	15	81.07	11.98			
Right flexion 240°(nm)	1.Defender	6	61.33	21.01	0.504	0,683	-
	2.Midfielder	5	52.40	7.02			
	3.Forward	4	54.00	2.94			
	4.Control	15	53.00	15.46			
Right extension 240°(nm)	1.Defender	6	88.50	18.43	1.713	0,189	-
	2.Midfielder	5	80.60	15.49			
	3.Forward	4	67.50	8.06			
	4.Control	15	83.33	14.31			
Left flexion 240°(nm)	1.Defender	6	54.67	13.23	1.021	0,399	-
	2.Midfielder	5	47.00	4.90			
	3.Forward	4	44.50	4.43			
	4.Control	15	49.47	10.15			

of soccer players playing in amateur leagues [24] and the third league [25]; however, they were found to be lower when compared with junior national team [25, 26] and professional soccer players [27, 28]. In addition, in line with the results of our study, other studies have found the strength rate to decrease as angular speed increased. When the results are examined, it can be seen that as the quality of football leagues increase, strength rates give better results, and that training by top-level leagues should be

programmed more systematically and scientifically than the lower leagues and the content should also be more systematic and scientific.

When the isokinetic knee strengths were compared in terms of positions, significant differences were determined between defenders and forwards and midfielders in 60°sec^{-1} right and left knee extension and 60°sec^{-1} left knee flexion strengths in favour of defenders ($p < 0.05$). No statistically difference was observed in other

angular speeds ($p > 0.05$). According to the results of our study, when isokinetic knee strengths were examined according to positions, it was found that significant distinction decreased as angular speed increased. Other studies comparing isokinetic knee strength with respect to positions showed that defenders had higher strength rates than forwards and midfielders [7, 29]. Based on this, defenders showing higher rates than midfielders and forwards at lower angular speeds was thought to be the result of defenders having to move faster within the game to prevent the attacks by the opponent and, due to their sudden reactions at the moment of defence, they have more developed fast twitch muscle fibril structures [30].

When the agility times of soccer players and the control group were examined, a distinction was significantly found in favour of the soccer players ($p < 0.05$). However, when agility times were compared in terms of soccer players' positions, no distinction was found ($p > 0.05$). Agility times in our study and those in literature were found to be in parallel [19, 35]. When the association between isokinetic knee strength and agility times were examined, a negative correlation was found only between 240°sec^{-1} right knee extension strength and agility ($p < 0.05$). No significance was found in 60°sec^{-1} and 180°sec^{-1} angular speeds. When some studies that analysed the association between knee strength and agility were examined [31, 32], it was found that the studies which did not find correlation between two parameters were found to be in parallel with our study. Another studies were examined, it was found that small correlation between two parameters [33, 34]. When the association between these two parameters was

analysed, it was found that isokinetic knee strength did not have an influence on agility in low angular speeds [36] but had a positive influence on agility as angular speed increased [37, 38].

Conclusion

In summary, it was found that isokinetic strength rates in soccer players differed in terms of the quality of the league they played in, and amateur soccer players were found to have lower strength rates than those playing in national teams or those playing professionally. According to positions, it was found that defenders had better results than players in other positions in 60°sec^{-1} knee strengths. Besides, it was found that agility times of soccer players decreased as 240°sec^{-1} right knee extension strength increased; however, no correlation was found between positions.

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Conflict of interest

The authors declare no conflict of interest.

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