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Comparison of Agility, Sprint, Anaerobic Power and Aerobic Capacities of Soccer Players by Playing Positions

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Abstract

This study was carried out to compare the agility, sprint, anaerobic power and aerobic capacities of the soccer players by their playing positions. 33 male soccer players (defenders (n=8) 20±1.73 years; midfielders (n=10) 20.09±1.97 years forwards (n=7) 20.55±1.91) with a training age of over 5 years playing in different positions in Kastamonu amateur league participated in the study voluntarily. First, Body Mass Index (BMI) values were calculated by measuring the height and weight of each player. Then, Illinois Agility Test, Yoyo Intermittent Recovery Test, 30 m. Sprint Test and Running-Based Anaerobic Sprint Test (RAST) were conducted. Statistical analysis was done with the SPSS 22.0 program. No statistically significant differences were observed between defenders, midfielder and forwards in Yoyo Test (m.), MaxVO_2 (ml/kg/min.), RAST maximal power, RAST average power and RAST fatigue index ($p>0.05$). However, a significant difference was found between players in Illinois Test (sec.) and 30 m. Sprint Test (sec.) ($p<0.05$). Forwards and midfielders were more agile than defenders, and midfielders were faster than defenders. It will therefore contribute to their performance to evaluate physical and physiological needs according to playing positions as the distances players cover vary depending on their playing positions (defense, midfield and forward) along with the movements they perform on the pitch and the frequency of these movements.

Keywords: soccer, anaerobic power, aerobic capacity

1. Introduction

Soccer is a game which is played within its rules by a certain number of players in a limited area using all parts of the body except for the hands and the result is determined by the number of goals scored or conceded (Göral & Göral 2015). Soccer is seen as the most popular sport in the world. It is a complex sports discipline in which aerobic and anaerobic energy systems are used and factors such as overall endurance and coordination affect performance (Sever, 2013). In addition, soccer is a sport which embodies physical performance characteristics such as agility, speed, power and strength, and is influenced by all these parameters (Hazır et al., 2010).

Agility is a physical characteristic required for a successful performance in soccer and it is equally important for other sports activities. Agility can also be defined as the control and coordination ability that enables the body and joints to be in the right position in space while quickly changing direction during a series of movements (Shephard & Young 2006). Agility can be defined simply as the ability to change direction rapidly. In other words, it is the rapid whole body movement with change of direction in response to stimuli coming from the environment. Agility in soccer is the most fundamental performance component that determines the quality in players' movements such as rapid acceleration and deceleration and in their sprints which require quick change of direction. For this reason, it is necessary for the players to predict what they will do depending on the effect likely to arise and the decision they have made, and adjust the speed of their movement accordingly. Agility can be improved by techniques specific to sports. It has an effect on body position, ability to change direction and quick acceleration. There is a relationship between body position and the applied force; the body for example leans forward while accelerating, returns to its initial vertical position while decelerating and moves sideways during vertical displacements. These factors can also be perfected over time through training (Özdemir, 2013).

Sprint training generally aims to improve skills such as straight sprint acceleration which does not involve change of direction, achieving maximal speed and maintaining speed. It was found that straight sprint training does not have a

significant effect on high-speed running performance involving change of direction, and that specific agility training does not improve straight sprint performance (Young et al., 2001). For this reason, the level of significance between straight sprint and agility (running speed with change of direction) is not as high as expected (Hazır et al., 2010).

Anaerobic performance largely includes explosive exercises that end in a short time. The immediate need for the energy for these types of efforts is provided by ATP-CP and anaerobic glycolysis. Anaerobic capacity is therefore the total amount of the energy that is obtainable from the anaerobic energy systems (Köklü et al., 2007). It is stated that anaerobic performance depends on two factors: anaerobic power and anaerobic capacity (Sutton et al., 2000). Of these two factors, anaerobic power depends on the use of alactacid energy system (ATP-PCr system) in relation to the ATP regeneration process in high-intensity, short-duration burst of efforts while anaerobic capacity is largely based on the use of the lactacid energy system (anaerobic glycolysis) (Bencke et al., 2002; Inbar & Bar-Or 1986; Kearney et al., 2000; Müniroğlu et al., 2012).

In soccer, anaerobic power and capacity are needed to start running quickly, to run fast, to change the direction quickly, to head the ball, to jump high and to quickly swing the foot to kick the ball (Köklü et al., 2007).

In all sporting activities, the energy required for movement is generated through metabolic processes. All muscle contractions, whether voluntary or involuntary, require energy. Therefore, the primary source of this energy (ATP) is adenosine triphosphate. The energy produced can be used in any process, for example in metabolic conditions or for muscle contractions. Anaerobic threshold is the point at which energy metabolism starts to switch to anaerobic metabolism due to a reduction in the amount of oxygen required by the muscles during incremental exercises. The exercises that remain below this threshold are therefore called aerobic exercise, while those exceed this threshold are called anaerobic exercises. Some researchers report that anaerobic power and capacity are determinants of performance in sports which require speed, leap, quick acceleration or change of direction. Aerobic power is defined as the maximum rate of oxygen consumption ($MaxVO_2$) with the ability to produce aerobic energy during incremental exercise. Used as a synonym for "endurance", aerobic capacity is defined as the ability to maintain an exercise for a long time (Müniroğlu et al., 2012).

2. Method

2.1 Participants

This study was conducted with 33 male soccer players (n=8 defense, n=10 midfield and n=7 forward) playing in different positions in Kastamonu amateur league. Players with no disability and with a training age of over 5 years were included in the study. The research is limited to the data obtained from these soccer players.

2.2 Data Collection Tools

First, the body mass index (BMI) values were calculated by measuring the height and weight of each player. Later, Illinois Agility Test, Yoyo Intermittent Recovery Test, 30 m. Sprint Test and Running-Based Anaerobic Sprint Test (RAST) were conducted. All participants were informed about the test protocols before each test.

2.2.1 Body Weight and Height

Body height was measured with an accuracy of 0.1 cm. using a Holtain (UK) stadiometer (Aslan & Koç 2015). Participants took in and held a deep breath while keeping their head in the frankfort plane, and the vertical distance from the standing surface to vertex (top of the head) was measured (Gordon et al., 1988). Body weight was measured to the nearest 0.100 gr. via Tanita (Japan) body fat analyser. Players were weighed barefoot and in sportswear. Data regarding body weight and height were added to the personal information forms and then formulated.

$$BMI = \text{Body weight (kg.)} / \text{Height (cm.}^2\text{)}$$

The BMI values of all participants were obtained by dividing the weight in kilograms by the height in centimeters squared (Sevimli, 2008).

2.2.2 Illinois Agility Test

The Illinois agility test course is 10 m. in length and 5 m. in width with 3 cones spaced 3.3 m. apart and placed on a straight line down the center of the area. The test consists of 40 m. sprint and 20 m. shuttle run with 180 ºturns at each 10 meter. After test course is prepared, a two-gate photocell electronic timing system with a precision of 0.01 second is placed at start and finish line. Before they perform the test, participants need to be informed about the test and the test course, and then allowed to try it 3-4 times at a slow pace. After that, the participants do warm-up and stretching exercises for 5-6 minutes at a slow pace set by themselves. The participants in the sample group are asked to sprint ahead from the starting line of the test course, in a prone (front lying, face down) position, with their elbows flexed and hands placed at the sides of their chest, palms on the floor. Results are recorded in seconds. The test is administered once (Hazır et al., 2015).

2.2.3 Yo-Yo Intermittent Recovery Test (YYIRT)

YYIRT is a test developed to measure the aerobic power of an athlete. The test is performed on a course of 25 m. involving two markers that are set 20 meters apart and a third one 5 m. apart to show the distance of recovery. Pre-test instructions for completing the test are clearly given to the athletes. The audio (signal) CD is played with a CD player (Sony CMT-FX 200, Japan), so the athletes are required to reach the 20 m. marker at each audio signal given at regular intervals. The test starts at a speed of 10 km/second. Once instructed by the CD, the athletes begin running 20 m. in an increasing speed to a recorded audio signal, turn and run back to the starting line. When they get back, they have 10 seconds for an active recovery in the 5 m. area behind the line. Each time they cover a distance of 40 m. As the test progresses the amount of time they have to complete each pair of runs gets shorter, so they are required to run faster to keep pace with the audio. If the athletes fail to reach the 20 m. marker in time, a warning is given and the test is completed at the third warning. The total distance covered by the athletes is recorded (Delicelioglu et al., 2014).

2.2.4 30 m. Sprint Test

10 m. and 30 m. sprint performance of soccer players were measured using a photocell test system – Newtest 300 (Finland) test battery. Participants were instructed to start the test at the starting line 1 m behind the photocell when they were ready. 10 m. and 30 m. sprint performances of the players were measured by means of the photocells positioned at the distances of 10 m. and 30 m. Each participant was asked to perform the test twice at 3-minute intervals and the best score was recorded (Delicelioğlu et al., 2014).

2.2.5 Running-Based Anaerobic Sprint Test (RAST)

RAST (Repeated Sprint Ability test protocol- repeated anaerobic sprint test) involves six sprints over 35 m. with a 10 second recovery between each sprint. The Newtest 300 (Finland) test battery was used to determine the repeated sprint ability of the athletes. Once the participants started running right behind the start-line photocell, the photocell began measuring and the performance values were recorded in seconds (Ceylan et al., 2016).

2.3 Statistics and Data Analysis

Statistical analysis was done with the SPSS 22.0 program, with the level of significance chosen as 0.05 and a confidence interval set at 95%. Kolmogorov-Smirnov test was applied to test for a normal distribution. Since the data were normally distributed, the One-Way ANOVA was used in situations where more than two independent groups were compared.

3. Results

Table 1. Descriptive Statistics by Playing Positions

Variables	Position		
	Defense	Mid-field	Forward
Age (year)	20±1.73	20.09±1.97	20.55±1.91
Height (cm.)	1.80±1.75	1.82±1.73	1.78±0.06
Weight (kg.)	66.91±12.51	66.91±6.93	70.55±7.87
Body Mass Index (kg / cm.^{2})	22.77±4.12	22.20±2.01	22.18±2.61

Descriptive statistics of the soccer players participating in the study are shown in Table 1. The number of observations for all parameters is 33.

Table 2. Comparison of Motor Characteristics in Soccer Players by Playing Positions

Variables		Position	N	X	Sd±	F	p	Difference
Illinois Test (sec.)	1	Defense	11	15.46	1.06	9.827	0.001*	1-2
	2	Midfield	11	14.30	0.19			1-3
	3	Forward	11	14.53	0.31			
	4	Total	33	14.76	0.81			
Yo-Yo Test (m.)	1	Defense	11	1705.45	600.8	0.176	0.840	
	2	Midfield	11	1712.72	562.2			
	3	Forward	11	1829.09	477.0			
	4	Total	33	1749.09	534.8			
$MaxVO_2$ (ml/kg/min.)	1	Defense	11	51.18	4.03	0.854	0.436	
	2	Midfield	11	53.25	3.44			
	3	Forward	11	52.45	3.76			
	4	Total	33	52.29	3.73			
30 m. Sprint Test (sec.)	1	Defense	11	4.46	0.33	4.325	0.022*	1-2
	2	Midfield	11	4.15	0.11			
	3	Forward	11	4.30	0.23			
	4	Total	33	4.30	0.27			
RAST Maximal Power	1	Defense	11	1005.2	378.1	0.605	0.553	
	2	Midfield	11	963.18	336.6			
	3	Forward	11	1120.41	324.4			
	4	Total	33	1029.63	342.8			
RAST Average Power	1	Defense	11	676.40	183.4	0.536	0.591	
	2	Midfield	11	669.04	144.7			
	3	Forward	11	735.94	168.3			
	4	Total	33	693.80	163.8			
RAST Fatigue Index	1	Defense	11	16.99	5.03	0.088	0.916	
	2	Midfield	11	16.15	5.72			
	3	Forward	11	16.22	4.77			
	4	Total	33	16.45	5.04			

*$p<0.05$

Table 2 shows that there is a significant difference between the scores on Illinois Agility Test and 30 m. Sprint Test ($p<0.05$), yet no significant difference was found between the players in regard to $MaxVO_2$ (ml/kg/min.), Maximal Power, Average Power and Fatigue Index values obtained on Yo-Yo Test and RAST ($p>0.05$). These findings indicate that the scores obtained by defenders on Illinois Test were lower than those of midfielders and forwards. It can therefore be suggested that midfielders and forwards are more agile than defenders. In addition, it is seen that defenders showed a better performance of 30 m. Sprint Test than midfielders. It can be said that the midfielders can accelerate more quickly in short distances compared to the defenders.

4. Discussion

This study was conducted to compare the agility, sprint, anaerobic power and aerobic capacities of soccer players by their positions on the field of play. Participants were assigned to three groups as defenders, midfielders and forwards. The average age of the defenders was 20±1.73 years, the average height was 1.80±1.75cm. and the average body weight was 66.91±12.51kg. and their average BMI was found to be 22.77±4.12. The average age of the midfielders was 20.09±1.97 years, average height was 1.82±1.73 cm., average weight was 66.91±6.93 kg. and the average BMI value

was 22.20±2.01. The average age of forwards was 20.55±1.91 years, average height was 1.78±0.06 cm., average body weight was 70.55±7.87 kg. and the average BMI was 22.18±2.61. Statistical analysis showed no significant differences in BMI values, Yo-Yo Test (m.), $MaxVO_2$ (ml.kg.min-1), RAST Maximal Power, RAST Average Power and RAST Fatigue Index between defense, midfield and forward players ($p>0.05$). Nevertheless, the Illinois Test (sec.) and 30 m. Sprint Test (sec.) scores showed that defenders exhibited a better performance than midfielders and forwards. While our findings are consistent with some previous research, there are also other studies with contrary findings. Therefore, in this research, discussion and evaluation will be based on scientific evidence related to variables.

Delicelioğlu et al. (2014) found that the 30 m. sprint time in young soccer players was 4.15±010 (sec.) and the distance covered during YYIRT was 2052.0±3813.7 (m.). İmamoğlu et al. (2004) found that the average age of the male students from the School of Physical Education and Sports was 21.47±1.63 years and the 30 m. sprint time was 4.27±0.06 seconds. Tokgöz and Dalkıran (2015) found the 30 m. sprint time to be 4.30±0.15 in 26 male soccer players with an average age of 19.65±3.45years playing for different amateur soccer clubs in the city of Burdur.

In a study entitled "A Comparison of Motor Characteristics in Youth Soccer Players by Playing Positions" Yapıcı et al. (2016) reported that the average age of defenders was 19.16±0.83 years, the average height was 1.75±5.84 cm. and the average weight was 70.75±5.15 kg. The average age of midfielders was 19.5±1.16 years, average height was 180±4.53 cm. and the average weight was 74.16±6.76 kg. The average age of forwards was 18.75±0.96 years, average height was 1.76±5.66 cm. and average weight was 74±4.72 kg. The 30 m. (sec.) sprint times were found to be 4.28±0.06 m/sec., 4.18±0.130 m/sec. and 4.29±0.070 m/sec. for defenders, midfielders and forwards, respectively. Their Yo-Yo Test results indicated that midfielders (2838.33±279.01 m.) and forwards (2813.33±373.80 m.) covered a greater number of distance compared to defenders that could run a distance of 2346.66±607.66 m.

Köklü et al. (2009) conducted a similar study entitled "Comparison of Some Physical Fitness and Somatotype Characteristics of Young Soccer Players Regarding Their Playing Positions" and they found that defenders had an average age of 16.4±0.4 years, an average height of 175.4±6.0 cm., an average weight of 65.02±6.7 kg. and an average BMI of 21.15±1.5 midfielders had an average age of 16.2±0.3 years, an average height of 171.4±4.6 cm., an average weight of 63.3±5.9 kg. and an average BMI of 21.52±1.62, and forwards had an average age of 16.5±0.5 years, an average height of 171.8±3.9 cm., and average weight of 63.9±6.5 kg. and an average BMI of 21.61±1.68.

In his master's thesis "Determining the Somatotype Characteristics of Soccer Players in regard to Playing Positions" Döner (2011) found that the players participating in the study had an average age of 21.60±3.23 years, with an average height of 174.95±6.10 cm. for defense players, 173±4.55 cm. for midfield players and 178±5.26 cm. for forwards. The average BMI of the players was calculated to be 22.35±2.37 for defenders, 21.32±2.32 for midfielders and 22.53±1.99 ($kg/cm.^2$) for forwards.

Ceylan et al. (2009) conducted a study with soccer players aged 14-19 years and found the following mean values: height=U15: 165.81 cm., U17: 177.78 cm. and U19: 175.57 cm.; BMI = U15: 20.00, U17: 21.20 and U19: 21.44.30 $kg/cm.^2$ sprint times were 4.36 m/sec., 4.29 m/sec. and 4.08 m/sec. respectively. Finally, the RAST scores were computed as follows: U15: 5.14 m/sec., U17: 4.91 m/sec. and U19: 4.92 m/sec. Arslan (2010) found 30 m. sprint times to be 4.01±014 m/sec., 4.13±0.12 m/sec. and 4.14±0.16 m/sec. for defenders, midfielders and forwards respectively.

Performances of the players participating in the Yo-Yo Intermittent Recovery Test indicated that top-elite male soccer players playing matches at the international level and those doing highest intensity training had a higher performance level on the Yo-Yo test (3420 m.) than moderately trained soccer players (2810 m.) and players playing at a lower level (2330 m.) (Castagna et al., 2006). When the findings reported by Castagna et al. (2006) and those obtained in the current study are compared, it is seen that the performance scores achieved by midfielders and forwards are slightly higher than those of defenders.

Aslan and Koç (2015) reported the following $MaxVO_2$ (ml.kg.min-1) values in regard to playing positions of soccer players: 50.90±9.66 for goalkeepers, 48.98±4.4 for defenders, 50.58±3.65 for backs, 49.27±5.57 for midfielders, 52.31±4.67 for wingers and 48.33±5.52 for forwards. They found that wingers had the highest value of $MaxVO_2$ and forwards the lowest.

Sever (2013) investigated the $MaxVO_2$ values in a group of young soccer players aged 16-17 years and found the mean $MaxVO_2$ value of 46.362±5.708 for defenders, 47.484±5.534 for midfielders and 43.888±5.123 for forwards. Midfielders showed a higher mean $MaxVO_2$ than forwards.

Amiri et al. (2010) conducted a study with soccer players for agility performance using the Illinois Agility Test after different warm-up protocols consisting of static, dynamic, combined stretching, and no stretching. The test results obtained were 14.18±0.66 seconds (no stretch), 14.90±0.38 seconds (static), 13.95±0.32 seconds (dynamic), and 14.50±0.35 seconds (combined).

Açak et al. (2012) administered the Illinois Agility Test to Turkish Hearing Impaired Futsal Team consisting of male

players who either cannot hear at all or can only hear using a hearing aid. The test results revealed a mean value of 15.74±0.49 seconds for the players who cannot hear at all and 15.15±0.51 seconds for those using a hearing aid.

5. Conclusion

The results of the study showed that forwards and midfielders were more agile than defenders, and midfielders were faster than defenders. As the distances soccer players cover vary according to their playing positions (defense, midfield and forward) together with the movements they perform on the pitch and the frequency of these movements, it will contribute to their performance to evaluate physical and physiological needs according to playing positions.

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