

Analysis of agility, speed and power values in young football players

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ABSTRACT

The present study aimed to investigate agility, speed and power values in football players in terms of gender and age. For this purpose, measurement results of a total of 208 football players aged between 12 and 16 years were evaluated. A statistically significant difference was found between jump, agility, speed and power values of football players in terms of gender ($p < 0.001$). A significant difference was found in jump, agility, speed and power values of male football players in terms of age ($p < 0.001$). There was no significant difference in agility values of female football players in terms of age ($p > 0.05$), but there was a significant difference in jump, sprint and power values ($p < 0.001$). Vertical jump values of football players showed positive correlation with anaerobic and aerobic power values and negative correlation with agility, 10- and 20-metre run time and fat percentage ($p < 0.001$). The positive correlation of fat percentage with agility test, 10- and 20-metre run values was significant ($p < 0.001$). Speed, agility and power values of male football players were higher than those of female football players. An increase was observed in these values with increasing age. It is recommended to carry out studies to increase the agility of female football players with the increase in age.

KEYWORDS

Football; agility; aerobic power; anaerobic power

1. INTRODUCTION

Football is a multifaceted sport with high intensity, consisting of a variety of activities (sprints, tackles, jumps, changes in direction and speed) that challenge numerous technical, cognitive, neuromuscular and metabolic processes (Rowan et al., 2019; Hermassi et al., 2023; Stanković et al., 2023). The performance of a player or team in this sport can be influenced by anaerobic capacity and aerobic metabolism, which can provide up to 90% of the total energy cost of a football match and

depend on the position of the player (Clemente et al., 2020). In football games, which involve intermittent exercises such as low-medium and high-intensity running, sprints, turns and jumps, players need to have a high aerobic capacity physiologically and the ability to convert anaerobic energy rapidly. In elite football, a player covers a total distance of approximately 10-12 km. Although the rate of high-intensity running (around 30%) is lower than that of walking and low-intensity running, it is physically and physiologically challenging for players to perform high-intensity running and activities frequently and in short intervals (Mohr et al., 2003; Mulazimoğlu et al., 2018). The ability of footballers to engage in a variety of vigorous, explosive and low-intensity activities has a significant impact on how effectively they perform during games (Young et al., 2021).

The performance of footballers depends on numerous factors such as physical, physiological, technical, tactical and psychological aspects. Football involves high-demand tasks such as acceleration, deceleration and rapid changes of direction, and players are also expected to perform at high levels in terms of strength, speed, endurance and power (Alexe et al., 2024; Gürer et al., 2024; Karadağ et al., 2024; Yurtseven et al., 2024). Football players require advanced neuromuscular system strength and high anaerobic power in order to efficiently use basic movement patterns, ballistic movements, stretching-shortening cycles to perform actions such as sudden turns, acceleration and deceleration during competitions (Aksoy et al., 2024). Performance during agility is determined by athletes' ability to identify cues in their environment, make correct decisions and recover quickly from a change of direction (Spiteri et al., 2013).

Female professional footballers have been found to perform high-speed runs ranging from 911 to 1063 m and sprint distances ranging from 223 to 307 m in official games. Male professional footballers have running speeds ranging from 618 to 1001 m and sprint distances ranging from 153 to 295 m (Nobari et al., 2021). Vertical jump is an integral component of explosive performance. Vertical jump tests play a very important role in determining parameters. Vertical jump performed with proper training methods is said to play a major role in the development of hips, legs, knees and ankles. However, it is said that vertical jump performance depends not only on lower limb strength, but also on the force production and contraction speed of the muscle, the degree of contraction, and intramuscular coordination (Muehlbauer et al., 2015; Paoli et al., 2012). Vertical jump performance has been shown to be a valuable indicator of the neuromuscular status of footballers due to the relationship of height performance with force production and musculoskeletal system. In addition,

horizontal muscle strength plays an important role in football and early studies have highlighted the relationship between horizontal jump assessment and sprint performance in non-disabled players (Maulder, & Cronin, 2005; Yanci et al., 2014).

Agility refers to the movement of the whole body or only the upper or lower body parts to quickly change running direction without losing precision or balance (Szabo et al., 2020). Studies have concluded that agility enhances the game of football and reduces the likelihood of injury (Ghorpade et al., 2021). Agility test results characterize a soccer player's ability to accelerate and stop and change direction quickly (Trecroci et al., 2018). Sprinting ability, especially combined with short recovery periods, is one of the most important physical parameters. Sprinting has been suggested as the most frequent action performed before a goal (Theodoros et al., 2016). Players in the German national football team have been found to perform ~17 sprints per match (Tomáš et al., 2014). Furthermore, a recent study of sprints performed during games in the English Premier League over a 7-season period showed an increase in sprint distance (~35%) and number of sprints (~85%) in 2012-13 compared to 2006-7, with an average sprint distance of ~6 m (Barnes et al., 2014). Sprint performance is defined as a cyclic motor activity consisting of rapid repetition of steps, determined by the capacity to accelerate and the ability to maintain the maximum speed reached (Giulia et al., 2017). At the individual level, the 20-metre shuttle run test is a true indicator of peak max VO_2 (Tomkinson et al., 2019). In early adolescence, the maximum oxygen uptake (VO_2 max) during football games can range from 50 to 64 ml/kg/min. These competitions usually involve a distance of about 6500 m, about 670 m of high-intensity running and about 300 m of very high-intensity running (Strøyer et al. 2004). A high VO_2 max is required to compete at a professional level in football (Clemente et al., 2020; Buchheit et al., 2010). A good VO_2 max therefore clearly indicates good physical fitness for a football player and can prevent or minimize injury risks (Beltz et al., 2016). It is recognized that improving aerobic capacity in football players helps them to recover quickly from the actions they face during competitions and to maintain their physical condition at an optimum level throughout the season (McEwan et al., 2020). In adolescence, VO_2 max is linked to body size and biological maturation rhythm in athletes and non-athletes (Carvalho et al., 2013).

VO_2 max values in children should be determined with respect to age and gender (Beltz et al., 2016). Examination of VO_2 max values in childhood and adolescence has revealed differences between genders and between educated and uneducated participants (Ghouili et al., 2023). Sport-specific research studies have shown that different characteristics such as sprint, change of direction,

vertical and horizontal jump, balance and dribbling should be known by coaches in order to differentiate between sport classes using the key determinants of football performance (Reina et al., 2018; Peña-González et al., 2021). Studies have found differences in physical, physiological and anthropometric variables between different age groups, playing positions and categories (Figueira et al., 2018; Silva et al., 2022). Therefore, physical and anthropometric measurements as well as motor tests have been found to be important in predicting football performance (Bongiovanni et al., 2021; Hermassi et al., 2023). As young people advance through adolescence, their physical and physiological characteristics change significantly over the years. This can have a profound impact on their sports performance, especially in terms of speed and agility, which are critical components of success in football (Yapıcı et al., 2023, Pojskic et al., 2018, Slimani & Nikolaidis, 2018). Agility allows athletes to quickly change direction, avoid opponents and maintain control over the ball (Young et al., 2015). Therefore, studies on the impact of age on the development of these key attributes are important to optimize performance and ensure the long-term success of young athletes in these sports. Speed and acceleration data are required to customize the design of training programs for athletes (Aktaş, 2023). Information about the timing and extent of changes in the physical performance of athletes will also be of great value to coaches/fitness coaches in terms of knowing when to expect and when not to expect players to improve certain physical characteristics or physical performance (Smpokos et al., 2022). Monitoring and evaluating the anaerobic and aerobic capacities of football players can help coaches to evaluate the effect of training practices and the overall training program, resulting in improved training prescriptions. Therefore, the aim of the present study is to examine the development, similarities and differences in agility, speed and strength values of 12-16 years old soccer players with respect to some demographic characteristics.

2. METHODS

2.1. Design and participants

The present study aimed to investigate agility, speed and power values in football players in terms of gender and age. For this purpose, measurement results of a total of 208 football players aged between 12 and 16 years were evaluated. A total of 208 football players, 131 males and 87 females, aged between 12-16 years, who were playing amateur football in Samsun province, participated voluntarily in the present study.

2.2. Instruments and procedures

A number of different parameters were measured in the study. Weight was measured without shoes and in sportswear. The value was recorded after the participant stood still on the measuring device. Height was also measured without shoes and in sportswear. During the measurement, it was ensured that the projection of the heel, hip, back and head (back part) were in the same vertical direction. The head was positioned with the eyes facing forward. After the participants took their position, they were asked to take a deep breath and hold it, and the measurement was made at that moment.

Vertical jump test: Vertical jump test measures the ability to jump quickly in a vertical direction. Test taker tries to jump as high as possible with both feet in front of the platform hanging on the wall. Before the test, normal arm length of the test taker was determined in front of the platform. At the end of the test, the difference between the jump distance and arm length was determined and the vertical jump distance was recorded in cm. The test was repeated twice for the participants, and the best result was recorded (Yanci et al., 2016).

Agility t-test: With the start command, participants ran straight to the cone which was 9.14 metres away from the starting cone and directly opposite the starting cone and touched the cone with their right hand. Then they ran sideways to the cone which was 4.57 metres away on the left side of the cone and touched it with their left hand, then ran sideways to the cone which was 9.14 metres away to the right and touched it with their right hand. Then, they came to the cone at the centre point with a side jog, touched it with the left hand and returned to the starting cone with a jog. In this test, the participants performed 3 maximal repetitions with full rest. The participant's best time was recorded. The times were recorded with an accuracy of 0.01 seconds by 2 electronic photocells connected to a Lafayette 63501 timer.

10-metre sprint: 10 m sprint test performance was measured by recording the time required to perform a 10 m linear sprint using two pairs of time gates (Witty System; Microgate, Bolzano, Italy). Participants were instructed to exert maximum effort over the entire distance and started from a standing position 0.5 m before the first timing gate (Dos'Santos et al., 2019). The fastest time (sec) from two trials was recorded.

20-metre sprint: The test takers placed the tip of one foot on the starting line. When they were ready, they ran forward and crossed the arrival line 20 metres ahead of them. They took the

correct position on the exit line 1 metre behind the photocell. They were warned to run with the highest speed and to cross the finish line quickly without slowing down.

20 m shuttle run: All footballers completed the graded test once in football boots between 17:00 and 20:00, exactly 24 hours after their last training session. All test sessions were performed at the same time of day to minimise the effects of daily variation in the measured parameters. During the test, participants ran between two lines 20 m apart, following the rhythm of pre-recorded audio signals. The first parts of the test were reserved as a warm-up phase due to the slower initial pace. The starting speed was set at 8.5 km/h and increased by 0.5 km/h every minute. The test was terminated if the participant failed to reach the finish lines twice in a row or if the player reported fatigue.

Skinfold thickness measurements: Skinfold thickness measurements were taken from the triceps, subscapula and suprailiac regions of the participants by using a skinfold caliper (Holtain LTD, England). The measurements were taken twice from the right side of the children, and the average of the two measurements was recorded as the result. For the measurement of skinfold thickness, the thickness of the subcutaneous fat layer between the thumb and index finger was pulled up slightly enough to separate it from the muscle tissue. The caliper was placed approximately 1 cm away from the fingers and the thickness of the subcutaneous fat layer was read from the indicator on the caliper within 2-3 s and recorded in mm.

Triceps skinfold thickness: The right elbow was placed at a 90° angle and the distance between the prominence of the acromion and the prominence of the olecranon on the posterior aspect of the arm was measured with a tape measure and the midpoint was marked. The measurement was then made from this midpoint parallel to the axis of the arm.

Subscapular skinfold thickness: Skinfold thickness was measured with the thumb, index and middle fingers of the left hand just below the scapula by lifting the skin and subcutaneous fat layer in accordance with the natural orientation of the skin fold.

Suprailiac skinfold thickness: With the footballer in an upright posture with the feet together and arms hanging freely at the sides, the measurement was made from the top of the iliac crest diagonally over the axilla line.

Calculation of body density and body fat percentage: Body densities (BM) of the participants were determined individually with the J-P (Jackson-Pollock) formula (1985) by using skinfold thicknesses. Body fat percentages (BMI) were then calculated using the Siri formula). The Jackson-Pollock and Siri formulae used for the research group were: *J-P equation* = $VY = \text{chest} + \text{abdomen} + \text{thighs} = \text{sum of skinfolds (ST)}$ Body Density = $1.10938 - (0.0008267 \times \text{ST}) + (0.0000016 \times \text{ST}^2) - (0.0002574 \times \text{age})$. *Siri equation* = $VYY\% = (495 / VY) - 450$

Calculation of peak and average power: Calculation of peak and average power were calculated according to Johnson and Bahamonde (1996) formulae: *Peak Anaerobic Power (W)* = $78.5 \times \text{jump distance (cm)} + 60.6 \times \text{body weight (kg)} - 15.3 \times \text{height (cm)} - 1,308$. *Mean anaerobic Power (W)* = $41.4 \times \text{jump distance (cm)} + 31.2 \times \text{body weight (kg)} - 13.9 \times \text{height (cm)} + 431$

Aerobic power: Estimated max VO₂ (ml/kg/min) was obtained from the 20 m shuttle run test using the following regressions for 6-18 years of age: *VO₂ max* = $31.025 \times \text{Maximal Aerobic Rate (km/h)} - 3.248 \times \text{Age (years)} + 0.1536 \times \text{Maximal Aerobic Rate (km/h)} \times \text{Age (years)}$.

2.3. Statistical analyses

Statistical analyses were made with SPSS 25.00 software. Normality assumption of the data collected in the study was evaluated by Kolmogorov-Smirnov test ($p > 0.05$). The data were found to be normally distributed. Student t-test was used for pairwise comparisons, one-way analysis of variance was used for multiple comparisons, and LSD tests were used to determine the differences. Statistical significance was set at $p < 0.05$.

3. RESULTS

Results are presented in the following tables 1-5. While the age, sports age and body weight of the football players of this study were similar, height and fat percentage were found to be statistically significant ($p < 0.001$) (Table 1).

A statistically significant difference was found between the jump, agility, speed and power values of football players by gender ($p < 0,001$). It was found that male football players had higher jumping height, anaerobic and aerobic power and lower agility, 10-metre and 20-metre sprint time when compared with female football players. In other words, agility, 10-metre and 20-metre values were better in male footballers than female footballers (Table 2).

Table 1. Anthropometric characteristics and fat percentage of football players by gender

Parametres	Gender	N	Mean	St. dev.	T	p
Age (Years)	Male	131	13.99	1.44	0.78	0.445
	Female	87	13.86	1.46		
Height (cm)	Male	131	161.28	9.38	7.77	<0.001
	Female	87	151.55	8.53		
Weight (kg)	Male	131	50.49	9.61	1.76	0.092
	Female	87	48.18	9.40		
Body fat (%)	Male	131	14.84	3.90	-3.62	<0.001
	Female	87	16.63	2.99		
Sports age (Years)	Male	131	5.92	1.44	0.78	0.456
	Female	87	5.85	1.46		

Table 2. Jump, agility, speed and power values of football players by gender

Parametres	Gender	N	Mean	Std. Deviation	t	p
Vertical jump (cm)	Male	131	44,37	11,03	5,58	<0,001
	Female	87	37,21	5,70		
Agility (sec)	Male	131	12,82	0,87	-5,47	<0,001
	Female	87	13,46	0,80		
10 metres (sec)	Male	131	1,70	0,12	-10,39	<0,001
	Female	87	1,83	0,09		
20 metres (sec)	Male	131	3,10	0,23	-8,78	<0,001
	Female	87	3,33	0,16		
Peak anaerobic power (Watt)	Male	131	2761,56	1135,31	3,93	<0,001
	Female	87	2217,74	744,82		
Mean anaerobic power (Watt)	Male	131	1598,59	561,43	3,77	<0,001
	Female	87	1370,19	352,22		
Aerobic power (ml/kg/min)	Male	131	50,42	3,09	3,30	<0,001
	Female	87	49,14	2,33		

A significant difference was found in jump, agility, speed and power values of male football players in terms of age ($p < 0.001$). There was an increase in jump value, an increase in anaerobic and aerobic power values, and shorter distances in agility and sprint values with increasing age (Table 3).

While agility values of female football players were not significantly different by age ($p > 0.05$), significant differences were found in jump, sprint and power values ($p < 0.001$). There was an increase in jump value, an increase in anaerobic and aerobic power values, and shorter distances in agility and sprint values with increasing age (Table 4).

Table 3. Comparison of jump, agility, speed and power values of male football players by age

Parametres	Age	n	Mean	Std. Deviation	F/LSD	p
Vertical jump (cm)	12 (1)	24	39,79	13,57	11,93	<0,001
	13 (2)	36	38,92	6,56	1,2,3<4,	
	14 (3)	16	41,19	6,51	5	
	15 (4)	28	48,64	10,78		
	16 (5)	27	53,19	8,66		
Agility (sec)	12 (1)	24	13,42	0,82	7,95	<0,001
	13 (2)	36	12,85	0,72	1>2,3,5	
	14 (3)	16	12,59	0,72	2,4>5	
	15 (4)	28	12,98	0,71		
	16 (5)	27	12,22	0,96		
10 metres (sec)	12 (1)	24	1,80	0,06	16,03	<0,001
	13 (2)	36	1,71	0,07	1>2,3,4,	
	14 (3)	16	1,69	0,06	5	
	15 (4)	28	1,68	0,07	2>4,5	
	16 (5)	27	1,65	0,07	3,4>5	
20 metres (sec)	12 (1)	24	3,28	0,14	13,28	<0,001
	13 (2)	36	3,15	0,19	1>2,3,4,	
	14 (3)	16	3,03	0,15	5	
	15 (4)	28	3,06	0,18	2>3,4,5	
	16 (5)	27	2,94	0,21	3,4>5	
Peak anaerobic power (Watt)	12 (1)	24	2188,94	1164,71	15,70	<0,001
	13 (2)	36	2149,72	702,94	1,2<4,5	
	14 (3)	16	2669,41	1115,98	3,4<5	
	15 (4)	28	3040,55	946,53		
	16 (5)	27	3851,61	886,91		
Mean anaerobic power (Watt)	12 (1)	24	1356,96	603,61	13,35	<0,001
	13 (2)	36	1302,45	343,14	1,2<4,5	
	14 (3)	16	1528,87	545,01	3,4<5	
	15 (4)	28	1733,39	495,00		
	16 (5)	27	2109,75	447,43		
Aerobic power (ml/kg/min)	12 (1)	24	49,08	6,06	4,76	0,001
	13 (2)	36	50,13	1,68	1<5,6	
	14 (3)	16	50,38	1,82	2,3,4<6	
	15 (4)	28	50,61	1,29		
	16 (5)	27	52,30	1,20		

Table 4. Comparison of jump, agility, speed and power values of female football players by age

Parametres	Age	n	Mean	Std. Deviation	F/LSD	p
Vertical jump (cm)	12 (1)	22	31,82	3,61	11,83	<0,001
	13 (2)	18	36,89	5,06	1,<2,3,4	
	14 (3)	17	38,59	3,37	,5	
	15 (4)	13	39,85	7,05	2<5	
	16 (5)	17	41,12	4,23		
Agility (sec)	12 (1)	22	13,35	0,34	1,50	0,257
	13 (2)	18	13,73	0,90		
	14 (3)	17	13,18	0,95		
	15 (4)	13	13,36	0,64		
	16 (5)	17	13,68	1,01		
10 metres (sec)	12 (1)	22	1,79	0,08	6,35	<0,001
	13 (2)	18	1,81	0,09	1,2<3,5	
	14 (3)	17	1,90	0,08	3>4	
	15 (4)	13	1,79	0,04		
	16 (5)	17	1,87	0,10		
20 metres (sec)	12 (1)	22	3,31	0,12	6,23	<0,001
	13 (2)	18	3,31	0,14	1,2,3,4,	
	14 (3)	17	3,24	0,19	<5	
	15 (4)	13	3,30	0,06		
	16 (5)	17	3,47	0,15		
Peak anaerobic power (Watt)	12 (1)	22	1318,10	248,83	45,39	<0,001
	13 (2)	18	1964,65	292,23	1<2,3,4,	
	14 (3)	17	2522,03	510,44	5	
	15 (4)	13	2798,35	762,36	2<3,4,5 3<5	
Mean anaerobic power (Watt)	16 (5)	17	2901,69	243,27	36,61	<0,001
	13 (2)	18	1279,47	163,51	1<2,3,4,	
	14 (3)	17	1487,04	251,90	5	
	15 (4)	13	1652,00	384,38	2<3,4,5	
	16 (5)	17	1675,05	135,43	3<4,5 4<5	
Aerobic power (ml/kg/min)	12 (1)	22	45,86	0,64	71,74	<0,001
	13 (2)	18	48,89	1,84	1<2,3,4,	
	14 (3)	17	50,94	0,75	5	
	15 (4)	13	50,00	1,00	2<3,4,5	
	16 (5)	17	51,18	0,73	3>4 4<5	

Vertical jump values of football players showed positive correlation with anaerobic and aerobic power values and negative correlation with agility, 10 and 20 metres running time and fat percentage ($p<0.001$). Anaerobic and aerobic power values had a negative correlation with agility test, 10-metre and 20-metre run values. The positive correlation of fat percentage with agility test, 10 and 20 metre run values was significant ($p<0.001$). (Table 5).

Table 5. Correlation of strength, agility, speed and fat percentage values in football players

	Peak anaerobic power	Mean anaerobic power	Aerobic power	Agility	10 metres	20 metres	Fat percentage
Vertical jump	,896**	,903**	,519**	-,402**	-,444**	-,500**	-,170*
Peak anaerobic Power		,996**	,630**	-,286**	-,286**	-,389**	,105
Mean anaerobic Power			,619**	-,272**	-,267**	-,367**	,122
Aerobic power				-,161*	-,089	-,213**	,112
Agility					,653**	,604**	,310**
10 metres						,834**	,504**
20 metres							,443**

4. DISCUSSION

In this study, the mean age was found to be 13.99 years for male football players and 13.86 years for female football players, while the mean sports age was 5.92 years for males and 5.86 years for females. Fat percentage was found to be 14.84% in male football players and 16.63% in female football players. In terms of gender, the age, body weight and sporting age of football players were similar ($p>0.005$), while height was higher in males and fat percentage was higher in females ($p<0.001$).

Vertical jump capacity in football players is fundamental to compete effectively in both offense and defense, in game situations such as headers and tackles (Jiménez-Reyes et al., 2016). In a study conducted by Silva et al. (2024) on soccer players, it was emphasized that vertical jump-two-foot performance (in terms of both height and power) was better in male athletes than in female athletes. There are other studies which show the superiority of men in jump performance compared to women (McMahon et al., 2018). Başkaya et al. (2023) found vertical jump values of 10-12 years old football players with an average of 29.65 cm in the best group in pre-test and 37.55 cm in post-test as a result of a 10-week study. Vertical jump in elite Portuguese female football players aged around 18 years was found to be between 26.92 and 29.92 cm (Pompeo et al., 2023). In another study, the vertical jump height of U15 football players was found to be 51.31 cm (İmamoğlu et al., 2018). In the present study, mean vertical jump values were 44.37 cm for male football players and 37.21 cm for female football players. A significant difference was found in the vertical jump values of soccer players in terms of gender ($p<0.001$). Vertical jump values of male and female football players were

found to be significantly different in terms of age ($p < 0.001$) ($p < 0,001$). This difference was caused by the fact that 12-, 13- and 14-year-old male football players had lower jump values than 15- and 16-year-old male football players. In females, this difference was generally lower in female football players aged 12 and 13 years. Vertical jump performance requires rapid and high-intensity muscle power production to throw the body into the air (Pedley et al., 2017). For this reason, it is necessary to include more studies on increasing jumping abilities in female football players compared to males.

Team sports such as football are characterized by its intermittent nature, frequent switches, changes of direction and changes in activity intensity in a very short time. This ability, called agility, is certainly linked to success in football training. Trecroci et al. (2018) reported that there was no difference between elite and intermediate level football players when they observed the agility of U15 football players. Skābardis et al. (2019) found agility test values between 9.47 and 9.85 sec in their study. Skābardis et al., (2019) stated that from U15 to U16, physical characteristics differed in terms of agility. In the present study, the mean agility test values were 12.82 sec for male football players and 13.46 sec for female football players. A significant difference was found in the agility test values of football players in terms of gender ($p < 0.001$). Chattana et al. (2024) showed significant differences in agility between male and female football players by using T-test and Illinois test. It was concluded that female players were less agile than male players. In the present study, agility test values of male football players were significantly different in terms of age ($p < 0.001$). The best agility value was found in 16-year-old football players (12.22 sec). No significant difference was found in agility test values in female football players in terms of age ($p > 0.05$). Measures should be taken to improve agility test values with increasing age in female football players.

Alexe et al. (2024) found that the 10-metre sprint time in elite female football players aged around 15 years was between 1.90 and 2.00 sec, although it varied according to the positions. They also found that the 20-metre sprint time of female football players around the age of 15 years was between 3.31 and 3.48 sec, although it varied according to the positions (Alexe et al., 2024). Mendez-Villanueva et al. (2011) found the 10-metre sprint value in football players as 1.93 sec for U14, 1.80 sec for U16 and 1.73 sec for U18. Mendez-Villanueva et al. (2011) found the 20-metre sprint value in football players as 2.85 sec for U14, 2.53 sec for U16 and 2.34 sec for U18 in their study. In the study of Yamak and İmamoğlu (2019), no significant difference was found in repetitive speed in 20 m sprint in U16-U18 age groups. Skābardis et al. (2019) reported the 20-metre sprint time as 2.46 sec for U16 and 2.65 sec for U14. They reported that the maximum speed increased from U16 to U17.

Silva et al. (2024) reported that besides the level of play and performance during the practices, comparisons between the ages of the players also showed differences. U15 players were faster than U17 players at very short distances (<5 metres). Aktaş (2023) found agility value as 10.11 sec, 10 m sprint time as 1.65 sec and 20 m sprint time as 2.96 sec in male 15-year-old futsal players and agility value as 12.17 sec, 10 m sprint time as 2.30 sec and 20 m sprint time as 3.78 sec in female futsal players. In the present study, 10-metre sprint mean values were found to be 1.70 s for male football players and 1.83 s for female football players. In the present study, 20-metre sprint mean values were found to be 3.10 sec in male football players and 3.33 sec in female football players. A significant difference was found in the 10 and 20-metre sprint values of football players in terms of gender ($p<0.001$). Based on the studies of Gall et al. (2002), Mendez-Villanueva et al. (2011) and Maly et al. (2015) suggested that sprinting ability improves between 12 and 18 years of age. Again, 10 and 20-metre sprint values were significantly different in male football players in terms of age ($p<0.001$). This is due to the biological development of young players and the increasing intensity of football training activities with age (Theodoros et al., 2016). In the present study, the values of 10 and 20 metres sprint times decreased with increasing age. For 16 years of age, the 10-metre sprint time was found to be 1.65 sec, and the 20-metre sprint time was found to be 2.94 sec. 10 and 20-metre sprint times in female football players were significantly different ($p<0.001$). This difference was in general due to the fact that the 16-year-olds ran these distances in less time. Mendez-Villanueva et al. (2011) reported in their study that the positive effects of age on sprint speed qualities during growth in well-trained football players are likely to be more related to biological maturation than to anthropometric characteristics alone.

In addition to body size, other factors influence gender differences in anaerobic power. In the present study, the mean peak anaerobic power was 2761.56 Watt in male football players and 2217.74 W in female football players. Mean anaerobic power values were 1598.59 Watt in male football players and 1370.19 Watt in female football players. Peak anaerobic and mean anaerobic power values in male and female football players were significantly different in terms of gender and increased significantly with increasing age ($p<0.001$). It is expected that there is no significant difference in anaerobic power output between male and female subjects.

With regard to the 20-metre shuttle run test, Max VO_2 normative values were given as 48.4 ml/kg/min in males and 51.6 ml/kg/min in females between the ages of 9 and 17 (Tomkinson et al., 2003). Ortega et al. (2011) reported max VO_2 values as 46.2 ml/kg/min in males and 53.8 ml/kg/min

in females for 12-18 years of age in Europe. Max VO₂ values calculated with 20 metre shuttle run were reported as 49.5-50.2 ml/kg/min in males and 51.6-49.8 ml/kg/min in females for 10-18 years of age in Portuguese studies (Tomkinson et al.,2019). The relative max VO₂ of boys remains relatively constant throughout childhood at around 50 ml/kg/min, while that of girls tends to decrease gradually (by about 20% between years 8 and 13) (Ghouli et al., 2023). In football, VO₂ max ranges from 50 to 75 ml/kg/min (Stølen et al., 2005). Adjusted median curves of 2997 untrained American adolescents aged 12 to 18 years showed a slight increase in estimated VO₂ max from 42 ml/kg/min to 46 ml/kg/min and a slight decrease in girls from 39 to 37 (ml/kg/min) (Eisenmann et al.,2011). In 20-metre shuttle run, the estimated mean VO₂ max was found to be 52.12 ml.kg/min (Mulazimoğlu et al., 2018). In the present study, the mean aerobic power (Max VO₂) was 50.42 ml/kg/min in male football players and 49.14 ml/kg/min in female football players. While aerobic power values in male and female football players differed in terms of gender, they increased significantly with increasing age ($p<0.001$). Increasing specific training loads over the years seems to have a positive independent effect on the development of aerobic energy pathways in late adolescence (Ghouli et al., 2023). This may be explained by the fact that within a year after the period of rapid growth, the body adapts and thus football players are better able to control their own body in turns, accelerations and changes of direction.

In the relationship between agility and acceleration in Aktaş (2023) study, a positive correlation was found between agility and 10 m and 20 m acceleration values in men, and a strong positive correlation between agility and 10 m acceleration. In women, a negative and insignificant correlation was found between agility and acceleration parameters. Şimşek et al. (2014) found no correlation with VO₂ max values of participants in exercises such as sprinting and vertical jump that require short-term energy metabolism in football players. Fat mass can also negatively affect performance in 20 metre shuttle run test. Since fat mass is partially metabolically inactive and creates an additional load to be carried, increasing fat mass will proportionally decrease the highest mass-specific Max VO₂ (mL/kg/min) (Tomkinson et al., 2019). It was found that VO₂ max values increased as agility performance times decreased in football players (Kul and Aydemir 2024). Mendez-Villanueva et al. (2011) reported a positive correlation in 10 and 20 metre sprint values in football players. In the present study, vertical jump values of soccer players showed positive correlation with anaerobic and aerobic power values and negative correlation with agility, 10 and 20 metre sprint time and fat percentage ($p<0.001$). A negative correlation was found between anaerobic and aerobic power values and agility test, 10-metre and 20-metre sprint values. The positive

correlation of fat percentage with agility test, 10 and 20 metre sprint values was significant ($p < 0.001$).

5. CONCLUSIONS

A significant difference was found in vertical jump values of football players in terms of gender. Again, the vertical jump values of male and female football players were significantly different in terms of age. A significant difference was found in the agility test values of football players in terms of gender. While the agility test values of male football players were significantly different in terms of age, there was no significant difference in the agility test values of female football players. A significant difference was found in 10 and 20 metre sprint values of football players in terms of gender. Running times of 10 and 20 metres decreased with increasing age. Peak anaerobic and mean anaerobic power values of male and female football players were significantly different in terms of gender and increased significantly with increasing age. Aerobic power values in male and female football players differed in terms of gender but increased significantly with increasing age. Vertical jump values showed positive correlation with anaerobic and aerobic power values and negative correlation with agility, 10 and 20 metre sprint time and fat percentage. As a conclusion, speed, agility and power values of football players between the ages of 12-16 were higher in male football players than in female football players. Again, an increase was found in these values with increasing age. It is recommended to conduct studies to increase the agility of female football players with the increase in age.

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

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