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PHYSICAL AND PHYSIOLOGICAL STATUS IN AMERICAN FOOTBALL PLAYERS IN TURKIYE

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Abstract The purpose of this study was to examine the physical and physiological status of American football players in Turkiye. Forty-two American football players (age 22.7±2.3) participated in the study. The subjects were divided into 5 positional categories. All 42 subjects performed a comprehensive battery of tests, during two periods of testing. The first period included Anthropometric evaluation - there stature, body mass, body fat ratio (% fat), body mass index, waist-hip ratio (%), field tests - speed (10 yard, 40 yard) and VO_2 max (20 m shuttle-run) were the field tests selected. The second period of testing involved Laboratory Test, which included counter movement jump, vertical jump, hand-grip test and flexibility test. Anthropometric and physiological characteristics broken down in five groups were compared statistically using a Kruskal-Wallis test. The mean (±) age and playing experience of all players (n=42) were: 22.7 ± 2.3 and 2.7 ± 2.2 years, respectively. The mean (±) stature, body mass, %fat, body mass index and waist/hip ratio for all players were: 181.4 ± 6.3 cm, 96.1 ± 24.7 kg, 18.8 ± 5.8 %, 29.1 ± 7.0 kg/m^2 and 0.86 ± 0.06 %, respectively. The mean (±) 10-yard speed, 40-yard speed and estimated VO_2 max of all players were: 1.71 ± 0.13 s, 5.02 ± 0.77 s and 38.0 ± 8.2 kg/ml/m respectively. The mean (±) vertical jump, CMJ and right/left hand strength of all players were: 54.5 ± 7.7 cm, 45.7 ± 6.0 cm, 47.7 ± 10.2 kg and 44.9 ± 9.4 kg respectively. There were no significant differences ($p>0.05$) among individual positions for vertical jump, CMJ, right/left hand strength, flexibility, 10 yard, 40 yard or VO_2 max parameters. We suggest that AF training should be systematically incorporated into training science and we also think that there should be periodical evaluation of players through physical and physiological tests.
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Key words: American football, training, physiological status

INTRODUCTION

American football (AF) is a fascinating sport that has drawn people from over 50 countries on all 6 continents under its spell. AF, known in the United States and Canada simply as football, is a competitive team sport. AF is the most popular spectator sport in the United States. Organized football is played almost exclusively by men and boys, although a few amateur and semi-professional women's leagues have begun playing in recent years [1]. Since then the sport has experienced a significant expansion, especially in Europe, finally reaching its peak through the foundation of the European Federation of American Football (1996), followed by the International Federation of American Football (IFAF) [2]. The third appearance of AF as in international sport was at the World Games 2005.

American football is one of the newest sports in Turkiye. A special AF league was established in Turkiye in 1993; it is played at several city universities and is spreading rapidly; there were ten teams in 2005 season and sixteen in 2007. Scientific data are not available concerning the physiological characteristics of players along Turkish standards although such information is important as it provides reference values against which coaches may compare their players' performance in training. Players

compete in a challenging contest involving frequent bouts of high-intensity activity (e.g. passing and running, sprinting, tackling), separated by short bouts of low-intensity activity (e.g. standing, walking, jogging) [7, 11].

Playing position places specific demands on players. Because of the high degree of specific factors, differences in general performance variables can also be expected. Each team has 11 players on the field at a time. However, teams may substitute for any or all of their players, if time allows, during the break between plays. As a result, players have very specialized roles, and almost all of the 46 active players on an NFL team will play in any given game. Thus, teams are divided into three separate units: the offense, the defense and the special teams. In AF, the offensive team, or offense, is the team that begins a play from scrimmage in possession of the ball. The offensive team consists of Quarter Back, Center, Guard, Tackle, Tight End, Running Back and Wide Receiver. The defensive team, or defense, is the team that begins a play from scrimmage not in possession of the ball. The objective of the defensive team is to prevent the other team from scoring. The defensive team consists of Noise Tackle, Defensive End, Defensive Tackle, Line Backer, Corner Back and Safety. Special teams are units that are on the field during kickoffs, free kicks, punts, and field goal and extra point attempts. Most special team players are second- and third-string players from other positions.

Physiological profiles have become commonplace in a number of sports, including soccer and rugby, both of which have common threads with AF [12]. Useful information for the coach may be obtained by a comparison of results. Therefore, the aim of this study was to examine the physical and physiological status of AF players in Turkiye.

MATERIALS AND METHODS

SAMPLES

Forty-two AF players (age 22.7 ± 2.3) from the Ege University Dolphins AF club participated in the study. All the AF players gave informed consent to the participation in the study. The subjects were divided into 5 positional categories as shown in Table 1.

Table 1. Positional categories and numbers of the subjects tested

Positions	Number Of Subjects
Defensive Back (DB)	8
Offensive Back/Wide Receiver (OB/WR)	12
Line Backer (LB)	5
Offensive Line/ Tight End (OL/TE)	9
Defensive Line (DL)	8

TESTING PROCEDURE

All 42 subjects performed a comprehensive battery of tests, during two periods of testing [17]. The first session involved three tests, undertaken at the respective Ege University premises. The second session was conducted in the laboratory at Ege University Physical Education and Sports Department. Years of playing experience (PLE) were evaluated according to the playing years of the subjects.

ANTHROPOMETRY

The test session began with anthropometric measurements. Each player's stature and body mass was measured using mechanical medical scales. Skinfold thickness was measured by using skinfold calipers (Holtain Ltd., UK) at four sites on the right side of the body (triceps, subscapula, abdomen, suprailiac); then body fat ratio (% fat) of each subject was calculated with the Yuhasz equation [20].

FIELD TESTS

Speed (10 & 40 yard) and VO_2 max (20 m shuttle-run) were the field tests selected. The participants were instructed to refrain from strenuous exercise for at least 48 hours before the fitness test session, and to consume their normal pre-training diet before the test session. Speed tests were performed first. Running speed was evaluated from a 10-yrd and 40-yrd sprint using electronic timing gates

(Newtest 2000, Powertimer Measuring System, 1995, Finland). Before the first sprint test, the participants performed a 20-min warm-up that included short sprints. Subjects performed two trials for speed with a recovery of approximately 3 minutes between trials. Players were encouraged to perform low-intensity activities and stretches between trials. The timing gates were positioned at 10 and 40 yards cross wind from a predetermined starting point. They ran as quickly as possible over the 40-yrd distance. The fastest value obtained from two trials was used as the speed score.

Maximal oxygen uptake (VO_2 max) was assessed by means of a progressive shuttle run test [16]. The participants were required to run between two lines, 20 m apart, at various speeds related to estimated individual VO_2 max values. The test was commercially packaged as a high-quality audio cassette that emitted "sound signals" to control the pacing for the 20 m shuttles. The shuttle run test requires participants to increase their running speed by 0.14 $m \cdot s^{-1}$ (0.05 $km \cdot h^{-1}$) each minute (or level), the required change in running speed being indicated by a verbal cue on the tape (e.g. start of level 9). The total number of shuttles completed at volitional exhaustion, or when the participant missed the turning 'sound signal' on three consecutive occasions [16].

LABORATORY TEST

COUNTER MOVEMENT JUMP

In the counter movement jump (CMJ) it is possible to evaluate elastic energy [4]. During the breaking phase (mainly eccentric muscle action occurring in the leg extensor muscles) energy is stored and then it is utilized in the following propulsion (concentric) phase. Counter movement jumping was performed on a Newtest jump force plate (Newtest 2000, Powertimer Measuring System, 1995, Finland) that measured and relayed take-off forces to a computer. During testing, the CMJ was demonstrated and the participant performed three practice trials. This was followed by a 2 min recovery phase before data collection. The jumper stands on the contact mat and starts the jump with a preliminary counter movement. In the test condition, the jumper keeps the hands on the hips throughout. The jumper takes off straight upwards and lands on the balls of the feet. The position of the jumper on the mat has to be the same at take off and at landing. To obtain a more natural form of jumping, the participants performed the counter movement according to their self-selected speed and height. Each participant performed three successful jumps. A minimum of 90 s of rest between each trial was provided to minimize fatigue. The highest jump height recorded was used for further analysis.

VERTICAL JUMP

Performance in the static jump (SJ) describes jumping ability and explosive force production of the lower extremities. The result is expressed as the height of the rise of the center of gravity. The static jump is a basic test of speed strength and it can be applied successfully to a number of sport events. The vertical jump was performed with both feet on a Newtest jump force plate (Newtest 2000, Powertimer Measuring System, 1995, Finland). The static jump begins from a semisquatting position without a preparatory counter movement. The knee angle is 90 degrees in a static position. The jumper keeps the hands up-down freely. The jumper takes off straight upwards and lands on the balls of the feet. The position of the jumper on the mat has to be the same at takeoff and at landing. The highest jump height recorded was used for further analysis.

HAND-GRIP TEST

A grip dynamometer (Takei Physical Fitness Test, Hand Strength Dynamometer, Japan), calibrated by the suspension of weights, was used to measure grip strength to approximately 0.5 kg. One practice trial on each hand was followed by three tests on both hands. The tests were performed alternately between the left and right hands [10].

FLEXIBILITY TEST

The stretching procedure started from a floor sitting position. Subjects extended the knee of the dominant leg and folded the other leg to the side and kept the back straight while bending forward at the hip slowly and gently until a feeling of "maximum stretch without pain" at the hamstrings, while keeping the knee fully extended [5].

STATISTICAL ANALYSIS

The whole statistical procedure was performed using the SPSS 11.0 software for Windows. The data are presented as mean ± SD. Anthropometric and physiological characteristics in five groups were

compared statistically using a Kruskal-Wallis test. Post hoc analyses revealed differences between the five groups, and significance was determined at the 0.05 level.

RESULTS

ANTHROPOMETRIC CHARACTERISTICS

The mean (±) age and playing experience of all players (n=42) were 22.7 ± 2.3 and 2.7 ± 2.2 years, respectively. The mean (±) stature, body mass, % fat, body mass index and waist/hip ratio for all players were 181.4 ± 6.3 cm, 96.1 ± 24.7 kg, 18.8 ± 5.8 %, 29.1 ± 7.0 kg/m^2 and 0.86 ± 0.06 %, respectively.

OFFENSE & DEFENSE EVALUATION

Table 2. Age (years), stature (cm), body mass (kg), body mass index (kg/m^2), waist-hip ratio (WHR %), playing experience (PLE) of the players by playing positions (mean ± sd)

	Offense (n=21)	**Defense (n=21)**
Age (year)	22.6 ± 2.6	22.2 ± 1.8
PLE (year)	2.6 ± 2.2	2.7 ± 2.4
Stature (cm)	180.4 ± 6.7	182.5 ± 5.8
Body mass (kg)	101.5 ± 31.5	91.0 ± 12.1
% Fat	17.1 ± 5.1	15.7 ± 4.0
BMI (kg/m^2)	31.0 ± 8.7	27.0 ± 4.0
WHR (%)	0.87 ± 0.07	0.86 ± 0.04

Team positions can also be classified according to the specific individual position played (i.e. Center, Guard, Tackle, Tied End, Wide Receiver, Line Backer, Back, Safety), or according to five subgroups reflecting positional commonality (i.e. Defensive Back, Offensive Back/Wide Receiver, Line Backer, Offensive Line/Tight End, Defensive Line.)

EVALUATION OF FIVE DIFFERENT POSITION

Table 3. Mean, Std. Deviation and p value of five different playing positions in body mass, BMI, % fat and WHR

Body mass	**n**	**Mean**	**SD**	**p value**	**BMI**	**n**	**Mean**	**SD**	**p value**
DB	8	81.7	4.8		***DB***	8	24.8	2.0	
OB/WR	12	81.4	17.9		***OB/WR***	12	25.2	5.4	
LB	5	91.5	7.6	p<0.001	***LB***	5	28.3	2.7	p<0.01
OL/TE	9	116.7	30.5		***OL/TE***	9	34.3	9.0	
DL	8	112.0	17.9		***DL***	8	33.7	5.1	
% Fat	**n**	**Mean**	**SD**	**p value**	**WHR**	**n**	**Mean**	**SD**	**p value**
DB	8	15.0	3.8		***DB***	8	0.84	0.02	
OB/WR	12	15.5	5.2		***OB/WR***	12	0.83	0.05	
LB	5	17.8	3.6	p<0.01	***LB***	5	0.85	0.03	p<0.05
OL/TE	9	21.9	5.1		***OL/TE***	9	0.90	0.05	
DL	*8*	24.5	4.2		***DL***	8	0.90	0.07	

DB= Defensive Back, OB/WR= Offensive Back/Wide Receiver, LB= Line Backer, OL/TE= Offensive Line/Tight End, DL=Defensive Line.

Significant differences were detected among individual positions for body mass, body mass index, % fat, and waist/hip ratio. Offensive Line/Tight End and defensive line players were heavier (p<0.001, Figure1) and had greater % fat (p<0.01, Figure 4) than all other positions. In addition, Offensive Line/Tight End and Defensive Line players had greater WHR (p<0.05, Figure 3) and BMI ratios

(p<0.01, Figure 2) than all other positions. When the data were analyzed according to positional commonality, Offensive Line and Tight Ends (p<0.001, Figure 1) were heavier and had a greater BMI ratio (p<0.01, Figure 2) than Defensive Back, Offensive Back/Wide Receiver and Line Backer positional groups. Defensive Line players had a greater % fat ratio (p<0.01, Figure 4) and waist/hip ratio (p<0.05, Figure 3) than Defensive Back, Offensive Back/Wide Receiver and Line Backer positional groups. There were no significant differences (p>0.05) among individual positions for age, playing experience and stature.

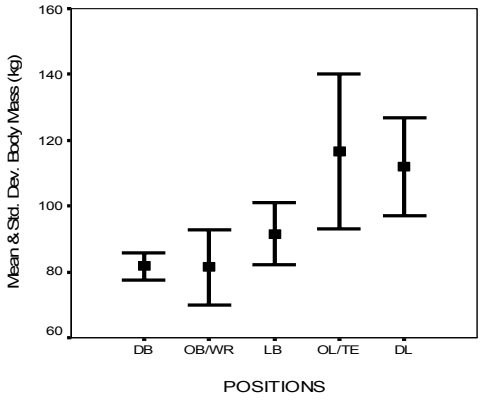

Figure 1. Comparison of the body mass (kg) of AF players according to positions

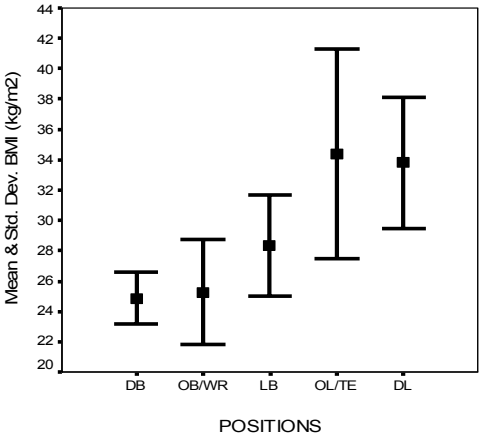

Figure 2. Comparison of the Body Mass Index (kg/m^2) of AF players according to positions

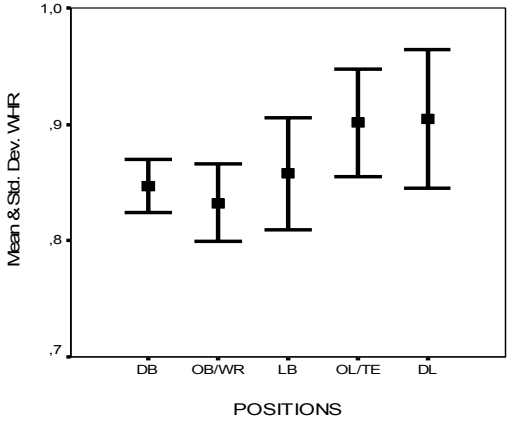

Figure 3. Comparison of the waist–hip ratio (WHR %) of AF players according to positions

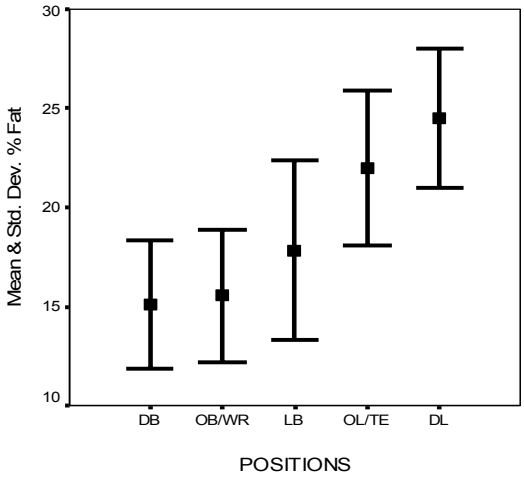

Figure 4. Comparison of the % fat ratio of AF players according to position

PHYSIOLOGICAL CHARACTERISTICS

The mean (±) 10 yard speed, 40 yard speed and estimated VO_2 max of all players were: 1.71 ± 0.13 s, 5.02 ± 0.77 s and 38.0 ± 8.2 kg/ml/min, respectively (Table 4). The mean (±) vertical jump, CMJ and right & left hand strengths of all players were: 54.5 ± 7.7 cm, 45.7 ± 6.0 cm, 47.7 ± 10.2 kg and 44.9 ± 9.4 kg, respectively (Table 5). There were no significant differences ($p>0.05$) among individual positions for vertical jump, CMJ, right & left hand strength, flexibility, 10 yard, 40 yard and VO_2 max (Table 6).

OFFENSE & DEFENSE EVALUATION

Table 4. Field Tests - 10 & 40 yard sprint times, VO_2 max (mean ± sd)

	Offense (n=21)	**Defense (n=21)**
10 yrd. (s)	1.72 ± 0.19	1.69 ± 0.08
40 yrd. (s)	5.43 ± 0.89	4.84 ± 0.64
VO_2 max (kg/ml/min)	35.9 ± 9.7	40.6 ± 5.4

Table 5. Vertical jump, Counter movement jump, Right & Left hand strengths and Flexibility for AF players (mean ± sd)

	Offense (n=21)	**Defense (n=21)**
Vertical Jump (cm)	53.2 ± 8.1	56.0 ± 7.2
CMJ (cm)	44.5 ± 6.8	46.7 ± 5.3
Flexibility (cm)	8.0 ± 8.9	8.0 ± 10.0
Right hand strength	44.7 ± 8.7	50.2 ± 5.4
Left hand strength	41.1 ± 9.2	47.8 ± 8.8

EVALUATION OF FIVE DIFFERENT POSITION

Table 6. Mean, Std. Deviation and p value of five different playing positions in Vertical jump, CMJ, Right & Left hand strength, Flexibility, 10 yard, 40 yard and VO_2 max

Vertical jump	n	Mean	SD	p value	CMJ	n	Mean	SD	p value
DB	8	56.5	6.5		***DB***	8	46.1	5.4	
OB/WR	12	57.1	9.3		***OB/WR***	12	47.5	6.0	
LB	5	57.2	5.9	p>0.05	***LB***	5	48.2	3.3	p>0.05
OL/TE	9	52.5	6.8		***OL/TE***	9	46.3	4.8	
DL	8	49.8	3.7		***DL***	8	43.1	5.1	
Right hand strength	**n**	**Mean**	**SD**	**p value**	**Left hand strength**	**n**	**Mean**	**SD**	**p value**
DB	8	49.4	13.4		***DB***	8	41.8	10.3	
OB/WR	12	46.1	9.3		***OB/WR***	12	44.0	8.8	
LB	5	50.6	3.9	p>0.05	***LB***	5	48.4	5.9	p>0.05
OL/TE	9	49.1	5.3		***OL/TE***	9	47.9	6.7	
DL	8	46.0	8.6		***DL***	8	44.7	6.2	
Flexibility	**n**	**Mean**	**SD**	**p value**	**10 yard**	**n**	**Mean**	**SD**	**p value**
DB	8	10.4	4.0		**DB**	8	1.68	0.90	
OB/WR	12	9.5	9.3		**OB/WR**	12	1.62	0.10	
LB	5	9.3	12.5	p>0.05	**LB**	5	1.71	0.10	p>0.05
OL/TE	9	9.6	4.7		**OL/TE**	9	1.67	0.10	
DL	8	2.4	13.5		**DL**	8	1.77	0.02	
40 yard	**n**	**Mean**	**SD**	**p value**	**VO_2 max**	**n**	**Mean**	**SD**	**p value**
DB	8	4.68	0.30		**DB**	8	41.4	3.7	
OB/WR	12	4.75	0.30		**OB/WR**	12	41.4	6.3	
LB	5	5.27	0.40	p>0.05	**LB**	5	42.5	5.1	p>0.05
OL/TE	9	5.54	1.00		**OL/TE**	9	35.6	8.3	
DL	8	5.11	0.70		**DL**	8	33.5	7.1	

DB= Defensive Back, OB/WR= Offensive Back/Wide Receiver, LB= Line Backer, OL/TE= Offensive Line/Tight End, DL=Defensive Line.

DISCUSSION

In field-based team sports, such as AF, there are requirements to perform repeated-sprint efforts of maximal or near maximal intensity [19], separated by short bouts of lower-intensity activity (recovery). As a result of the physical demands of the game, the physiological qualities of players are highly developed with players requiring high levels of anaerobic sprint ability (RSA), speed, muscular power, and agility [11].

Several studies [3, 6, 8] have examined the physiological and anthropometric characteristics of AF players but few have documented the influence of playing position on the fitness of these athletes. Previous studies into anthropometric characteristics of elite AF league players have shown significant differences among playing positions for stature, body mass, or % fat [9, 13, 18].

The present study is the first to compare the physiological and anthropometric characteristics of specific playing positions and positional playing groups in amateur Türkish AF players. The results of this study demonstrate that only anthropometric differences exist among individual playing positions in AF players; DB=OB/WR<LB<DL<OL/TE. OL/TE and DL are heavier ($p<0.001$, Figure 1), and have a greater BMI ($p<0.01$, Figure 2), skinfold thickness (% fat) ($p<0.01$, Figure 4) and WHR ($p<0.05$, Figure 3). Furthermore, defensive line players are lighter on average than offensive line players because of the requirements for greater movement abilities to play wider whole coverage zones and for pass rushing. The DL and OL/TE values reported here are similar to those reported by Kramer et al. [13] and Snow et al. [18] for a professional AF team in America. Likewise, the differences in DB, OB/WR and LB found in the present study indicate less body mass compared to other studies [13,18]. When we compare our BMI results with Snow et al. [18] & Kramer et al. [13] study, it is found that all results are similar in five positions.

In this comparison, it is found that our athletes' percentages of % fat are higher then theirs, except in OL/TE positions. It is thought that this differentiation may stem from different methodologies used to determine % fat [13, 18].

A recent report suggested a high prevalence of obesity as measured by BMI in professional football players. However, the data based solely on BMI calculations from body mass and weight posted on the NFL web site may not accurately portray the modern player regarding health status, because BMI calculations do not distinguish between fat and lean tissue. Despite the significant correlation between the variables of body composition and BMI, a purely associative value is of little help in determining magnitude, because of the composite fat and lean tissue components integrated in the BMI measurement [13].

As expected, OL/TE and DL had lower 10-yrd and 40-yrd speed, and lower estimated maximal aerobic power than other positional playing groups. Since AF players perform different playing activities during the game depending on their playing position, with tackles involved in significantly more physical collisions than backs. In this study no significant differences were detected among any of the five playing positions for 10 yard, 40 yard and estimated VO_2 max. These findings suggest that when training for position-specific improvements in aerobic fitness, players should be grouped according to their positional playing group (i.e. Offensive-Defensive Linemen, Wide Receiver, Line Backer, Defensive Back). The higher estimated VO_2 max in LB and WR may reflect their high work rate throughout the match.

The findings are similar in vertical jump height, CMJ height, and right & left hand strength among positional playing groups. The ability to generate high muscular force rapidly is an important attribute of AF players. Players are required to have high muscular strength and power to perform the tackling, lifting, pushing, and pulling tasks that occur during a match [14]. In addition, high muscular strength and power contribute to running speed, and are required to provide fast play-the-ball speed and leg drive in tackles [7]. The finding of similar vertical jump scores among positions suggests that muscular power is an equally important characteristic for all playing positions. However, while muscular power is an important characteristic for all playing positions, it has been suggested that this holds because OL and DL work over shorter distances. They require a greater ability to generate great forces rapidly [15]. It is possible that the similar vertical jump scores between OL & DL and other playing positions reflect the greater skinfold thickness of OL & DL and an attenuation of the power to body mass ratio in these players.

CONCLUSIONS

It appears that football players have become stronger, faster, and more powerful recently. Consequently, a longer period of training may be needed to explore optimal power, speed, and agility of players along Turkish standards.

PRACTICAL APPLICATION

We suggest that AF training should be systematically incorporated in the training science (Using heart rate values and blood lactate threshold levels) and coaches can construct their training while determining individualized exercise intensities for their players. Additionally, players should be periodically evaluated through physical and physiological tests.

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