THE EXAMINATION OF THE RELATIONSHIP BETWEEN MAXIMUM AEROBIC POWER, FORCED VITAL CAPACITY AND BODY COMPOSITION IN SOCCER PLAYERS

Kemal GÖRAL[1]

ABSTRACT

The aim of this study was to examine the relationship between maximum aerobic power, forced vital capacity and body composition in soccer players. 24 soccer players were voluntarily participated in this study. In this study, age, height, weight, maximal aerobic power, forced vital capacity, body mass index and body composition values were determined by measuring instruments. The data obtained in this study was recorded in SPSS program. In order to examine the relationship between the characteristics, Pearson Correlation test was applied. Soccer players' average maximal aerobic power, forced vital capacity, body mass index and body composition were determined as 55.5±2.68 ml.kg/min, 5.04±0.21 lt, 22.92±0.98 kg/m^2 and 10.46±1.65%, respectively. As a result, while there was significant relation between soccer players' maximal aerobic power and forced vital capacity and between body mass index and body composition, there wasn't any significant relation between other variables. Accordingly, it can be said that soccer players' aerobic power and vital capacity; body mass index and body fat percentage are the features affecting each other.
Key Words: Soccer, Aerobic power, Vital capacity, Body composition.

FUTBOLCULARDA MAKSİMAL AEROBİK GÜÇ, ZORLU VİTAL KAPASİTE VE VÜCUT KOMPOZİSYONU İLİŞKİSİNİN İNCELENMESİ

ÖZET

Bu çalışma, futbolcularda maksimal aerobik güç, zorlu vital kapasite ve vücut kompozisyonu ilişkisinin incelenmesi amacı ile yapılmıştır. Çalışmaya, 24 futbolcu gönüllü olarak katılmıştır. Araştırmada yaş, boy, vücut ağırlığı, maksimal aerobik güç, zorlu vital kapasite, beden kitle indeksi ve vücut kompozisyonu değerleri ölçüm aletleri ile tespit edilmiştir. Elde edilen veriler SPSS programında kaydedilmiştir. Özellikler arasındaki ilişkiyi incelemek için Pearson Korelâsyon testi uygulanmıştır. Futbolcuların maksimal aerobik güç, zorlu vital kapasite, beden kitle indeksi ve vücut yağ yüzdesi ortalamaları sırasıyla, 55.5±2.68 ml.kg/dk, 5.04±0.21 lt, 22.92±0.98 kg/m^2 ve %10.46±1.65 olarak tespit edilmiştir. Sonuç olarak, futbolcuların maksimal aerobik güçleri ile zorlu vital kapasiteleri ve vücut yağ yüzdeleri ile beden kitle indeksleri arasında anlamlı ilişkilere rastlanırken, diğer değişkenlerin birbirleri ile aralarında herhangi bir ilişki tespit edilememiştir. Buna göre, futbolcularda aerobik güç ile vital kapasite ve vücut yağ yüzdesi ile beden kitle indeksinin birbirini etkileyen özellikler olduğu söylenebilir.
Anahtar Kelimeler; Futbol, Aerobik güç, Vital kapasite, Vücut Kompozisyonu.

[1] Muğla Sıtkı Koçman University School of Physical Education and Sports, Turkey

INTRODUCTION

In the perspective of 17 rules accepted by specifying before, soccer is the most popular sporting branch that is played in rectangular field, which is at most 120 m, at least 90 m long and at most 90 m, at least 45 m wide, between two teams consisting of 1 goalkeeper and 10 players for each team. Scoring is based on passing a special designed 410-450 grams leather ball the goal line without using hands and arms. Four referees; one in the middle, two in lines and one on the edge, rule football (Ayran, 2006).

Although the exercises occurring in the soccer play are seen as more anaerobic content, maintaining the match during 90 minutes makes anaerobic capacity worthwhile. Aerobic effort creates 87.2% of the distance covered during a match. Heart rate of a soccer player in a minute in a soccer match is about 165. This is above 80% of the maximum VO_2 of a soccer player. Resistance to fatigue of a soccer player during a match depends on the aerobic capacity. It is underlined that football players have similar Max VO_2 (55-65 ml.kg.min) to long distance runners (Günay and Yüce, 2008). On the other hand, because of both the players genetic structure and metabolic and organic adaptations that occur in trainings, circulatory and respiratory functions is a matter that should be taken into consideration. Respiratory system has an important role as it supplies oxygen to organism and to the working muscles. As a result of the adaptation that occurs in trainings, positive improvements occur in lung functions of soccer players. Lungs and muscles are strengthened, supply oxygen to muscles for exercise by giving more oxygen than is needed. Aerobic potential or energy generating capacity of an organism in cases of oxygenated environments determines the athlete's endurance capacity. It can be said that aerobic power is limited by a person's ability to carry O_2. In general, the vital capacity of the players is examined (Günay and Yüce, 2008; Özkara, 2002). Vital capacity is the air volume that can be thrown out with maximal expiration made slowly and without difficulty after maximal inspiratory.

Vital capacity is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume. It is about 4.5 litres. Vital capacity varies proportional with length, inversely with age. Forced vital capacity (FVC) is air volume that exhaled by hard and fast expiration after a profound inspiration. In healthy people, FVC is equal to vital capacity (Gültekin, 2007). In general body composition is composed of fat, bone, muscle cells, other organic substances and extracellular fluid (Zorba and Saygın, 2009). In adult males, body fat ratio constitutes 15% to 17% of body weight. Fat cells cannot be used in the production of ATP by the muscle; their main purpose is to store lipids. As a result, fat in greater proportion in the body is detrimental to performance (Günay, Tamer and Cicioğlu, 2006).

In this context, our study was made with the aim of examining the relations of maximal aerobic power, forced vital capacity and body composition in soccer players.

METHOD

Selection of subjects: In this study, subject group consisted of 24 volunteer soccer players playing in the regional amateur leagues. Measurements of athletes were performed during competition period and in the rest days.

Height and body weight: Electronic weighbridge in the sensitivity of 0.1 kg was used to measure weight; digital height measurement tool in the sensitivity of 0.01 cm was used to measure height (Tamer, 2000).

Maximal Aerobic Power: 20 meter shuttle run test was used for maximal

aerobic power measurement. A voice record in which signal range increased 0.5 km/s at every minute was used for this test. Athletes were asked to touch the line at the end of 20 meter at every signal. Test was ended for the athletes who could not touch the lines in front of 20-meter lines twice. The results reported as ml/kg/min (Tamer, 2000).

FVC (Forced Vital Capacity): Forced vital capacity measurements were made three times with memory handheld spirometer; the best results were evaluated and were recorded in litres (Tamer, 2000).

Body composition: Holtain brand Skinfold calliper was used which presses 10 g/sq mm at each angle for measuring body fat percentage. Measurements were taken from the right side of subject when standing upright. In the measurement of skin thickness, subcutaneous fat layer thickness between the thumb and index finger was taken up slightly enough to be separated from the muscle tissue. Skinfold thickness held by locating 1 cm distance to calliper fingers was read on the indicator between 2-3 seconds. The measurements taken from 4 sites (biceps, triceps, suprailiac and subscapularis) were calculated according to the formula of Durning-Womersley and Siri (Özer, 2001; Tamer, 2000; Zorba and Saygın, 2009).

Durning-Womersley formula	Siri Formula
BD= 1.1620 – 0.0630 x X (Male 17-19 Year) BD= 1.1631 – 0.0632 x X (Male 20-29 Year) BD= 1.1422 – 0.0544 x X (Male 30-39 Year) BD=Body Density Log X = (bi+tr+ss+si)	% Fat = (4.95/BD - 4.50) x 100 bi = biceps skinfold thickness tr = triceps skinfold thickness si = suprailiac skinfold thickness ss = subscapula skinfold thickness

Body Mass Index (BMI) calculation: The following formula was used to measure body mass index. (Tamer, 2000; Zorba and Saygın, 2009).

Body Mass Index (BMI) = Body Weight / Length $(m)^2$

Statistical analysis: All data obtained in this study were recorded in SPSS. After arithmetic mean and standard deviation values of the data obtained was calculated, to examine the relationship between features Pearson's correlation tests were applied and the significance level $p < 0.05$ was taken.

RESULTS

In this study, tests and measurements were applied to 24 soccer players who played in the regional amateur league. All values were examined statistically and are presented in the following table.

Table 1.The Demographic Characteristics of Soccer Players

Variables	N	*Arithmetic Mean*	*Standard Deviation*	Minimum	Maximum
Age (years)	24	23,4	3,77	18,00	32,00
Height (cm)	24	178,1	4,19	172,00	188,00
Body Weight (kg)	24	72,7	3,94	67,00	84,00

The average age of the soccer players who participated in the study was 23.4±3.77 years, mean height 178.1±4.19 cm and body weight 72.7±3.94 kg, respectively.

Table 2. Maximal Aerobic Power (VO_2 Max.), Forced Vital Capacity (FVC) and Body Composition Values of Soccer Players

Variables	N	*Arithmetic Mean*	*Standard Deviation*	Minimum	Maximum
Aerobic capacity (ml.kg/min)	24	55,5	2,68	51,40	59,30
FVC (Forced Vital Capacity) (lt)	24	5,04	0,21	4,48	5,41
Body Mass Index (kg/m^2)	24	22,92	0,98	21,80	25,60
Body Fat Percentage (%)	24	10,46	1,65	8,10	14,20
Lean Body Weight (kg)	24	65,17	3,67	61,6	75,2
Fat Weight (kg)	24	7,53	1,26	5,4	10,5
Biceps skinfold thickness (mm)	24	4,69	0,51	3,80	5,70
Triceps skinfold thickness (mm)	24	6,65	0,58	5,10	7,50
Suprailiac skinfold thickness (mm)	24	7,11	0,75	6,10	8,40
Subscapula skinfold thickness (mm)	24	5,40	1,13	3,70	6,90

Maximal aerobic power mean of soccer players participated in the research was 55.5±2.68 ml.kg / min, FVC values mean was 5.04±0.21 lt, body fat percentages were 10.46±1.65% and body mass index values were 22.92±0.98 kg/m^2.

Table 3. Relations between maximal aerobic power of soccer players (VO_2 Max.), forced vital capacity (FVC) and body composition values

Variables		Maximal Aerobic Power (lt)	FVC (Forced Vital Capacity) (lt)	Body Mass Index (BMI)	Body Fat Percentage (%)
Maximal Aerobic Power(lt)	r		-,443*	-,158	-,086
	P		,030	,461	,690
	N		24	24	24
FVC (Forced Vital Capacity) (lt)	r	-,443*		,068	-,259
	P	,030		,751	,223
	N	24		24	24
Body Mass Index (BMI)	r	-,158	,068		,506*
	P	,461	,751		,012
	N	24	24		24
Body Fat Percentage (%)	r	-,086	-,259	,506*	
	P	,690	,223	,012	
	N	24	24	24	

***p<0.05**

Significant differences were found between maximal aerobic power characteristics and FVC values; body fat percentage and body mass index values of soccer players (p<0.05) (r=.-443; r=.506). No significant relationship was found between other variables (p>0.05).

DISCUSSION AND CONCLUSION

The aim of this study was to examine the relationship between maximum aerobic power, forced vital capacity and body composition in soccer players. The average age of the players who participated in the study was 23.4±3.77 years, mean height 178.1±4.19 cm, body weight 72.7±3.94 kg, respectively (Table 1). Sutton et al. (2009), in their study done with 4 team and 64 soccer players in Premiere League, found age, length, weight means as 26.2±4.0, 182±0.07, 83.2±7.5, respectively. Al-Hazzaa et al. (2001), found age, length, weight means as 25.2±2.3, 177.2±5.9, 73.1±6.8, respectively. Carling and Orhant (2010), in the study of professional soccer players in France first division, found age, length and weight means as 24.4±4.1, 182.1±5.8, 76.8±5.8, respectively. Chin et al. (1992), in the

study of professional soccer players in Hong Kong, found age, length and weight means as 26.3±4.2, 173.4±4.6, 67.7±5.0, respectively. Watson (1995), in the study of Irish soccer players, found age, length and weight means as 25.5±4.1, 181.4±8.2, 81.9±6.9, respectively. Erkmen, Kaplan and Taşkın (2005), in the study of soccer players in the second and third division in Turkey, found length and weight means as 181.12±5.72 and 177.06±5.91 cm, 74.53±7.13 and 69.67±5.10. Karakaş et al (2011) found age, length and weight means of Turkish soccer players as 23.41±4.25, 177.94±5.35, and 73.12±5.17, respectively. When we look at the literature studies, the research findings have similarities with the values of Turkish and foreign players age, height and body weight.

Maximal aerobic power mean of soccer players participated in the research was 55.5±2.68 ml.kg/min, forced vital capacity (FVC) average was 5.04±0.21 lt, body fat percentages were 10.46±1.65% and body mass index values were 22.92±0.98 kg/m^2 (Table 2). Carling and Orhant (2010) found body fat percentage of soccer players playing in first league of France to be 10.81±1.77% in pre-season, 10.19±1.75% in mid-season, 10.80±1.63% at the end of the season. Al-Hazzaa et al. (2001) found body fat percentage of Saudi soccer players to be 12.3±2.7%. Dittrich et al. (2011) found body fat percentage of soccer players to be 9.80±1.3%. Chin et al. (1992) found body fat percentage of professional soccer players from Hong Kong to be 7.3±3.0% and FVC values to be 5.1±0.6 lt. Watson (1995) found body fat percentage of Irish soccer players to be 15.0±4.2%, FVC values to be 6.0±0.5 lt and maximal aerobic power values to be 58.6±3.8 ml.kg/min. Boone et al. (2012) found body fat percentage of 289 professional soccer players playing in the first league of Belgium in 2003-2010 to be 11.0±2.5%, maximal aerobic power values to be 57.7±4.7 ml.kg/min. Manna, Khanna and Dhara (2011) found body fat percentage, maximal aerobic power values of Indian players playing regularly in matches in the last 4-7 years to be 13.0±1.3% and 60.2±4.2 ml.kg/min respectively. Kutáč (2012) found body fat percentage of Czech soccer players to be 10.67±3.92%. Lollo, Amaya-Farfan and Carvalho-Silva (2011) found body fat percentage of professional soccer players playing in first league of Brasilia to be 12.15±0.2%. De Araujo et al. (2012) found body fat percentage of professional soccer players to be 11.9±2.9% and maximal aerobic power values to be 51.2±6.8 ml.kg/min. Nikolaïdis[a] (2012) found body fat percentage of soccer players to be 15.1±3.0%. Boullosa et al. (2012) found body fat percentage of professional soccer players playing in first league of Spanish to be 10.7±0.6%. Mohammadi et al. (2013) found aerobic power of Iranian soccer players to be 52.78±0.98 ml.kg/min and body fat percentage to be 11.10±1.58%. Erkmen, Kaplan and Taşkın (2005) found body fat percentage of professional soccer players playing in the second league to be 12.03±2.21%, maximal aerobic power values to be 51.36±3.85 ml.kg/min and FVC values to be 4.72±0.89 lt; body fat percentage of professional soccer players playing in the third league to be 11.37±1.35%, maximal aerobic power values to be 51.73±4.01 ml.kg/min, FVC values to be 4.92±0.56 lt. Temoçin, Ek and Tekin (2004) found FVC values of amateur soccer players training regularly to be 4.72±1.03 lt, Kasımay et al. (2011) 5.07±0.13 lt. Ostojić (2000) found FVC of professional soccer players playing in the national first league to be 5.6±0.8 lt and in amateur soccer players to be 5.4±0.9 lt. In the literature, vital capacity and forced vital capacity (FVC) in healthy subjects are emphasized to be equal (Altürk Toraman, 2006; Gültekin,2007).

Lollo, Amaya-Farfan and Carvalho-Silva (2011) found body mass index of professional soccer players playing in the Brazil first league to be 22.6±0.2 kg/m^2; De Araujo et al. (2012), found body mass index of professional soccer players as 24.0±2.2 kg/m^2; Kutáč (2012) found body mass index of Czech soccer players as 22.83±1.83 kg/m^2; Nikolaïdis[a] (2012) found body mass index of in soccer players as 23.9±1.8 kg/m^2; Aguiar et al. (2008) found body mass index of Portuguese semi-professional soccer players as 23.73±1.28 kg/m^2; Mohammadi et al. (2013) found body mass index of Iranian soccer players as 24.66±1.98 kg/m^2, Arroyo et al. (2008) found body mass index of professional soccer players as 23.3±1.0 kg/m^2, Karakaş et al (2011) found body mass index of Turkish soccer players as 23.26±1.64 kg/m^2.

Significant correlation ($p<0.05$) was found in maximal aerobic power characteristics of soccer players participated in the research, FVC values and percentage of body fat and body mass index values of (r=.-443; r=.506), there were no correlation between other variables($p>0.05$). Manna, Khanna and Dhara (2011) found $p<0.01$ level of significant correlation between body fat percentage and VO_2 max values in soccer players. Sınırkavak, Dal and Çetinkaya (2004) found $p<0.05$ level of significant correlation between body fat percentage and VO_2 max values in elite athletes. Nikolaïdis[b] (2012) found a $p<0.05$ level of significant correlation between body fat percentages and aerobic power, $p<0.01$ level of significant correlation between body fat percentages and body mass index of soccer players in his study. Overall, the research findings show similarities with national and international studies in terms of maximal aerobic power, forced vital capacity, body mass index and body composition.

Consequently, while no correlations have been found between other variables, significant correlations have been found between maximal aerobic power and forced vital capacity of soccer players, and body fat percentage and body mass index. It can be said that aerobic capacity and vital capacity are the features that have impacts on each other; the same can be said for body mass index and body fat percentage.

REFERENCES

1. Aguiar M., Abrantes C., Maçãs V., Leite N., Sampaio J., Ibáñez S. “Effects of Intermittent or Continuous Training on Speed, Jump and Repeated-Sprint Ability in Semi-Professional Soccer Players”. The Open Sports Sciences Journal, Volume 1, 15-19, 2008.
2. Al-Hazza H.M., Almuzaini K.S., Al-Refaee S.A., Sulaiman M.A., Dafterdar M.Y., Al-Ghamedi A., Al-Khuraiji K.N. “Aerobic and anaerobic power characteristics of Saudi elite soccer players”, Journal of Sports Medicine & Physical Fitness, Vol.41, Issue 1. p.54-61, 2001.
3. Altürk Toraman Y. “Stabil kronik obstrüktif akciğer hastalarında inflamatuar belirteçler; c-reaktif protein, fibrinojen ve lökosit”, Yedikule Göğüs Hastalıkları ve Göğüs Cerrahisi Eğitim ve Araştırma Hastanesi, Uzmanlık tezi, İstanbul, 2006. [In Turkish]
4. Arroyo M., González-de-Suso JM., Sanchez C., Ansotegui L., Rocandio MA. “Body Image and Body Composition: Comparisons of Young Male Elite Soccer Players and Controls”, International Journal of Sport Nutrition and Exercise Metabolism, 18, 628-638, 2008.
5. Ayran T. “Ofsayt Kuralı İle Ofsayt Kuralı Olmadan Oynanan Futbol Oyunundaki Maç Analizi Sonuçlarının İncelenmesi”, Ankara Üniversitesi Sağlık Bilimleri Enstitüsü, Hareket ve Antrenman Anabilim Dalı, Yüksek Lisans Tezi, s.1, Ankara, 2006. [In Turkish]
6. Boone J., Vaeyens R., Steyaert A, Bossche LV., Bourgois J. “Physical fitness of elite Belgian soccer players by player position”, Journal of Strength and Conditioning Research, 26(8)/2051–2057, 2012.
7. Boullosa DA., Abreu L., Nakamura FY., Muñoz VE., Domínguez E., Leicht AS. “Cardiac Autonomic Adaptations in Elite Spanish Soccer Players During Preseason”, International Journal of Sports Physiology and Performance, 8, 400-409, 2013.
8. Carling C., Orhant E. “Variation in Body Composition in Professional Soccer Players: Interseasonal And Intraseasonal Changes And The Effects Of Exposure Tıme And Player Position”, Journal of Strength and Conditioning Research, 24(5)/1332–1339, 2010.

9.Chin MK., Lo YS., Li CT., So SH. "Physiological profiles of Hong Kong elite soccer players", British Journal of Sports Medicine, 26 (4), 262-266, 1992.
10.De Araujo SS., Mesquita TRR, Dos Santos RM, Oliveira JEL., Alves ARA. "Anthropometric, Functional, and Metabolic Profiles of Soccer Players", Journal of Exercise Physiology, Volume 15, Number 6, 37-47, 2012.
11.Dittrich N., Da Silva JF., Castagna C., De Lucas RC., Guglielmo, LGA. "Validity of Carminatti's test to determine physiological indices of aerobic power and capacity in soccer and futsal players", Journal of Strength and Conditioning Research, 25(11)/3099–3106, 2011.
12.Erkmen N., Kaplan T., Taşkın H. "Profesyonel Futbolcuların Hazırlık Sezonu Fiziksel ve Fizyolojik Parametrelerinin Tespiti ve Karşılaştırılması", Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, III (4) 137-144, 2005. [In Turkish]
13.Gültekin Ö. "Torakal seviyeli medulla spinalis yaralanmalı hastalarda solunum egzersizlerinin solunum fonksiyonlarına ve yaşam kalitesine etkisi", İstanbul Fizik Tedavi ve Rehabilitasyon Eğitim ve Araştırma Hastanesi, Uzmanlık tezi, İstanbul, 2007. [In Turkish]
14.Günay M., Yüce A.İ. "Futbol Antrenmanının Bilimsel Temelleri". Gazi kitabevi, Genişletilmiş 3. baskı, s.50, Ankara, 2008. [In Turkish]
15. Günay M., Tamer K., Cicioğlu İ. "Spor Fizyolojisi ve Performans Ölçümü". Gazi kitabevi, Ankara, 2006. [In Turkish]
16.Karakaş S., Yıldız Y., Köse H., Temoçin S., Kızılkaya K. "Profesyonel ve amatör futbolcularda takım, mevki ve fiziksel yapı faktörlerinin vücut kompozisyonu üzerine etkileri", ADÜ Tıp Fakültesi Dergisi, 12(1) : 63 – 69, 2011. [In Turkish]
17.Kasımay Ö., Yıldırım A., Ünal M., Kaçar Ö., Bilsel S., Kurtel H. "The Involvement of Nitric Oxide and Endothelin-1 in Exercise-Induced Bronchospasm in Young Soccer Players", Clin J Sport Med. 2011;21:237–242, 2011.
18.Kutáč P. "Application of typical error of measurement for accuracy of measurement of body composition in athletes using the BİA method", Medicina Sportiva, 16 (4): 150-154, 2012.
19.Lollo PCB, Amaya-Farfan J, De Carvalho-Silva LB. "Physiological and Physical Effects of Different Milk Protein Supplements in Elite Soccer Players", Journal of Human Kinetics, volume:30, 49–57, 2011.
20.Manna I., Khanna G.L., Dhara P.C. "Effect of Training on Morphological, Physiological and Biochemical Variables of U-19 Soccer Players", Baltic Journal Of Health And Physical Activity, Gdansk University Education and Sport in Gdansk, Volume:3, No:4, 237-247, 2011.
21.Mohammadi M., Kazemi A., Sazvar A., Rahimi G., Khademi AR., Monazaf S. "Evaluation of physical and physiological profiles of Iranian male elite soccer players", Advances in Environmental Biology, 7(2): 373-383, 2013.
22.Nikolaïdis PT[a]. "Age-Related Differences of Hamstring Flexibility in Male Soccer Players", Baltic Journal Of Health And Physical Activity, Gdansk University Education and Sport in Gdansk, Volume:4, No:2, 110-115, 2012.
23.Nikolaïdis PT[b]. "Physical Fitness is Inversely Related With Body Mass Index And Body Fat Percentage in Soccer Players Aged 16-18 Years", Med Pregl 2012; LXV (11-12): 470-475. Novi Sad: novembar-decembar, 2012.
24.Ostojić SM. "Physical and physiological characteristics of elite serbian soccer players", Physical Education and Sport, Vol. 1, No7, 2000, pp. 23–29, 2000.
25.Özer K. (2001). "Fiziksel Uygunluk". Nobel Yayın Dağıtım, Ankara. [In Turkish]
26.Özkara A. "Futbolda Testler". İlksan Matbaacılık, 1.baskı, s.119, Ankara, 2002. [In Turkish]
27.Sınırkavak G., Dal U., Çetinkaya Ö. "Elit Sporcularda Vücut Kompozisyonu İle Maksimal Oksijen Kapasitesi Arasındaki İlişki", Cumhuriyet Üniversitesi Tıp Fakültesi Dergisi, 26 (4):171–176, 2004. [In Turkish]
28.Sutton L., Scott M., Wallace J. Reilly T. "Body composition of English Premier League soccer players: Influence of playing position, international status, and ethnicity", Journal of Sports Sciences, August 2009; 27(10): 1019–1026, 2009.
29.Tamer K. (2000). "Sporda Fiziksel-Fizyolojik Performans Ölçülmesi ve Değerlendirilmesi". Bağırgan Yayımevi, 36, 138-185, Ankara. [In Turkish]
30.Temoçin S., Ek RO., Tekin TA. "Futbolcularda Sürat ve Dayanıklılığın Solunumsal Kapasite Üzerine Etkisi", Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, II (1) 31-35, 2004. [In Turkish]
31. Watson AWS. "Physical and fitness characteristics of successful Gaelic footballers", British Journal of Sports Medicine, Vol.29, No.4, pp.229-231, 1995.
32.Zorba E., Saygın Ö. "Fiziksel Aktivite ve Uygunluk". İnceler Ofset, 2.baskı, s.148, Ankara, 2009. [In Turkish]