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Physical Characteristics and Somatotype of Soccer Players according to Playing Level and Position

by
Tahir Hazir [1]

The purpose of this study was to assess the physical characteristics of soccer players according to playing level and position. A total of 305 professional male soccer players [Turkish Super League (SL) (n = 161) and Turkish First League (FL) (n = 144)] were involved in this study. All data were gathered at the beginning of preparatory period of mid-season. Height, weight, flexed and tensed upper arm and calf girths, humerus and femur biepicondylar breadths, and four skinfold thicknesses (triceps, subscapular, supraspinale, and medial calf) were measured. Somatotypes were estimated using the Heath-Carter method. SL players were older (p≤0.002), and heavier (p≤0.007) than FL players, while height (p ≥ 0.497) was similar between SL and FL groups. There were significant differences for BW (p≤0.000), and height (p≤0.000) between playing positions. Goalkeepers were taller (p≤0.000), and heavier (p≤0.001) than other players. Midfielders were shorter (p≤0.013) than other players, however, they were lighter than forwards (p≤0.008). The mean somatotype of the overall players was 2.4-4.8-2.3 (0.9-0.8-0.7) in SL and was 3.0-4.5-2.6 (0.9-0.9-0.8) in FL. SL players were more mesomorphic (p≤0.01), less endomorphic (p≤0.000), and less ectomorphic (p≤0.001) than FL players. Except for goalkeepers, there were significant differences in paired means between whole somatotype means of the SL and FL according to playing positions. The results of the present study demonstrate that both physical characteristics and somatotype of players were significantly different between playing levels and positions. Although the somatotype of soccer players in both levels was dominated by the mesomorph category, players at the higher playing level were more mesomorphic, and less endomorphic and ectomorphic than players at the lower level at all playing positions.

Key words*:* body weight, stature, somatotype, soccer

Sport, Physical Education & Recreation

Introduction

Soccer is a team sport that depends heavily on aerobic endurance and short-term, high intensity intermittent activities (Rampinini et al., 2009; Bangsbo et al., 2006; Mohr et al., 2003; Rienzi et al., 2000; Bangsbo et al., 1991), needing high levels of performance, combined with high levels of technical and tactical skills, and particular physical and physiological characteristics (Kalapotharakos et al., 2006). As in other team sports, soccer also involves different playing positions with different physical requirements (Mohr et al., 2003; Rienzi et al., 2000; Bangsbo, 1994). In order to compete at an elite level, soccer players are expected to possess morphological and physiological characteristics that are applicable both for the sport of soccer and specifically to their playing position. Although significant correlations were determined among soccer players' body weight, muscle mass and work-rate profile, the relationship between other anthropometric characteristics and work-rate profile was found to be more complicated (Rienzi et al., 2000). On the other hand, studies with young soccer players indicated that age and physical characteristics were important indica-

[1] - *Hacettepe University, School of Sport Sciences and Technology, Beytepe-Ankara, 06800, Turkey*

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tors in identifying talented players and selection for the game (Gil et al., 2007). Data on height, body mass, and body composition of soccer teams from previous studies (Taharaet al., 2006; Bloomfield et al., 2005; Matkovic et al., 2003; Casajús, 2001; Chin et al., 1992; Apor, 1988; White et al., 1988) suggest that players vary widely in physical characteristics. In contrast to previous studies (Matkovic et al., 2003; Reilly et al., 2000), a study by Hencken and White (2006) found that there was no significant variation between the anthropometric characteristics of different playing positions amongst elite soccer players. Moreover, Ostojic (2004) found that physical characteristics did not vary between professional and amateur soccer players. However, it is difficult to make accurate conclusions on the physical characteristics of soccer players according to playing level and position, due to a lack of consistency between different studies, in terms of playing level and playing position.

Somatotype is the basic classification of physical characteristics and body type. Three components were identified in the classical anthropometric somatotype method of Heath and Carter: relative fatness (endomorphy), musculoskeletal component (mesomorphy), and linearity (ectomorphy). The ideal somatotype for an athlete differs according to the requirements of the particular sport (Fry et al., 1991; Igbokwe, 1991; Foley et al., 1989; Toriola et al., 1985). Significant variations were determined in team sports regarding somatotype components, both for the different sports and the different playing positions (Gualdi-Russo and Zaccagni, 2001; Carlson et al., 1994; Carda and Looney, 1994). The somatotype scores of elite or professional soccer players were 2.2-5.4-2.2, 2.4-4.8-2.3, 2.70-4.94-2.95, and 2.2-5.4-2.9, respectively, in studies conducted in South America (Rienzi et al., 2000), Europe (Casajús, 2001), Asia-Pacific (Rahmawati et al., 2007), and Africa (Mathur et al., 1985). Although previous studies have indicated that the somatotype of elite soccer players was dominated by a balanced mesomorph category, the somatotype scores were not homogeneous.

There are a considerable number of published studies related to the kinathropometric (Hencken and White, 2006) and physiological variables (Kalapotharakos et al., 2006), training effect on soccer performance (Helgerud et al., 2001), match analysis (Mohr et al., 2003) and prevention and treatment of injuries (Engebretsen et al., 2008) at national and international soccer players. There is little data on the physical characteristics and somatotype of soccer players according to playing level and position. Hence, the purpose of the present study is to evaluate physical characteristics and somatotypes of soccer players according to their playing level and position.

Materials and methods

Subjects: A total of 305 full-time professional soccer players were assessed for physical characteristics and somatotype. Of the 305 participants, 161 were members of the Turkish Super League (SL), while the remaining 144 players were members of the Turkish First League (FL). The players were grouped according to their playing levels and positions as goalkeepers (22 SL and 17 FL), defenders (49 SL and 41 FL), midfielders (59 SL and 61 FL), and forwards (31 SL and 25 FL). Assessments took place at the beginning of a mid-season preparatory period in December or January, during five consecutive seasons between 2002 and 2007. All players had participated in normal daily soccer training and played one or two official matches weekly. All players and coaches were fully informed about the nature and purpose of the study in detail.

Anthropometry and Somatotype**:** To describe the physical characteristics and somatotype of the soccer players, height and body weight, four skinfolds (triceps, subscapular, supraspinale, medial calf), two bone breadths (biepicondylar humerus and femur), and two limb girths (arm flexed and tensed, calf) measurements were used. Height and body weight were measured before breakfast and all anthropometric measurements were taken at the same time of day (between 8:00AM and 10:30AM), within the first week of the mid-season preparatory period. Height was measured to the nearest 0.1 cm using a portable stadiometer (Holtain Ltd, Crymych, U.K.), and body weight (BW) to the nearest 0.1 kg using an electronic balance scale (Tanita TBF 401A, Japan), with the players wearing no shoes and only light clothing. Skinfold measurements were taken to the nearest 0.2 mm using a skinfold calliper (Holtain Ltd, Crymych, U.K.), while biepicondylar breadth was measured to the nearest 0.1 cm using a bicondylar calliper (Holtain Ltd, Crymych, U.K.), and limb girths were measured to the nearest 0.1 cm using a non-elastic tape (Japan). All measurements were taken from the right side of the body by the same tester, according to the procedures described in the Anthropometric Standardization Reference Manual (Lohman et al.,

Table 1

Descriptive statistics, technical error of measurement, % technical error of measurement and intra-class correlation coefficient for the anthropometric variables.

Parameters	Test 1	Test 2	TEM	TEM%	ICC
Subscapular skinfold (mm)	10.65±2.88 (Range 4.8 -23.4)	10.68± 2.88 (Range 5.0-25.2)	0.35	3.3	0.993
Triceps skinfold (mm)	7.88±2.89 (Range 3.0 -19.2)	7.91±2.91 (Range 3.0 -19.4)	0.28	3.5	0.995
Supraspinale skinfold (mm)	9.18±4.08 (Range 3.2 -25.4)	9.15±4.07 (Range 3.4 -27.8)	0.38	4.1	0.996
Medial calf skinfold (mm)	5.34±1.57 (Range 2.6-13.6)	5.34±1.60 (Range 2.6-13.8)	0.22	4.1	0.990
Upper arm girth (cm) (flexed and tensed)	31.15± 2.03 (Range 25.0-39.6)	31.17±2.02 (Range 24.2-39.5)	0.22	0.7	0.994
Calf girth (cm)	37.58±2.10 (Range 24.2-44.0)	37.6±1.98 (Range (24.5-44.1)	0.21	0.6	0.994
Biepicondylar breadth of the humerus (cm)	6.90±0.35 (Range 5.8-7.9)	6.90±0.35 (Range 5.8-7.9)	0.06	0.9	0.983
Biepicondylar breadth of the femur (cm)	9.87±0.48 (Range 8.4 -11.4)	9.86±0.48 (Range 8.3 -11.4)	0.07	0.7	0.987

TEM: Technical error of measurement, TEM %: % Technical error of measurement, ICC: Intra-class correlation coefficient.

1988). Two series of skinfolds, limb girths, and bone breadths were taken and arithmetic means of these measurements were used. The technical error of measurement (TEM) was lower than 5 % for skinfolds and lower than 2 % for the other measurements (Table 1). Body mass index (BMI) was then calculated as weight/height^2, where weight was expressed in kilograms (kg) and height in meters (m). The three somatotype components, endomorphy, mesomorphy, and ectomorphy, were calculated according to the Heath and Carter anthropometric somatotyping method using the following equations (Carter and Heath, 1990):

Endomorphy = - 0.7182 + 1451(X) - 0.00068 (X^2) + 0.0000014 (X^3)

(Where X = sum of supraspinale, subscapular and triceps skinfold and corrected for stature by multiplying the sum of skinfolds by 170.18/body height in cm)

Mesomorphy = (0.858Humerus width) + (0.601Femur width) + (0.188Corrected arm girth) + (0.161Corrected calf girth) - (0.131body height) + 4.5

(Where corrected arm girth = Arm girth - Biceps skinfold, Corrected calf girth = Calf girth – Calf skinfold)

Three different equations were used to calculate ectomorphy, depending on the height-weight ratio (HWR):

If HWR is ≥ 40.75, then Ectomorphy = 0.732HWR - 28.58

If HWR is 38.25 < HWR < 40.75, then Ectomorphy = 0.463HWR - 17.63

If HWR is ≤ 38.25, then Ectomorphy = 0.1

[Where HWR = (body height in cm) / ($\sqrt[3]{\text{weight in kg}}$)]

Statistical analysis

The descriptive statistics of the physical characteristics, somatotype components, and the relative frequencies in 13 different somatotype categories were calculated according to the participants'

Table 2

Physical characteristics of Super League and First League soccer players regarding playing position

Playing Position	Age (year)		Body weight (kg)		Height (cm)		BMI (kg/m²)	
	SL	FL	SL	FL	SL	FL	SL	FL
Goalkeeper	25.7±4.47	23.4±5.09	82.0±5.50	79.2±5.85	184.8±3.73	185.2±4.66	24.02±1.37	23.10±1.56
Defender	25.9±4.27	24.5±4.30	75.6±6.21	74.15±5.70	178.6±5.26	178.7±4.95	23.71±1.45	23.23±1.54
Midfielder	25.8±3.05	23.8±3.99	73.9±4.75	71.7±6.14	176.1±4.62	175.9±5.60	23.82±1.23	23.17±1.55
Forward	25.2±3.54	24.6±4.43	76.6±6.44	75.11±5.87	177.9±5.89	179.3±4.96	24.20±1.53	23.36±1.56
Overall	25.7±3.73	24.1±4.27	76.1±6.18	73.9±6.34	178.4±5.66	178.4±5.90	23.89±1.38	23.21±1.53

SL: Super league, FL: First league, BMI: Body mass index playing levels and each playing position. Differences for the physical characteristics were tested by a 2 x 4 two-way (playing level and playing position) analysis of variance (ANOVA). When the ANOVA F-ratio was significant ($p<0.05$) for playing positions, the Bonferroni adjustment for multiple comparisons was used to identify the differences among playing positions. The somatotype attitudinal distance (SAD) and somatotype attitudinal mean (SAM) were calculated for each playing level and position according to Carter's equations (Carter, 2002). The SAD parameter describes the somatotype distribution in three dimensions and gives the opportunity to analyse the whole somatotype. The SAMs are the average of the SADs. The SAMs of the playing levels and each position are the average distance in three dimensions of somatoplots from their mean somatotype. A special analysis of variance, called SANOVA, which uses the SAD, was used to examine differences in the whole somatotypes (three-dimensional somatotype distributions), according to the playing levels and positions (Carter, 2002). Furthermore, one-way ANOVA was used to identify the differences for the somatotype component means according to playing levels and positions. Statistical analysis was performed using SPSS (Ver. 10.0) and Somatotype Calculation and Analysis Software (Ver 1.1) (Goulding, 2002). The level of significance was set at two-tailed $p<0.05$ for all statistical tests.

Results

Physical characteristics of SL and FL soccer players, by playing positions, are shown in Table 2. SL players were older ($p\leq0.002$) and heavier ($p\leq0.007$) than FL players, while height ($p\geq0.497$) was similar between SL and FL. SL players, however, had significantly higher BMI ($p\leq0.000$) values than FL players. Significant differences were found for BW ($p\leq0.000$), and height ($p\leq0.000$) between playing positions. No statistically significant differences were observed regarding age ($p\geq0.837$) or BMI ($p\geq0.612$) for any of the playing positions. Goalkeepers were found to be taller ($p\leq0.000$) and heavier ($p\leq0.001$) than other players. Midfielders were shorter ($p\leq0.013$) than other players but were lighter than forwards ($p\leq0.008$). No significant interaction effect was observed for the physical characteristics between playing level and position ($p\geq0.643$).

Somatotype distributions of SL and FL soccer players are shown in Figure 1. The mean somatotype of the overall players was 2.4-4.8-2.3 (SD: 0.9-0.8-0.7) in the SL group and 3.0-4.5-2.6 (SD: 0.9-0.9-0.8) in the FL group (Table 3). Table 4 shows the percentage of profiles which fall under each of the major somatotype categories for SL and FL soccer players, according to playing positions. In the SL group, 38.5% of individual somatotypes were balanced mesomorph, 34.2% were endomorphic mesomorph, 14.3% were ectomorphic mesomorph, 4.3% were central, 3.1% were mesomorph-endomorph, and 5.1% were within other categories. In the FL group, 29.9% of individual somatotypes were endomorphic mesomorph, 23.6% were balanced mesomorph, 11.1 % were mesomorph-endomorph, 10.4% were central,

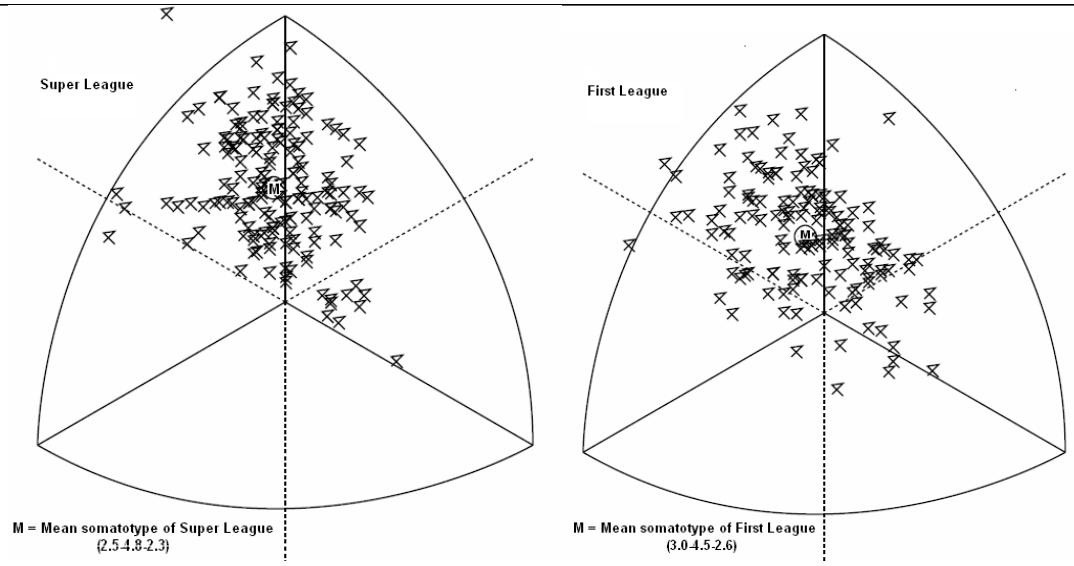

Figure 1

Somatotype distributions of soccer players in Super League and First League

9.0% were ectomorphic mesomorph, 6.9% were mesomorph-ectomorph, 3.5% were balanced ectomorph, and 5.6 % were within other categories (Table 4).

Somatoplots and somatotype means of soccer players according to playing positions are presented in Figure 2 and in Table 3. Somatotype means of players according to playing positions are also shown in a somatochart in Figure 3. SAMs for SL and FL soccer players, based on their playing positions, are given in Table 3. When the whole somatotype means were compared by using SANOVA, a significant difference was observed between the whole somatotype means of SL and FL players (SAD=0.67, F=16.11, p≤0.001). The components of somatotype (endomorphy-mesomorphy-ectomorphy) were evaluated statistically using one-way ANOVA to identify the influencing factors for this observed difference between the whole somatotype means. All of the somatotype components between the SL and FL were found to be significantly different. SL players were more mesomorphic (p≤0.01), less endomorphic (p≤0.000), and less ectomorphic (p≤0.001) than FL players (Table 3).

The differences between whole somatotype means of SL and FL players, according to playing positions, were compared in pairs using SANOVA. The SL and FL playing levels showed significant differences between whole somatotype means, according to playing positions, except for goalkeepers (Goalkeepers of the SL vs. FL: SAD = 0.75, F = 2.35, p≥0.13; defenders of the SL vs. FL: SAD = 0.68, F = 5.49, p≤ 0.02; midfielders of the SL vs. FL: SAD = 0.53, F = 4.23, p≤0.04; forwards of the SL vs. FL: SAD = 1.04, F = 5.57, p≤0.021). One-way ANOVA was used to identify when somatotype components contributed to the differences between whole somatotype means of playing positions for the two playing levels. One-way ANOVA results indicated that goalkeepers of the SL group were more mesomorphic (p≥0.302), less endomorphic (p≥0.103), and less ectomorphic (p≥0.066) than FL players, but the differences were not significant (Table 3). Defenders in the SL group were more significantly more mesomorphic (p≤0.049), and less endomorphic (p≤0.001) than FL players (Table 3). There was no significant difference between ectomorphy components of defenders in the SL and FL groups (p≥0.154). Mesomorphy components were similar for both midfielders and forwards of the SL and FL groups (p≥0.074 and p≥0.064, respectively), but FL players were significantly more endomorphic (p≤0.024 and p≤0.002, respectively) and ectomorphic (p≤0.033 and p≤0.049, respectively) than SL players for both playing positions (Table 3).

Discussion

Physical characteristics and somatotype findings of elite soccer players were gathered between 2002-2007. All of the study participants played professionally within the Super League (SL) and First division league (FL). The data was grouped by position of play and playing levels. The main finding of the study showed that the physical characteristics and somatotypes of soccer players are heterogeneous in relation to their playing levels and positions. Somatotypes assessed according to both playing levels and playing positions were observed to have mesomorphic characteristics. Whole somatotype means for all positions in SL were found to be significantly different than players in FL.

Table 3

Somatotype variables and SAM for Super League and First League soccer players regarding playing position.

Playing Position	SL		FL	
	Somatotype	SAM	Somatotype	SAM
Goalkeeper	2.9-4.6-2.6 (1.12-0.80-0.65)	1.30 ± 0.73	3.4-4.4-3.0 (1.01-0.81-0.83)	1.38± 0.58
Defender	2.4-4.8-2.3 (0.66-0.89-0.72)	1.17± 0.60	3.0-4.4-2.6 (0.90-0.90-0.80)	1.40± 0.67
Midfielder	2.6-4.9.2.2 (0.78-0.92-0.64)	1.24± 0.54	2.9-4.6-2.4 (0.77-0.91-0.79)	1.25± 0.69
Forward	2.4-5.0-2.1 (0.66-1.10-0.78)	1.25 ± 0.80	3.1-4.4-2.6 (1.01-1.13-0.83)	1.47 ± 0.86
Overall	2.5-4.8-2.3 (0.79-0.93-0.70)	1.24 ± 0.64	3.0-4.5-2.6 (0.90-0.90-0.80)	1.35 ± 0.71

SL: Super league, FL: First league, SAM: Somatotype attitudinal mean

The ages of players in the present study were found to be within the age ranges of soccer players playing in similar league levels (Table 5), but SL players (mean age 25.7 years) were older than FL players (mean age 24.1 years) (Table 2). The ages of elite soccer players were found to cover a wide range (17-35 years) and differed according to their positions, while their age means were in the range 20 to 29 years (Table 5). The mean age of 2,085 soccer players in four high level European Leagues (English Premier League, Spanish La Liga Division, Italian Serie A and German Bundesliga) in the 2001-2002 season was found to be 26.4 years (Bloomfield et al., 2005). A cross-sectional study by Díaz et al. (2003) of South American elite level soccer players, between the years of 1973-2000, showed that the mean age was 24±2 years in the 1970's, 26±2 in the 1980's and 27±3 years in the 1990's. Soccer is characteristically long-lasting, endurance-based, highly dynamic, and has different movement routines under high speed/intensity (Bangsbo, 1994; Mohr et al., 2003; Bangsbo et al., 2006; Rampinini et al., 2009). This leads to significant overload on cardiopulmonary and activity profile capacities, and, therefore, advanced age may be considered a disadvantage (Tessitore et al., 2005). However, in addition to physical and physiological capacity, competition experience can be considered as a significant factor in determining the quality of the game for elite level players. The active career period of soccer players has been gradually increasing due to the increased popularity and economic income of the sport, the higher social status and fame that has provided improvements in training methodologies, and improvements in medical support.

The heights of players in both playing levels were found to be similar, but the weight of SL players was higher than FL players (Table 2). In contrast to the present study, Ostojic (2004) observed no differences regarding height, body weight and skinfold thick-

Table 4

The percentage of profiles which fall under each of the major somatotype categories for Super League and First League soccer players regarding playing position

Playing Level	Somatotype Category	Golkeeper	Defender	Midfielder	Forward	Overall
SL	endomorph-ectomorph	0.0	0.0	0.0	0.0	0.0
FL		0.0	0.0	1.6	0.0	0.7
SL	ectomorphic endomorph	0.0	0.0	0.0	0.0	0.0
FL		0.0	0.0	0.0	0.0	0.0
SL	balanced endomorph	0.0	0.0	0.0	0.0	0.0
FL		5.9	0.0	0.0	0.0	0.7
SL	mesomorphic endomorph	4.5	1.8	0.0	0.0	0.6
FL		5.9	2.2	0.0	4.0	2.1
SL	mesomorph-endomorph	4.5	1.8	5.1	0.0	3.1
FL		23.5	10.9	6.5	12.0	11.1
SL	endomorphic mesomorph	22.7	37.0	39.0	29.0	34.2
FL		11.8	34.8	34.4	32.0	29.2
SL	balanced mesomorph	31.8	37.0	33.9	54.8	38.5
FL		11.8	15.2	32.8	20.0	23.6
SL	ectomorphic mesomorph	27.3	13.0	11.9	9.7	14.3
FL		17.6	8.7	6.5	4.0	8.3
SL	mesomorph-ectomorph	0.0	3.7	0.0	0.0	1.2
FL		11.8	8.7	4.9	8.0	7.6
SL	mesomorphic ectomorph	4.5	1.8	3.4	0.0	2.5
FL		0.0	2.2	3.3	0.0	2.1
SL	balanced ectomorph	0.0	1.8	0.0	3.2	1.2
FL		5.9	2.2	1.6	12.0	4.2
SL	endomorphic ectomorph	0.0	0.0	0.0	0.0	0.0
FL		0.0	0.0	0.0	0.0	0.0
SL	central	4.5	1.8	6.8	3.2	4.3
FL		5.9	15.2	8.2	8.0	10.4

SL: Super league, FL: First league

ness between elite level and amateur soccer players. Different studies (see Table 5) show that soccer players in national and international competitions vary widely in body weight, height and BMI, according to geographical location, ethnicity, nutritional habits, and playing styles. For professional and/or elite players in Europe, the Middle East and South America, mean heights were 176.0 – 183.0 cm, weight was generally <80 kg (range 65.6 - 78.7 kg), and BMI was between 23.00-24.45 kg/m² (Table 5). Height, weight and BMI for both levels, measured in the present study were found to be within the ranges of European, Middle Eastern and South American soccer players (Table 5), whereas body dimensions for both level players were found to be larger than players in Asia-Pacific countries (Bandyopadhyay, 2007; Reeves et al., 1999; Chin et al., 1992). It is considered that although body size is not a prerequisite for high level performance, a specific height can be a significant factor for tactical success. A cross-sectional study by Díaz et al. (2003), conducted over a period of 27 years, showed that in Central and South America, taller soccer players were preferred in the 1990's (176±5 cm) than in the 1970's (173±4 cm). Although height varied according to their league and playing positions, the mean height of 2,085 elite soccer players in four European leagues (1.81±0.06 m) were found to be taller than Central and South American soccer players during the 1990's (Bloomfield et al., 2005). BMI for both playing levels were found to be within the limits of normal population. However, SL players exhibited significantly higher values than FL players (Table 2). On the other hand, the mean BMI values for both SL and FL players in the present study were found to be higher than the mean BMI value (23.0 kg/m²) of 2,085 soccer players playing in four European elite level leagues (Bloomfield et al., 2005). The weight of SL players of the present study was found to be higher than European League players (Table 2), whereas FL players were lower. Moreover, the heights of Turkish players at both playing levels were found to be shorter than European League players. These results can be an indicator that elite level players in the four European

Table 5

Physical characteristics of soccer players from previous studies

References	n	Level	Age (year)	Height (m or cm)	Body weight (kg)	BMI (kg/m²)
Dellal et al., 2008	10	Elite	26.0±2.9	181.4±5.9	78.3±4.4	-
Melchiorri et al., 2007	14	Professional	25.1±2.6	182.6±3.8	77.7±5.7	23.3±1.4
	18	Professional	25.1±5.7	180.9±5.6	73.7±8.2	22.5±2
Krustrup et al., 2006	119	Elite	23	1.81	74.9	-
Kalapotharakos et al., 2006	19	Elite	26.0±4.0	180.0±5.0	78.0±4.5	-
	15	Elite	24.0±4.0	178.0±4.0	74.8±4.2	-
	20	Elite	23.0±3.0	179.0±7.0	75.3±6.4	-
Bloomfield et al.,2005	2085	Elite	26.4±4.4	1.81±0.06	75.5±6.3	23.0±1.2
Ostojic, 2004	30	Elite	24.1±2.5	181.8±5.6	77.3±5.8	-
	30	Amateur	21.8±2.9	180.9±7.2	75.9±6.1	-
Ostojic, 2003	30	Professional	23.5±3.1	182.8±6.0	76.8±6.1	24.45±1.82
Matkovic et al., 2003	57	Elite	23.2±3.4	180.6±5.7	77.6±5.7	-
Mohr et al., 2003	18	Top-class Professional	26.4±0.9	1.80±0.01	75.4±1.5	-
	24	Professional	26.5±1.0	1.81±0.02	75.4±1.7	-
Kalinski et al., 2002	74	Elite	23.0±2.2	178.3±6.3	75.8±6.0	-
Casajús, 2001	15	Elite	26.3±3.15	180.0±0.08	78.5±6.45	-
Rienzi et al., 2000	11	Elite	29.0±4.0	1.77±0.4	74.5±4.4	-
	12	Professional	24.9±1.3	182.1±1.5	74.9±2.4	-
Chin et al., 1992	24	Elite	26.3±4.2	173.4±4.6	67.7±5.0	-
Casajús and Aragonés, 1991	16	National	26.1±2.19	177.7±6.53	77.3±6.08	-
Apor, 1988	10	Professional	22.9±3.0	176.5±5.4	70.5±4.0	-
	14	Professional	21.6±6.4	177.6±4.3	73.5±6.3	-
	12	Professional	24.5±3.0	178.8±4.8	73.1±4.3	-
	18	Professional	26.0±3.6	178.2±5.4	74.1±5.2	-
	10	Professional	23.8±2.9	178.1±3.6	75.1±2.9	-
White et al., 1988	17	Professional	23.3±0.9	180.4±1.7	76.7±1.5	23.6±0.4
Mathur et al., 1985	25	Elite	25.2±4.8	175.1±5.1	72.9±6.4	-
Present study	161	Elite	25.7±3.73	178.4±5.66	76.1±6.18	23.89±1.38
	144	Professional	24.1±4.27	178.4±5.90	73.9±6.34	23.21±1.53

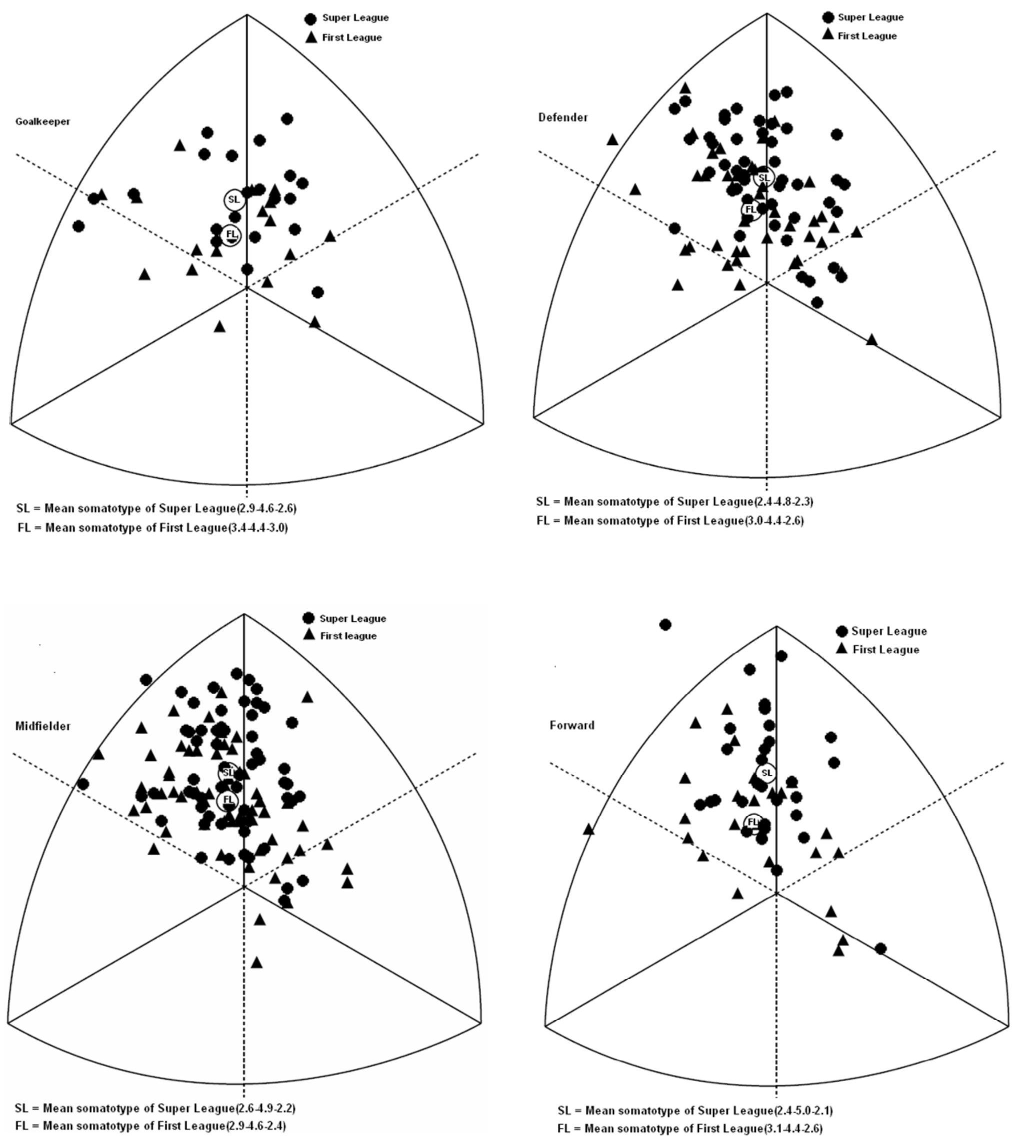

Figure 2

Somatotype distributions of soccer players of Super League and First League regarding playing position

Leagues in the study by Bloomfield et al. (2005) were leaner than SL and FL players in the present study. It can be argued that the higher BMI value of SL players than FL players, with higher mesomorphy, lower endomorphy and ectomorphy components (Table 3), could be an advantage during the game, where strength, power and agility are performance components of the game. In a study by Slaughter and Lohman (1976), the endomorphic component of Heath and Carter's anthropometric somatotyping method showed a significant relationship between body weight and body fat, whereas the mesomorphic component showed a significantly close relationship with lean body mass and height. A study by Silvestre et al. (2006) showed significant relationships between body composition and physical performance components, such as power strength, speed and endurance. In conclusion, it can be added that body types with high muscle content can be advantageous for high intensity and repetitive type intermittent activity, such as soccer.

It was expected that different playing positions in elite soccer would demonstrate different anthropometric characteristics as a result of the work load profile and physiological characteristics required for different playing position and differing personal training regimes. According to Reilly et al. (2000), weight and height are the most common anthropometric characteristics of soccer players that can display morphological optimization according to the position in the team. The height and weight of players in the present study showed wide variation

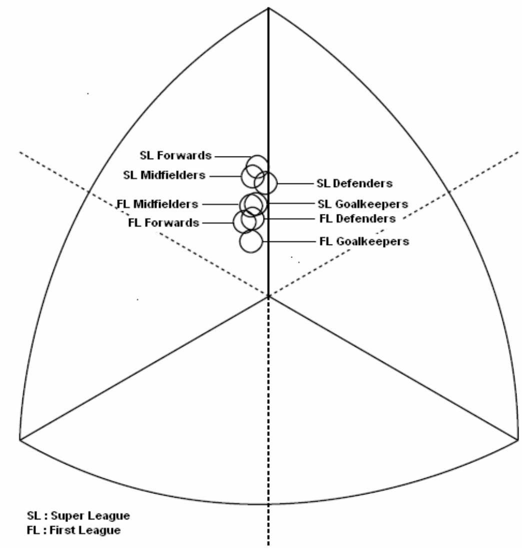

Figure 3
Mean somatotype for Super League and First League soccer players regarding playing position

among different positions, which was similar to findings in European players (Davis et al., 1992; Matkovic et al., 2003). The height and weight of goalkeepers were greater than other players (Table 2). It is widely accepted that greater height in goalkeepers brings advantage in the game regarding activities such as jumping and reaching the ball. Midfield players in the present study were shorter than players in other positions, while their weight is lighter than forwards (Table 2). It can be argued that the physical traits observed in midfielders enable them to move more efficiently and cover longer distances on the field. On the other hand, although players in defensive positions were found to be heavier and taller than other players, and this is considered to provide an advantage for their playing positions, the defensive players in the present study were similar to the other players, except midfielders. Hencken and White (2006) found that height, weight, fat, muscle, skeleton and lean body mass were distributed homogeneously for English Premier League players. Body measures were also observed to be similar among playing positions for semi-professional soccer players (Reeves et al., 1999). In contrast to the previous studies, the present study showed homogeneity in age and BMI in playing positions. The age and BMI were different for both their positions and league for the soccer players playing in four European Leagues (Bloomfield et al., 2005). In general, goalkeepers' career periods were longer, while forwards' had shorter careers than other players (Bloomfield et al., 2005). The advanced age of goalkeepers can be an advantage for their specific role, which requires experience.

Although the somatotype categories of both SL (2.5-4.8-2.3) and FL (3.0-4.5-2.6) soccer players falls within the balanced mesomorphy category, when player position is not considered, SANOVA indicated a significant difference between whole somatotype means of the two playing levels. SL players were more mesomorphic, less endomorphic and ectomorphic than FL players. Moreover, the distribution of the soccer players in the somatochart, according to their playing level (Figure 1) and the percentage falling within major somatotype categories (Table 4), showed that SL players were more mesomorphic and homogeneously distributed among somatotype categories. Furthermore, the fact that the SAMs of SL players were lower than FL players' (Table 3) was an indicator that the somatotypes of SL players were more homogeneously distributed. SL players were localized above the northwest-southeast line (above the mesomorph-endomorph and balanced ectomorph axis), whereas some FL players were distributed below this line (Figure 1). The observation that most of the FL players had a tendency to localize on the southwest of the line (endomorphy axis), above which SL players were located, is an indicator that the endomorphy component is high in these players. Likewise, 87% of SL players were within categories in which the mesomorphy component is dominant, while only 61% of FL players fell into the same category (Table 4). Of the FL players, 13.9% were within categories that are endomorphy dominant, whereas only 0.7% of SL players fell into the same category. These results showed that the somatotype of higher level players is more homogeneous and mesomorphic, and the somatotype of lower level players is more endomorphic and heterogeneous. On the other hand, the findings that 4.2% of SL players and 10.4% of FL players did not have a dominant component (central) were noteworthy. Regarding the playing levels, the SL players' somatotype difference might be the result of variables such as training level, the frequency of training and competitive matches, and higher level of nutritional and medical support.

Somatotypes of soccer players in general show a mesomorphic characteristic and their somatotype category is balanced mesomorph (Mathur et al., 1985; Apor, 1988; White et al., 1988; Casajús and Aragonés, 1991; Ramadan and Byrd, 1991; Rienzi et al., 2000; Casajús, 2001; Bandyopadhyay, 2007; Rahmawati et al., 2007). In the present study, the somatotype category of the soccer teams was similar to those of elite players from other countries. The mesomorphy score was observed to have a wide range of distribution in higher level soccer players in other countries. The somatotype components of SL players (2.5-4.8-2.3) in the present study showed similar somatotype components to the Spanish La Liga (2.4-4.8-2.3) (Casajús, 2001), whereas FL players' somatotype components (3.0-4.5-2.6) were different. Although the somatotype category of FL players was also balanced mesomorph, they had more endomorphic and ectomorphic, and less mesomorphic component than SL and La Liga players. Similarly, FL players had the same mesomorphy but higher endomorphy and ectomorphy scores than the Kuwaiti National Team (2.0-4.50-2.08) that participated in the 1982 World Cup (Ramadan and Byrd, 1991). The mesomorphy score of the Portuguese First League (2.8-5.6-2.2) (Gomes et al., 1989) (cited by Casajús, 2001), the Spanish National Team (1990 World Cup) (2.2-5.1-1.9) (Casajús and Aragonés, 1991), top level Hungarian (2.1-5.1-2.3) (Apor, 1988), and elite level South American players (2.2-5.4-2.2) (Rienzi et al., 2000) were higher than the mesomorphy score obtained in the present study and other previous works. Conversely, the somatotype of English First League players (2.6-4.2-2.8) during the late 1980's (White, 1988) were found to be more ectomorphic and less mesomorphic when compared to the results obtained for both SL and FL leagues in the present study. The dominance of the mesomorphy component for soccer players is compatible with characteristics of the soccer game. Short-term, high-intensity repetitive activities are related to high muscle strength. The scores of the somatotype components of soccer players are close to the somatotype scores of athletes engaged in sports that include similar type of activities (Toriola et al., 1985; Foley et al., 1989; Fry et al., 1991; Igbokwe, 1991).

Whole somatotype means of SL players were found to be significantly different than FL players, except goalkeepers (Figure 2), when somatotype of players in different playing levels were compared according to their playing positions. Endomorphy scores of SL players in all positions were found to be considerably lower than FL players. On the other hand, the mesomorphy scores of SL players were higher (Figure 3) and ectomorphy scores were lower than FL players in all playing positions, but these components were not as evident as endomorphy. Thus, mesomorphy scores of SL defensive players were higher than FL players, but their ectomorphy scores were similar, whereas the ectomorphy scores of midfielders and forwards of SL were lower than FL players, but their mesomorphy scores were similar. The higher endomorphy components in lower level players, compared to higher level players, could be the result of less intensive training, workload profile in matches, and energy expenditure.

The results of the present study indicate that the physical characteristics of soccer players were heterogeneous with regards to playing levels and playing positions. The whole somatotype means for both playing levels were within the balanced mesomorph category, while somatotype percentage in categories, where the mesomorphy component was dominant, was higher in higher level players than lower level players. Consequently, higher level players were more mesomorphic, and less endomorphic and ectomorphic than lower level players. Although whole somatotype means for the same playing positions differed between the playing levels, these differences were especially evident for the endomorphy component in all positions. In other words, lower level players were more endomorphic than higher level players for all playing positions. Since the endomorphic component is closely related to adipose tissue (Slaughter and Lohman, 1976), it has a negative influence on performance. Fat tissue is unable to contract and develop force and, therefore, it represents additional body weight during the 90 minutes of the game, and causes unnecessary expenditure of energy, which may lead to earlier fatigue during the game. More importantly, endomorphic inclination may be regarded as an indicator of under-training. Therefore, it is important to regularly control body fat content and undertake somatotype assessment.

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Corresponding author

Tahir Hazir
Hacettepe University, School of Sport Sciences and Technology,
Beytepe-Ankara, 06800, Turkey
Phone: +90 0312 29768 90
Fax: +90 0312 299 21 67
E-mail address: thazir@hacettepe.edu.tr