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ORIGINAL ARTICLE

Body composition using bioelectrical impedance analysis in elite young soccer players: the effects of age and playing position

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Abstract Most of the research in body composition of young soccer players has used anthropometric techniques as assessment methods. On the other hand, there is lack of data concerning bioelectrical impedance analysis (BIA) in young soccer players, a method which might provide more detailed information on body composition than the traditional anthropometric techniques.

Purpose Therefore, the aim of this study was to examine body composition assessed by BIA of young soccer players with regard to their age and playing position.

Methods We examined the body composition of 65 soccer players (age 15.2 ± 0.2 years, weight 63.3 ± 9.4 kg, height 171.5 ± 8.3 cm and training experience of 9.0 ± 1.5 years), classified into three age groups (U14, ~13 years; U16, ~15 years; and U18, ~17 years) and four playing positions (goalkeepers, defenders, midfielders and forwards).

Results U14 showed lower weight, BMI, intracellular and extracellular water, protein, mineral mass, basal metabolism and all parameters of body balance ($p < 0.001$) than U16 and U18. Within each age group, there were differences between forwards and defenders ($p < 0.05$). Also, we found differences between defenders of different age groups; defenders in the younger group had lower values in all parameters than their older counterparts and the same trend was noticed in midfielders.

Conclusions Our findings with regard to positional differences in weight, height, BMI and body fat percentage were in agreement with previous studies. However, what is novel is that we observed corresponding differences in the cellular level, which should be confirmed by future studies.

Keywords Football · Adolescents · Anthropometry · Positional roles

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Introduction

Soccer is one of the most popular sports nowadays. It is a complex sport which requires an increased emotional stress and performance of continuous activities (e.g., walking and running) alternating with intermittent tasks (e.g., sprinting, jumping, kicking, changing of direction and dribbling) [10, 15]. For this reason, players need to develop morphological and functional performance-related characteristics. Among these characteristics, an important field of interest is body composition. The evaluation of body composition is used in sports science to monitor training and nutritional status, and in the context of players' selection and talent identification [6, 19, 22].

According to the five-level model [38], there are several approaches to study body composition. The abovementioned studies have mainly focused on Level V (whole body) to examine parameters such as height, weight and BMI, and on Level IV (tissue-system) to examine parameters such as body fat percentage, fat mass and fat-free mass. To the best of our knowledge, no study has been ever carried out using Level I (atomic) and Level II (molecular) approaches to examine body composition in sport populations. Very limited data exist in athletes with regard to Level III (cellular), which provides details about cellular mass, extracellular fluids and solids; in this level, one study has been conducted in volleyball players [24] and two studies on soccer players [7, 27]. In contrast with the anthropometric techniques widely used in Level IV and V, bioelectrical impedance analysis (BIA), which is based on more sophisticated equipment, serves as the assessment method in Level III. In addition to its applications on examining body composition with regard to sport performance, BIA has been also applied to monitor soft tissue injury and healing [5, 28]. This type of methodology has gained importance in the last years, both in health and sport fields [13, 14, 23, 26]. The Inbody 720 is one of the devices, which has shown a better relation with other type of techniques, both in women and in athletes, being a reliable tool for this purpose [16, 31]. It is important to determine the body composition of athletes as the body components are related to performance.

The preliminary research of Burdukiewicz and colleagues [7] has provided important information on soccer body composition by studying age-related and positional differences. However, the age effect on positional differences in young soccer players has not been studied yet. In a recent research on male team handball players [30], it was shown that positional differences were not the same for adolescent and adult players indicating the existence of an age effect on positional differences. Consequently, further research on the effect of age (e.g., among groups with different age) and playing position (e.g., among forwards, defenders, midfielders and goalkeepers, GKs) on body composition in adolescent soccer players is needed. Therefore, the aim of this study was threefold; (1) to examine age-related differences in body composition, (2) to explore positional differences within each age group and (3) to study whether similar positional differences were observed in the various age groups.

Methods

Study design and participants

A descriptive cross-sectional study was conducted. A total of 65 soccer players, members of Malaga Soccer Club (Malaga, Spain), participated in this study (age 15.2 ± 0.2 years; weight 63.3 ± 9.4 kg, height 171.5 ± 8.3 cm and competitive experience of 9.0 ± 1.5 years). All soccer players were national and international competitors. The participants were divided into three groups, Under-14 (U14), Under-16 (U16) and Under-18 (U18), with mean age 13.0 ± 0.1 years ($n = 22$), 15.0 ± 0.1 years ($n = 22$) and 17.0 ± 0.1 years ($n = 22$), respectively. Four specific positions (forwards, midfielders, defenders and GKs) were considered. Inclusion criteria were that participants should (1) have a minimum of three years of systematic soccer training, (2) train between 4 and 6 days per week and 90–120 min per training unit, and (3) have competed at least for 2 years. Exclusion criteria were that they should (1) not be injured at the time of the study; (2) not be under medication that could alter the results of the study. Nine soccer players were removed (four for injuries, five by non-attendance). All players and their parents or tutors were fully informed and they gave their consent in writing. The present study was approved by the local institutional review board (University of Spain). The measurements were performed according to the ethical standards of the Helsinki Declaration.

Procedures

The study consisted of the evaluation of the body composition in three age groups (U14, U16 and U18) of soccer players by means of Bioelectric Impedance. All the players were summoned first thing in the morning, after 8-h sleep and before breakfast, not having taken any type of liquids and having last gone to the bathroom 30 min before the beginning of the programmed tasks. Furthermore, they had not carried out any type of physical effort in the previous 12 h to the measurements. Body composition was assessed with bioelectrical impedance analysis. Inbody (720) (Biospace, Korea) is a multi-frequency impedance plethysmograph body composition analyzer, which takes readings from the body using an eight-point tactile electrode method, measuring resistance at five specific frequencies (1, 50, 250, 500, and 1 MHz) and reactance at three specific frequencies (5, 50, and 250 kHz).

The participant's identification number, height, age, and sex were entered into the analyzer. Then, the participants were instructed to slightly separate their arms and remain still during the assessment. They were placed in a standing position with extension of the shoulder joint of 30°. Eight electrodes were used, placed on: feet (metatarsal–calcaneal) and hands (metacarpals 2°–5° fingers and thumb phalanx). Data were electronically imported to Excel using Lookin'Body 3.0 software. Precision of the repeated measurements expressed as coefficient of variation was, on average, 0.6 % for fat mass.

Statistical analysis

The data obtained were treated with the statistical analysis software SPSS 15.0. All the results were expressed in mean and standard deviations. Groups were evaluated using analysis of the variance (ANOVA). A Tukey test was used as a post hoc test. Three types of differences were compared: (1) differences between age groups (U14, U16 and

U18); (2) differences between their playing positions into the same category; (3) differences between playing in the same position between categories. p values of less than 0.05 were regarded as significant.

Results

U14 soccer players had lower weight, BMI (Table 1), intra-extracellular water, in protein and mineral mass than U16 and U18 ($p < 0.001$) (Table 2). U16 revealed also lower protein mass than U18 ($p < 0.05$) (Table 2). There were no differences in mass and fat percentage between groups. Also, basal metabolism was lower in U14 than in U16 and U18 ($p < 0.001$) (Table 3). When assessing the body balance, the results revealed that U14 had lower (right and left arm and leg, trunk) all parameters than U16 and U18 ($p < 0.001$) (Table 4).

The analysis was performed between the playing positions of each category (intra category), and the playing position compared with the playing position of the other categories. The results of this study demonstrated that soccer players of different positions, in the same age category, had differences only between forwards and defenders ($p < 0.05$) (Table 1). Defender U14 showed the lowest value in almost all parameters (mass, body mass index, intra- and extracellular water, protein mass, mineral mass, basal metabolism, right and left arm and trunk) than U16 and U18 defenders ($p < 0.001$). We also observed the same trend in midfielders U14 players regarding midfielders U16 and U18 players ($p < 0.001$).

Discussion

The main findings of the present study were to examine body composition assessed by BIA of young soccer players with regard to their age and playing position. With regard to anthropometric characteristics, it was observed that U14 had similar values as age-matched children of general population [36]. U16 and U18 had higher values than age-matched normal population, especially in protein mass and mineral mass. An explanation for these differences in U16 and U18 was that systematic training in a sport such as soccer induced differences in anthropometric variables in comparison to general population [17]. On the other hand, U14 had closer values to general population, because the years of experience of regular training were less in this age group than in U16 and U18. These differences in anthropometric characteristics were important, because they might influence the effectiveness of soccer players' responses in the field and, therefore, anthropometric profiles might contribute to a better understanding of the players' suitability for soccer, particularly at a high level of play [33]. In addition to sport performance, research of anthropometric characteristics had also implications for

Table 1 General anthropometric characteristics in group of young soccer players by age group and playing position

Group	Position (code)	N	Weight (kg)		Height (cm)		BMI (kg m^{-2})	
			$X \pm$ SD	Differences	$X \pm$ SD	Differences	$X \pm$ SD	Differences
U14	Forwards (1)	2	61.44 ± 8.54	ab***;	164 ± 7	6–10*	22.77 ± 2.21	ab***;
	Defenders (2)	7	50.62 ± 3.46	ac***;	163 ± 4		18.96 ± 0.91	ac***;
	Midfielders (3)	8	45.69 ± 2.76	1–2*;	158 ± 4		18.32 ± 1.19	2–6***;
	GKs (4)	5	55.81 ± 4.26	2–6***;	167 ± 4		20.76 ± 1.79	2–10**;
	Total (a)	22	52.26 ± 6.37	2–10***	163 ± 5		19.79 ± 1.90	3–11***
U16	Forwards (5)	1	71.66 ± 0.00		177 ± 0		22.87 ± 0.00	
	Defenders (6)	7	66.62 ± 5.47		170 ± 7		23.01 ± 1.71	
	Midfielders (7)	9	65.26 ± 4.13		173 ± 9		21.77 ± 1.60	
	GKs (8)	4	62.84 ± 3.14		171 ± 7		21.62 ± 1.26	
	Total (b)	21	66.07 ± 4.85		172 ± 7		22.47 ± 1.62	
U18	Forwards (9)	3	70.61 ± 3.86		179 ± 4		22.05 ± 1.30	
	Defenders (10)	7	72.93 ± 8.54		180 ± 1		22.39 ± 1.83	
	Midfielders (11)	8	67.90 ± 3.47		175 ± 4		22.11 ± 1.53	
	GKs (12)	4	66.59 ± 2.76		182 ± 8		20.08 ± 0.06	
	Total (c)	22	69.94 ± 5.65		178 ± 4		22.00 ± 1.59	
Total		65	63.31 ± 9.43		171 ± 8		21.47 ± 2.03	

BMI body mass index, a = U14, b = U16, c = U18

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 2 Body composition of young soccer players by age group and playing position

Group	Position (code)	N	Intracellular water (l)		Extracellular water (l)		Protein mass (kg)		Mineral mass (kg)	
			$X \pm SD$	Dif.	$X \pm SD$	Dif.	$X \pm SD$	Dif.	$X \pm SD$	Dif.
U14	Forwards (1)	2	22.75 ± 1.06	ab***;	13.85 ± 1.06	ab***;	9.80 ± 0.42	ab***;	3.44 ± 0.39	ab***;
	Defenders (2)	7	20.47 ± 1.61	ac***;	12.58 ± 0.98	ac***;	8.85 ± 6.68	ac***;	3.10 ± 0.26	ac***;
	Midfielders (3)	8	17.67 ± 1.37	1–5*;	11.05 ± 0.64	bc*;	7.65 ± 0.55	bc*;	2.77 ± 3.44	1–5*;
	Goalkeepers (4)	5	22.84 ± 1.85	2–6***;	13.82 ± 0.95	1–5*;	9.88 ± 0.80	1–5*;	3.44 ± 0.31	2–6***;
	Total (a)	22	20.77 ± 2.52	2–10***;	12.73 ± 1.38	2–6***;	8.98 ± 1.08	1–9*;	3.16 ± 0.36	2–10***;
U16	Forwards (5)	1	30.10 ± 0.00	3–4***;	18.40 ± 0.00	2–10***;	13.00 ± 00	2–6***;	4.60 ± 0.00	3–7***
	Defenders (6)	7	26.99 ± 2.07	3–7***	15.83 ± 1.26	3–4*;	11.64 ± 0.87	2–10***;	4.03 ± 0.41	
	Midfielders (7)	9	26.10 ± 2.76		15.50 ± 1.78	3–7***	11.28 ± 1.20	3–4*;	3.94 ± 0.41	
	Goalkeepers (8)	4	26.60 ± 4.42		15.55 ± 0.70		11.50 ± 0.14	3–7***	3.99 ± 0.14	
	Total (b)	21	26.86 ± 2.22		15.85 ± 1.43		11.60 ± 0.95		4.03 ± 0.39	
U18	Forwards (9)	3	28.90 ± 2.97		17.43 ± 1.33		12.50 ± 1.31		4.19 ± 0.35	
	Defenders (10)	7	30.08 ± 2.16		17.80 ± 1.51		13.00 ± 0.94		4.45 ± 0.38	
	Midfielders (11)	8	27.56 ± 1.64		16.19 ± 0.95		11.92 ± 0.72		4.12 ± 0.23	
	Goalkeepers (12)	4	28.30 ± 2.68		16.75 ± 1.77		12.20 ± 1.13		4.24 ± 0.51	
	Total (c)	22	28.72 ± 2.25		16.99 ± 1.29		12.41 ± 0.98		4.26 ± 0.34	
Total		65	25.63 ± 4.11		15.29 ± 2.25		11.08 ± 1.77		3.84 ± 0.59	

Dif. differences, a = U14, b = U16, c = U18

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 3 Fat mass, % fat, basal metabolism and visceral fat area in soccer players by age group and playing position

Group	Position (code)	*N*	Fat mass (kg)		% Fat		Basal metabolism (kcal)		Visceral fat area (gr)	
			X ± SD	Dif.	*X* ± SD	Dif.	X ± SD	Dif.	*X* ± SD	Dif.
U14	Forwards (1)	2	11.55 ± 5.58		18.27 ± 6.50		1448.58 ± 64.47	ab***;	35.66 ± 15.74	a–b***
	Defenders (2)	7	5.60 ± 0.52		10.91 ± 1.29		1313.35 ± 75.86	ac***;	10.37 ± 4.50	
	Midfielders (3)	8	6.55 ± 2.54		14.27 ± 5.06		1215.24 ± 58.37	bc*;	18.31 ± 12.40	
	GKs (4)	5	5.82 ± 0.69		10.79 ± 1.23		1449.51 ± 83.52	1–5*;	9.26 ± 5.86	
	Total (a)	22	6.55 ± 2.54		12.53 ± 3.89		1356.67 ± 115.16	2–6***;	14.89 ± 11.56	
U16	Forwards (5)	1	5.60 ± 0.00		7.81 ± 0.00		1797.00 ± 0.00	2–10***;	24.45 ± 0.00	
	Defenders (6)	7	8.12 ± 3.57		12.03 ± 4.93		1633.63 ± 98.47	3–4*;	32.41 ± 15.23	
	Midfielders (7)	9	8.42 ± 2.24		13.09 ± 4.19		1597.93 ± 132.99	3–7***;	35.67 ± 15.79	
	GKs (8)	4	5.20 ± 3.68		8.12 ± 5.44		1615.28 ± 11.63	3–11***	26.97 ± 8.65	
	Total (b)	21	7.72 ± 3.13		11.63 ± 4.65		1630.58 ± 106.66		32.26 ± 13.93	
U18	Forwards (9)	3	7.60 ± 2.19		10.94 ± 3.67		1730.31 ± 127.03		18.52 ± 8.04	
	Defenders (10)	7	7.57 ± 2.96		10.45 ± 3.06		1781.81 ± 98.23		19.47 ± 11.92	
	Midfielders (11)	8	8.09 ± 2.61		11.79 ± 3.18		1662.17 ± 75.53		26.94 ± 15.26	
	GKs (12)	4	5.05 ± 0.21		7.59 ± 0.41		1699.43 ± 133.16		10.09 ± 7.20	
	Total (c)	22	7.53 ± 2.56		10.77 ± 3.11		1717.99 ± 103.21		21.37 ± 13.01	
Total		65	7.29 ± 2.77		11.53 ± 3.88		1580.73 ± 187.75		22.76 ± 14.46	

Dif. differences, a = U14, b = U16, c = U18

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

obesity and overweight in adolescence, which has become an important public health issue [2]; the existence of overweight and obesity during childhood and adolescence might be linked to other diseases [1]. Although soccer has been the most widely practiced sport in Europe [4], few studies so far have researched the prevalence of overweight and obesity in young male soccer [29]. Recent research (e.g., [29, 37]) indicated that skeletal and chronological age might influence FFM and also that sport participation cannot guarantee physiological body mass and body composition; thus, it was necessary to prescribe exercise targeting body mass and BF control. Differences comparing young players with sedentary youth and/or professional players have been found in a sport such as soccer [17].

BF in the total sample of the present study (~11.5 %) was in agreement with existing literature [3, 10, 11, 17, 18], which reported values ranging between 7 and 13 %. Although there was no significant difference in BF among U14, U16 and U18, a trend for lower values in the older groups was noticed (12.5, 11.6 and 10.8 %, respectively), which was in line with the notion that young soccer players tended to have higher values than their older counterparts [12]. Nevertheless, regarding the possible difference as to specific positions, the reviewed literature is contradictory [3, 32]. Studies show body mass index (BMI) values ranging from 17 to 20 kg m^{-2} in 9- to 14-year-old players [34]; and between 20 and 23 kg m^{-2} in 14- to 18-year-old players [17]; it was observed that GKs and defenders had the highest levels [32]. So, it is observed that the BMI values in U14 players are lower than those obtained by U16 and U18 players, condition that supports findings by other authors [10, 18, 21, 34].

The fat percentage shows no differences among groups, but the total group mean average (11.53 %) is consistent with young soccer players (10–17 %) [8, 11, 12, 18, 20, 34, 35]; and at the same time it is close to the percentages shown by elite players (10–12 %) [9, 23]. Even though there are no differences, there is a tendency for this fat percentage to reduce as age increases (Table 3). This is important because the amount of fat in the body is important from the physiological point of a view of exercise, as higher fat percentages correlate with a poorer physical performance [18].

U14 group shows lower values in protein mass and mineral mass as compared to cadet and juniors (Table 2); however, at a relative level, they show lower percentages of body mass (Table 1). The sample in the present study was trained soccer players of an elite club, with years of experience in soccer training, and therefore we would expect to find that protein mass and mineral mass increased in the older groups, whereas BF decreased. Accordingly, the results showed that U14 group had lower body mass than the other groups.

In addition to information on intra- and extracellular mass, bioelectric impedance provided also data about the

Table 4 Body balance soccer players by age group and playing position

Group	Position (code)	N	Right arm (kg)		Left arm (kg)		Trunk (kg)		Right leg (kg)		Left leg (kg)	
			$X \pm$ SD	Dif.	$X \pm$ SD	Dif.	X ± SD	Dif.	$X \pm$ SD	Dif.	$X \pm$ SD	Dif.
U14	Forwards (1)	2	2.56 ± 0.05	ab***;	2.46 ± 0.05	ab***;	21.14 ± 0.59	ab***;	7.64 ± 0.61	ab***;	7.60 ± 0.66	ab***;
	Defenders (2)	7	2.06 ± 0.26	ac***;	2.00 ± 0.27	ac***;	18.32 ± 1.55	ac***;	7.30 ± 0.62	ac***;	7.30 ± 0.61	ac***;
	Midfielders (3)	8	1.73 ± 0.29	1–5**;	1.68 ± 0.30	1–5**;	16.23 ± 1.86	1–5**;	6.05 ± 0.56	bc***;	6.05 ± 0.70	bc***;
	GKs (4)	5	2.41 ± 0.28	1–9*;	2.39 ± 0.28	1–9*;	20.65 ± 1.65	1–9*;	8.23 ± 0.66	1–5*;	8.16 ± 0.69	1–9*;
	Total (a)	22	2.14 ± 0.39	2–6***;	2.096 ± 0.39	2–6***;	18.84 ± 2.36	2–6***;	7.32 ± 0.99	2–6*;	7.29 ± 0.99	2–6***;
U16	Forwards (5)	1	3.84 ± 0.00	2–10***;	3.68 ± 0.00	2–10***;	28.39 ± 0.00	2–10***;	9.91 ± 0.00	2–10***;	10.02 ± 0.00	2–10***;
	Defenders (6)	7	3.14 ± 0.27	3–7***;	3.09 ± 0.24	3–4*;	24.81 ± 1.63	3–11*	8.99 ± 0.86	3–4*;	8.98 ± 0.82	3–4*;
	Midfielders (7)	9	3.00 ± 0.42	3–11***	2.96 ± 0.46	3–7***;	24.23 ± 2.59		8.84 ± 1.37	3–7***;	8.82 ± 1.43	3–7***;
	GKs (8)	4	3.04 ± 0.32		3.06 ± 0.31	3–11***	24.45 ± 1.78		8.81 ± 0.8	3–11***	8.76 ± 0.08	3–11***
	Total (b)	21	3.12 ± 0.36		3.08 ± 0.34		24.81 ± 2.03		8.98 ± 0.95		8.97 ± 0.97	
U18	Forwards (9)	3	3.56 ± 0.51		3.48 ± 0.48		27.40 ± 2.73		10.49 ± 0.78		10.41 ± 0.79	
	Defenders (10)	7	3.52 ± 0.28		3.45 ± 0.27		27.32 ± 1.56		10.88 ± 0.63		10.72 ± 0.56	
	Midfielders (11)	8	3.10 ± 0.30		3.12 ± 0.25		24.11 ± 1.60		9.65 ± 0.72		9.57 ± 0.58	
	GKs (12)	4	3.24 ± 0.17		3.22 ± 0.31		25.86 ± 1.62		10.40 ± 1.51		10.25 ± 1.64	
	Total (c)	22	3.33 ± 0.36		3.30 ± 0.32		36.30 ± 1.96		10.28 ± 0.89		10.17 ± 0.84	
Total		65	2.91 ± 0.63		2.85 ± 0.63		23.48 ± 3.84		8.94 ± 1.54		8.89 ± 1.51	

Dif. differences, a = U14, b = U16, c = U18

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

mass of different parts of the body contributing to the evaluation of possible imbalances, which might induce injury in the future. The data showed no differences in the same group in either side of the body, but there was a significant statistical difference among U14 with U16 and U18 groups in the left and right leg mass, trunk mass and left and right arm mass (Table 4). In relative values, and in spite of the differences, these differences were less pronounced, as in the superior limbs (right and left arm) the sample has values of between 4 and 5 % of body mass, and in the lower limbs the percentages range from 14 to 15 %. Soccer is a sport that includes continuous activities such as running and walking, interspersed with intermittent tasks such as sprinting, jumping, kicking the ball and dribbling [15] and, therefore, the differences among age groups are important due to the difference in the years of training. The most remarkable differences were revealed in the trunk mass, where U18 players had approximately 52 % of their total mass as compared to a 36 % in U14 group. This observation might result from an accumulation of regular training in soccer. In fact, several authors have recorded differences regarding the muscle strength related to the competitive level, which could be around 7 % in a bench press test [39], and of 8–16 % in lumbar and abdominal muscles [22]. Within the analysis carried out in this study, we have analyzed the differences between specific positions in each category and the differences in the same specific position between categories. The differences between specific positions in the same category were practically non-existent, but logically the size of the sample was not big enough, and furthermore, it was not evenly distributed among positions, and therefore this study can be considered as an approximation to the use of Bioelectric Impedance as a tool to mark differences at an anthropometric level in young soccer players.

However, different authors have pointed out differences regarding the specific position in young soccer players [3, 18, 35], in which there is an agreement that the forwards are usually the tallest and the GKs the heaviest. At the same time, it has been reported that the fat percentage tends to be lower in forwards, followed by midfielders and defenders [3, 35]. This follow-up is interesting as a higher amount of fat significantly decreases jumping and sprinting performance, and it is also negatively correlated with endurance and agility [18].

Nevertheless, there are few studies, which have analyzed the evolution of these parameters in the different specific positions considering age. This could be very interesting because the effect of years of practice and biological maturity on chronological age and body structure should be taken into account [25]. Actually, when comparing the different specific positions by age group, despite the relatively small number of soccer players per position, the differences were obvious and striking. Therefore, it was observed that U14 defenders and midfielders had lower values than their older counterparts regarding parameters such as protein mass, mineral mass and intracellular water (Tables 2, 3). BF showed no difference, although a trend of decrease in BF as age increased was observed, mainly in GKs. In general, a stabilization of the different anthropometric components in forwards and GKs as they grew older was recorded, whereas great differences in defenders and midfielders were observed, which indicated the need to carry out monitoring throughout the entire professional life of the soccer player, for as it has been shown, this monitoring has a direct relation with the typical actions from soccer [18].

Conclusions

In conclusion, U16 and U18 were taller and heavier than U14 soccer players. U14 soccer players had higher BF than U16 and U18. U14 defenders and midfielders were lighter and were shorter, and had less intracellular and extracellular water, and lower basal metabolism than their U16 and U18 counterparts. These differences should be taken into account by soccer technical staff (e.g., coaches and fitness trainers), as they contribute to a better monitoring of young players.

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Conflict of interest The authors declare no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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