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Anthropometry, Body Composition, and Physical Fitness in Semi-Professional Soccer Players: Differences between Sexes and Playing Position

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Abstract: Performance in soccer has been associated with specific morphological characteristics. Few studies have simultaneously compared the relationships between physical fitness and body composition in both sexes. This study aimed (i) to analyze the differences in anthropometric parameters, body composition, and physical fitness between sexes and playing position in soccer players and (ii) to determine the relationship among anthropometric and body composition parameters to physical fitness parameters according to sex. A total of 50 soccer players (men: n = 26; women: n = 24), participated in the study. Assessments of nutritional intake, anthropometry, body composition, and physical fitness (isometric strength, maximal aerobic capacity, and vertical jump) were carried out. Differences between sexes were observed in all anthropometric and body composition parameters ($p < 0.001$). There were differences between midfielders and forwards in fat percentage ($p < 0.05$). Regarding physical condition, differences were found between sexes in all tests performed ($p < 0.001$). In men soccer players, there were significant correlations between body composition and aerobic capacity ($p < 0.05$), while in women soccer players, there were correlations with isometric strength tests ($p < 0.05$). Anthropometry, body composition, and physical fitness differed between sexes. Fat percentages were different among playing positions. There were relationships between anthropometry and body composition with physical fitness. Knowledge of anthropometric and fitness characteristics by playing position and gender in soccer players could help develop specific training programs.

Keywords: team sport; gender; football; assessment

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1. Introduction

Soccer is the world's most popular sport [1]. Soccer, like other team sports, is presented as a dynamic system, where there is a competitive relationship between the teams and the cooperation of the members of the same team [2]. It is considered a high-intensity intermittent team sport due to its acyclic nature and the numerous changes in intensity during the game [3].

Performance in soccer depends on several factors, such as technical, tactical, physiological, and mental. In relation to physiological factors, strength, power, and endurance play an important role [1]. Strength is a basic quality that influences power performance. An increase in maximal strength is generally related to an improvement in relative strength and, therefore, to an improvement in power skills. A significant relationship has been observed between maximal strength, acceleration, and speed of movement [1]. This performance relationship is supported by jumping test results as well as sprinting results [4]. Due to the increased strength of muscle contraction force, improvements in skills such as turning and speed changes occur [3]. Regarding endurance, the distances covered by top-level soccer players are approximately 10 to 12 km for field players [1]. During a soccer match, a sprint occurs approximately every 90 s, each with an average duration of 2 to 4 s [5]. On the other hand, approximately, each player performs between 1000 and 1400 short actions [1].

Within the physical aspect, success in soccer has been associated with specific morphological characteristics and fitness-related parameters [6]. Anthropometric measurements, body composition, and physical condition, including cardiorespiratory endurance, muscular strength, muscular endurance, and flexibility are key to successful performance [1,7]. These parameters are evaluated by means of a vertical jump test, speed test, acceleration test, progressive round-trip test, and isometric/isotonic/isokinetic strength test [8,9]. The results obtained provide information for coaches and physical trainers to monitor the condition of the players, to program and plan sports training, as well as to assess the probability of injury, as it is known that there is a relationship between some anthropometric characteristics and the risk of injury [10]. In addition, it is possible to find a relationship between body composition and performance parameters in soccer, such as speed and power [7,8,11].

The physical demands are different depending on the playing position and have been previously studied [8,12,13]. It is known that midfielders (M) run a significantly greater distance than other positions. Similarly, a forwards (F) performs many more sprints and high-intensity actions than a defender (DF) or M [14,15]. In addition to the different physical demands among playing positions, it has been reported that soccer players have different anthropometric characteristics depending on the playing position [8]. This suggests that there are specific physiological demands and anthropometric characteristics for different playing positions [16]. For example, the mean range of % body fat ranged from 11.2 to 31.91 %, 8.5 to 29.84 %, 8.4 to 25.82 %, and 9.39 to 27.89 % for goalkeeper (GK), DF, M, and F, respectively [17]. Previous studies showed that the percentage of body fat was lower in M [18]. This fact could be due to M covering longer distances running compared to the other positions [12]. These data could result in the selection of young players based on superior physiological performance and anthropometric advantage [8].

Body composition is highly related to performance in physical fitness tests in soccer players [19]. Increased fat values result in additional body mass and decreased performance [20]. A low fat percentage is related to better sprint, acceleration, change of direction, and jumping times [21]. Gender differences in body composition become apparent during puberty, where men have greater muscle weight compared to women [22]. Despite the existence of physiological differences between the sexes [23], the hypothesis that these differences decrease when comparisons are made between highly trained men and women has existed for some time [24].

Previous studies have analyzed sex differences in body composition [24,25] and physical fitness [26,27], as well as differences among playing positions in these variables [20,28]. However, few studies have simultaneously compared anthropometric characteristics and body composition in both sexes using the same research design, which is an important methodological aspect [27]. In view of the above, the objectives of the present study were: (i) to analyze the differences in anthropometric parameters, body composition, and physical condition between sexes and playing position in soccer players, and (ii) to relate anthropometric and body composition parameters to physical condition parameters according to sex.

2. Materials and Methods

2.1. Participants

Participants signed a consent form informing them of all procedures before enrolling in the study. The protocol was reviewed and approved by the Biomedical Ethics Committee of the University of Extremadura following the guidelines of the Helsinki Declaration, updated at the World Medical Assembly in Fortaleza (2013), for research in humans (135/2020). Each participant was assigned a code for sample treatment to maintain anonymity.

A total of 50 soccer players, men (n = 26) and women (n = 24), participated in the present study. The men soccer players belonged to a semi-professional senior team in the fourth category of Spanish soccer. The women soccer players belonged to a semi-professional club that played in the second national category. Both clubs trained and competed in the city of Cáceres (Spain). The characteristics of the participants are shown in Table 1.

Table 1. Characteristics of the participants.

		Men Soccer Players	Women Soccer Players
n		26	24
	GK + DF	10	10
Playing position (n)	M	10	7
	F	6	7
Age (years)		20.62 ± 2.66	23.21 ± 4.11
Experience (years)		14.73 ± 3.13	14.51 ± 4.94

GK: goalkeepers; DF: defenders; M: midfielders; F: forwards.

The participants in each group were classified according to their playing positions into 3 groups: goalkeepers + defenders (GK + DF), midfielders (M) and forwards (F). Due to the small number of players, the GK were included in the DF. The training season began in August, training 5 days a week for a duration of 120 min at the beginning of the season. All players trained together except for the GKs, who dedicated part of their training to specific training sessions.

The requirements to participate in the study were the following: (a) to have at least 5 years' experience competing in federated soccer; (b) not to have followed any special diet (vegan diet, ketogenic diet, paleo diet, etc.) during the previous 3 months; and (c) not to have suffered any type of illness or injury that would have absented the player from training during the previous 3 months. In addition, the women soccer players had to meet the following criteria: (a) to have regular menstrual cycles during the 6 months prior to the study; (b) not to suffer from health problems related to the menstrual cycle; and (c) not to use hormonal contraceptive methods.

2.2. Study Design

The present cross-sectional, quasi-experimental study was carried out during the first weeks of the competition. The assessments were performed in one week. The men were tested for the first two days and the women for the following two days. The tests were performed in the following order: anthropometry and body composition, vertical jump, isometric strength, and maximal incremental test to exhaustion.

2.3. Anthropometry and Body Composition

The materials used for the anthropometric assessment were the following: a wall-mounted measuring rod (Seca 220. Hamburg, Germany); an electronic digital scale (Seca 769. Hamburg, Germany); a Holtain© 610ND pachymeter (Holtain, Crymych, UK); a Holtain© 604 pachymeter (Holtain, Crymych, UK), and a Seca© 201 tape measure (Seca, Hamburg, Germany). The anthropometric characteristics of the participants were evaluated in the morning and under identical conditions (fasting, barefoot and with as little clothing as possible). The measurements obtained were stretch stature, body mass, skinfolds (abdominal, suprascapular, subscapular, tricipital, thigh, and calf), breadth (bistyloid, humerus, and femur) and girth (relaxed arm and calf). All measurements were performed by the same investigator, following the recommendations of the International Society for the Advancement of Kinanthropometry [29]. The formulas for calculating the muscle and fat compartments were obtained following the guidelines of the previous authors [29]. The Yuhasz equation was used to calculate the fat percentage [30]. The muscle percentage was obtained by dividing the muscle weight, obtained by subtracting the body, bone (Von Doblen equation modified by Rocha [29]), fat, and residual (Wurch equation [29]) weights, with the body mass and dividing by 100. Three assessments were made for each parameter (skinfolds, breadth, and girth), and the mean was chosen for statistical analysis.

2.4. Physical Fitness Assessment

All tests were performed under similar atmospheric conditions (between 20 °C and 26 °C temperature and 45 and 55% relative humidity).

2.4.1. Vertical Jump

The explosive strength of the lower limbs was evaluated by means of two vertical jump tests. A photoelectric cell platform (Optojump, Mycrogate, Mahopac, New York, NY, USA) was used to perform the tests. The jump test without counter movement (SJ) and the jump test with counter movement (CMJ) were performed following the guidelines by Bosco et al. [31]. Previous to the test executions, a warm-up consisting of knee and hip mobility was performed. After that, the participants performed 4–5 half squats without load and then an isometric squat for 5 s [32].

After the warm-up, the first SJ jump was performed. The participants started the movement from a 90° isometric squat position, which was measured with a goniometer, and the arms resting on the hips. Starting from this position, the subjects had to perform a jump without countermovement at the highest possible intensity, extending the knees and ankles. Two attempts were made, and the best one was selected for analysis. There was a 30 s rest between jumps. Regarding the CMJ jump, participants started the execution from an upright position, with feet shoulder-width apart and hands on hips. From this position, subjects performed a knee flexion-extension in a single sequence followed by a jump of maximum possible intensity. Like the SJ, two attempts were made and the best one was selected for analysis. There was also a 30 s rest between jumps.

2.4.2. Isometric Strength

Isometric strength was evaluated in the upper and lower limbs. The procedures are detailed below.

The isometric strength of the upper limb was assessed using hand grip dynamometry. For this purpose, a warm-up consisting of arm and wrist mobility followed by 10 continuous presses on a rubber ball was performed [33]. A dynamometer (Takei A5401, Tokyo, Japan) was used for the assessment, which was adapted according to the size of the hand and the subjective comfort of the participant. After adaptation, the participants had to perform a maximum contraction with the elbow extended and the dynamometer close to the outside of the hip. The contraction had a duration of 3 s without flexing the elbow. The dominant hand was assessed by performing two attempts with a 30 s rest.

Participants stepped on the dynamometer, gripping the hold while maintaining a squat position by bending the knees to approximately 90° and keeping the back straight. The height of the grip was adjusted according to the anthropometric characteristics of the participant (knee height). Maintaining the position described above, the subjects were encouraged to perform the maximum isometric contraction with the legs while maintaining the position. The maximum result obtained after two attempts was used for analysis. Likewise, there was a 30 s rest between attempts.

2.4.3. Maximal Aerobic Capacity

After the above assessments, the participants performed a maximal exercise test on a treadmill (Ergofit Trac Alpin 4000, Pirmasens, Germany) equipped with a gas analyzer (Geratherm Respiratory GMBH, Ergostik, Ref 40.400, Bad Kissingen, Germany) and a heart rate monitor (Polar® H10, Kempele, Finland).

The maximal exercise test protocol consisted of 1 km/h increments every minute until exhaustion was reached, starting at a speed of 7 km/h with a steady 1% gradient. Previously, the participants performed a warm-up for 5 min at a speed of 6 km/h [34].

The following parameters were established to consider the test maximal: (a) a respiratory exchange ratio greater than 1.05 and (b) a plateau in the oxygen consumption parameter.

2.4.4. Statistical Analysis

Data were processed with IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA) and expressed as the mean ± standard deviation. $p < 0.05$ differences were considered to be statistically significant.

The normality of the distribution of variables was analyzed with the Shapiro–Wilk test. A two-way ANOVA (sex effect and playing position effect) was used. Effect size was calculated using a two-way ANOVA with partial eta-squared, where 0.01–0.06 was a small effect size, 0.06–0.14 was a moderate effect size, and >0.14 was a large effect size [35].

A Pearson correlation study was performed to determine the relationships between anthropometric and body composition parameters and physical fitness parameters. Correlation thresholds were as follows: 0.00 to 0.30 (0.00 to −0.30) = negligible correlation; 0.30 to 0.50 (−0.30 to −0.50) = low correlation; 0.50 to 0.70 (−0.50 to −0.70) = moderate correlation; 0.70 to 0.90 (−0.70 to −0.90)= high correlation; 0.90 to 1.00 (−0.90 to −1.00)= very high correlation [36]. A simple linear regression analysis was performed on statistically significant relationships.

3. Results

The results obtained in the present study are shown below. Table 2 shows the anthropometric and body composition parameters according to sex and playing position. Differences between sexes were observed in all the parameters analyzed ($p < 0.001$). There were no differences according to the effect of playing position and the sex × position interaction. However, there were differences between positions in fat percentage ($p < 0.05$) according to the Bonferroni post-hoc.

Table 2. Anthropometry and body composition according to sex and playing position.

		Men Soccer Players	Women Soccer Players	Sex Effect	Position Effect	Sex × Position
Stretch stature (m)	GK + DF	1.76 ± 0.06	1.62 ± 0.05	<0.001 ^	0.701	0.494 ′
	M	1.75 ± 0.04	1.66 ± 0.07			
	F	1.76 ± 0.06	1.67 ± 0.06			
Body mass (kg)	GK + DF	73.35 ± 6.87	58.55 ± 6.49	<0.001 ^	0.551 ′	0.399 ′
	M	68.92 ± 4.37	59.02 ± 7.62			
	F	71.00 ± 4.95	61.88 ± 8.46			
Σ6 skinfold (mm)	GK + DF	57.65 ± 12.27	96.50 ± 19.91	<0.001 ^	0.642 ′	0.308 ′
	M	56.74 ± 11.44	94.50 ± 18.23			
	F	60.36 ± 10.52	92.14 ± 19.49			
Fat (%)	GK + DF	9.23 ± 1.19	18.36 ± 2.84	<0.001 ^	0.830	0.457
	M	9.14 ± 1.10	18.07 ± 2.60			
	F	10.46 ± 1.01 *	19.73 ± 2.78 *			
Fat (kg)	GK + DF	6.78 ± 1.17	10.74 ± 1.99	<0.001 ^	0.870	0.938
	M	6.31 ± 0.92	10.77 ± 2.77			
	F	7.42 ± 0.79	11.00 ± 2.44			

Table 2. *Cont.*

		Men Soccer Players	Women Soccer Players	Sex Effect	Position Effect	Sex × Position
Muscle (%)	GK + DF	50.87 ± 1.37	45.87 ± 3.31	<0.001 ^	0.625 ′	0.812
	M	50.63 ± 1.25	45.60 ± 2.32			
	F	51.45 ± 3.13	45.82 ± 3.65			
Muscle (kg)	GK + DF	37.34 ± 4.09	26.90 ± 3.84	<0.001 ^	0.479 ^	0.565 ′
	M	34.91 ± 2.57	26.86 ± 3.24			
	F	36.53 ± 3.55	28.37 ± 4.85			

GK: goalkeepers; DF: defenders; M: midfielders; F: forwards; * $p < 0.05$ differences M vs. F; ′ moderate effect size; ^ large effect size.

Table 3 shows the values obtained in the physical condition tests. There were differences between sexes in all the tests performed, with higher values in men soccer players. There were no significant differences between playing positions or in the sex × position interaction.

Table 3. Physical fitness according to sex and playing position.

		Men Soccer Players	Women Soccer Players	Sex Effect	Position Effect	Sex × Position
SJ (cm)	GK + DF	54.38 ± 5.81	35.55 ± 6.29	<0.001 ^	0.370 ′	0.499
	M	47.88 ± 5.94	35.12 ± 9.66			
	F	52.70 ± 6.32	36.70 ± 3.63			
SJ (s)	GK + DF	0.666 ± 0.036	0.539 ± 0.048	<0.001 ^	0.355 ′	0.643
	M	0.622 ± 0.039	0.531 ± 0.07			
	F	0.655 ± 0.038	0.546 ± 0.026			
CMJ (cm)	GK + DF	57.92 ± 7.37	40.00 ± 6.32	<0.001 ^	0.398 ′	0.873
	M	53.78 ± 5.05	38.46 ± 7.49			
	F	60.36 ± 6.63	41.67 ± 8.19			
CMJ (s)	GK + DF	0.686 ± 0.044	0.569 ± 0.046	<0.001 ^	0.461	0.998
	M	0.668 ± 0.030	0.551 ± 0.091			
	F	0.701 ± 0.038	0.581 ± 0.055			
Dominant hand grip (kg)	GK + DF	46.90 ± 5.45	28.25 ± 2.96	<0.001 ^	0.092 ^	0.069 ^
	M	41.78 ± 4.72	25.60 ± 2.70			
	F	41.33 ± 5.68	34.50 ± 7.85			
Isometric strength lower limbs (kg)	GK + DF	145.78 ± 34.71	86.31 ± 22.49	<0.001 ^	0.447 ′	0.297 ^
	M	127.28 ± 16.06	98.50 ± 22.59			
	F	149.16 ± 12.58	106.62 ± 25.14			
VO_{2max} (L/min)	GK + DF	3.70 ± 0.29	2.36 ± 0.35	<0.001 ^	0.620	0.787
	M	3.48 ± 0.18	2.29 ± 0.30			
	F	3.67 ± 0.49	2.25 ± 0.68			
VO_{2max} (mL/kg/min)	GK + DF	51.07 ± 3.70	39.47 ± 6.05	<0.001 ^	0.570	0.963
	M	53.38 ± 1.79	41.30 ± 5.51			
	F	50.90 ± 3.26	40.17 ± 8.92			

Table 3. *Cont.*

		Men Soccer Players	Women Soccer Players	Sex Effect	Position Effect	Sex × Position
Time (min)	GK + DF	12.42 ± 2.20	8.75 ± 1.00	<0.001 ^	0.472 ′	0.210 ^
	M	12.78 ± 1.52	9.79 ± 1.26			
	F	11.33 ± 0.57	10.12 ± 1.10			
$Speed_{max}$ (km/h)	GK + DF	19.42 ± 2.57	15.50 ± 1.19	<0.001 ^	0.821	0.379 ′
	M	18.16 ± 1.27	16.20 ± 1.30			
	F	18.33 ± 0.57	16.50 ± 1.29			

GK: goalkeepers; DF: defenders; M: midfielders; F: forwards; SJ: squat jump; CMJ: countermovement jump; VO_{2max}: maximum oxygen uptake; ′ moderate effect size; ^ large effect size.

Table 4 shows the general results of the relationships between the physical condition parameters and the anthropometry and body composition parameters. All the related parameters were significant ($p < 0.001$).

Table 4. Relationships between body composition and physical fitness parameters in all participants.

		Stretch Stature (m)	Body Mass (kg)	Σ6 Skinfold (mm)	Fat (%)	Fat (Kg)	Muscle (%)	Muscle (Kg)
SJ (cm)	*r*	0.631	0.677	−0.572	−0.711	−0.516	0.695	0.726
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SJ (s)	*r*	0.622	0.667	−0.574	−0.708	−0.516	0.695	0.726
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CMJ (cm)	*r*	0.599	0.637	−0.583	−0.713	−0.520	0.648	0.718
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CMJ (s)	*r*	0.592	0.635	−0.596	−0.718	−0.525	0.654	0.757
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dominant hand grip (kg)	*r*	0.660	0.734	−0.528	−0.671	−0.440	0.556	0.757
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isometric strength lower limbs (kg)	*r*	0.691	0.748	−0.524	−0.630	−0.397	0.529	0.794
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VO_{2max} (L/min)	*r*	0.672	0.732	−0.667	−0.667	−0.631	0.791	0.718
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VO_{2max} (mL/kg/min)	*r*	0.521	0.593	−0.691	−0.767	−0.631	0.728	0.693
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Time (min)	*r*	0.541	0.573	−0.691	−0.735	−0.617	0.641	0.654
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
$Speed_{max}$ (km/h)	*r*	0.552	0.581	−0.659	−0.759	−0.595	0.633	0.660
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

SJ: squat jump; CMJ: countermovement jump; VO_{2max}: maximum oxygen uptake; r: Pearson's correlation.

Table 5 shows the results obtained in the relationships between anthropometric parameters and body composition with physical fitness parameters in men soccer players. There were significant correlations between the anthropometric and body composition parameters with the parameters obtained from the maximal incremental test. Specifically, between the parameters body mass and VO_{2max}; stretch stature and VO_{2max}; sum of folds and total time of the test; sum of folds and maximum speed; fat percentage and total time of the test; fat percentage and maximum speed; muscle mass and VO_{2max} ($p < 0.05$).

Table 5. Relationships between anthropometry and body composition parameters and physical condition parameters in men soccer players.

		Body Mass (kg)	Stretch Stature (m)	Σ6 Skinfold (mm)	Fat (%)	Fat (Kg)	Muscle (%)	Muscle (Kg)
SJ (cm)	*r*	0.360	0.360	−0.139	−0.145	−0.296	−0.051	0.297
	p	0.109	0.106	0.547	0.500	0.193	0.826	0.191
SJ (s)	*r*	0.357	0.360	−0.146	−0.167	0.295	0.054	0.294
	p	0.112	0.180	0.521	0.421	0.196	0.818	0.196
CMJ (cm)	*r*	−0.007	0.095	0.069	0.069	0.038	0.163	0.050
	p	0.977	0.684	0.765	0.766	0.871	0.481	0.830
CMJ (s)	*r*	−0.052	0.090	0.006	0.006	−0.032	0.183	0.017
	p	0.822	0.699	0.978	0.979	0.889	0.427	0.941
Dominant hand grip (kg)	*r*	0.347	0.158	−0.021	−0.021	0.191	0.149	0.357
	p	0.105	0.470	0.924	0.923	0.382	0.498	0.095
Isometric strength lower limbs (kg)	*r*	0.261	0.290	0.049	0.050	0.284	−0.061	0.374
	p	0.223	0.169	0.819	0.818	0.179	0.779	0.072
VO_{2max} (L/min)	*r*	0.609	0.558	−0.076	−0.076	0.246	0.269	0.605
	p	0.002	0.005	0.726	0.725	0.246	0.204	0.002
VO_{2max} (mL/kg/min)	*r*	−0.145	0.060	−0.256	−0.256	−0.279	0.093	−0.097
	p	0.500	0.780	0.228	0.228	0.187	0.666	0.652
Time (min)	*r*	0.107	0.102	−0.430	−0.431	−0.282	0.225	0.164
	p	0.620	0.635	0.036	0.036	0.181	0.291	0.443
$Speed_{max}$ (km/h)	*r*	0.168	0.176	−0.381	−0.392	−0.202	0.264	0.229
	p	0.431	0.410	0.043	0.041	0.344	0.212	0.281

SJ: squat jump; CMJ: countermovement jump; VO_{2max}: maximum oxygen uptake; r: Pearson's correlation.

Table 6 shows the results obtained in the relationships between anthropometric parameters and body composition with physical fitness parameters in women soccer players. There were significant correlations between the parameters body mass and Stretch stature with isometric strength (hand grip and lower limbs); fat weight and hand grip; muscle weight and CMJ; muscle weight and isometric strength lower limbs ($p < 0.05$).

Table 6. Relationships between anthropometry and body composition parameters and physical condition parameters in women soccer players.

		Body Mass (kg)	Stretch Stature (m)	Σ6 Skinfold (mm)	Fat (%)	Fat (Kg)	Muscle (%)	Muscle (kg)
SJ (cm)	*r*	0.304	0.105	−0.180	−0.175	0.063	0.294	0.378
	p	0.158	0.632	0.412	0.431	0.774	0.173	0.075
SJ (s)	*r*	0.281	0.107	−0.185	−0.190	0.046	0.290	0.357
	p	0.194	0.626	0.399	0.381	0.835	0.179	0.094
CMJ (cm)	*r*	0.139	0.217	−0.158	−0.143	0.164	0.298	0.493
	p	0.306	0.320	0.471	0.501	0.454	0.167	0.017
CMJ (s)	*r*	0.217	0.190	−0.156	−0.150	0.162	0.299	0.485
	p	0.320	0.384	0.477	0.489	0.460	0.166	0.019
Dominant hand grip (kg)	*r*	0.606	0.520	0.228	0.211	0.526	−0.152	0.434
	p	0.002	0.009	0.284	0.231	0.008	0.479	0.034
Isometric strength lower limbs (kg)	*r*	0.643	0.620	−0.109	−0.108	0.278	0.152	0.628
	p	0.001	0.001	0.614	0.613	0.189	0.477	0.001
VO_{2max} (L/min)	*r*	0.165	−0.082	0.110	0.105	0.141	0.125	0.220
	p	0.527	0.754	0.674	0.712	0.588	0.631	0.397
VO_{2max} (mL/kg/min)	*r*	0.362	−0.025	−0.202	−0.201	0.078	0.458	0.405
	p	0.153	0.925	0.438	0.439	0.765	0.064	0.089
Time (min)	*r*	0.261	0.151	−0.158	−0.120	0.062	0.227	0.316
	p	0.312	0.563	0.545	0.654	0.814	0.381	0.217
$Speed_{Max}$ (km/h)	*r*	0.216	0.089	−0.064	−0.012	0.097	0.149	0.249
	p	0.406	0.734	0.806	0.951	0.712	0.568	0.335

SJ: squat jump; CMJ: countermovement jump; VO_{2max}: maximum oxygen uptake; r: Pearson's correlation.

Figure 1 shows the linear regressions of significant relationships in men soccer players.

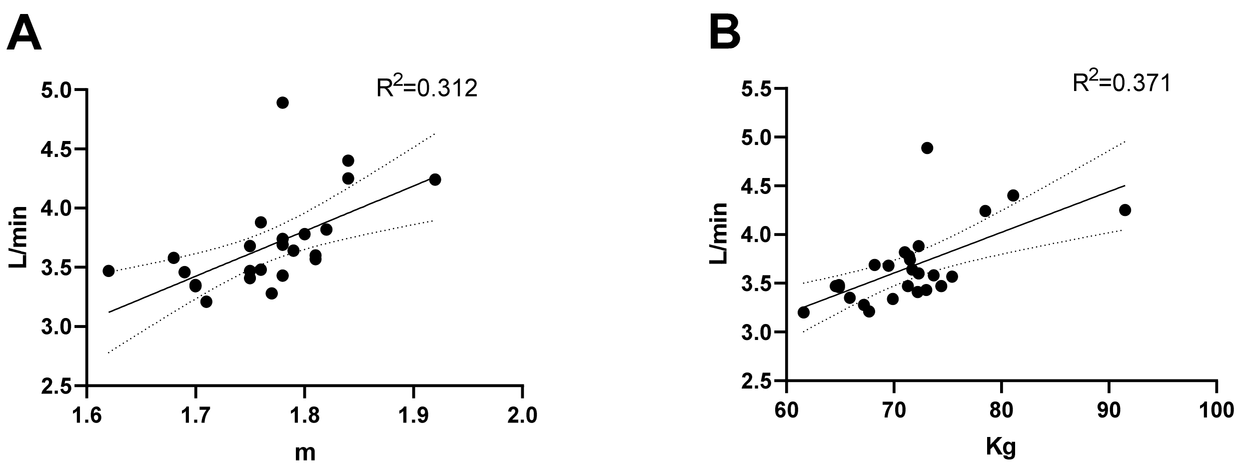

Figure 1. *Cont.*

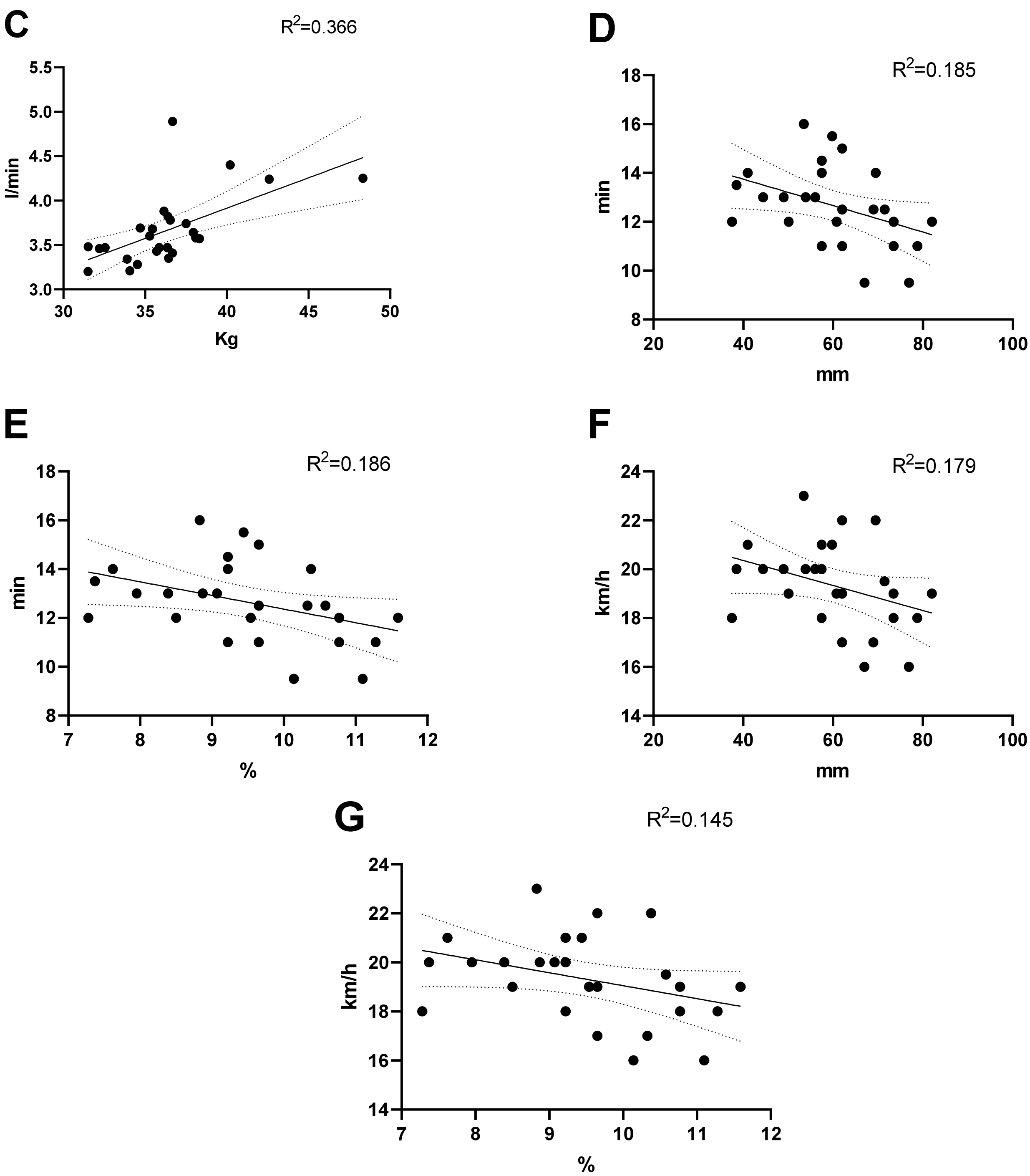

Figure 1. Linear regressions of statistically significant correlations in men soccer players. (**A**) VO_{2max} and stretch stature; (**B**) VO_{2max} and body mass; (**C**) VO_{2max} and muscle weight; (**D**) maximum time in the incremental test and skinfolds; (**E**) maximum time in the incremental test and fat percentage; (**F**) maximum speed in the maximum incremental test and skinfolds; (**G**) maximum speed in the maximum incremental test and fat percentage; VO_{2max}: maximum oxygen uptake.

Figure 2 shows the linear regressions of the significant relationships in women soccer players.

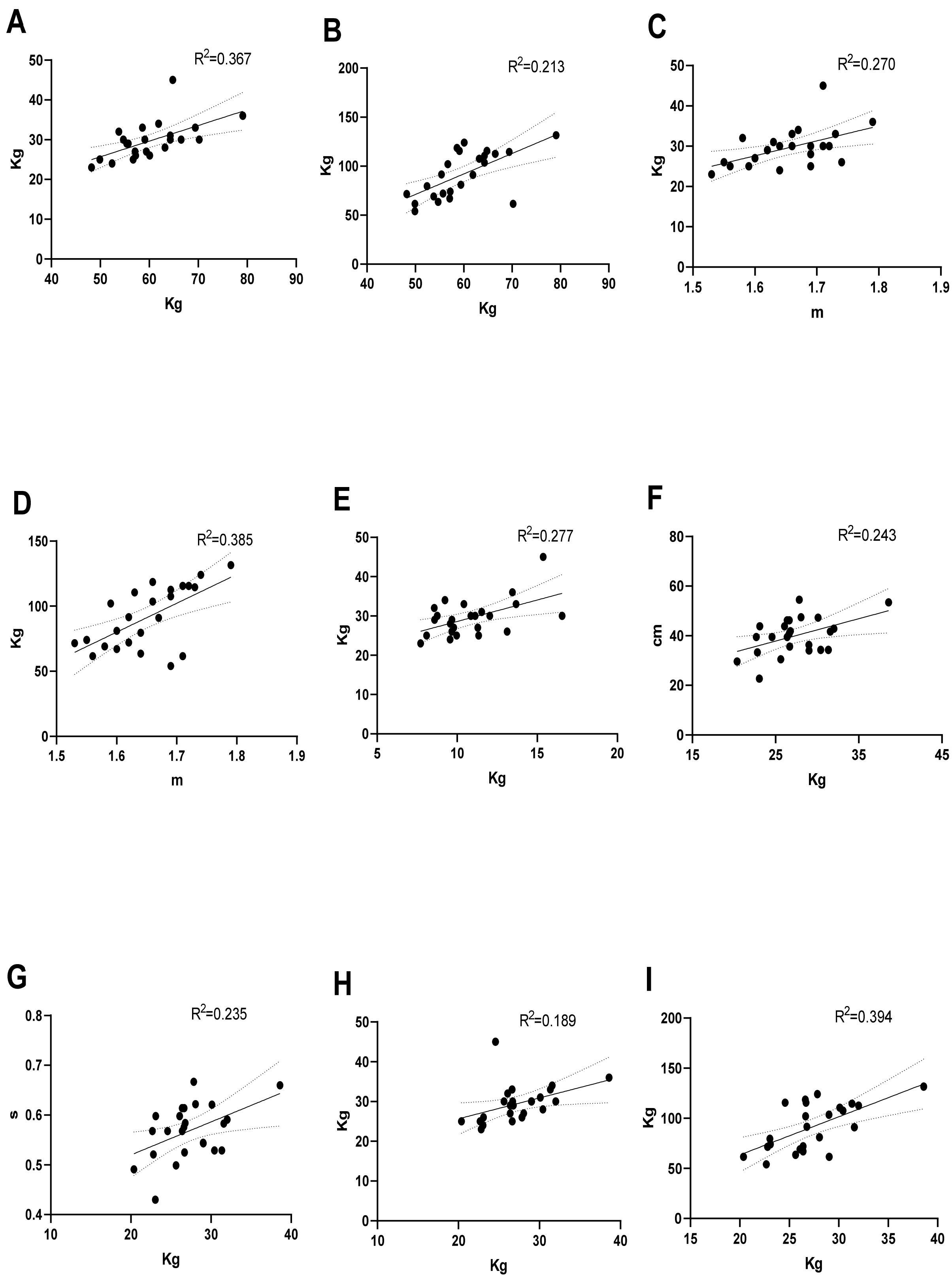

Figure 2. Linear regressions of statistically significant correlations in women soccer players. (**A**) Body mass and hand grip; (**B**) body mass and lower limb isometric strength; (**C**) stretch stature and hand grip; (**D**) stretch stature and lower limb isometric strength; (**E**) fat weight and hand grip; (**F**) muscle mass and CMJ height; (**G**) muscle mass and CMJ flight time; (**H**) muscle mass and hand grip; (**I**) muscle mass and lower limb isometric strength; CMJ: countermovement jump.

4. Discussion

The objectives of the present study were (i) to analyze the differences in anthropometric parameters, body composition, and physical condition between sexes and playing position in soccer players and (ii) to relate anthropometric and body composition parameters with physical condition parameters according to sex. The findings of the present study were: (1) anthropometric and body composition characteristics differed between sexes; (2) fat percentage was higher in F than in M; (3) men soccer players showed better results in physical condition tests compared to women soccer players; and (4) there were significant relationships between anthropometric and physical condition parameters and physical condition tests, at a general level and differentiating between sexes. The evaluation of body composition in athletes can help optimize competitive performance, which is of interest to sports professionals [37]. Improved body composition in athletes is associated with improvements in cardiorespiratory fitness and strength [38]. The data reported in the present study are similar to those reported in previous studies on soccer players [8,28,39].

The sex differences in anthropometry and body composition reported in the present study are in line with previous studies in soccer players [24] and other sports [40–43]. Mascherini et al. [24] observed in 18 elite men soccer players and 18 elite women soccer players significant sex differences in stretch stature, body mass, fold sum, fat mass, muscle mass, and fat-free mass. Due to the difference in level, body composition values in women soccer players were lower compared to the present study. Similarly, Baker et al. [25] reported on a sample of 43 elite soccer players (men, n = 23; women, n = 20) differences in body mass, stretch stature, fat mass, and fat percentage. However, the previous authors used the dual-energy X-ray absorptiometry technique. Taketomi et al. [44] reported that men soccer players were taller, heavier, and had lower fat mass and body fat percentage, and higher skeletal muscle mass compared to women soccer players. Gender differences in body composition are evident at an early stage and are most significant during puberty [45]. Men have greater muscle weight, larger bones, and reduced fat in the extremities, whereas women have a more peripheral fat distribution. Sex differences in body composition are mainly attributed to the action of sex steroid hormones as they drive dimorphisms during pubertal development. These gender differences continue throughout life [46].

Regarding sex differences in physical fitness, Cardoso de Araujo et al. [27] reported, in a sample of 76 soccer players (29 women and 47 men, aged 17–34 years) from the German Bundesliga (the highest level of the German soccer league), differences in height in CMJ, SJ, and maximum distance in an incremental test, showing a relation to the results of the present study. Despite the high level, women soccer players in the present study obtained better results in CMJ performance compared to the women players in the previous study. On the other hand, Mujika et al. [47] reported, on a sample of 68 (34 female and 34 male players) Spanish first division and youth soccer players, that men soccer players showed higher values in the Yo-Yo test, CMJ and sprint compared to women soccer players. Similarly, Ramírez-Campillo et al. [48] reported sex differences in the vertical jump, speed, medicine ball throw, and 20 m multi-stage shuttle run. The observed sex differences in the vertical jump could be due to a lower relative concentric vertical force and eccentric rate of force development in women when jumping [27]. This may also be partially explained by differences in lower extremity muscle morphology, such as muscle size and pennation angle [49]. As for the strength tests, several structural factors, such as muscle cross-sectional area, specific strain (force per cross-sectional area), tendon stiffness, pennation angle, muscle fiber length, and fascicle length, could explain the gender differences in force-generating capabilities [50]. In addition, men have higher absolute muscle power than women, which is a key factor in performance in typical actions during a match such as jumps, accelerations, and speed [51].

In the present study the fat percentage was lower in M, showing significant differences with F ($p < 0.05$). This parameter was lower in men soccer players ($p < 0.001$). A report on young high-level players reported that F presented higher estimated body fat values than the rest of the field players [52]. Likewise, previous studies on elite soccer players showed that body fat percentage was lower in M compared to other positions [42], in agreement with the present study. In contrast, Cárdenas-Fernández et al. [28] reported in 174 young male soccer players (11–18 years old) differences in fat percentage among playing positions, being higher in GK and lower in F. Likewise, Gil et al. [20] reported, in a sample of 241 Spanish players between 14 and 22 years of age, that F showed lower body mass and fat percentages and higher muscle percentages. The previous authors used a similar methodology to determine anthropometric and body composition parameters as in the present study. Discrepancies between investigations could be due to the age of the participating subjects, as well as the level and style of play of the team, which could influence the training methodology and physical demands during the match. The review by Slimani and Nikolaidis [53] reported differences in fat percentage and body mass according to playing position, being generally higher in GK and DF. Similarly, Lago-Peñas et al. [8] reported that GK and central DF presented higher values of mass and fat percentage. Due to the differences in physical demands, M cover longer distances running and sprinting compared to the other positions. In addition, M tend to spend less time standing still on the field [12]. It should be noted that energy expenditure during a match depends on the player's position [14]. All of the above could generate decreases in fat and body mass, this being the playing position that obtains the lowest values in these parameters.

No significant positional differences were evidenced in the different physical condition tests performed. Previous studies reported that GK and F reach greater stretch stature in the vertical jump tests compared to the rest of the positions. On the other hand, wingers are the fastest players without being significant, and F and M present higher VO_{2max} values [8,20]. The absence of positional differences for jumping performance is reiterated in previous findings in professional players in Iceland [54], South Africa [55] and USA college players [56]. In the present study, it was reported that GK+DF and F jumped higher, had higher strength values, and had higher absolute VO_{2max} compared to M. However, in relation to body mass, M had higher VO_{2max} values. Certain positions would benefit from the ability to execute higher vertical jumps, especially those who regularly engage in head-to-head duels in dangerous areas in front of the goal, such as GK, DF, and F. M run long distances compared to the other positions [14,15]. They have to perform both defensive and offensive skills and are always asked to perform long runs; therefore, M must have a high level of aerobic fitness [57].

Regarding the relationships between body composition and physical fitness, Leão et al. [11] observed in a sample of 66 U-16, U-17, and U-19 male soccer players highly significant positive relationships between muscle mass and CMJ and highly significant negative relationships between CMJ and fat percentage. Other authors [58] reported negative relationships between sprint time and aerobic capacity with fat percentage. In women soccer players, VO_{2max} correlated directly with fat percentage [59]. Body composition is closely related to the ability of players to achieve peak performance in various soccer-related performance tests [7]. A high level of fat acts as an extra body mass in motor actions, in which the body mass must continuously lift against gravity, and can substantially decrease the player's performance [20]. Body fat determines the amount of biomechanical inertia that a soccer player must overcome when accelerating and changing direction, so there is a mismatch between a high fat percentage and performance [20]. In addition, some researchers found that body fat percentage could differentiate higher-level soccer players from lower-level players [17].

Some limitations should be taken into consideration: (i) the absence of soccer-specific tests (repeat sprint ability, agility, changes of direction, maximum acceleration, or maximum speed), (ii) the small number of participants; (iii) GK were included in the group of DF; (iv) specify further the groups analyzed (fullbacks, defensive M, extreme F ...); (v) technical measurement error was not analyzed; and (vi) the absence of other, more accurate methods to assess body composition (dual-energy X-ray absorptiometry). Finally, future research should determine or analyze the relationships between body composition and physical condition, both in M and F in different playing categories and training stages to determine sensitive phases of development of the most relevant physical qualities in soccer.

5. Conclusions

Anthropometry, body composition, and physical condition differed considerably according to sex. Regarding differences among positions, no differences were observed in physical condition parameters. However, M showed lower fat percentages in comparison with F.

Anthropometry and body composition values were significantly related to physical fitness parameters. Differentiating between sexes, significant relationships were found in men soccer players between parameters that evaluate maximal aerobic capacity and body composition. While in women soccer players, significant relationships were observed between parameters of isometric strength and body composition.

Coaches should be aware of gender differences when planning and analyzing training data. Knowledge of anthropometric and fitness characteristics according to playing position and gender in soccer players could help coaches/fitness trainers create specific training programs for optimal physical preparation. The results according to gender and playing position could be used as a reference by semi-professional soccer teams.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Biomedical Ethics Committee of the University of Extremadura (Spain), following the Helsinki Declaration of ethical guidelines for research on human subjects (135/2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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