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Comparative Analysis of Body Composition Profiles among Latin American Elite Football Players Competing in Europe

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Abstract: It has yet to be determined whether or not differences in body composition are present between international and non-international players playing in the same elite professional club competition. Similarly, it is not yet clear whether or not differences in body composition exist according to ethnic origin where relative homogeneity is to be expected among soccer players. There is no single anthropometric profile that guarantees sporting success, as success differs according to characteristics. The aim of this study was to assess the description, comparison, and correlation of the body composition profile of Latin American professional football players playing in European leagues. The sample was composed of 238 Latin American male football players from European professional football leagues of Spain, Italy and England during the competition period. Differences were found in all measures. The present study shows that Latin American professional football players playing in Europe have significant differences in various body composition variables such as weight, height, WC, skinfold and fat values. This means that training, revalidation after injury and the classifications of sporting performance carried out in European football clubs should take into account the anthropometric difference between Latin American and European players.

Keywords: football; athletic performance; body composition; Latin American football players

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1. Introduction

The investigation of body composition involves the determination of the main components of the human body, methods and techniques used to obtain them and the impact of biological factors (gender, age, physical activity and nutritional status) [1]. Knowledge of body composition is important for elite athletes, because fat mass does not directly provide the necessary energy, but it does contribute to the weight that has to be mobilized during sports, and is, therefore, a sports performance problem when it exceeds the adequate values [2]. The anthropometric assessment provides us with a series of very relevant data to know the current physical fitness state of the subject. Data such as perimeters, skin folds and diameters are of great importance when it comes to knowing the body composition of the person being assessed. These data allow us to monitor the current fitness state of the player and to verify the changes that occur in their physique as a result of training and nutrition. Anthropometry emerges as an evaluation and measurement tool that serves to quantify the dimensions of the human body, and to provide objectivity, becoming a valuable method in the area of body measurements. It is based on taking muscle perimeters, skin folds, bone diameters, heights, lengths and weights using appropriate instruments [1–3].

A high percentage of fat mass is associated with a low strength-to-weight ratio, lower acceleration and higher energy expenditure, while the contrary is true for a high percentage of fat-free mass [3]. Studies have also found high inverse correlation rates between body fat percentage and sports performance, relating a high % of body fat with low sports performance and highlighting the incompatibility between maximizing performance in sport and high subcutaneous fat levels [4,5].

In the particular case of football, the distance covered by football players during a football match is significantly related to muscle percentage. The evaluation of body composition is important to evaluate the training response. Fluctuations in an athlete's body mass deserve the coaches' attention, as is the case for muscle hypertrophy in strength training [6]. Nevertheless, an excess in caloric intake may increase body mass with an associated increase in fat mass. In addition, it is possible that a training program may modify body composition, decreasing the proportion of adipose tissue and increasing the proportion of muscle tissue [7]. In addition, a training program with anthropometric measurements provides a check for asymmetric muscle distribution, which may facilitate the detection of injuries [8].

The use of anthropometry does not end with monitoring the training adaptations. Rehabilitation takes several months when an athlete has suffered a severe injury, during which the measurement of body composition can be a tool to monitor and minimize an increase in body fat. When activity has been limited and eating habits become poor, athletes can gain body fat rapidly, making it difficult to for the athelete to return to their best potential if they have gained body fat and lost muscle mass [9]. Studies show that team sportsmen show great homogeneity, with very specific anthropometric patterns that are closely related to the player's performance in competitions [10]. However, for field football, it is quite possible that, even at high performance, specific morphological characteristics are not desired or predictive of performance. Additionally, it has yet to be determined whether or not differences in body composition are present between non-international and international football players playing in the same football club. Likewise, it is still unclear whether or not there are differences in body composition according to ethnic origin in elite professional leagues, where relative uniformity is desired for soccer players. It is important to support the notion of relating somatotype with sports performance, and when the above relations are known, to adapt training according to somatotype to optimize sport performance. From the literature on professional football, there is no single anthropometric profile reported that guarantees sporting success. On the contrary, the somatotype of football players differs according to their individual characteristics, serving as a correlation and control variable for optimal sports performance within the same team [11]. Therefore, the aim of this study was to assess the description of, comparison among, and correlation between the body composition profile of Latin American professional football players playing in European leagues.

2. Materials and Methods

Design and subjects: The study design was cross-sectional, descriptive, and comparative. The study protocols and procedures were developed following the standards of the Declaration of Helsinki and approved by the Research Ethics Committee of the University of Murcia, Spain (code: 17772). Prior to participating in the study, all participants were informed of the objectives of the research and provided their written informed consent. The sample was composed of 238 football players from European professional football leagues aged between 22 and 30 years old, with a minimum sport training experience of one year playing at a professional level in Europe. The inclusion criteria were males of Latin American nationality and professional players of a European football team in the first- or second-division leagues. Excluded were players who were injured at the time of the study or had an illness. The data were collected in the European cities where the study subjects played in the professional football leagues of Spain, Italy and England during the competition period. In addition, an informed consent form was offered to all the participants where they were informed about the objectives of the study, and their voluntary participation in it was approved.

Anthropometrics: Anthropometric variables were taken by trained regular personnel of the European Leagues, certified by ISAK, International Society for the Advancement of Kinanthropometry, with a technical measurement error of 0.04% for basic measurements and of 2.12% for skinfolds, following the international standards recommended by the ISAK. All measures were taken in the morning. Height was measured (centimeters) using Seca 214 (SECA Deutschland, Hamburg, Germany) and weight (kilograms) was measured with Tanita BC-418 (Tanita, Tokyo, Japan). On the measurement days, the football players should neither have performed high-intensity exercise the previous day, nor have performed training or stretching sessions on the same day. All participants were weighed wearing light clothing and barefoot (0.6 kg was subtracted from the total for clothing) [1]. Body mass index (BMI) was calculated by dividing the weight in kilograms by the square of the height in meters (kg/m^2). The skinfolds were measured with a Holtein plicometer. The folds measured were tricipital, subscapular, suprailiac, abdominal, mid-leg and calf. Both Faulkner's and Carter's fat estimation formulas were used [12–17]. All anthropometric measurements were taken in triplicate, using the mean of both for subsequent analysis.

Statistics: Sample size calculations were performed using the G* POWER software v. 3.1.9.7 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) with an alpha of 0.05, an effect size of 0.40 and a statistical power of 0.95, and to establish statistical differences between conditions, a minimal of 144 participants were required to be included. Statistical analysis was performed with the R statistical computing software v.4.3.0 (R Core Team, Vienna, Austria). The normality of the variables was analyzed using the Kolmogorov–Smirnov test with the Lilliefors correction, and the homoscedasticity was analyzed using the Levene test. For the basic descriptions, means and standard deviations (SD) were used. For comparisons between groups of continuous variables, the parametric ANOVA test was used. For comparisons between groups of bivariate correlations, Pearson's correlation coefficient was used. All *p*-values given are based on the two-tailed test, and the level of significance for all tests was set at 95%.

3. Results

The final sample consisted of 238 football players, of which 33.6% were Colombians, 11.8% were Argentinians, 21.4% were Chileans, 9.2% were Venezuelans, 2.1% were Uruguayans, 18.5% were Brazilians, 0.8% were Paraguayans and 2.5% were Ecuadorians.

Comparing the nationalities, typical characteristics were found and showed differences ($p < 0.001$) that are illustrated by radar charts. Figure 1 shows the anthropometric differences by nationality, where it can be clearly seen how the values for Argentinians are far below all the average values of the sample. The measured variables grouped per nationality and per playing position can be found in Table 1. All body composition variables under study showed statistically significant differences grouped by position (defenders: DF; midfielders: MF; strikers: ST). Paraguayan football players show the highest mean weight values, followed by Brazilians, while Argentinians are the least heavy players. Correcting this weight value for the height of the players, using the BMI, it is still the Paraguayans who have the highest average values, followed in this case by the Ecuadorians, and the Uruguayan players have the lowest BMI values. In terms of folds, Ecuadorian players have the lowest mean values for the tricipital, suprailiac, abdominal, thigh and calf folds, while Uruguayan players have the lowest mean values for the subscapular fold. The highest fold values correspond to the Chileans for the triceps, to the Paraguayans for the subscapular and abdominal folds, to the Venezuelans for the suprailiac and calf. The heaviest players according to Faulkner and Carter methodology are the Chileans and Venezuelans and the least heavy players are the Ecuadorians, Argentinians and Brazilians.

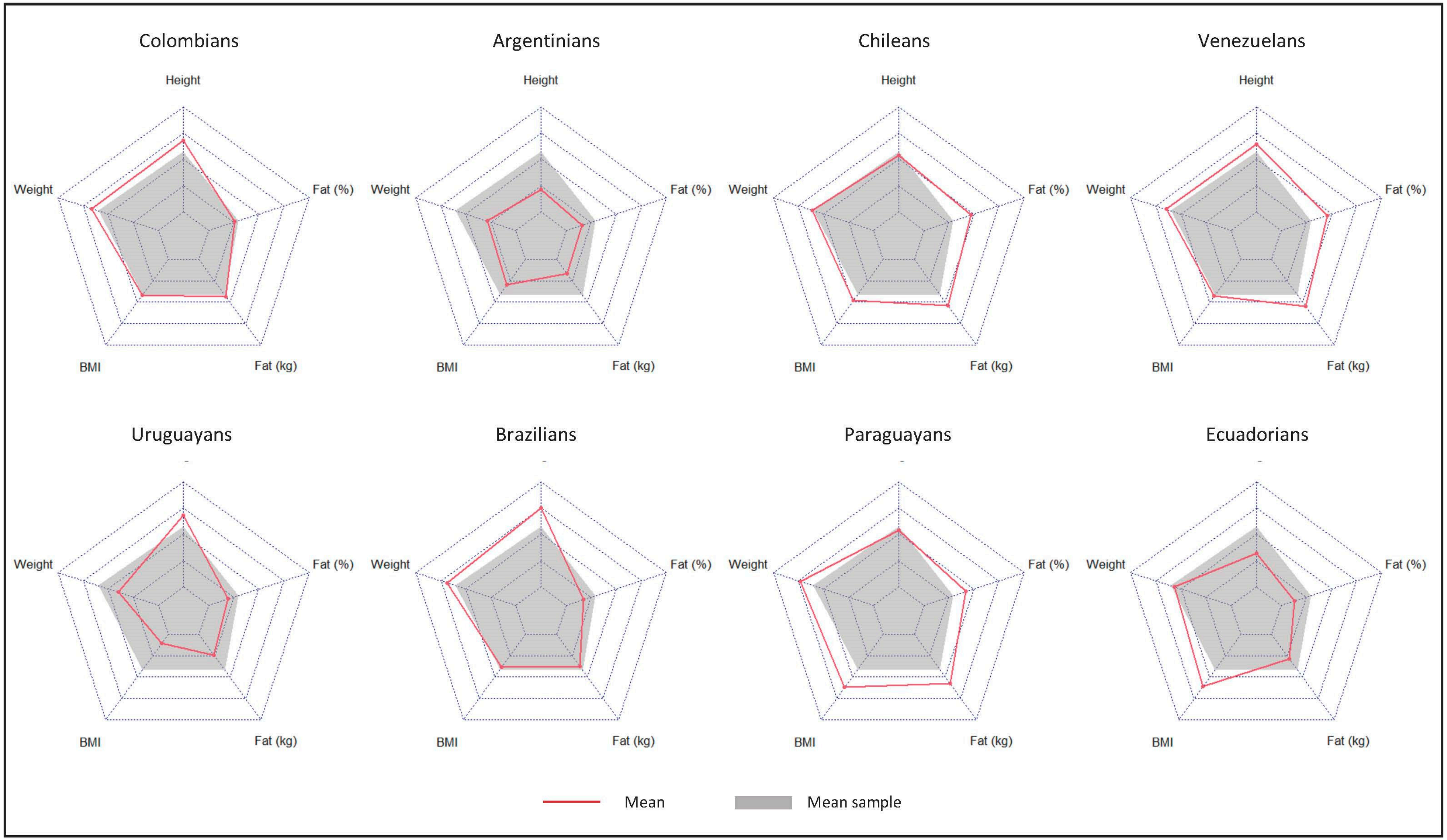

Figure 1. Radar charts of the study sample.

Table 1. Body composition values for different Latin American groups of professional football players.

	Playing Position		Colombians (N = 80)	Argentinians (N = 28)	Chileans (N = 51)	Venezuelans (N = 22)	Uruguayans (N = 5)	Brazilians (N = 44)	Paraguayans (N = 2)	Ecuadorians (N = 6)	Total (N = 238)
Weight (Kg)	Total	Mean (SD)	76.04 (3.28)	63.31 (12.54)	74.18 (3.78)	75.59 (3.39)	67.28 (1.69)	76.83 (6.36)	78.30 (0.57)	72.78 (0.50)	74.00 (7.12)
		F (P *)				17.746 (<0.001)					
	DF	Mean (SD)	74.53 (1.70)	82.71 (1.09)	83.37 (0.47)	-	-	80.20 (5.87)	-	72.78 (0.50)	77.69 (5.08)
		F (P *)				15.768 (<0.001)					
	MF	Mean (SD)	74.87 (0.72)	-	73.34 (1.79)	-	-	73.99 (0.95)	-	-	74.07 (1.53)
		F (P *)				12.58 (<0.001)					
	ST	Mean (SD)	81.69 (3.39)	55.55 (1.02)	75.14 (7.03)	75.59 (3.39)	67.28 (1.69)	72.71 (5.68)	78.30 (0.57)	-	71.01 (10.02)
		F (P *)				82.436 (<0.001)					
BMI (Kg/m^2)	Total	Mean (SD)	23.79 (1.40)	22.71 (1.67)	24.32 (1.13)	23.86 (0.52)	21.00 (0.53)	23.47 (1.01)	25.57 (0.18)	25.48 (0.17)	23.72 (1.39)
		F (P *)				10.753 (<0.001)					
	DF	Mean (SD)	22.01 (0.50)	25.25 (0.33)	24.36 (0.14)	-	-	23.98 (0.53)	-	25.48 (0.17)	23.49 (1.40)
		F (P *)				130.542 (<0.001)					
	MF	Mean (SD)	25.02 (0.24)	-	24.02 (0.40)	-	-	23.35 (0.30)	-	-	24.41 (0.66)
		F (P *)				127.782 (<0.001)					
	ST	Mean (SD)	23.89 (0.49)	21.70 (0.40)	26.08 (2.32)	23.86 (0.52)	21.00 (0.53)	22.69 (1.33)	25.57 (0.18)	-	23.22 (1.64)
		F (P *)				30.174 (<0.001)					
Height (m)	Total	Mean (SD)	1.79 (0.06)	1.66 (0.10)	1.75 (0.03)	1.78 (0.05)	1.79 (0.00)	1.81 (0.05)	1.75 (0.01)	1.69 (0.00)	1.76 (0.07)
		F (P *)				21.71 (<0.001)					
	DF	Mean (SD)	1.84 (0.01)	1.81 (0.01)	1.85 (0.02)	-	-	1.83 (0.05)	-	1.69 (0.02)	1.82 (0.05)
		F (P *)				29.978 (<0.001)					
	MF	Mean (SD)	1.73 (0.02)	-	1.75 (0.01)	-	-	1.78 (0.01)	-	-	1.74 (0.02)
		F (P *)				86.734 (<0.001)					
	ST	Mean (SD)	1.85 (0.05)	1.60 (0.01)	1.70 (0.02)	1.78 (0.05)	1.79 (0.01)	1.79 (0.03)	1.75 (0.01)	-	1.74 (0.10)
		F (P *)				81.381 (<0.001)					
Tricipital skinfold (mm)	Total	Mean (SD)	5.95 (0.88)	5.87 (1.07)	9.68 (2.01)	8.98 (1.19)	6.68 (0.77)	5.93 (1.80)	6.70 (0.71)	4.60 (0.38)	7.09 (2.24)
		F (P *)				42.097 (<0.001)					
	DF	Mean (SD)	6.34 (0.86)	7.35 (0.40)	10.87 (1.33)	-	-	6.78 (1.88)	-	4.60 (0.38)	6.66 (1.69)
		F (P *)				12.917 (<0.001)					
	MF	Mean (SD)	5.60 (0.43)	-	9.73 (2.14)	-	-	4.19 (0.23)	-	-	8.01 (2.81)
		F (P *)				55.162 (<0.001)					
	ST	Mean (SD)	5.64 (1.04)	5.28 (0.51)	8.89 (1.01)	8.98 (1.19)	6.68 (0.77)	5.41 (1.25)	6.70 (0.71)	-	6.71 (1.90)
		F (P *)				37.025 (<0.001)					

Table 1. *Cont.*

	Playing Position		Colombians (N = 80)	Argentinians (N = 28)	Chileans (N = 51)	Venezuelans (N = 22)	Uruguayans (N = 5)	Brazilians (N = 44)	Paraguayans (N = 2)	Ecuadorians (N = 6)	Total (N = 238)
Subscapular skinfold (mm)	Total	Mean (SD)	8.31 (1.37)	7.64 (0.56)	8.91 (1.44)	8.64 (1.37)	7.36 (0.55)	7.33 (1.22)	10.40 (0.00)	8.32 (0.74)	8.19 (1.39)
		F (P *)				7.787 (<0.001)					
	DF	Mean (SD)	7.38 (0.61)	8.23 (0.69)	9.53 (0.81)	-	-	7.20 (0.81)	-	8.32 (0.74)	7.60 (0.90)
		F (P *)				11.02 (<0.001)					
	MF	Mean (SD)	9.97 (0.59)	-	8.51 (1.18)	-	-	6.03 (0.18)	-	-	8.64 (1.48)
		F (P *)				40.78 (<0.001)					
	ST	Mean (SD)	7.98 (1.22)	7.41 (0.28)	11.00 (1.18)	8.64 (1.37)	7.36 (0.55)	8.19 (1.43)	10.40 (0.01)	-	8.32 (1.47)
		F (P *)				11.241 (<0.001)					
Suprailiac skinfold (mm)	Total	Mean (SD)	6.74 (1.48)	5.78 (0.50)	8.67 (1.94)	9.44 (2.92)	5.48 (0.33)	5.61 (1.15)	8.00 (0.28)	5.30 (0.60)	7.04 (2.14)
		F (P *)				23.055 (<0.001)					
	DF	Mean (SD)	7.45 (1.83)	6.00 (0.45)	10.33 (1.01)	-	-	5.54 (1.07)	-	5.30 (0.60)	6.56 (1.81)
		F (P *)				13.186 (<0.001)					
	MF	Mean (SD)	6.18 (0.53)	-	8.45 (2.01)	-	-	4.14 (0.26)	-	-	7.38 (2.19)
		F (P *)				27.795 (<0.001)					
	ST	Mean (SD)	6.13 (0.99)	5.69 (0.50)	9.21 (1.52)	9.44 (2.92)	5.48 (0.33)	6.44 (0.69)	8.00 (0.28)	-	7.17 (2.28)
		F (P *)				13.488 (<0.001)					
Abdominal skinfold (mm)	Total	Mean (SD)	10.05 (2.18)	7.73 (0.81)	12.31 (3.79)	11.82 (2.37)	8.76 (0.71)	8.48 (2.19)	12.40 (0.00)	7.67 (0.62)	10.06 (3.02)
		F (P *)				14.26 (<0.001)					
	DF	Mean (SD)	10.73 (1.57)	7.64 (1.12)	15.47 (4.10)	-	-	8.73 (2.72)	-	7.67 (0.62)	9.61 (2.69)
		F (P *)				11.907 (<0.001)					
	MF	Mean (SD)	11.09 (1.34)	-	11.49 (3.45)	-	-	6.83 (0.33)	-	-	10.89 (3.13)
		F (P *)				8.155 (<0.001)					
	ST	Mean (SD)	7.60 (2.15)	7.76 (0.68)	15.74 (3.38)	11.82 (2.37)	8.76 (0.71)	8.91 (1.23)	12.40 (0.01)	-	9.77 (3.09)
		F (P *)				24.163 (<0.001)					
Thigh skinfold (mm)	Total	Mean (SD)	7.81 (1.49)	7.15 (0.64)	10.10 (2.58)	8.64 (0.85)	10.12 (1.94)	7.66 (3.36)	7.00 (0.00)	5.77 (0.56)	8.30 (2.44)
		F (P *)				8.916 (<0.001)					
	DF	Mean (SD)	8.49 (1.05)	6.81 (0.86)	16.40 (1.64)	-	-	8.74 (4.04)	-	5.77 (0.56)	8.49 (3.15)
		F (P *)				9.939 (<0.001)					
	MF	Mean (SD)	7.65 (0.70)	-	9.49 (1.68)	-	-	5.06 (0.40)	-	-	8.52 (1.99)
		F (P *)				35.116 (<0.001)					
	ST	Mean (SD)	6.77 (2.15)	7.28 (0.49)	10.99 (3.51)	8.64 (0.85)	10.12 (1.94)	7.19 (1.93)	7.00 (0.01)	-	7.98 (2.08)
		F (P *)				7.997 (<0.001)					

Table 1. *Cont.*

	Playing Position		Colombians (N = 80)	Argentinians (N = 28)	Chileans (N = 51)	Venezuelans (N = 22)	Uruguayans (N = 5)	Brazilians (N = 44)	Paraguayans (N = 2)	Ecuadorians (N = 6)	Total (N = 238)
Twin skinfold (mm)	Total	Mean (SD)	4.62 (0.51)	4.77 (0.40)	5.32 (0.94)	6.20 (1.38)	5.32 (0.23)	4.51 (0.76)	3.50 (0.14)	3.42 (0.22)	4.91 (0.97)
		F (P *)				17.357 (<0.001)					
	DF	Mean (SD)	4.69 (0.43)	4.58 (0.54)	7.00 (1.25)	-	-	4.93 (0.68)	-	3.42 (0.22)	4.75 (0.85)
		F (P *)				20.625 (<0.001)					
	MF	Mean (SD)	4.83 (0.32)	-	5.02 (0.70)	-	-	3.94 (0.76)	-	-	4.86 (0.70)
		F (P *)				8.843 (<0.001)					
	ST	Mean (SD)	4.24 (0.65)	4.85 (0.32)	6.34 (0.53)	6.20 (1.38)	5.32 (0.23)	4.10 (0.44)	3.50 (0.14)	-	5.07 (1.19)
		F (P *)				17.17 (<0.001)					
Faulkner Fat (%)	Total	Mean (SD)	10.53 (0.65)	9.92 (0.34)	11.84 (1.18)	11.73 (1.03)	10.11 (0.25)	9.97 (0.85)	11.52 (0.15)	9.74 (0.32)	10.74 (1.16)
		F (P *)				27.565 (<0.001)					
	DF	Mean (SD)	10.66 (0.60)	10.25 (0.37)	12.85 (1.10)	-	-	10.11 (0.93)	-	9.74 (0.32)	10.44 (0.93)
		F (P *)				11.797 (<0.001)					
	MF	Mean (SD)	10.81 (0.32)	-	11.62 (1.15)	-	-	9.02 (0.06)	-	-	11.13 (1.22)
		F (P *)				24.902 (<0.001)					
	ST	Mean (SD)	9.97 (0.72)	9.78 (0.21)	12.64 (0.90)	11.73 (1.03)	10.11 (0.25)	10.21 (0.61)	11.52 (0.15)	-	10.67 (1.20)
		F (P *)				26.32 (<0.001)					
Carter Fat (%)	Total	Mean (SD)	7.15 (0.61)	6.67 (0.24)	8.36 (0.98)	8.23 (0.84)	7.18 (0.37)	6.73 (0.96)	7.62 (0.12)	6.27 (0.28)	7.37 (1.04)
		F (P *)				25.252 (<0.001)					
	DF	Mean (SD)	7.32 (0.53)	6.85 (0.30)	9.90 (1.04)	-	-	6.99 (1.09)	-	6.27 (0.28)	7.17 (1.00)
		F (P *)				12.507 (<0.001)					
	MF	Mean (SD)	7.34 (0.29)	-	8.12 (0.84)	-	-	5.75 (0.12)	-	-	7.66 (1.01)
		F (P *)				37.737 (<0.001)					
	ST	Mean (SD)	6.61 (0.75)	6.60 (0.18)	9.11 (0.83)	8.23 (0.84)	7.18 (0.37)	6.81 (0.63)	7.62 (0.12)	-	7.31 (1.06)
		F (P *)									

* ANOVA test. DF: defenders. MF: midfielders. ST: strikers.

Table 2 shows the bivariate correlations between weight, height, and BMI with skinfolds, % fat and estimated fat-free mass, grouped by nationality. For weight, Colombian players have negative correlations (p = 0.001) for abdominal and calf skinfold values (p = 0.003). Argentinians are positively correlated for weight with tricipital and subscapular skinfold (p < 0.001). Chileans have a positively correlated weight with all skinfolds except for the tricipital skinfold. Venezuelans also show positive correlations between all skinfolds except the tricipital skinfold. Venezuelans also have correlations between all the folds and weight except the abdominal fold, although unlike Chileans, in this case, these are negative correlations. Uruguayans have positive correlations with the thigh fold and Ecuadorians with the abdominal and calf fold. Brazilians are the only players who do not show any correlation between weight and body folds. The correlation of these folds with the BMI of the players shows negative values for Colombians in the tricipital skinfold and for Argentinians in the thigh and for Brazilians in the subscapular skinfold, with positive correlations for the tricipital in Argentinians and Venezuelans; for the subscapular skinfold in Colombians, Argentinians, Chileans, Venezuelans and Brazilians; for the suprailiac skinfold in Venezuelans; for the abdominal in Chileans, Venezuelans and Ecuadorians; for the thigh in Chileans and Uruguayans; and for the calf in Chileans, Venezuelans and Ecuadorians.

Table 2. Correlations of weight, height and BMI between bodyfoldsand fat % in Latin American football players.

			Tricipital Skinfold (mm)	Subscapular Skinfold (mm)	Suprailiac Skinfold (mm)	Abdominal Skinfold (mm)	Thigh Skinfold (mm)	Twin Skinfold (mm)	Faulkner Fat (%)	Carter Fat (%)	Fat Weight (Kg)
Weight (Kg)	Colombians	R	0.053	−0.082	−0.055	−0.413 **	−0.229	−0.379 **	−0.247	−0.271 *	0.457 **
	Argentinians	R	0.886 **	0.677 **	0.25	−0.052	−0.355	−0.290	0.639 **	0.457 *	0.991 **
	Chileans	R	0.198	0.495 **	0.344 *	0.402 **	0.664 **	0.496 **	0.430 **	0.586 **	0.730 **
	Venezuelans	R	−0.595 **	−0.738 **	−0.894 **	−0.389	0.106	−0.777 **	−0.784 **	−0.778 **	−0.411
	Uruguayans	R	0.532	0.729	0.030	0.721	0.897 *	0.734	0.827	0.914 *	0.956 *
	Brazilians	R	0.215	−0.231	−0.110	−0.036	0.265	0.123	−0.018	0.097	0.663 **
	Ecuadorians	R	0.319	0.657	0.729	0.949 **	0.446	0.818 *	0.792	0.786	0.852 *
BMI (Kg/m^2)	Colombians	R	−0.312 *	0.781 **	−0.227	0.046	−0.174	0.114	0.131	0.061	0.322 *
	Argentinians	R	0.853 **	0.681 **	0.183	−0.020	−0.374 *	−0.244	0.621 **	0.442 *	0.979 **
	Chileans	R	0.037	0.569 **	0.136	0.302*	0.493 **	0.504 **	0.299 *	0.433 **	0.490 **
	Venezuelans	R	0.544 *	0.720 **	0.789 **	0.501*	0.417	0.753 **	0.764 **	0.813 **	0.668 **
	Uruguayans	R	0.532	0.729	0.030	0.721	0.897*	0.734	0.827	0.914 *	0.956 *
	Brazilians	R	0.212	−0.385 **	−0.089	0.049	0.267	0.181	−0.015	0.104	0.568 **
	Ecuadorians	R	0.319	0.657	0.729	0.949 **	0.446	0.818 *	0.792	0.786	0.852 *
Height (m)	Colombians	R	0.331 **	−0.788 **	0.173	−0.340 **	−0.003	−0.380 **	−0.300 *	−0.252	0.033
	Argentinians	R	0.895 **	0.666 **	0.285	−0.070	−0.336	−0.313	0.642 **	0.461 *	0.989 **
	Chileans	R	0.210	−0.014	0.283*	0.168	0.290 *	0.051	0.206	0.255	0.378 **
	Venezuelans	R	−0.630 **	−0.799 **	−0.940 **	−0.461 *	−0.060	−0.839 **	−0.848 **	−0.860 **	−0.535 *
	Uruguayans	R	0.225	0.158	0.124	0.138	0.121	0.252	0.568	0.104	0.103
	Brazilians	R	0.187	−0.040	−0.089	−0.077	0.220	0.053	0.003	0.087	0.609 **
	Ecuadorians	R	0.439	0.121	0.213	0.137	0.162	0.302	0.619	0.217	0.364

Pearson's correlation coefficient. * <0.05, ** <0.001.

4. Discussion

The study of body composition is particularly important in sports in which body weight must repeatedly move against gravity. The body composition of football players is likely to change over the course of the competitive season as a result of training and competition, diet and habitual activity. Multiple factors affect the relationship between measured % fat and BMI. Polynomial regression analysis showed that the relationship between % fat and BMI was quadratic, not linear. This curvilinear trend was similar for both female and male data [18]. Although the aim of this study was not to analyze body composition by position, these data were also grouped by relevance to on-field football sport performance research, showing statistically significant differences according to playing position as expected ($p < 0.001$). With respect to Colombian professional players who play in Europe, the mean value obtained for weight was 76.04 kg, and the mean values for height were 1.79 m and 10.53% and 7.15% for % fat according to Faulkner and Carter, respectively, which are very similar to the data obtained in the study by Kammerer Lopez in which a comparative study of different formulas for estimating the percentage of fat with absorptiometry in Colombian football players was proposed [19].

Similar values were obtained in the Chilean subjects studied with respect to those obtained by other authors [20–22]. The mean weight value was 74.18 kg, and the mean height values were 1.75 m and 11.84% and 8.36% for % fat according to Faulkner and Carter, respectively.

The Argentinian players studied had the lowest values for weight and height, but they did not have the lowest values for fat. In this case, we found different values to those obtained by Wittich et al. [23] or those found by Bua et al. [24], but these studies were carried out on amateur players.

Arana et al. [25] found a homogeneous distribution in the Venezuelan football players they studied, with similar data to those found in the Venezuelan football players in this study. The same occurred with the study by Gerota-Neto et al. [26], where it was shown that Brazilian footballers have specific morphological characteristics that are different from those of other footballers. It should be noted that no studies have been found that show body composition values of Uruguayan, Paraguayan or Ecuadorian football players, demonstrating the importance of carrying out descriptive studies in football players of different nationalities.

In the correlation study of weight, BMI and height with bodyfolds and % fat, it is observed that Colombian and Venezuelan football players have a negative correlation of weight with % fat, while this is positive for Argentinians, Chileans and Uruguayans. Colombians and Venezuelans seem to have lower fat values when their weights are higher, in contrast to Argentinians, Chileans and Uruguayans, where the decrease in body fat could be associated with a decrease in weight [27]. Regarding height, only Colombians and Venezuelans have an inverse correlation with % fat.

Wagner and Heyward [28] reviewed research comparing white and black racial groups and found that black males had higher body protein content and mineral mass than white males, resulting in higher bone and muscle density and muscle mass, with a tendency towards a mesomorphic somatotype. However, these studies have not been conducted in other populations that may have different body composition characteristics (Caucasians, Native American, Asian, African American, and Polynesian people) where there seem to be differential changes in % fat and BMI [17].

The present study results suggest that endogenous differences in the fat-free compartment between ethnic groups are reduced as long-term effects of elite football participation. However, longitudinal studies would be needed to confirm this. While it is logical that an Asian player may be misclassified, given the tendency for a higher body % fat at a given body mass index, which is often evident in Asian populations [29–31], our study population does not use a different classification than that used for European players. Further research on the influence of ethnicity on body composition in elite professional athletes is justified, ideally with sufficient numbers of participants to allow for a specific breakdown according to race or ethnicity.

The results of the present study suggest that, while football players are distinguished from members of the general population by their body composition, there are sufficient differences for professional players at elite professional clubs in Europe to be treated differently in terms of optimizing their performance and improving body composition, although once players compete at the professional elite level, factors other than anthropometry, body composition, and ethnicity may determine whether or not they reach the international level.

Deurenberg and Deurenberg-Yap [29] examined the variance across ethnic groups with the mean difference between estimated and measured % fat. The mean differences for Chinese people were small (1% fat) but were large for the sample of Ethiopian women and men (9.9 and 10.0% fat, respectively). In contrast, the mean difference between black women and men was 1.9% fat. The meta-measurement underestimated the % fat of Indonesian and Thai women and men. These mean differences ranged from 5.9–8.8% fat. The meta-assessment overestimated the fat % of Polynesian men (74.1% fat) and women (73.9% fat). The results of the meta-analysis led Deurenberg and Deurenberg-Yap [29] to suggest the need to use population-specific cut-off points to determine body composition.

In today's professional football, different nationalities coexist in the same locker room, which makes it of special interest to treat differently those variables of body composition that differ depending on the nationality of the player, such as size, weight or fat percentage, and therefore to set different objectives for players even if they belong to the same team. This approach reinforces the idea of personalizing training and recommendations for each player in the professional elite.

Strengths and limitations of the study. The present study shows, as its main strength, that the study of body composition in professional football should be done on a fully personalized basis. This study has several limitations. Firstly, the cross-sectional study limits the ability to establish a cause–effect relationship between weight and fat. Secondly, the data obtained do not include those of nutritional health studies, so it is proposed to so include these in future studies. Thirdly, given that the sample studied is exclusive to professional football, the generalizability to other populations may be limited. Once the possible differences in body composition have been detected, it would be necessary to increase the number of studies with a larger number of male and females subject under study, including football leagues from other countries and also involving football leagues from other continents that could give greater statistical strength to the variability in the body composition of elite football players.

5. Conclusions

In conclusion, the present study shows that in Latin American professional football players playing in Europe, there are significant differences in different body composition variables such as height, weight, WC, skinfold and fat values. This means that the treatment of these data and the possible classifications of sporting performance carried out in football clubs should be different for players other than European players, e.g., Latin American and African American football players. More studies should be conducted on the body composition of professional football players of different nationalities.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the University of Murcia, Spain (code 17772). All participants were informed of the purpose and the implications of the study, and all provided their written informed consent to participate. The results and writing of this manuscript followed the Committee on Publication Ethics (COPE) guidelines on how to deal with potential acts of misconduct, maintaining the integrity of the research and its presentation following the rules of good scientific practice, the trust in the journal, the professionalism of scientific authorship, and the entire scientific endeavor.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent was obtained from the patient(s) to publish this paper.

Data Availability Statement: There are restrictions on the availability of data for this trial, due to the signed consent agreements around data sharing, which only allow access to external researchers for studies following the project's purposes. Requestors wishing to access the trial data used in this study can make a request to mariscal@ugr.es.

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