Article

Comparative study of the body composition profile of Latin American Elite Soccer playing in Europe

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Abstract: Knowledge of body composition is essential for athletes for their sport performance. It has yet to be determined whether 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 differences in body composition according to ethnic origin exist in the elite professional game, where relative homogeneity is to be expected among soccer players. There is no single anthropometric profile that guarantees sporting success, as the somatotype of football players differs according to their individual characteristics. The aim of this study was to assess the description and comparison of the body composition profile of latin american professional football players playing in european leagues. The sample was composed of 238 subjects football players from European professional football leagues. Differences were found in all variables measured. 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 weight, height, 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 to other European or African-American football players.

Keywords: Football, athletic performance, body composition, Latin-American soccers.

1. Introduction

The study of body composition includes the determination of the main components of the human body, the techniques and methods used to obtain them and the influence of biological factors such as age, sex, nutritional status or physical activity [1]. Knowledge of body composition is essential for athletes for several reasons. Firstly, fat mass does not directly provide the individual with energy, but it does contribute to the weight that has to be mobilised in sport, and is therefore an impediment when it exceeds the appropriate values [2]. The anthropometric assessment provides us with a series of very relevant data in order to know the current 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 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 this observational curiosity, and to provide objectivity to its many results, becoming a valuable method in the area of body measurements. It is based on taking muscle perimeters, skin folds, bone diameters, heights, heights, heights and weights using appropriate instruments.

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It has been proven that a high proportion of fat mass is related to a low strength-to-weight ratio, reduced acceleration and increased energy consumption, while the opposite is true for a high proportion of fat-free mass [3]. Studies have also shown high correlation rates between body fat percentage and sports performance [4,5] highlighting the incompatibility between maximising performance in sport and high subcutaneous fat levels.

In the particular case of football [6], muscle percentage is an important factor related to the distance covered by players during a football match. The assessment of body composition is especially important in monitoring the response to training. Any fluctuation in an athlete's body mass deserves the attention of the coach. For example, with strength training, an increase in muscle mass can be expected due to hypertrophy of the musculature. However, body mass may have increased due to an increase in fat mass, related to excess caloric intake. On the other hand, it is possible that a training programme does not produce changes in total body mass, but it does modify body composition, increasing the proportion of muscle tissue and decreasing the proportion of adipose tissue [7] In addition, it allows to check if the muscle distribution is asymmetrical, which may be desirable in some sports, but may facilitate the occurrence of injuries in others [8].

But its usefulness does not end with monitoring the effects of training. When an athlete has suffered a severe injury, where rehabilitation will take several months, measuring body composition on a monthly basis can be a tool to minimise an increase in body fat. Athletes can gain body fat rapidly when activity has been limited and eating habits have been poor, and it is difficult to return the athlete to their best potential if they have lost muscle and gained body fat [9]. It is quite possible that field football, even at high performance, does not require specific morphological characteristics. However, studies show that team sportsmen show a great homogeneity, with very specific anthropometric patterns that are closely related to the player's performance in competition [10].

However, it has yet to be determined whether 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 differences in body composition according to ethnic origin exist in the elite professional game, where relative homogeneity is to be expected among soccer players [11].

The literature shows that there is no single anthropometric profile that guarantees sporting success, as the somatotype of football players differs according to their individual characteristics. Therefore, the aim of this study was to assess the description and comparison of 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 in accordance with 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 subjects football players from European professional football leagues. The inclusion criteria were be of Latin American nationality and play for a European professional football team in the first or second division; players who were injured at the time of the study or had an illness were excluded.

Anthropometrics: Anthropometric variables were taken by trained personnel. Height was measured in centimetres using a wall-mounted stadiometer (Seca 214, SECA Deutschland, Hamburg, Germany) and weight in kilograms with a high-precision scale (Tanita BC-418, Tanita, Tokyo, Japan). All participants were weighed barefoot and wearing light clothing, subtracting 0.6 kg from the total for clothing [1]. Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters (kg/m2). 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.

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Statistics: Statistical analysis was performed with the R statistical computing software (R Core Team, Vienna, Austria). The normality of the variables was analysed using the Kolmogorov–Smirnov test with the Lilliefors correction, and the homoscedasticity with the Levene test. For the basic descriptions, frequencies, minimum, maximum, means, and standard deviations (SD) were used. For comparisons between groups of continuous variables, the ANOVA Test was used. For comparisons between groups of bivariate correlations, Spearman's Rho correlation coefficient was used. All reported P-values are based on the two-tailed test and the level of statistical 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% argentinians, 21,4% chileans, 9,2% venezuelans, 2,1% uruguayans, 18,5% brazilians, 0,8% paraguayans y 2,5% ecuadorians. Differences were found in all variables measured (p<0,001) (Table 1). 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 fattest players according to Faulkner and Carter are the chileans and venezuelans and the least fat players are the ecuadorians, argentinians and brazilians.

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

		Mean	SD	Minimum	Maximum	P*
Weight (Kg)	Colombians	76,04	3,28	72,30	84,60	<0,001
	Argentinians	63,31	12,54	53,80	83,90	
	Chileans	74,18	3,78	65,30	83,90	
	Venezuelans	75,59	3,39	71,50	80,70	
	Uruguayans	67,28	1,69	64,30	68,30	
	Brazilians	76,83	6,36	63,50	87,30	
	Paraguayans	78,30	0,57	77,90	78,70	
	Ecuadorians	72,78	0,50	72,10	73,40	
	Total	74,00	7,12	53,80	87,30	
BMI (Kg/m^2)	Colombians	23,79	1,40	21,36	25,43	<0,001
	Argentinians	22,71	1,67	21,02	25,61	
	Chileans	24,32	1,13	22,86	28,89	
	Venezuelans	23,86	0,52	23,08	24,94	
	Uruguayans	21,00	0,53	20,07	21,32	
	Brazilians	23,47	1,01	20,73	24,70	
	Paraguayans	25,57	0,18	25,44	25,70	
	Ecuadorians	25,48	0,17	25,24	25,70	
	Total	23,72	1,39	20,07	28,89	
Height (m)	Colombians	1,79	0,06	1,73	1,88	<0,001
	Argentinians	1,66	0,10	1,60	1,81	
	Chileans	1,75	0,03	1,69	1,85	
	Venezuelans	1,78	0,05	1,74	1,85	
	Uruguayans	1,79	0,00	1,79	1,79	
	Brazilians	1,81	0,05	1,73	1,88	
	Paraguayans	1,75	0,00	1,75	1,75	

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	Ecuadorians	1,69	0,00	1,69	1,69	
	Total	1,76	0,07	1,60	1,88	
	Colombians	5,95	0,88	4,00	8,40	
	Argentinians	5,87	1,07	4,40	8,20	
	Chileans	9,68	2,01	6,20	14,10	
	Venezuelans	8,98	1,19	7,00	11,00	
Tricipital skinfold (mm)	Uruguayans	6,68	0,77	5,80	7,80	<0,001
	Brazilians	5,93	1,80	3,80	10,00	
	Paraguayans	6,70	0,71	6,20	7,20	
	Ecuadorians	4,60	0,38	4,20	5,20	
	Total	7,09	2,24	3,80	14,10	
	Colombians	8,31	1,37	6,20	11,60	
	Argentinians	7,64	0,56	7,00	9,80	
	Chileans	8,91	1,44	7,20	12,60	
	Venezuelans	8,64	1,37	6,40	11,20	
Subscapular skinfold (mm)	Uruguayans	7,36	0,55	6,60	8,00	<0,001
	Brazilians	7,33	1,22	5,60	10,20	
	Paraguayans	10,40	0,00	10,40	10,40	
	Ecuadorians	8,32	0,74	7,80	9,80	
	Total	8,19	1,39	5,60	12,60	
	Colombians	6,74	1,48	4,80	11,20	
	Argentinians	5,78	0,50	5,00	7,00	
	Chileans	8,67	1,94	5,00	15,10	
	Venezuelans	9,44	2,92	5,40	13,30	
Suprailiac skinfold (mm)	Uruguayans	5,48	0,33	5,20	6,00	<0,001
	Brazilians	5,61	1,15	3,80	8,80	
	Paraguayans	8,00	0,28	7,80	8,20	
	Ecuadorians	5,30	0,60	4,80	6,40	
	Total	7,04	2,14	3,80	15,10	
	Colombians	10,05	2,18	5,80	15,40	
	Argentinians	7,73	0,81	6,40	10,00	
	Chileans	12,31	3,79	7,20	21,50	
	Venezuelans	11,82	2,37	9,00	19,00	
Abdominal skinfold (mm)	Uruguayans	8,76	0,71	8,00	9,40	<0,001
	Brazilians	8,48	2,19	5,80	16,60	
	Paraguayans	12,40	0,00	12,40	12,40	
	Ecuadorians	7,67	0,62	7,00	8,40	
	Total	10,06	3,02	5,80	21,50	
	Colombians	7,81	1,49	5,20	14,00	
	Argentinians	7,15	0,64	5,80	8,60	
	Chileans	10,10	2,58	4,00	18,20	
	Venezuelans	8,64	0,85	7,20	10,60	
Thigh skinfold (mm)	Uruguayans	10,12	1,94	7,20	12,60	<0,001
	Brazilians	7,66	3,36	4,80	18,40	
	Paraguayans	7,00	0,00	7,00	7,00	
	Ecuadorians	5,77	0,56	5,00	6,40	
	Total	8,30	2,44	4,00	18,40	
	Colombians	4,62	0,51	3,00	6,00	
	Argentinians	4,77	0,40	4,00	5,50	
	Chileans	5,32	0,94	3,60	8,40	
Twin skinfold (mm)	Venezuelans	6,20	1,38	4,00	8,40	<0,001
	Uruguayans	5,32	0,23	5,00	5,60	
	Brazilians	4,51	0,76	3,40	6,40	

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	Paraguayans	3,50	0,14	3,40	3,60	
	Ecuadorians	3,42	0,22	3,10	3,80	
	Total	4,91	0,97	3,00	8,40	
	Colombians	10,53	0,65	9,18	12,18	
	Argentinians	9,92	0,34	9,39	11,08	
	Chileans	11,84	1,18	10,22	15,07	
	Venezuelans	11,73	1,03	10,31	13,92	<0,001
Faulkner Fat (%)	Uruguayans	10,11	0,25	9,73	10,34	
	Brazilians	9,97	0,85	8,93	12,61	
	Paraguayans	11,52	0,15	11,41	11,63	
	Ecuadorians	9,74	0,32	9,49	10,34	
	Total	10,74	1,16	8,93	15,07	
	Colombians	7,15	0,61	5,90	8,78	
	Argentinians	6,67	0,24	6,22	7,50	
	Chileans	8,36	0,98	7,02	11,09	
	Venezuelans	8,23	0,84	6,97	9,74	<0,001
Carter Fat (%)	Uruguayans	7,18	0,37	6,57	7,58	
	Brazilians	6,73	0,96	5,62	9,84	
	Paraguayans	7,62	0,12	7,54	7,71	
	Ecuadorians	6,27	0,28	6,04	6,78	
	Total	7,37	1,04	5,62	11,09	
	Colombians	8,05	0,55	6,83	9,70	
	Argentinians	6,30	1,42	5,17	9,23	
	Chileans	8,80	1,16	7,35	11,84	
	Venezuelans	8,85	0,53	8,15	10,16	<0,001
Fat weight (Kg)	Uruguayans	6,80	0,32	6,26	7,04	
	Brazilians	7,66	0,90	5,98	10,20	
	Paraguayans	9,02	0,05	8,98	9,06	
	Ecuadorians	7,09	0,27	6,86	7,59	
	Total	7,95	1,23	5,17	11,84	
	Colombians	89,47	0,65	87,82	90,82	
	Argentinians	90,08	0,34	88,92	90,61	
	Chileans	88,16	1,18	84,93	89,78	
	Venezuelans	88,27	1,03	86,08	89,69	<0,001
Faulkner fat-free mass (%)	Uruguayans	89,89	0,25	89,66	90,27	
	Brazilians	90,03	0,85	87,39	91,07	
	Paraguayans	88,48	0,15	88,37	88,59	
	Ecuadorians	90,26	0,32	89,66	90,51	
	Total	89,26	1,16	84,93	91,07	
	Colombians	68,42	3,46	64,91	76,11	
	Argentinians	57,01	11,13	48,55	75,45	
	Chileans	65,38	3,04	57,55	73,15	
	Venezuelans	66,80	3,71	62,49	72,27	<0,001
Carter fat-free mass (%)	Uruguayans	60,48	1,39	58,04	61,38	
	Brazilians	69,17	5,80	57,17	79,35	
	Paraguayans	69,28	0,62	68,84	69,72	
	Ecuadorians	65,69	0,30	65,22	66,03	
	Total	65,98	6,64	48,55	79,35	

*ANOVA Test

Table 2 shows the bivariate correlations between the weight, height and BMI with skinfolds and % fat and fat free mass estimated from these, grouped by nationality. For weight, Colombian players have negative correlations (P=0.001) for abdominal and calf skinfold (P=0.003); Argentinians are

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positively correlated for weight with tricipital and subscapular skinfold (P<0.001); Chileans positively correlate weight with all skinfolds except tricipital skinfold; Venezuelans also positively correlate all skinfolds with all skinfolds except tricipital skinfold; Venezuelans also correlate all the folds with weight except the abdominal fold, although unlike Chileans, in this case they are negative correlations; Uruguayans positively correlate with the thigh fold and Ecuadorians with the abdominal and calf fold; Brazilians are the only players who do not obtain 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, for Argentines in the thigh and for Brazilians in the subscapular, with positive correlations for the tricipital in Argentines and Venezuelans, for the subscapular in Colombians, Argentines, Chileans, Venezuelans and Brazilians; for the suprailiac 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 Ecuadorian

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Table 2. Correlations of weight, height and BMI between bodyfolds and 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**
		P	0,685	0,534	0,674	0,001	0,079	0,003	0,057	0,036	<0,001
	Argentinians	R	0,886**	0,677**	0,25	-0,052	-0,355	-0,290	0,639**	0,457*	0,991**
		P	<0,001	<0,001	0,199	0,791	0,063	0,135	<0,001	0,015	<0,001
	Chileans	R	0,198	0,495**	0,344*	0,402**	0,664**	0,496**	0,430**	0,586**	0,730**
		P	0,163	<0,001	0,013	0,003	<0,001	<0,001	0,002	<0,001	<0,001
	Venezuelans	R	-0,595**	-0,738**	-0,894**	-0,389	0,106	-0,777**	-0,784**	-0,778**	-0,411
		P	0,004	<0,001	<0,001	0,081	0,649	<0,001	<0,001	<0,001	0,064
	Uruguayans	R	0,532	0,729	0,030	0,721	0,897*	0,734	0,827	0,914*	0,956*
		P	0,357	0,163	0,962	0,170	0,039	0,158	0,084	0,030	0,011
	Brazilians	R	0,215	-0,231	-0,110	-0,036	0,265	0,123	-0,018	0,097	0,663**
		P	0,161	0,131	0,476	0,815	0,082	0,427	0,909	0,532	<0,001
	Ecuadorians	R	0,319	0,657	0,729	0,949**	0,446	0,818*	0,792	0,786	0,852*
		P	0,538	0,156	0,100	0,004	0,375	0,047	0,061	0,064	0,031
BMI (Kg/m^2)	Colombians	R	-0,312*	0,781**	-0,227	0,046	-0,174	0,114	0,131	0,061	0,322*
		P	0,015	<0,001	0,081	0,729	0,183	0,386	0,317	0,642	0,012
	Argentinians	R	0,853**	0,681**	0,183	-0,02	-0,374*	-0,244	0,621**	0,442*	0,979**
		P	<0,001	<0,001	0,352	0,921	0,05	0,210	<0,001	0,019	<0,001
	Chileans	R	0,037	0,569**	0,136	0,302*	0,493**	0,504**	0,299*	0,433**	0,490**
		P	0,796	<0,001	0,341	0,031	<0,001	<0,001	0,033	0,002	<0,001
	Venezuelans	R	0,544*	0,720**	0,789**	0,501*	0,417	0,753**	0,764**	0,813**	0,668**
		P	0,011	<0,001	<0,001	0,021	0,060	<0,001	<0,001	<0,001	<0,001

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	Uruguayans	R	0,532	0,729	0,030	0,721	0,897*	0,734	0,827	0,914*	0,956*
		P	0,357	0,163	0,962	0,170	0,039	0,158	0,084	0,030	0,011
	Brazilians	R	0,212	-0,385**	-0,089	0,049	0,267	0,181	-0,015	0,104	0,568**
		P	0,167	0,010	0,565	0,754	0,080	0,239	0,925	0,500	<0,001
	Ecuadorians	R	0,319	0,657	0,729	0,949**	0,446	0,818*	0,792	0,786	0,852*
		P	0,538	0,156	0,100	0,004	0,375	0,047	0,061	0,064	0,031
	Colombians	R	0,331**	-0,788**	0,173	-0,340**	-0,003	-0,380**	-0,300*	-0,252	0,033
		P	0,010	<0,001	0,187	0,008	0,985	0,003	0,020	0,052	0,801
	Argentinians	R	0,895**	0,666**	0,285	-0,070	-0,336	-0,313	0,642**	0,461*	0,989**
		P	<0,001	<0,001	0,141	0,724	0,081	0,105	<0,001	0,014	<0,001
	Chileans	R	0,210	-0,014	0,283*	0,168	0,290*	0,051	0,206	0,255	0,378**
		P	0,139	0,922	0,044	0,240	0,039	0,723	0,146	0,071	0,006
Height (m)	Venezuelans	R	-0,630**	-0,799**	-0,940**	-0,461*	-0,060	-0,839**	-0,848**	-0,860**	-0,535*
		P	0,002	<0,001	<0,001	0,035	0,796	<0,001	<0,001	<0,001	0,012
	Uruguayans	R	0,225	0,158	0,124	0,138	0,121	0,252	0,568	0,104	0,103
		P	0,176	0,230	0,512	0,210	0,743	0,537	0,102	0,349	0,423
	Brazilians	R	0,187	-0,040	-0,089	-0,077	0,220	0,053	0,003	0,087	0,609**
		P	0,225	0,797	0,567	0,620	0,151	0,732	0,983	0,572	<0,001
	Ecuadorians	R	0,439	0,121	0,213	0,137	0,162	0,302	0,619	0,217	0,364
		P	0,161	0,231	0,132	0,342	0,218	0,892	0,136	0,235	0,242

Spearman's Rho correlation

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4. Discussion

There are several factors affect the relationship between BMI and measured %fat. The polynomial regression analysis documented that the relationship between BMI and %fat was quadratic, not linear. This curvilinear trend was common to both the male and female data [18].

The study of body composition is important in those sports where body weight must be moved repeatedly against gravity. Body composition among soccer players is likely to change during the course of the competitive season as a result of training and competition, habitual activity, and diet. 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 having to set different objectives for players even if they belong to the same team. This approach reinforces the idea of personalising training and recommendations for each player in the professional elite. With respect to Colombian professional players who play in Europe, the average values obtained for weight were 76.04 kg, for height 1.79 m and 10.53% and 7.15% according to Faulkner and Carter respectively, very similar to the data obtained in the study by Kammerer Lopez in which they proposed a comparative study of different formulas for estimating the percentage of fat with absorptiometry in Colombian football players [19].

With respect to Chilean players, similar values are also obtained in the subjects studied with respect to other authors [20-22], The mean weight values were 74.18 kg, a height of 1.75 m and 11.84% and 8.36% according to Faulkner and Carter respectively.

The Argentinean players studied were the least heavy with a mean value of 63.31kg, they were also the least tall with a mean value of 1.66m, however they were not the ones with the lowest fat values (9.92% and 6.67 according to Faulkner and Carter respectively), although they were close to those with the lowest fat values, which were the Ecuadorians. In this case, we found different values to those obtained by Wittich et al. [23] or those found by Bua et al. [24], although these were carried out on amateur players.

Arana et al. [25] found a homogeneous distribution in their Venezuelan football players studied, with data similar to those found in the Venezuelan football players in this study. The same happened with the study of body composition in Brazilian football players by Gerota-Neto et al. [26] where the results of this study show that football players have specific morphological characteristics related to body composition compared to a control group, concluding that it is possible to conclude that the Brazilian professional football players studied by Gerota-neto et al. [26] showed significant differences in body composition compared to non-players. It is noteworthy that we have not found scientific studies that show body composition values of Uruguayan, Paraguayan and Ecuadorian football players, which shows the importance of carrying out a greater number of studies that describe the specific characteristics of players of different nationalities playing in the same professional team.

In the correlation study of weight, BMI and height with bodyfolds and the percentage of fat estimated through these folds, it is observed that Colombian and Venezuelan players are the only ones who inversely correlate weight with the percentage of fat, this correlation being positive for Argentinians, Chileans and Uruguayans, This would generate different ways of dealing with the optimisation of body composition from the perspective of fat percentage and weight, and it should be understood that Colombians and Venezuelans seem to have lower fat values when their weights are higher, unlike Argentinians, Chileans and Uruguayans, where the decrease in fat could be associated with a decrease in weight [27]; looking at height, it is again only Colombians and Venezuelans who have an inverse correlation with fat percentage. It has been established that, compared to Caucasians, there are differences in the body composition of people of African-American and Asian origin. Wagner and Heyward [28] conducted a review of investigations in which black and white racial groups were compared, with black males having greater body protein content and mineral mass than white males, leading to greater muscle mass and bone and muscle density, with a tendency towards the meso-morphic somatotype, However, these studies have not been conducted in other populations of

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different nationalities that may have different body composition characteristics (Caucasians, Amerindians, Asians, African-Americans, Polynesians) where there seem to be differentiating changes in fat percentage and BMI [17].

The results of the present study suggest that the long-term effects of elite football participation reduce endogenous differences in the fat-free compartment between ethnic groups; however, longitudinal studies would be needed to confirm this. While it is logical that an Asian player may be misclassified, given the tendency for higher body fatness 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 those used by other European players. Further research on the effects of ethnicity on body composition in elite professional athletes is warranted, 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 optimising 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 they reach international level.

Deurenberg [29] applied the meta-analysis equation developed in white subjects to group data from several different ethnic groups. They examined the variation across ethnic groups with the mean difference between measured and estimated % fat. The mean differences for the Chinese were small, 1 % fat, but the mean differences for the sample of Ethiopian men and women were large, 10.0 and 9.9 % fat. In contrast, the mean difference between black men and women was 1.9% fat. The meta-measurement underestimated the % fat of Thai and Indonesian men and women. These mean differences ranged from 5.9 to 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 [29] and associates to suggest the need to use population-specific cut-off points to define body composition.

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 personalised 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 nutritional health studies, so it is proposed to do so in future studies. Thirdly, given that the sample studied is exclusive of professional football, generalisability to other populations may be limited.

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 weight, height, 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 to other European or African-American football players. More studies should be done on the body composition of professional football players of different nationalities.

Author Contributions: JC-P, JAL, FO-S and MM-A designed the study and wrote the protocol; BR, NG-B and MM-A recruited the participants; JC-P, JAL and NG-B collected data; JC-P, FO-S and MM-A conducted the statistical analysis; JC-P, FO-S and MM-A wrote the first draft of the manuscript, and all authors commented on previous versions of the manuscript. All authors (JC-P, JAL, NG-B, FO-S, BR and MM-A) read and approved the final manuscript. All authors have read and agreed to the published version of the manuscript.

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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

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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 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 has been obtained from the patient(s) to publish this paper if applicable.

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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