applied sciences

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Optimizing Field Body Fat Percentage Assessment in Professional Soccer Players

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Abstract: Body composition is a determinant of performance in soccer. To estimate the body fat percentage (%BF), dual energy X-ray absorptiometry (DXA) is effective though this method is expensive and not readily accessible. This study examines the validity of widely used field methods based on anthropometric data and bioelectrical impedance analysis (BIA). Participants were 21 male Spanish First Division soccer players aged between 22 and 35 years. In each participant, body fat mass was determined by BIA and using 18 anthropometric equations including skinfold (SKF) measurements. DXA was used as reference. Correlation with DXA measurements was excellent for all equations and separate SKF measurements yet only moderate for BIA. However, only the equation recently developed for use in soccer players based on iliac crest and triceps SKFs showed no significant or standardized differences with DXA-derived %BF and these measurements also had the lowest bias. Our findings suggest that when DXA is not available, the best field method for %BF assessment in footballers is the equation based on iliac crest and triceps SKF. As another good option, we propose the sum of triceps, subscapular, supraspinal, and abdominal SKFs, as this combination also showed good correlation with DXA.

Keywords: football; fat mass; bioelectrical impedance; dual X-ray absorptiometry; skinfolds

Citation: Martinez-Ferran, M.; Rafei, E.; Romero-Morales, C.; Pérez-Ruiz, M.; Lam-Meléndez, A.; Munguia-Izquierdo, D.; Pareja-Galeano, H. Optimizing Field Body Fat Percentage Assessment in Professional Soccer Players. *Appl. Sci.* **2022**, *12*, 727. https://doi.org/10.3390/app12020727

Academic Editor: Redha Taiar

Received: 1 December 2021
Accepted: 5 January 2022
Published: 12 January 2022

1. Introduction

Soccer is a high intensity, intermittent team sport in which player body composition, especially in terms of fat and lean tissues, conditions fitness and performance [1–3]. Accordingly, in soccer players a high body fat percentage (%BF) has negative impacts on power-to-weight ratio, aerobic fitness, thermoregulation, acceleration capacity, and energy expenditure [3,4]. In contrast, skeletal muscle mass contributes to strength and power performance, and it is essential that this mass is maintained during injury or immobilization [3,4].

Methods used to assess body composition in soccer players need to be accurate, valid, and practically feasible to monitor meaningful changes [4]. Today, dual energy X-ray absorptiometry (DXA) is accepted as a reference method to assess body composition and a practical criterion method to assess fat mass in athletes [5]. However, DXA is not always accessible, it is expensive and its use requires a high level of expertise [4]. Moreover, DXA emits radiation, which although only scarce, will limit the frequency of measurements in soccer players, as in this sport, body composition needs be assessed at different time points during the season [4].

In professional players, body fat mass is commonly estimated through field methods such as bioelectrical impedance analysis (BIA) and anthropometric measures, especially skinfold (SKF) thickness measurements [5]. Anthropometry is a cost-effective, acceptable, and practical method to assess body composition when conducted by a trained anthropometrist following appropriate guidelines, such as the recommendations of the International Society for the Advancement of Kinanthropometry (ISAK). Several equations for predicting fat mass have been developed for both non-athletic and athletic populations [6] although there are large differences between them. Moreover, only three equations have been specifically designed for football players, and these have not been validated for use in other sports modalities [2,5,7]. Hence, rather than estimating %BF using equations, the nutrition expert group of the Union of European Football Associations (UEFA) recommends the use of absolute SKFs to measure changes in body composition [4]. Therefore, the sum of SKFs measurement could be another valid alternative as an indicator of adiposity in professional soccer players, being a direct method without the need to apply any of the many existing equations, and showing a large relationship with DXA-determined body fat [2]. However, specific equations for elite male soccer players, explaining >78% variance in DXA-derived %BF using only two site skinfolds have been developed, measurement that can be performed in only 2–3 min [5].

We need reference values for fat percentage values with harmonization of anthropometric methodology in homogeneous elite male soccer players to get representative samples of professional soccer players.

BIA has been widely used to estimate body composition. In football, this method is starting to gain popularity because of benefits such as its short measurement time, technical simplicity, and low cost [2,8–12]. However, its accuracy in determining %BF is limited [8] and its validity has not been proven against a reference method [9]. Additionally, for a proper evaluation, exercise should be avoided, which is an important limitation in athletes [8].

Many studies have used anthropometric equations to predict fat mass in professional soccer players [13–16]. However, in only a few are data compared with DXA measurements to determine which method is more effective [2,5–7] and no study has recruited high national level soccer players. Given the importance of accurate assessment of body composition in soccer players due its impact on performance [3,4] and reduce injuries [17] in soccer players and the extended use of field methods, this study was designed to determine which field method, anthropometric equations, BIA or absolute SKFs, are the most valid using DXA as the reference standard to measure %BF in elite soccer players.

2. Materials and Methods

2.1. Participants

Participants of this cross-sectional study were 21 male soccer players of a Spanish National First Division team; two of the players were goalkeepers. Data were collected during the competition season in November 2019. Over the study period, all participants were completing 4–5 training sessions and participating in one official football match per week.

Before the study outset, participants were informed of the study protocol, goal, and possible risks and gave their written informed consent. The study protocol was in line with the principles of the Declaration of Helsinki [18] and received institutional Ethics Committee approval.

2.2. Body Fat Mass Measurement

Standardized procedures of three different methods were used to estimate %BF: DXA, BIA, and anthropometry/SKF measurements. DXA was used as the reference, as is considered the practical criterion reference [5].

All participants were asked to keep a diary of daily food and water intake during the study. Determinations were made first thing in the morning, in fasted, well-hydrated, and rested state, with no intense physical activity for at least 12 h, as suggested by Slater et al. (2018) [19]. Participants were asked to remove all metal objects and wear minimal clothing. Measurements were taken in a well-ventilated examination room with controlled temperature and humidity.

2.2.1. Anthropometry

Body mass and height were measured barefoot and in underwear to the nearest 0.1 kg and 0.1 cm using a stadiometer Ano Sayol SL (Barcelona, Spain) and analogue scales (Asimed T2, Barcelona, Spain). Body mass index (BMI) was then calculated as weight (kg)/height (m^2). SKF thickness was measured with a SKF calliper at eight sites (triceps, biceps, subscapular, iliac crest, supraspinale, abdominal, anterior thigh, and medial calf). In each subject, double anthropometric measurements were obtained and the mean of the two measures was analyzed. When the technical error of measurement was more than 5% for SKF measurements, a third measurement was taken so that the median could be recorded. All anthropometric measurements were made by an accredited ISAK level 1 anthropometrist following standard methods [20].

Eighteen anthropometric equations were used to estimate %BF. Eleven of these equations were designed for populations of athletes [21–28], three of which for use in soccer players [2,5,7]. In addition, %BF was also assessed using seven anthropometric equations developed for healthy and normal weight non-athletic populations [29–35]. The different anthropometric equations used are provided in the Supplementary Materials. As some of these equations estimate only body density, fat percentage can then be calculated from density using Siri's formula [36].

In addition, we determined %BF according to the sums of SKF measurements made at: four body sites (triceps, abdominal, anterior thigh, and medial calf [7], (triceps, subscapular, biceps, and iliac crest [31]), and (triceps, subscapular, supraspinal and abdominal [25]); five body sites (biceps, subscapular, triceps, iliac crest, and anterior thigh [37]); six body sites (triceps, subscapular, supraspinal, abdominal, anterior thigh and medial calf [14]); and seven body sites (triceps, biceps, subscapular, supraspinale, abdominal, anterior thigh and medial calf [22]). We also estimated %BF using the sum of all eight SFK measurements (triceps, biceps, subscapular, iliac crest, supraspinale, abdominal, anterior thigh, and medial calf).

2.2.2. Bioelectric Impedance Analysis

To measure body mass and composition, BIA measurements were taken using a Tanita BC-545N device. Prior to the measurements, participants' palms and soles were wiped with an electrolyte tissue and they were then asked to stand on the Tanita scale, making sure their soles were in contact with the foot electrodes. Prior to measurements, data including sex, age, and height were entered into the device and participants were asked to place the thumb and fingers in the set location and grasp firmly. During %BF measurement, the subject remains motionless to avoid errors in the results. Measurements were repeated twice in each participant, and the means of the two measures entered in the analysis. If the first two measures were farther than 0.05% apart, a third measurement was taken and the median of the three measures was considered in the analysis.

2.2.3. Dual Energy X-ray Absorptiometry

Whole body %BF was measured with a DXA (Hologic QDR Discovery Wi, Bedford, MA, USA) (Plank, 2005) using Hologic APEX v. 4.0.2. software. The instrument was calibrated using a lumbar spine phantom as recommended by the manufacturer. The test was the "whole body" test in which participants were asked to maintain a supine position with slight abduction and external rotation of the hip on a stretcher for 8 min. A single trained DXA technician positioned the participants and performed the scans with the NHANES body composition correction function disabled [38].

2.2.4. Statistical Analysis

Descriptive statistics were calculated for each variable. Relative and absolute technical errors of the measurements were calculated [39]. The normality of the distribution of data was verified by the Kolmogorov–Smirnov and Shapiro–Wilk tests. Variables showing skewed distributions were log-transformed to obtain a normal distribution. To compare %BF between DXA, BIA, SKF-based anthropometry equations and absolute SKFs, the paired *t*-test, Pearson correlation (±90% CI), bias, limits of agreement, standardized differences (±90% CI), and qualitative differences were used. Correlation coefficients were qualitatively ranked by magnitude as trivial, $r < 0.1$; small, $0.1 < r < 0.3$; moderate, $0.3 < r < 0.5$; large, $0.5 < r < 0.7$; very large, $0.7 < r < 0.9$; almost perfect, $0.9 < r < 1.0$; and perfect $r = 1.0$ [40].

The effect size of the standardized differences in %BF was determined by Cohen's d statistic, and Hopkin's scale was used to determine the magnitude of the effect size, where 0–0.2 = trivial, 0.2–0.6 = small, 0.6–1.2 = moderate, 1.2–2.0 = large, and >2.0 = very large [40]. A practically worthwhile difference was assumed when the difference score was at least 0.2 of the between-subject SD. The probability of a true difference between methods was qualitatively classified as almost certainly not, <0.5%; very unlikely, 0.5–5%; unlikely, 5–25%; possibly, 25–75%; likely, 75–95%; very likely, 95–99.5%; and almost certainly, >99.5%. Substantial effect was defined as >75% [41].

All statistical tests were carried out using Statistical Package for the Social Sciences version 23 (IBM, Chicago, IL, USA) and Microsoft Excel software (Microsoft, Redmond, WA, USA). Significance was set at $p < 0.05$.

3. Results

The characteristics of the participants and descriptive values of %BF estimated from DXA, BIA, SKF-based equations and absolute SKFs are shown in Table 1. Taking DXA as reference, all equations, SKFs and BIA measurements underestimated %BF. For all SKFs, the technical errors of measurements were lower than 3.60%.

Table 1. Subject characteristics and body fat percentages estimated using the methods DXA, BIA, anthropometric equations and absolute SKFs in elite soccer players ($n = 21$).

	Mean	SD	Minimum	Maximum
Age (years)	26.3	3.7	22.2	35.5
Weight (kg)	77.4	6.1	64.9	89.2
Height (cm)	181.2	6.7	169.0	193.0
BMI (kg/m^2)	23.6	1.2	21.0	25.6
SKF (mm):				
Triceps	5.7	1.9	3.0	10.50
Subscapular	8.1	2.0	6.0	15.0
Biceps	2.5	0.8	1.5	4.5
Iliac crest	9.6	2.8	6.5	17.0
Supraspinale	5.2	1.7	3.5	9.0
Abdominal	11.5	5.0	5.5	26.5
Calf	7.7	3.0	5.0	16.5
Thigh	3.9	1.1	2.0	6.5
DXA (%BF)	15.3	2.0	11.9	18.9
BIA (%BF)	13.0	2.5	7.6	17.5
EQUATIONS (%BF)				
Carter (1982)	7.0	1.3	5.4	10.5
Civar et al. (2006)	10.6	2.1	8.1	15.6

Table 1. *Cont.*

	Mean	SD	Minimum	Maximum
Evans et al. (2005)	8.8	2.3	6.2	14.3
Faulkner (1966)	10.4	1.4	8.7	13.8
Forsyth and Sinning (1973)	10.6	3.6	5.8	19.6
Munguia-Izquierdo et al. (2018)	9.2	1.7	7.3	13.4
Stewart and James Hannan (2000)	7.8	3.2	3.7	16.4
Suarez-Arrones et al. (2018)	15.0	2.0	12.7	19.9
White et al. (1980)	7.2	1.6	5.5	11.4
Withers et al. (1987)	7.9	2.3	5.1	14.0
Eston et al. (2005)	8.9	2.1	6.5	15.0
Durnin and Rahaman (1967)	11.6	2.6	7.9	17.8
Durnin and Womersley (1974)	11.4	2.7	7.7	16.8
Lean et al. (1996)	10.7	2.7	6.4	16.3
Lohman (1981)	11.9	4.4	6.8	22.7
Peterson et al. (2003)	14.5	2.4	11.4	19.6
Wilmore and Behnke (1969)	11.7	2.3	8.9	18.5

BIA (bioelectric impedance analysis), BMI (body mass index), DXA (dual-energy X-ray absorptiometry).

Correlations, biases, limits of agreement and systematic, standardized, and qualitative differences between DXA %BF and other estimates of %BF for elite male soccer players are shown in Table 2. All equation-derived estimates correlated very well with the DXA results (r = 0.72 to 0.84; all $p < 0.05$). However, BIA %BF data showed only moderate positive correlation (r = 0.42; $p < 0.05$). Further, only the equation of Suarez-Arrones et al. (2018), which showed no significant or standardized differences in relation to DXA, did not display practically worthwhile differences or substantial differences with the other methods and had the lowest bias. The rest of the equations and BIA data showed high biases.

Table 2. Cross-sectional validity of body fat percentage measurements made by BIA and anthropometric equations using DXA as reference in elite male soccer players ($n = 21$).

	Correlation (90% CI)	Bias (±LoA)	Standardized Differences (90% CL)	Qualitative Assessment	
BIA	0.42 (0.05–0.68)	−2.30 * (±4.91)	−1.09 (0.45)	Almost certainly	0/0/100
Equations: Carter (1982)	0.78 (0.58–0.89)	−8.30 * (±2.53)	−5.65 (0.30)	Almost certainly	0/0/100
Civar et al. (2006)	0.72 (0.47–0.86)	−4.68 * (±3.02)	−2.68 (0.35)	Almost certainly	0/0/100
Evans et al. (2005)	0.79 (0.59–0.90)	−6.51 * (±2.81)	−4.11 (0.42)	Almost certainly	0/0/100
Faulkner (1966)	0.79 (0.59–0.90)	−4.87 * (±2.45)	−2.74 (0.23)	Almost certainly	0/0/100
Forsyth and Sinning (1973)	0.73 (0.49–0.86)	−4.73 * (±4.92)	−2.93 (0.62)	Almost certainly	0/0/100
Munguia-Izquierdo et al. (2018)	0.82 (0.64–0.91)	−6.15 * (±2.28)	−3.72 (0.27)	Almost certainly	0/0/100
Suarez-Arrones et al. (2018)	0.79 (0.60–0.90)	−0.30 (±2.56)	−0.14 (0.23)	Possibly	1/67/32
Stewart and James Hannan (2000)	0.73 (0.50–0.87)	−7.52 * (±4.36)	−5.30 (0.81)	Almost certainly	0/0/100
Reilly et al. (2009)	0.78 (0.58–0.89)	−5.86 * (±2.46)	−3.47 (0.25)	Almost certainly	0/0/100
White et al. (1980)	0.80 (0.61–0.90)	−8.13 * (±2.46)	−5.52 (0.35)	Almost certainly	0/0/100
Withers et al. (1987)	0.78 (0.58–0.89)	−7.38 * (±2.88)	−4.89 (0.48)	Almost certainly	0/0/100
Eston et al. (2005)	0.75 (0.53–0.88)	−6.41 * (±2.80)	−3.98 (0.37)	Almost certainly	0/0/100
Durnin and Rahaman (1967)	0.84 (0.67–0.92)	−3.75 * (±2.76)	−2.10 (0.33)	Almost certainly	0/0/100
Durnin and Womersley (1974)	0.74 (0.51–0.87)	−3.92 * (±3.52)	−1.86 (0.32)	Almost certainly	0/0/100
Lean et al. (1996)	0.81 (0.62–0.91)	−4.65 * (±3.06)	−2.74 (0.43)	Almost certainly	0/0/100
Lohman (1981)	0.78 (0.58–0.89)	−3.42 * (±6.14)	−2.15 (0.65)	Almost certainly	0/0/100
Peterson et al. (2003)	0.80 (0.61–0.90)	−0.81 * (±2.83)	−0.38 (0.26)	Likely	0/11/88
Wilmore and Behnke (1969)	0.75 (0.52–0.87)	−3.60 * (±3.17)	−1.98 (0.34)	Almost certainly	0/0/100

BIA (bioelectric impedance analysis). Significant differences between DXA percentage fat mass and other practical estimates of percentage fat mass using paired *t* test *.

All SKF measurements except for subscapular SKF showed significant good to very good positive correlations with DXA-derived %BF (r = 0.50 to 0.81; all $p < 0.05$) (Table 3). All sums of SKFs showed significant large positive correlation with DXA-derived %BF (r = 0.78 to 0.82; all $p < 0.001$) (Table 3).

Table 3. Relationship between DXA-derived % body fat values and those derived from different skinfold measurements or the sum of several skinfold measurements in elite male soccer players (*n* = 21).

Skinfold	Correlation	Significance (*p*)
Triceps (T)	0.81	<0.001
Subscapular (Sb)	0.42	0.061
Biceps (B)	0.51	0.017
Iliac crest (IC)	0.75	<0.001
Supraspinale (Sp)	0.76	<0.001
Abdominal (Ab)	0.74	<0.001
Thigh (Th)	0.69	0.001
Calf (Ca)	0.50	0.022
Sum of 4 (T, Ab, Th, Ca)	0.78	<0.001
Sum of 4 (T, Sb, B, IC)	0.80	<0.001
Sum of 4 (T, Sb, Sp, Ab)	0.82	<0.001
Sum of 5 (T, Sb, B, IC, Th)	0.81	<0.001
Sum of 6 (Sb, T, Sp, Ab, Th, Ca)	0.79	<0.001
Sum of 7 (B, Sb, T, Sp, Ab, Th, Ca)	0.78	<0.001
Sum of 8 (B, Sb, T, IC, Sp, Ab, Th, Ca)	0.81	<0.001

4. Discussion

This study sought to identify, using DXA as reference, which field method out of those based on anthropometric equations, absolute SKFs, and BIA was the most valid to predict %BF in elite soccer players. Our main findings were that (1) while all the anthropometric equations but one showed high correlation with DXA, only the equation developed by Suarez-Arrones et al. (2018), did not show significant differences against DXA; (2) several sets of SKF measurements showed high correlation with DXA, especially the sum of four measurements (triceps, subscapular, supraspinale, and abdominal); and (3) compared to the anthropometry-derived data, BIA results correlated less with DXA measurements and significant differences in %BF were produced between BIA and DXA.

Our data indicate significant standardized differences in fat mass prediction depending on the method used. DXA-derived body fat percentages were similar to values reported in recent studies conducted in international-level elite male soccer players from the Italian Serie A league [5] and the Australian A-league competition [1]. However, our DXA-derived values were higher than those described in Italian Series A league [3] and English Premier league [42,43] players. These differences between studies could be attributed to possible differences in the training history of players [43], or the league stage [3], or perhaps even the different DXA model used and its software. All SKF-based anthropometry equations used in this study showed excellent correlation with DXA, yet variations in bias and agreement levels determine that these methods are not interchangeable. Moreover, we should be cautious when using them for fat mass evaluation in professional soccer players. Similar findings were found in international [5] and youth [2] male soccer players. There seems to be no agreement as to which SKF equations correlate best with DXA in the few studies that have compared these methods to predict fat mass in professional soccer players [5–7].

Two equations have been developed to assess %BF specifically in professional soccer players [5,7]. The equation by Reilly et al. (2009), showed significant differences with DXA-derived %BF in our study, in line with the results of López-Taylor et al. (2018) and Suarez-Arrones et al. (2018). In contrast, the equation of Suarez-Arrones et al. (2018), showed good agreement with our DXA results, consistent with higher correlation with DXA reported than the equation of Reilly et al. (2009). The equation by Suarez-Arrones et al. (2018), thus seems an effective way to estimate %BF based on two SKF measurements. However, this good performance needs to be confirmed in elite soccer players.

The sum of several SKF measurements at different body sites showed high correlation with DXA, in agreement with the findings of three studies that used this method to calculate body fat in elite soccer players [2,5,36]. We found that the sum of triceps, subscapular, supraspinale, and abdominal SKF showed best correlation with DXA-derived %BF. Similar correlation was reported by Munguia-Izquierdo et al. (2018), for the sum of these four SKF measurements. According to Reilly et al. (2009), a different set of four SKF measurements (anterior thigh, abdominal, triceps and calf), shows even better agreement with DXA. However, this new equation was found here to correlate less well with DXA as well as in the studies of Suarez-Arrones et al. (2018) and Munguia-Izquierdo et al. (2018). Hence, the sum of several SKF measurements could be a good option to estimate %BF in soccer players, as it was suggested by the UEFA's expert nutrition group [4]. We recommend the sum of triceps, subscapular, supraspinale, and abdominal SKFs, as the use of more did not offer any additional benefit and could weaken correlation with DXA as shown by our results and those of Munguia-Izquierdo et al. (2018) and Suarez-Arrones et al. (2018).

BIA is a widely used method to assess body composition but it is of limited accuracy for estimating body fat [8]. Although BIA has been validated in clinical practice [44], few studies in athletes have compared BIA with a reference method such as DXA [9]. In our study, BIA was found to show the lowest correlation with DXA and also it significantly underestimated %BF in comparison with this reference method. Skinfold measurements were better predictors of DXA-derived fat mass than BIA in our study population, which is consistent with the findings of others in male elite soccer players [2,5]. Consequently, BIA does not seem valid for assessing %BF in soccer players, as its measurements vary significantly from those provided by the reference method. Moreover, it correlated poorly with anthropometry equations or absolute SKF measurements.

One of the main limitations of body composition assessment has been the use of numerous types of devices and brands [9]. Here, we used three methods to estimate %BF and the anthropometric procedure was performed following ISAK guidelines [20] by an accredited level I anthropometrist. In similar studies, the same three methods were used, and the same guidelines were followed for anthropometry. However, in each study different instruments and equations were used. Thus, it is difficult to compare the results of the studies that have examined this issue limiting the identification of the best anthropometry equation to analyze %BF in elite soccer players. The use of DXA as a reference method has been also considered a limitation [2], as it has shown moderate accuracy and precision for %BF in highly trained team sports players [44]. Another limitation of our study was the small sample size. As a strength, participants were a homogeneous group of elite soccer players from a professional Spanish club competing at the highest national level (i.e., La Liga) who had the same level of training and similar diet. However, the individual amount and type of training performed by players was not recorded. Additionally, this study used a cross-sectional design which does not allow to determine the most effective field methods for measuring changes in %BF with confidence [2]. Therefore, further longitudinal studies are needed to accurately measure %BF over time in elite soccer player. Additionally, further studies involving female soccer players and players of different levels of competition are needed.

DXA is a widely accepted reference method for assessing fat mass in athletes. However, the equipment is costly, and it is not usually accessible to most sport clubs. Thus, field methods such as anthropometry and BIA are used to evaluate body composition in athletes. Of these methods, anthropometry seems a better option, and while it is a low-cost and practical method, it should be performed by an accredited anthropometrist and following ISAK guidelines. Moreover, the best anthropometry equation to estimate %BF needs to be selected as there are several options and they do not seem interchangeable with each other or with the reference method. For soccer players, there is no consensus regarding the most accurate equation. Our data suggest the equation developed by Suarez-Arrones et al. (2018), for soccer players is a good candidate. This formula requires only two SKF measurements, reducing the testing time which is crucial when many players have to be repeatedly tested over a season. A good alternative that showed high correlation with DXA in our soccer players is the sum of four SKF determinations (triceps, subscapular, supraespinale, and abdomen). This method avoids the problems faced with anthropometric equations and is also a quick method. This study sought to identify, using DXA as reference, which field method out of those based on anthropometric equations, absolute SKFs, and BIA was the most valid to predict %BF in elite soccer players. Our main findings were that (1) of all the anthropometric equations one showed high correlation with DXA, only the equation developed by Suarez-Arrones et al. (2018), did not show significant differences against DXA; (2) several sets of SKF measurements showed high correlation with DXA, especially the sum of four measurements (triceps, subscapular, supraspinale, and abdominal); and (3) compared to the anthropometry-derived data, BIA results correlated less with DXA measurements and significant differences in %BF were produced between BIA and DXA.

5. Conclusions

The use of BIA to estimate %BF in professional soccer players does not seem sufficiently accurate. Anthropometry is an accepted method provided it is performed by a trained anthropometrist and guidelines are followed. However, most equations do not provide an accurate estimation of %BF, except that designed for use in professional soccer players by Suarez-Arrones et al. (2018). We would recommend this equation when DXA is not available. Otherwise, the sum of four SKF determinations (triceps, subscapular, supraspinale, and abdominal) could be a good alternative.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/app12020727/s1. Table S1: Anthropometric equations developed to estimate body fat percentage in athletes and the general population.

Author Contributions: Conceptualization, M.M.-F. and H.P.-G.; methodology, M.M.-F., H.P.-G., M.P.-R. and A.L.-M.; software, D.M.-I. and C.R.-M.; validation, M.M.-F., D.M.-I. and H.P.-G.; formal analysis, D.M.-I. and C.R.-M.; investigation, M.M.-F., D.M.-I. and E.R.; resources, M.P.-R., D.M.-I. and C.R.-M.; data curation, D.M.-I.; writing—original draft preparation, E.R. and M.M.-F.; writing—review and editing, M.M.-F., H.P.-G. and D.M.-I.; visualization, M.M.-F., H.P.-G. and D.M.-I.; supervision, H.P.-G.; project administration, H.P.-G. All authors have read and agreed to the published version of the manuscript.

Funding: No sources of funding were used to assist in the preparation of this article.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Clinical Research Ethics Committee of the Community of Madrid (AGL2016-77288-R).

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

Data Availability Statement: The data presented in this study are available on reasonable request from the corresponding author.

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

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