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Anthropometric and Biochemical Analysis and Dietary Habits in Elite Spanish Female Football Players

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Abstract: There is a recent growth and development with regard to the female athlete. This trend has been reflected in a greater concern for aspects such as nutrition, body composition and the health of female athletes, given the repercussion of these factors on their sporting performance. The aim was to carry out an anthropometric and nutritional assessment of elite Spanish female football athletes based on different biochemical parameters. Ethical consent was obtained from a total of 21 players from a Spanish elite women's football team(20-33years). Anthropometric analysis was carried out using the International Society for the Advancement of Kineanthropometry(ISAK). Clinical analyses were performed by the club's medical staff at the beginning of the season through serum and fasting urine samples taken by the players. The athletes presented fat% of 19.1(SD±2.89). 100% of the players had Mg values within the reference values. Values below reference values were observed for Hb (85.7%), vit.D (33.3%), ferritin (23.8%), serum iron (28.6%), transferrin (4.8%) and TSI (42.9%); and above for CK (42.9%), basal cortisol (38.1%), testosterone (19%) and creatinine, total cholesterol, iron, transferrin, TSI and serotonin (4.8%). Differences in Mg levels were only observed between playing positions ($p<0.05$). There were associations between age and vit.D levels ($r=0.607$), and weight with vit.D levels (-0.464) and blood cholesterol (-0.487) among others. Given the nutritional knowledge of Spanish elite female football players, as well as the prevalence of deficiencies in iron metabolism parameters and vit.D levels in athletes, the need to implement a correct nutritional assessment and education in this type of athletes is highlighted

Keywords: body composition; female athletes; football; biochemical analysis; nutrition; diet

1. Introduction

Nowadays, at an international level, the figure of the female sportswoman and especially the female football is gaining more and more strength, which is reflected in the increase in the number of scientific references available related to the sport of football and the female population (Table 1). This aspect highlights the increasing strength and intensity of the improvement of important aspects for performance and the prevention of illnesses, injuries or health problems in this sports population [1–6].

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Table 1. Results in the PubMed search engine from 2000 to 2023 when entering the terms "football" AND "sport woman".

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2	1	1	6	4	9	5	18	13	12	12	27
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
27	31	32	42	43	51	62	72	160	180	168	148

All these studies and advances bring with them a series of changes such as various improvements in discipline, training and material provided to the players; improvements in the technification of training, in readaptation and in the individualisation of this, as well as in the body composition of the players, to help provide useful data and values in the evaluation process of the sportswoman.

The nutritional section is an aspect that is not far from this trend, showing a similar tendency in the field of nutrition, hormonal health and the athlete's menstrual cycle, among others [7–11]. This is also associated with the anthropometric study of the athlete due to its link with the athlete's training and nutritional status [12,13], as well as the need for optimal body composition in sports performance [11,14,15].

Nowadays, sports practice is being pushed to limits that were unthinkable 40 years ago. This is why more and more professionals (nutritionists, rehabilitation specialists, physiotherapists, doctors, etc.) are involved in increasing, renewing, enriching and developing new techniques in sporting disciplines. Improved nutrition and timing can make one athlete stand out from another. Optimal performance is the main goal for the player and the coaching staff, so attention must be paid to the smallest detail. Many of the players in the top leagues have little knowledge of the amount of macronutrients they need for optimal performance, as well as energy-deficient diets [16–19]. This could cause health problems such as low levels of vitamin D, Ca, altered iron metabolism indicators, or altered disposition of hormones such as cortisol and testosterone [20,21]. Therefore, good nutrition and body composition could produce an increase in performance and decrease fatigue after the accumulation of loads and training. This will be effective if the necessary amount of nutrients is ingested with an organisation of intakes and the timing of intakes according to their needs with the possible use of nutritional supplements [22–24].

Therefore, the aim of this study is to carry out an anthropometric and nutritional assessment of elite Spanish women's football athletes based on different biochemical parameters.

2. Materials and Methods

2.1. Participants

Ethics statement: This study has been approved by the Ethics Committee of the Universitat Oberta de Catalunya (UOC) and the Ethics Committee of the Research Project of the University of Murcia (nº OTRI-1117), and strictly complies with data protection regulations and the Helsinki protocol. The reporting of this study complies with the STROBE statement.

Data were collected from August to December 2023 in a Spanish First Division women's Football Team.

The sample consisted of 23 female players in the First Team squad aged 20-35 years. Informed consents were collected from the athletes before the start of the study. Those participants who did not want to fill it in were excluded from the study (n=2), so the total sample was reduced to 21 players.

2.2. Design and Procedure

Anthropometric information (weight, 6- and 8-skinfolds sum, height) was obtained using the standardised norms of the International Society for the Advancement of Kineanthropometry (ISAK) [13]. Weight was measured with Tanita (BC-545N), height was obtained with a portable detachable stadiometer (SECA 20-205cm), skinfolds (triceps, subscapular, biceps, iliac crest, supraspinal, abdominal, thigh and leg) were obtained with a Cesfort millimetre tape measure and skinfolds with a 0.2 mm Holtain plicometer. The anthropometrists who took the measurements and made the notes were Isak level 2. These anthropometric assessments were carried out during the start of the season before training (14:30 - 15:00h), where the players come in non-fasting conditions. Body fat percentages were estimated using the Carter and Faulkner equation to obtain the fat percentage. Body Mass Index (BMI) was determined by dividing the body mass in kilograms by the square of the height expressed in metres.

The clinical analyses were carried out by the club's medical service at the beginning of the season in August. This procedure was performed on the players at 8:00 a.m. with a fasting state on their part. The biochemical evaluation was carried out by blood and urine samples, the blood sample was obtained from the median ulnar and cephalic veins (upper forearm). Included were haemacytometry, serum biochemistry (vitamin D (ng/mL), B-complex vitamins (B1 (ug/dL), B6 (nmol/L, B12 (pg/mL)), CK (IU/L), magnesium (mg/dL)), iron metabolism, lipids, hormones (cortisol (µg/dL), testosterone (ng/dL), serotonin (ng/mL)), qualitative analysis...etc. Additional values such as haemoglobin (g/dL), creatinine (mg/dL), CK, Mg, Vitamin D, total cholesterol (mg/dL), ferritin (ng/mL), iron (µg/dL), transferrin (mg/dL), TSI (saturation index), basal cortisol, testosterone, free testosterone (pg/dL) and serotonin were obtained and selected for each player.

Participants were subjected to a closed-response questionnaire asking about their eating habits, their perception of healthy eating and sports nutrition. Also included were questions about regularity of menstruation, drug intake, labelling, perception of body composition and feelings of recovery. Questions encompassed post and pre-game nutrition, timing, supplementation and hydration.

2.3. Statistical Analysis

Statistical analysis was carried out using SPSS v.25 statistical software. Normality and homoscedasticity of variables were analysed using the Shapiro-Wilk and Levene tests respectively. Means, maximums, minimums, standard deviations (SD), frequencies and percentages (%) were used for the basic description. For the calculation of the correlation coefficient (r) between the different non-parametric variables, Spearman's correlation coefficient (r) was used. For the comparisons of means of the different independent variables with the playing positions of the players, the non-parametric Kruskal-Wallis H-test for more than two groups was used; as a post-hoc statistical test, the Mann-Whitney U-test was used, adjusting the significance values by Bonferroni correction for different tests. The level of statistical significance for all tests was set at 95%.

3. Results

Table 2 shows the age and body composition characteristics of the 21 athletes finally included in the study.

Table 2. Descriptive statistics of the population. Age and body composition of the players.

	N	Minimum	Maximum	Mean	SD*
Age (yrs)	21	20,00	33,00	24,38	3,41
Weight (kg)	21	53,70	80,60	63,09	7,95
BMI (kg/m^2)	21	18,98	25,63	22,27	1,62
Σ6 (mm)	21	59,60	144,80	85,48	20,78
Σ8 (mm)	21	72,80	155,80	109,29	23,49
Fat Faulkner (%)	21	14,50	25,15	19,09	2,86
Fat Carter (%)	21	12,87	26,14	16,89	3,23

*SD: Standard Deviation.

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Table 3 summarises the age and body composition characteristics of the players distinguishing by playing position. Despite the different physical demands of the different playing positions in the sport of football, no significant differences were observed in any of the anthropometric characteristics and the age of the players according to their playing position.

Table 4 shows a summary of the biochemical parameters obtained from the total sample and their adjustment to the reference values.

Table 5 lists the biochemical variables in the different playing positions. Only differences in blood magnesium levels were observed between the different playing positions. In the post-hoc analysis, these differences in magnesium levels were observed between wing-back and winger (p=0.027), centre-back and goalkeeper (p=0.023), goalkeeper and winger (p=0.024), striker and centre-back (p=0.019), striker and winger (p=0.022), and wing-back and centre-back (p=0.032).

Table 6 shows the bivariate correlations between age, body composition and anthropometric measures and serum variables of the athletes. The highest correlation was observed between plasma iron levels and I.S.T levels (r=0.956), and transferrin and serum ferritin levels (r=-0.764). Strong correlations were observed between the age of the player and her vitamin D levels (r=0.607). And serum transferrin levels and I.S.T. values (-0.544).

Correlations were also observed between player's weight and her fat percentage (Faulkner) (0.435); player's weight and her serum vitamin D levels (ng/mL) (-0.464); player's weight and blood cholesterol levels (mg/dL) (-0.487); plasma iron levels with Hb values (0.462); and transferrin levels with serum iron values ($p<0.05$) (-0.441).

In relation to the eating habits of the female athletes close to training, 76% of the players drank between 500-1000 L of liquid after training until they went to bed, although all the athletes considered it important to replenish their fluids after training. Only 42.9% prioritised carbohydrate-rich foods before sports practice. 85.7% of them had their post-training meal between 1-2 h after training, where 61.9% prioritised foods rich in protein, while 23.8% prioritised foods rich in carbohydrates and proteins in these post-training intakes. Finally, 19% reported both difficulty in recovering after sport and irregular menstrual cycles.

Table 3. Anthropometric characteristics and differences by playing position.

	Position																								
	Goalkeeper				**Centre-back**				**Wing-back**				**Midfielder**				**Winger**				**Striker**				
	Mean	**Minimum**	**Maximum**	**SD***	**Mean**	**Minimum**	**Maximum**	**SD***	**Mean**	**Minimum**	**Maximum**	**SD***	**Mean**	**Minimum**	**Maximum**	**SD***	**Mean**	**Minimum**	**Maximum**	**SD***	**Mean**	**Minimum**	**Maximum**	**SD***	**P****
Age	25	21	28	5	26	24	29	3	23	21	25	2	23	20	30	3	24	23	25	1	28	25	33	4	0,273
Weight (kg)	69,80	62,00	77,60	11,03	68,70	67,20	70,30	1,55	60,43	56,30	62,90	3,60	59,43	53,70	74,50	7,24	70,70	60,80	80,60	14,00	60,37	54,20	68,00	7,02	0,202
Height (m)	1,69	1,63	1,74	0,08	1,72	1,68	1,75	0,04	1,66	1,64	1,70	0,03	1,66	1,55	1,81	0,08	1,73	1,66	1,79	0,09	1,69	1,64	1,74	0,05	0,488
BMI (kg/m^2)	24,48	23,34	25,63	1,62	23,25	22,40	24,91	1,43	21,94	20,93	23,39	1,29	21,60	20,21	22,81	0,98	23,61	22,06	25,16	2,19	21,11	18,98	22,46	1,87	0,174
Σ6 (mm)	114,50	112,00	117,00	3,54	77,77	64,20	84,60	11,75	78,67	59,60	96,60	18,53	90,73	66,00	144,80	25,57	71,65	69,80	73,50	2,62	75,93	65,00	85,00	10,13	0,265
Σ8 (mm)	148,49	141,18	155,80	10,34	102,33	81,20	114,20	18,35	101,57	72,80	129,30	28,26	113,28	83,50	148,50	22,54	97,80	91,60	104,00	8,77	94,93	76,80	112,00	17,62	0,281
% Fat Faulkner	23,86	22,58	25,15	1,82	18,45	16,36	20,55	2,10	17,83	14,50	21,30	3,40	19,74	16,48	23,66	2,59	18,31	17,04	19,57	1,79	16,63	14,89	17,91	1,57	0,194
% Fat Carter	21,42	21,03	21,81	0,55	15,70	13,58	16,76	1,83	15,84	12,87	18,63	2,89	17,72	13,86	26,14	3,98	14,74	14,46	15,03	0,41	15,41	13,71	16,82	1,58	0,265

*SD: Standard Deviation **ANOVA.

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Table 4. Biochemical variables total.

	Minimum	Maximum	Mean	SD*	Below the reference values (%)	Within of the reference values (%)	Above the reference values (%)
Haemoglobin (14,0-17,5 g/dL)	11,80	14,50	13,22	0,67	85,70	14,30	0,00
Creatinine (0,70-1,20 mg/dL)	0,61	11,18	1,38	2,24	4,80	90,50	4,80
CK (0,0-190,0 UI/L)	67,60	307,00	175,10	60,48	0,00	57,10	42,90
Mg (1,60-2,55 mg/dL)	1,83	2,30	2,07	0,10	0,00	100,00	0,00
Vitamin D (ng/mL)	18,70	63,80	34,61	10,23	33,30	66,70	0,00
Total Cholesterol (0-200 mg/dL)	114,00	204,00	154,95	22,81	0,00	95,20	4,80
Ferritin (30,0-400,0 ng/mL)	12,40	181,00	69,40	46,01	23,80	76,20	0,00
Serum iron (59-158 µg/dL)	32,00	168,00	82,09	37,54	28,60	66,70	4,80
Transferrin (200.0-360 mg/dL)	195,00	361,00	252,71	42,42	4,80	90,50	4,80
I.S.T (20,00-50,00 %)	7,90	51,36	23,22	11,85	42,90	52,40	4,80
Basal Cortisol (6,20-19,40 µg/dL)	14,20	22,80	18,22	2,51	0,00	61,90	38,10
Testosterone (330.00 -805.00 ng/dL)	10,40	71,41	38,58	13,93	0,00	81,00	19,00
Free Testosterone* (pg/dL)	0,70	2,50	1,37	0,48	0,00	100,00	0,00
Serotonin (20 - 206 ng/mL)	58,00	241,00	124,76	43,32	0,00	95,20	4,80

*SD: Standard Deviation.

Table 5. Biochemical variables by playing position.

	Position						
	Goalkeeper (n=2) Mean(SD) Adequacy (n)	**Centreback (n=3) Mean(SD) Adequacy (n)**	**Wingback (n=3) Mean(SD) Adequacy (n)**	**Midfielder (n=8) Mean(SD) Adequacy (n)**	**Winger (n=2) Mean(SD) Adequacy (n)**	**Striker (n=3) Mean(SD) Adequacy (n)**	**P***
Haemoglobin (14,0-17,5 g/dL)	13,95(0,49) (1)	13,77(0,64) (1)	13,03(0,31) (0)	13,05(0,80) (1)	13,20(0,85) (0)	12,90(0,26) (0)	0,241
Creatinine (0,70-1,20 mg/dL)	0,85(0,12) (2)	0,91(0,13) (3)	0,87(0,11) (3)	0,83(0,13) (7)	6,18(7,07) (1)	1,03(0,08) (3)	0,078
CK (0,0-190,0 UI/L)	160,00(2,83) (2)	137,20(66,05) (2)	151,57(74,04) (2)	175,13(44,53) (4)	298,50(12,02) (0)	164,33(33,32) (2)	0,255
Mg (1,60-2,55 mg/dL)	1,94(0,16) (2)	2,15(0,02) (3)	2,00(0,09) (3)	2,11(0,09) (8)	2,16(0,01) (2)	2,01(0,06) (3)	0,029
Vitamin D (ng/mL)	35,75(15,49) (1)	30,23(5,17) (1)	32,23(7,70) (2)	33,68(8,67) (6)	31,05(11,95) (1)	45,53(16,56) (3)	0,764
Total Cholesterol (0-200 mg/dL)	146,00(35,36) (2)	142,67(24,83) (3)	148,33(31,88) (3)	159,00(11,16) (8)	140,00(29,70) (2)	179,00(23,26) (2)	0,390
Ferritin (30,0-400,0 ng/mL)	129,55(72,76) (2)	64,07(51,76) (2)	89,13(16,92) (3)	60,95(50,22) (5)	53,55(12,09) (2)	48,03(34,58) (2)	0,559
Serum iron (59-158 µg/dL)	77,00(19,80) (2)	97,67(42,83) (3)	127,33(54,81) (2)	67,38(26,47) (4)	66,50(33,23) (1)	74,33(37,42) (2)	0,608
Transferrin (200.0-360 mg/dL)	210,50(3,54) (2)	254,00(34,22) (3)	241,00(7,94) (3)	264,25(61,12) (6)	271,50(33,23) (2)	248,00(14,93) (3)	0,439
I.S.T (20,00-50,00 %)	20,94(0,04) (2)	24,91(10,14) (2)	37,65(16,87) (1)	20,07(11,41) (3)	16,91(6,55) (1)	21,30(11,55) (2)	0,545
Basal Cortisol (6,20-19,40 µg/dL)	18,50(6,08) (1)	20,13(0,25) (0)	17,63(2,81) (2)	17,71(1,72) (7)	16,65(0,35) (2)	19,13(3,94) (1)	0,438
Testosterone (330.00 - 805.00 ng/dL)	34,38(15,74) (2)	40,28(11,27) (3)	40,98(9,30) (2)	38,79(16,12) (6)	46,22(19,74) (1)	31,68(18,44) (3)	0,915
Free Testosterone* (pg/dL)	1,40(0,57) (2)	1,47(0,45) (3)	1,37(0,38) (3)	1,35(0,56) (8)	1,50(0,99) (2)	1,23(0,46) (3)	0,988
Serotonin (20 - 206 ng/mL)	92,50(48,79) (2)	99,33(44,06) (3)	136,00(37,47) (3)	125,50(31,93) (8)	182,00(83,44) (1)	120,33(40,92) (3)	0,558

*ANOVA.

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Table 6. Correlation between age, body composition and biochemical variables.

		Age	Haemoglobin	CK	Mg	Vitamin D	Total Cholesterol	Ferritin	Serum iron	Transferrin	I.S.T	Basal Cortisol	Testosterone	Free Testosterone	Serotonin
Age	R		0,162	-0,115	-0,140	0,607	0,279	-0,071	0,250	0,102	0,275	0,055	-0,244	-0,212	-0,243
	P		0,484	0,621	0,545	0,003**	0,220	0,760	0,274	0,661	0,227	0,814	0,286	0,357	0,288
Weight	R	-0,210	0,168	-0,165	0,136	-0,464	-0,487	0,180	0,047	-0,214	-0,051	0,407	0,294	0,302	-0,219
	P	0,361	0,467	0,475	0,558	0,034*	0,025*	0,435	0,840	0,352	0,825	0,067	0,196	0,184	0,340
Height	R	-0,221	0,075	-0,078	0,119	-0,323	-0,426	0,068	0,206	-0,091	0,110	0,507	0,124	0,089	-0,216
	P	0,336	0,748	0,737	0,607	0,154	0,054	0,769	0,370	0,694	0,635	0,019*	0,593	0,701	0,347
BMI	R	-0,116	0,098	-0,082	0,049	-0,520	-0,254	0,157	-0,160	-0,213	-0,238	0,329	0,187	0,233	-0,234
	P	0,617	0,672	0,724	0,832	0,016*	0,267	0,496	0,489	0,354	0,300	0,145	0,417	0,310	0,308
Σ6	R	-0,133	0,061	-0,325	-0,362	-0,197	0,088	0,178	-0,070	-0,209	-0,078	0,088	0,073	0,133	-0,495
	P	0,565	0,792	0,151	0,107	0,391	0,703	0,440	0,763	0,363	0,737	0,703	0,754	0,566	0,023
Σ8	R	-0,121	0,080	-0,340	-0,311	-0,237	0,047*	0,209	-0,113	-0,180	-0,134	0,132	0,076	0,106	-0,436
	P	0,602	0,729	0,132	0,170	0,302	0,839	0,364	0,626	0,434	0,563	0,569	0,743	0,648	0,048*
%Faulkner	R	-0,244	0,066	-0,206	-0,194	-0,301	-0,014	0,265	-0,217	-0,237	-0,213	0,040	0,099	0,118	-0,331
	P	0,287	0,775	0,369	0,398	0,184	0,953	0,246	0,345	0,301	0,354	0,865	0,670	0,609	0,143
%Carter	R	-0,133	0,061	-0,325	-0,362	-0,197	0,088	0,178	-0,070	-0,209	-0,078	0,088	0,073	0,133	-0,495
	P	0,565	0,792	0,151	0,107	0,391	0,703	0,440	0,763	0,363	0,737	0,703	0,754	0,566	0,023

* $p < 0,05$; ** $p < 0,01$; by Spearman's rho correlation test.

4. Discussion

Women's sport has undergone a remarkable evolution in recent years. In terms of anthropometry, there are no specific characteristics, but the possession of specific anthropometric characteristics can define what type of player is suitable for each position on the field. Having a correct body composition will help athletes to offer a better physical performance and reduce the chances of muscle, ligament or tendon injuries [25,26]. The objective for this sport is to have less fat tissue without limiting performance and taking into account the athlete's sensations. In the players, it can be observed that the results have a different sum of skinfolds and different percentages of fat.

There are, so to speak, no exact anthropometric characteristics for this division, as many of the articles do not show characteristic values for women's football [25], nor are there any standardised values for players according to their position [27–29]. Many of the players in this study have a low and ideal skinfold sum for performance. External studies note that a sum of between 45-76 mm would be a normal amount of fat for optimal performance [29]. It is observed that the mean body fat percentage is higher in female goalkeepers than in the rest players. This is in line with other studies that report that this increase in body fat could be due to the lack of endurance in this type of position [30].

However, the mean total sum of 6 skinfolds for all participants in the present study shows a value of 85 mm, significantly higher than the range given above. Other data in female football players show that the total skinfold sum in adult female football players is around 90+-26.7 [31].

Within the biochemical analysis, different results have been obtained that provide information on the health status of the players. In haemoglobin, a fundamental marker for transmitting optimum performance, 18 players were found to have a level (85.7%) below 12 g/dL. This could highlight the presence of anaemia in these athletes [32]

In iron metabolism, different values were found depending on the parameter to be evaluated. For example, in serum iron, normal values in women are between 50-140 micrg/dL, with 5 players in this study having a serum level of less than 50, in addition to 2 players close to the minimum value. Iron is a fundamental component of red blood cells for oxygen transport. Serum iron below in a recovery phase may indicate haemoglobin and myoglobin deficiency [32,33]. Ferritin, a value for which deficiency may be sufficient for dietary-nutritional intervention, may be due to iron deficiency, protein deficiency, intestinal bleeding in very intense or high-impact exercise. Other studies highlight this higher risk in this type of athletes in impact sports, despite having intakes above the recommended levels [34]. It is thus observed that 23.8% of the female players had values below the reference values. The last two values of iron metabolism are transferrin and the saturation index.

Serum creatine kinase (CK) levels are highly dependent on age, sex, race, muscle mass, physical activity and very hot weather conditions. Athletes can have a much higher resting CK than an untrained person. A large increase in serum CK level markers combined with reduced exercise tolerance could be a marker of overtraining [35]. In the present sample 42.9% of the participants were found to be above the defined CK values.

It should be noted that the entire sample had magnesium values within the reference values. Magnesium plays a very important role in phosphorylation and oxidation-reduction reactions, making it an essential ion in physical exercise, as well as being a cofactor in energy metabolism reactions. Serum levels depend on the intensity and duration of exercise [32]. However, 33.3% of the players had a moderate vitamin D deficiency. Vitamin D has important roles in the repair and maintenance of musculoskeletal function, bone health, immunity and inflammation, and therefore directly affects optimal performance status [36–38].

Hormone studies provide information on athlete adaptation to training intensity and duration. These markers are used to assess: poor exercise adaptation, recovery processes or to detect overtraining. Cortisol, testosterone and free testosterone are used. In addition, the testosterone/cortisol ratio (T/C) is often used, as it indicates the internal load of the training and the individual response of the organism to these exercises. Free testosterone is a marker of the impact of physical load and long-term exercise adaptation. Low levels of free testosterone may indicate a state of overtraining, but must be accompanied by increased cortisol levels. High cortisol levels indicate that the training is causing great stress to the body, which may be due to the high training load, low glycogen stores, or that the athlete is not resting adequately or other environmental factors. All of these, as well as other hormones (such as catecholamines) are used to individualise training loads or to devise dietary and nutritional strategies to improve the performance status of the athlete. In the results of the present study, it is observed that 38.1% of the athletes had a value above the reference, but in free testosterone, all of them had values within the reference values. However, it would be interesting to assess these values later in the season to evaluate the body's adaptation to training [32,39].

Hydration is a fundamental part of this, as severe dehydration can lead to a decrease in physical performance, as well as increasing the risk of injury. A state of dehydration decreases aerobic energy gain, strength decreases and lactic acid cannot be transported away from the muscle. Fluid replenishment after training is essential, as losses depending on the subject, climate and type of training can be large. The result of the survey shows that 76.2% of them drank after training 500-1000L. Fluid replenishment after training should be 150% of the weight lost, so the vast majority may not reach the necessary requirement to replenish fluids and salts lost in training [26,40–42].

Of the players included in the study, 85.7% of them ate their meal after training within 1-2 hours. The replenishment of 1.2 g/kg of Hc and 20-30 g of protein after an activity or training session favours the replenishment of both the glycogen spent and the repair of the muscle fibres used [26,43–45]. Of these players, 61.9% reported eating foods rich in carbohydrates and protein after training, which shows that most of them may have some knowledge of post-training food and nutrition. However, more nutritional intervention is required in this group of athletes in order to improve aspects of correct replenishment after training.

Finally, 19% of them answered that they did not have regular menstruation. This is an important aspect in women's health where many of the sportswomen have irregularities due to high demands, intensity, low energy availability, or alterations in sleep and stress. It is for this reason that all sportswomen should be made aware that they should seek professionals to help them improve this condition, which can have repercussions on both their health and their performance [18,19,46,47].

5. Conclusions

Although the anthropometric status of the players was different and within the mean reference values, there were no significant differences between the different playing positions. All athletes had magnesium levels within normal ranges. However, there was a high prevalence of deficiencies in parameters linked to iron metabolism and vitamin D levels. Given the nutritional knowledge of the players, it is important to develop a greater number of studies that implement the need for proper nutritional assessment and education in these athletes.

In order to carry out this work, data was collected from the players at the beginning of the season. Therefore, different measurements and chemical analyses at different times of the season have not been contracted. In addition, the absence of dietary records in the design of the study may limit the nutritional assessment and evaluation of the athletes, and these tools could provide a more complete nutritional assessment.

Author Contributions: The study was designed by AM-F, JC-P and MM-A; data were collected and analysed by AM-F, AA-A, NG-B, JAL and MM-A; data interpretation and manuscript preparation were undertaken by AM-F, NG-B, JAL, JC-P and MM-A. All authors reviewed and ap-proved the final manuscript. All authors 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: This study has been approved by the Ethics Committee of the Universitat Oberta de Catalunya (UOC) and the Ethics Committee of the Research Project of the University of Murcia (nº OTRI-1117), and strictly complies with data protection regulations and the Helsinki protocol. The reporting of this study complies with the STROBE statement.

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

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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