REFERENCE VALUES OF BODY COMPOSITION MEASURED BY DXA IN A SAMPLE OF PROFESSIONAL FOOTBALL PLAYERS FROM ITALY AND ENGLAND OVER TWO SEASONS

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Abstract - Elite football requires a balance of speed, endurance, strength, and agility, where body composition influences performance and biomechanics. Each playing position demands specific morphological characteristics. However, there are few studies providing position-specific reference values for professional footballers. This study analyses the body composition of professional football players using dual-energy X-ray absorptiometry (DXA) over two seasons in teams from Italy and England. A total of 112 professional players were evaluated, classified by playing position, and their body composition values were monitored at four different points each season. Measurements included fat mass, total lean mass, and lower limb lean mass, alongside various body composition indices. The results show that defenders and goalkeepers have higher body fat percentages, whereas wingers, full-backs, and central midfielders exhibit lower fat mass and lean mass. Defensive midfielders stand out for having higher total and lower limb lean mass. A reduction in fat mass was observed after the pre-season, followed by a return to baseline values at the end of the season. The discussion highlights the impact of body composition on performance and position-specific characteristics on the pitch. The study concludes that body composition varies by playing position and throughout the season, suggesting the importance of its monitoring to optimise performance. The study provides useful reference values for coaches and fitness trainers.

Keywords - Fat Mass, Lean Mass, Elite football, Dual-Energy X-ray Absorptiometry

I. INTRODUCTION

Elite football is a highly demanding sport that requires an optimal balance of speed, endurance, strength, and agility. Among the factors influencing players' performance, body composition plays a key role, as it affects biomechanical efficiency, energy metabolism, and injury prevention (1). Different playing positions demand specific physical characteristics: defenders and goalkeepers tend to have a higher percentage of body fat, whereas midfielders and forwards generally have lower fat mass and higher lean mass, particularly in the lower limbs (4).

Accurate body composition analysis is an essential tool for coaches and fitness trainers, enabling the optimisation of sports performance and the design of individualised training programmes. Among the most commonly used measurement methods, dual-energy X-ray absorptiometry (DXA) is considered the most precise, as it differentiates between fat mass, lean mass, and bone mineral content (2,3). However, its application in elite footballers remains limited, and there are no specific reference values available.

Furthermore, previous studies have shown that body composition varies throughout the season, with a reduction in fat mass during pre-season and a recovery phase towards the end of the season (4,6). The distribution of body fat is also relevant, as excessive fat in the abdominal region may impact muscle recovery, endurance, and inflammation markers (7).

Considering these factors, this study aims to analyse the body composition of professional footballers over two seasons, establishing reference values and differences by playing position measured by DXA. These values may be useful for coaches, fitness trainers, and nutritionists. Additionally, specific profiles will be established according to playing position, and the relationship with body composition will be assessed. This study represents a significant advance in characterising body composition in professional football and will serve as a basis for future research and applications in evaluating and optimising elite players' performance.

The study hypothesis is that players will show differences in body composition variables depending on their role or position on the pitch, as well as an evolution of these variables throughout the season.

II. MATERIALS AND METHODS

Study Design: An observational retrospective study was conducted to evaluate the evolution of professional football players' body composition over two seasons.

Sample/Participants: A total of 112 male players from Udinese Calcio (Serie A, Italy) and Watford FC (Championship, England) were analysed, aged between 18 and 35 years. Players were classified into seven playing positions: goalkeeper, centre-back, full-back, defensive midfielder (pivot), central midfielder, winger, and striker.

Inclusion and Exclusion Criteria: First-team players with continuous participation in training and matches for at least six months were included. Youth players, loaned players, those with low participation, or those outside the team dynamics were excluded.

Dual-Energy X-ray Absorptiometry (DXA) and Analysed Variables: A DXA scanner (QDR, Horizon series, Hologic Inc., Bedford, MA, USA, GE Lunar Prodigy) was used to measure total and lower limb fat mass, total lean mass, and different body indices. Measurements were taken every 6–7 weeks under controlled conditions (fasting, same time of day, no metallic objects worn by the evaluated players).

Statistical Analysis: Data were analysed at four points during each season (July, October, January, and April), using means, standard deviations, and quartiles. SPSS for Windows (v. 22.0; SPSS Inc., Chicago, IL, USA) was used to compare values across positions and seasons.

III. RESULTS

The body composition of players according to playing position is shown in Table 1.

	Leg Lean M(kg)	Total Lean M (kg)	TotalFatM (kg)	TotalFatM (%)	Fat M Index	Lean LegIndex	Total Lean Index
CENTRE BACK							
2022/2023	27.95 ± 2.27	73.35 ± 4.78	9.75 ± 1.98	11.26 ± 2.48	2.76 ± 0.58	7.89 ± 0.61	20.72 ± 1.17
2023/2024	27.50 ± 1.15	73.93 ± 2.54	10.97 ± 1.51	12.32 ± 1.56	3.01 ± 0.43	7.56 ± 0.31	20.32 ± 0.83
STRIKER							
2022/2023	25.94 ± 2.52	68.41 ± 5.60	9.38 ± 2.56	11.53 ± 2.98	2.79 ± 0.80	7.68 ± 0.59	20.27 ± 1.37
2023/2024	25.02 ± 1.82	66.33 ± 2.92	9.54 ± 2.31	11.91 ± 2.23	2.81 ± 0.54	7.44 ± 0.54	19.72 ± 0.88
WINGER							
2022/2023	24.58 ± 2.36	64.50 ± 6.78	7.95 ± 1.07	10.66 ± 2.01	2.50 ± 0.36	7.74 ± 0.73	20.29 ± 1.94
2023/2024	24.73 ± 3.19	65.28 ± 7.21	8.71 ± 1.42	11.25 ± 1.76	2.69 ± 0.39	7.64 ± 0.91	20.15 ± 1.89
FULLBACK							
2022/2023	25.80 ± 3.08	66.20 ± 6.80	8.62 ± 1.85	11.01 ± 2.12	2.68 ± 0.56	8.01 ± 0.67	20.56 ± 1.29
2023/2024	24.37 ± 2.26	64.61 ± 3.38	8.47 ± 1.43	11.14 ± 2.22	2.59 ± 0.44	7.48 ± 0.86	19.80 ± 1.23
CENTRAL MIDFIELDER							
2022/2023	24.39 ± 2.54	64.70 ± 4.37	10.07 ± 1.89	12.95 ± 2.69	3.13 ± 0.59	7.57 ± 0.79	20.10 ± 1.40
2023/2024	25.79 ± 2.17	66.71 ± 3.49	8.74 ± 1.21	11.15 ± 1.76	2.67 ± 0.40	7.88 ± 0.61	20.39 ± 1.19
PIVOT (DEFENSIVE MIDFIELDER)							
2022/2023	28.93 ± 1.63	76.55 ± 2.55	9.59 ± 2.47	10.60 ± 2.22	2.81 ± 0.64	8.51 ± 0.28	22.53 ± 0.71
2023/2024	28.81 ± 0.69	76.94 ± 1.22	10.35 ± 2.17	11.30 ± 2.21	3.05 ± 0.61	8.51 ± 0.23	22.73 ± 0.56
GOALKEEPER							

2022/2023	26.46 ± 2.27	73.32 ± 4.35	12.32 ± 2.95	13.84 ± 3.39	3.36 ± 0.87	7.17 ± 0.49	19.87 ± 0.49
2023/2024	26.36 ± 1.57	72.08 ± 2.76	11.92 ± 2.04	13.53 ± 2.21	3.29 ± 0.58	7.28 ± 0.46	19.88 ± 0.79

Table 1. General characteristics of the different positions during the two seasons of study.

M: Mass

Body composition by position at different times of the season, as well as the average of both seasons, is shown in Table 2.

	Leg Lean M(kg)	**Total Lean M (kg)**	**TotalFatM (kg)**	**TotalFatM (%)**	**Fat M Index**	**Lean LegIndex**	**Total Lean Index**
CENTRE BACK							
July (n = 21)	27.59 ± 1.75	73.24 ± 4.85	10.34 ± 2.29	11.96 ± 2.97	2.91 ± 0.70	7.75 ± 0.44	20.58 ± 1.13
October (n = 19)	28.29 ± 2.30	73.64 ± 4.71	9.55 ± 1.97	10.92 ± 2.27	2.67 ± 0.54	7.91 ± 0.64	20.59 ± 1.20
January (n = 20)	27.83 ± 2.13	73.91 ± 4.00	10.15 ± 1.75	11.54 ± 1.93	2.84 ± 0.46	7.81 ± 0.63	20.73 ± 1.20
April (n = 16)	27.62 ± 2.03	73.19 ± 3.68	10.24 ± 1.65	11.71 ± 1.83	2.88 ± 0.47	7.75 ± 0.58	20.54 ± 0.88
STRIKER							
July (n = 14)	24.90 ± 2.20	66.00 ± 4.42	9.11 ± 2.49	11.55 ± 2.45	2.76 ± 0.76	7.54 ± 0.47	20.01 ± 1.08
October (n = 11)	24.63 ± 3.03	64.13 ± 7.59	7.93 ± 1.15	10.67 ± 2.37	2.50 ± 0.36	7.75 ± 0.93	20.15 ± 2.20
January (n = 16)	24.49 ± 2.77	64.79 ± 6.56	8.33 ± 1.55	10.88 ± 1.97	2.59 ± 0.45	7.62 ± 0.79	20.15 ± 1.73
April (n = 12)	25.14 ± 2.84	65.37 ± 7.03	8.34 ± 1.31	10.84 ± 1.88	2.58 ± 0.39	7.78 ± 0.76	20.22 ± 1.81
WINGER							
July (n = 16)	24.47 ± 2.61	64.89 ± 7.34	8.35 ± 1.16	11.10 ± 1.78	2.62 ± 0.34	7.68 ± 0.84	20.35 ± 2.09
October (n = 9)	23.56 ± 3.18	61.62 ± 8.39	8.26 ± 1.16	11.49 ± 2.49	2.61 ± 0.37	7.44 ± 1.02	19.47 ± 2.45
January (n = 13)	22.97 ± 2.65	61.62 ± 7.03	8.48 ± 1.12	11.61 ± 1.93	2.67 ± 0.35	7.24 ± 0.85	19.40 ± 1.94
April (n = 10)	23.05 ± 2.56	60.46 ± 6.74	8.37 ± 0.70	11.68 ± 1.91	2.62 ± 0.30	7.19 ± 0.63	18.84 ± 1.57
FULLBACK							
July (n = 11)	24.74 ± 2.45	64.34 ± 5.46	8.07 ± 0.96	10.70 ± 1.47	2.54 ± 0.26	7.79 ± 0.69	20.24 ± 1.17
October (n = 10)	25.42 ± 2.82	66.04 ± 6.00	8.37 ± 2.27	10.73 ± 2.73	2.58 ± 0.71	7.83 ± 0.75	20.35 ± 1.37
January (n = 12)	26.16 ± 3.19	65.44 ± 6.01	8.74 ± 1.77	11.35 ± 2.42	2.69 ± 0.58	7.72 ± 0.86	20.09 ± 1.39
April (n = 13)	25.62 ± 3.13	66.38 ± 5.97	8.96 ± 1.63	11.36 ± 2.02	2.75 ± 0.48	7.87 ± 0.90	20.37 ± 1.43
CENTRAL MIDFIELDER							
July (n = 14)	24.13 ± 2.24	64.49 ± 3.93	10.03 ± 2.10	13.05 ± 2.84	3.12 ± 0.64	7.51 ± 0.68	20.07 ± 1.25
October (n = 9)	25.79 ± 2.20	67.08 ± 3.91	9.33 ± 1.48	11.65 ± 2.13	2.87 ± 0.41	7.95 ± 0.78	20.67 ± 1.51
January (n = 11)	24.65 ± 2.89	65.00 ± 4.65	9.74 ± 1.71	12.49 ± 2.50	3.00 ± 0.55	7.59 ± 0.85	20.03 ± 1.45
April (n = 7)	24.89 ± 2.79	64.75 ± 4.62	9.54 ± 2.08	12.33 ± 2.97	2.96 ± 0.73	7.67 ± 0.72	19.98 ± 1.27

PIVOT (DEFENSIVE MIDFIELDER)							
July (n = 6)	28.21 ± 1.09	75.75 ± 2.62	9.67 ± 2.77	10.79 ± 2.63	2.84 ± 0.75	8.33 ± 1.40	22.39 ± 0.89
October (n = 5)	29.36 ± 1.62	76.86 ± 1.96	9.63 ± 2.57	10.62 ± 2.47	2.82 ± 0.69	8.63 ± 0.35	22.62 ± 0.62
January (n = 4)	29.30 ± 1.26	77.29 ± 1.82	10.54 ± 2.19	11.38 ± 1.96	3.08 ± 0.56	8.58 ± 0.21	22.65 ± 0.30
April (n = 3)	28.85 ± 0.92	77.69 ± 0.39	10.15 ± 2.12	11.03 ± 2.10	3.00 ± 0.59	8.55 ± 0.22	23.03 ± 0.39
GOALKEEPER							
July (n = 16)	25.82 ± 2.19	72.24 ± 4.06	12.33 ± 2.94	14.20 ± 3.51	3.38 ± 0.88	7.02 ± 0.52	19.65 ± 0.82
October (n = 11)	26.49 ± 2.13	72.88 ± 4.31	12.35 ± 2.76	13.83 ± 3.09	3.40 ± 0.84	7.25 ± 0.49	19.95 ± 0.82
January (n = 11)	26.74 ± 2.05	73.53 ± 3.68	12.16 ± 2.50	13.49 ± 2.70	3.31 ± 0.71	7.28 ± 0.46	20.01 ± 0.69
April (n = 12)	26.88 ± 1.80	73.21 ± 3.86	11.84 ± 2.63	13.26 ± 2.81	3.23 ± 0.73	7.33 ± 0.40	19.98 ± 0.87

Table 2.Characteristics of the different playing positions at four points of the season, as well as the average of both seasons.

M: Mass

IV. DISCUSSION AND CONCLUSIONS

The results of this study show differences in elite footballers' body composition according to their playing position. Centre-backs and goalkeepers were found to have the highest percentages of body fat, whereas wingers, full-backs, and central midfielders had lower fat mass and total lean mass. Defensive midfielders, on the other hand, stood out for having greater lean mass in their legs and torso, which may be related to their evolving role in the game, which demands strength and physical duels, as previously observed by other authors (6).

It was also observed that body composition varies throughout the season. Players start pre-season with poorer parameters (higher fat mass and lower lean mass), improve in the initial months due to training load, and return to similar values at the end of the season. This pattern was consistent across all positions, although full-backs, wingers, and defensive midfielders had lower fat mass values from the start.

These findings align with previous studies (4,6), which have reported that professional footballers start pre-season with less favorable body composition parameters (primarily fat mass, lean mass, and lower limb lean mass) compared to the start of the competitive season (4,6). Additionally, all players, regardless of position, arrive at pre-season with similar characteristics (4), likely due to a period of reduced physical activity during the off-season, as observed in our data.

Some limitations are thatthe findings are not generalisable to other sports or competition levels. Additionally, individual factors such as genetics and nutritional habits may influence the results. Furthermore, direct performance parameters were not evaluated, preventing precise correlations between body composition and performance.

In conclusion, the composition varies according to playing position and throughout the season, highlighting the importance of monitoring it to optimise performance. The obtained results can serve as a reference for coaches and fitness trainers in training planning and physical condition monitoring of players.

BIBLIOGRAPHIC REFERENCES

[1] Ceballos-Gurrola, O., Bernal-Reyes, F., Jardón-Rosas, M., Enríquez-Reyna, M. C., Durazo-Quiroz, J., & Ramírez-Siqueiros, M. G. (2021). Composición corporal y rendimiento físico de jugadores de fútbol soccer universitario por posición de juego (Bodycomposition and physical performance ofcollege soccer byplayers position). Retos, 39, 52-57.

[2] García, N., Zapata, D., Sáez, C., Yáñez, R., & Peñailillo, L. (2015). Valoración de la masa grasa en futbolistas jóvenes de alto rendimiento: comparación de métodos antropométricos con absorciometría dual de rayos X (DEXA). Arch. Med. Deporte, 32(168), 208-214.

[3] Sebastiá-Rico, J., Jiménez-Alfageme, R., Soriano, J. M., Sanchis-Chordà, J., Alonso-Calvar, M., Ferriz-Valero, A., & Miguel, J. (2022, July). Revisión Sistemática De La Composición Corporal En Futbolistas Profesionales Masculinos: Comparación Entre Diferentes Métodos. In XVII WORLD CONFERENCE ON KINANTHROPOMETRY XVII CONGRESO MUNDIAL DE CINEANTROPOMETRIA (p. 153).

[4] Molina-López, A., Moya-Amaya, H., Estevan-Navarro, P., Berral-Aguilar, A. J., Rojano-Ortega, D., & Berral-de-la-Rosa, F. J. (2022). Cambios en la composición corporal y ángulo de fase durante la pretemporada en jugadores de fútbol profesional. International Journal of Morphology, 40(2), 348-354.

[5] Devlin, B. L., Kingsley, M., Leveritt, M. D., & Belski, R. (2017). Seasonal changes in soccer players' body composition

and dietary intake practices. The Journal of Strength & Conditioning Research, 31(12), 3319-3326.

[6] Figueiredo, D. H., Dourado, A. C., Stanganelli, L. C. R., & Gonçalves, H. R. (2021). Evaluation of body composition and its relationship with physical fitness in professional soccer players at the beginning of pre-season. Retos: nuevas tendencias en educación física, deporte y recreación, (40), 117-125.

[7] Festa, A., D'AgostinoJr, R., Williams, K., Karter, A. J., Mayer-Davis, E. J., Tracy, R. P., &Haffner, S. M. (2001). The relation of body fat mass and distribution to markers of chronic inflammation. International journalofobesity, 25(10), 1407-1415.

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