Young women soccer players. Anthropometric and physiological characteristics. Evolution in a Sports season

Pilar Oyón[1], Luis Franco[2], Francisco J. Rubio[3], Alfredo Valero[4]

[1]Unitat Medicina de l'Esport, Hospital Universitari Sant Joan de Reus. [2]Unitat Medicina de l' Esport, Hospital Universitari Sant Joan de Reus. Facultad de Medicina, Universitat Rovira i Virgili. [3]Unitat Medicina de l' Esport Hospital Comarcal Amposta-Centre Tecnificació Esportiva Amposta. Unitat Medicina Esport, Hospital Universitari Sant Joan de Reus. [4]Unitat Medicina de l' Esport, Hospital Universitari Sant Joan de Reus.

Received: 01.04.2015
Accepted: 15.06.2015

Summary

Background: Female's football has had a great improvement and in the number of players over the last decades. Our goal is to analyse both anthropometrical characteristics and physical capacity of young women football players, comparing our results with current literature and assess the evolution during a season.
Methods: 21 women football players were examined. All between 12-15 years old and used to train twice a week during 90 minutes each session; playing a match at the weekend as well. Players positions were not discriminated. They all passed a sports physical exam at the beginning and at the end of the study. This check-up included a thorough medical history, a physical exam, blood pressure, rest-electrocardiogram, anthropometry (weight, height, 6 skin-fold thickness) and the Astrand step test. Descriptive statistical analysis and paired means comparison were performed.
Results: We observed a weight gain, a growth in height and a rise in body fat percentage throughout the season. The average weight increased from 48.83 (8.17) to 52.82 (7.69) kg. Height augmentation was from 158.5 (6.19) to 160.7 (5.33) cm, and body fat percentage moved up from 14.7 (3.84) to 16.9 (3.98) %. Maximal oxygen uptake incremented from 42.95 (6.13) to 44.58 (9.37) ml/kg/min. The body fat percentage results are slightly lower than reference values in senior elite women football players (17.5-28.3%) while maximal oxygen uptake is lower than reference range for European women elite football players (47-57 ml/kg/min).
Discussion and conclusions: The results concerning weight (p<0.0001), height (p<0.0001), body fat percentage (p=0.002) and absolute values of maximal oxygen uptake (p=0.009) are statistically significant. Given the age of the players, it is difficult to attribute which part of these results is due to growth itself and which one is due to training.

Key words:
Football. Anthropometry. Maximal oxygen uptake (VO_2 max).

Fútbol femenino categorías inferiores. Características antropométricas y fisiológicas. Evolución a lo largo de una temporada

Resumen

Introducción: El fútbol femenino ha experimentado un importante aumento de practicantes en las últimas décadas. Se aportan datos antropométricos y de condición física de jugadoras de fútbol en formación valorando su evolución a lo largo de una temporada y comparándolos con los existentes en la literatura.
Material y métodos: Se estudiaron 21 jugadoras de edades comprendidas entre 12 y 15 años, que entrenaban 2 días/semana, 90 minutos/sesión, más el partido del fin de semana. No se diferenció por posiciones en el terreno deportivo. Todas ellas realizaron un examen médico-deportivo al inicio y al final del estudio, que incluyó: anamnesis, exploración física, tensión arterial, ECG de reposo, antropometría (peso, talla, 6 pliegues) y Test de Banco de Astrand. Se realizó estudio estadístico descriptivo y comparación de medias para datos apareados.
Resultados: A lo largo del año se observa un aumento del peso: media de 48,83 (8,17) a 52,82 (7,69) Kg, de la talla: media de 158,5 (6,19) a 160,7 (5,33) cm , del % de grasa: media de 14,7 (3,84) % a 16,9 (3,98) % y un aumento del VO_2max: media de 42,95 (6,13) a 44,58 (9,37) ml/Kg/min. Los valores del % de grasa son algo inferiores a los descritos en jugadoras de categoría senior de equipos de elite (rango de 17,5-28,3%), mientras que el VO_2max se sitúa por debajo del rango de referencia para jugadoras europeas de elite (47-57 ml/kg/min).
Discusión y conclusiones: Las diferencias halladas entre los dos controles son estadísticamente significativas en el peso (p<0,0001), talla (p<0,0001), % graso (p=0,002) y VO_2max en valores absolutos (p=0,009) y no en valores referidos al peso. En las edades objeto de estudio es difícil atribuir en qué proporción estas variaciones se deben al crecimiento y desarrollo y que parte al entrenamiento físico.

Palabras clave:
Fútbol femenino. Antropometría. VO_2 máx.

Correspondence: Francisco J. Rubio
E-mail: fjrubio@grupsagessa.com

Introduction

The practice of women's football has increased significantly over the past decade, both on a national and international scale. The number of licences in 2003-4 was 13,582, and in 2012-13 this figure reached 28,129, spelling a 52% increase in licences in 10 seasons[1].

Football is an acyclic sport with a high number of non-linear actions and interactions, resulting from the execution of technical-tactical variables of speed, space and time. It is an intermittent sport, in which efforts are made employing varying degrees of intensity with unpredictable recovery times, encompassing situations in which the player is stopped, walking, jogging or sprinting[2,3].

As a result of the interest emerging from the increase in very young female football players, studies and research projects have been undertaken with the aim of bringing us closer to the before now unexplored reality of the morphological and functional characteristics of these sportswomen.

According to Ekblom[4], weight, height and fat percentage elements are not essential for playing football well. This is due to the lack of specific features among footballers, given that the range of values observed is very wide.

Despite the majority of research carried out till now being based on describing the anthropometric and physiological characteristics of players[5-8], studies have begun to emerge regarding the development and requirements of competition[9].

Studies of the anthropometric and functional profile of female Spanish football players are scarce, making it difficult to find reference values to these effects, though this does not occur on an international level. Along with the scarcity of bibliographic references, it should also be noted that one of the distinguishing features of football is the existence of diverse types of players, with vastly different performance shown by footballers with a similar typology[10].

Our aim is to discover the state of physical fitness of the players at the Reus Deportiu Football School, and to evaluate their possible modification and evolution throughout a season as a result of the training process as well as growth and maturity, and to compare the results with existing literature.

Material and methods

Sample

The sample studied is made up of 21 female field players aged between 12 and 15 years (average 13.48 in the first control and 14.03 in the second control), belonging to the Reus Deportiu Football School. The players trained over 10 months, 2 days a week for 90 minutes each day, as well as competing in weekly matches and competing in the Catalonian Women's First Division for their age-group.

Procedure

The parents and players were informed about the methodology and objectives of the study, and their corresponding informed consent was required for participation. Two controls were carried out, the first for the pre-season (September) and the second during the competition season (April), which included:

- Medical-sport test: anamnesis, physical exploration using apparatus, blood pressure and resting electro-cardiogram.
- Anthropometric study following the regulations set by the International Society for the Advancement in Kineanthropometry (ISAK) and the Spanish Cineanthropometric Group (GREC), taking measurements of weight, height, six skinfolds (triceps, sub-scapular, abdominal, supra-spinal, anterior thigh, medial leg) to determine the fat % using the Yuhasz formula[11].
- Sub-maximum effort test, Astrand bench test, using a 33-cm high bench, which participants had to get on and off for five minutes at a rhythm of 22.5 times a minute to the pace of a metronome, with a constant cadence, with continuous electrocardiographic monitoring and a recorded blood pressure. This allowed for a reliable assessment of the participant's clinical condition, heart-rate response, blood pressure response to the sub-maximal effort, and their aerobic condition via the indirect calculation of oxygen consumption.

Material

- Anthropometric: Añó Sayol Weighing Scale (0-150 kg, 100 gram accuracy) and Añó Sayol height measuring rod (55-200 centimetres, 1 millimetre accuracy). Holtain Skinfold calliper (0-40 mm; 0.2 mm accuracy). Dermographic pencil. Anthropometric box.
- Astrand bench test: 33-cm high bench, EK-41 Hellige Cardiotest and Hellige Servomed Monitor, Taktell Piccolo Wittner Serie 830 Metronome, Riester Sphygmomanometer. Casio Stopwatch. Vo_{2max} estimate using the Astrand and Ryhming Normogram.

The data was handled using the Student t and the two controls were checked using the Wilcoxon test for non-parametric paired data.

Results

Table 1 displays the average values for weight (Kg), height (cm), body mass index (BMI, in Kg/m^2) and body fat percentage. We can see that over the season there was an increase in weight, height and BMI, with a statistical significance of $p < 0.0001$ and the fat percentage with a statistical significance of $p < 0.002$.

Table 2 displays the average values of the six skinfolds studied, revealing an increase in the second control when compared to the first in all skinfolds, with a statistical significance in all of $p < 0.0002$.

In the Astrand bench test, improvement was achieved over the season in the maximum VO_2 in absolute value (1/min) with a statistical significance of $p < 0.0095$, but not in values relating to weight ($p < 0.4576$). No significant differences were found in the final blood pressure and final heart-rate frequencies. Table 3.

Table 1. Anthropometric characteristics of the sample.

	Weight 1	Weight 2	Height 1	Height 2	% Fat 1	% Fat 2	BMI 1	BMI 2
Average	48.83	52.82	158.53	160.77	14.70	16.91	19.41	20.44
SD	8.17	7.691	6.21	5.33	3.84	3.98	7.53	8.17
Significance	p<0.0001		p<0.0001		p<0.002		p<0.0001	

SD: Standard deviation; Weight 1, Height 1, % Fat 1, BMI 1: Control September; Weight 2, Height 2, % Fat 2, BMI 2: Control April.

Table 2. Evolution of skinfolds.

Skinfolds	Average	SD	Significance
Triceps 1	11.66	2.98	
Triceps 2	14.33	3.89	p<0.0002
Sub-scapular 1	8.04	2.42	
Sub-scapular 2	9.51	2.56	p<0.0002
Suprailiac 1	7.75	4.32	
Suprailiac 2	9.88	4.91	p<0.0002
Abdominal 1	14.24	7.87	
Abdominal 2	16.25	7.26	p<0.0002
Anterior thigh 1	12.57	5.87	
Anterior thigh 2	14.53	6.01	p<0.0002
Leg 1	18.31	3.66	
Leg 2	21.44	5.44	p<0.0002

SD: Standard deviation; Triceps 1, Sub-scapular 1, Suprailiac 1, Abdominal 1, Thigh anterior 1, Medial leg 1: Control September; Triceps 2, Sub-scapular 2, Suprailiac 2, Abdominal 2, Thigh anterior 2, Medial leg 2: Control April.

Table 3. Evolution of the Astrand Test variables.

Astrand Test Variables	Average	SD	Significance
Systolic arterial pressure 1	130.72	12.72	
Systolic arterial pressure 2	128.8	16.73	
Diastolic arterial pressure 1	49.29	13.44	
Diastolic arterial pressure 2	56.67	10.17	
Final heart rate 1	156	12.46	
Final heart rate 2	154	15.91	
Max.VO2 (l/min) 1	2.09	0.41	
Max.VO2 (l/min) 2	2.33	0.51	P<0.0095
Max. VO2 (ml/Kg/min) 1	42.95	6.13	
Max. VO2 (ml/Kg/min) 2	44.58	9.38	P<0.4576

SD: Standard deviation; 1: Control September. 2: Control April.

Table 4. Anthropometric characteristics of female football players, Average (SD).

Authors	Country	Sample (N)	Age (years)	Height (cm)	Weight (Kg)	% Fat
Wilhers RT, *et al* (1986)	Australia	10	24.4 (4.5)	158.1 (5.7)	55.4 (6.5)	20.8 (4.7)
Davis JA, Brewer J (1992)	England	14	24.5 (3.6)	166.0 (6.1)	60.8 (5.2)	21.1 (3.6)
Rhodes Ec, *et al* (1992)	Canada	12	20.3	164.8	59.5	19.7 (4.0)
Tumilty D, Darby S (1992)	Australia	20	23.1 (3.4)	164.5 (6.1)	58.5 (5.7)	19.7 (4.0)
Jensen K, Larsson B (1993)	Denmark	10	24.7	169	62.2	20.1
Reiter L, *et al* (1996)		11	23.8 (2.9)			23.8 (4.6)
Tamer K, *et al* (1997)	Turkey	22				18.3 (1.71)
Rico-Sanz J (1998)						21
Scott D (2002)	England	26	22.2 (6.2)	163.2 (5.7)	63.3 (6.2)	24.2 (3.8)
Todd MK, *et al* (2002)	England	120	22.6 (5.9)	163.4 (5.9)	61.8 (6.7)	24.4 (3.9)
Clark M, *et al* (2003)	EEUU					16.1-16.4
Sieger, *et al* (2003)		17	16.49 (0.91)	167.42 (4.64)	61.46(9.43)	12.13 (4.66)
Polman R, *et al* (2004)	England	12	21.2 (3.1)	163 (0.65)	64.5 (6.2)	26.7 (2.87)
Can F, *et al* (2004)	Turkey	17	20.73 (2.09)	162.4 (4.64)	56.63 (5.03)	19.75 (0.69)
Garrido, *et al* (2004)	Spain			160.77		14.76
Gómez M, *et al* (2006)	Spain	52	20.73 (4.34)	163.0 (0.06)	59.1 (8.14)	16.01 (3.08)
Ramos JJ, *et al* (2007)	Spain	20				14.6 (2.4)
Sedano S, *et al* (2009)	Spain	90	19.91 (3.70)	161.39 (1.04)	61.20 (1.59)	29.35 (1.15)
Sedano S, *et al* (2009)	Spain	100	21.25 (3.71)	161.30 (0.66)	57.88 (0.81)	21.88 (0.97)
First control sample study	Spain	21	14.64 (0.75)	158.53 (6.21)	48.83 (8.17)	14.70 (3.84)
Second control sample study	Spain	21	15.06 (0.74)	160.77 (5.33)	52.82 (7.69)	16.91 (3.98)

Discussion

Table 4 displays the anthropometric values described in the bibliography. It is worth being cautious when comparing this data, given that the differences found may be due to the different measurement techniques and formulas applied to obtain them, as well as the heterogeneity of the groups studied (number, age, weight, height, and sporting level).

Table 5. Max. VO2 (ml/Kg/min) in female football players. Average (SD).

Authors	Country	Sample (N)	Age (years)	Max. V02 (ml/kg/min)
Colquhoun, *et al.* (1986)	Australia	10		47.9 (8.1)
Davis JA, Brewer J (1992)	England 1	14	24.5 (3.6)	48.4 (4.7)
Davis JA, Brewer J (1992)	England 2	14		52.2 (5.1)
Tumilty D, Darby S (1992)	Australia	20	23.1 (3.4)	48.5 (4.8)
Jensen K, Larsson B (1993)	Denmark	10	24.7	53.3-57.6
Rhodes EC, *et al.* (1992)	Canada	12		47.1 (6.4)
Evangelista M, *et al.* (1992)	Italy	12		49.76 (8.3)
Tamer K, *et al.* (1997)	Turkey	22		43.15 (4.06)
Miles A, *et al.* (1993)		10		42.5
Reiter L, *et al.* (1996)		11		42.4 (6.1)
Hoare DG, *et al.* (2000)	Australia	17		39.4 (4.3)
Tumilty D (2000)	Australia	17		50.3 (5.1)
Helgerud J, *et al.* (2002)	Norway	12		54 (3.54)
Todd MK, *et al.* (2002)	England	120		44.8 (5.8)
Polman R, *et al.* (2004)	England	12		38.6 (3.72)
Aracheta C, *et al.* (2006)	Spain	10	20.3 (3.8)	45.1 (6.3)
Scott D, *et al.* (2007)		14		53.4 (3.8)
First study sample control	Spain	21	14.64 (0.75)	42.95 (6.13)
Second study sample control	Spain	21	15.06 (0.74)	44.58 (9.38)

England 1: Pre-season; England 2: During season.

According to Ekblom[4], weight and height elements are not essential for playing football well, as the range of values observed is very wide and because no features specific to footballers have been described.

It would seem that being taller, as in other sports, can be advantageous in certain positions. This variable oscillates between 158.1 and 169 centimetres, a parameter within which the entire sample is included, though nearer the lower rather than the upper range[12].

The height registered falls below that obtained from female footballers in other countries[5,6,13-20]. Results can be found that are similar to those described among female Spanish footballers[8,21,22]. It would be interesting to analyse the height patterns of the general population in the countries where these studies were carried out, to see if there are any differences or if they are limited exclusively to the field of female footballers.

When comparing the weight of the female footballers from our sample, we encountered identical data as that found for height comparison.

The same occurred with the starting and end fat percentages, which are lower than those described in female Spanish football players[8], and female players from other countries[4,6,14-18] and similar to those referred to by Garrido *et al*.[21] and Ramos *et al*.[22] among female Spanish footballers and Clark e*t al*.[23] among female North American University footballers.

As we can see in Table 5, the maximum VO2 obtained in the two controls is within the range described in the bibliography for footballers of different ages and sporting levels: 39.4 -53.4 ml/Kg/min; the oxygen consumption described by Bangsbo[24] of 61 ml/Kg/min is not considered to be a benchmark reference, as it was an isolated case in one female player. The values are similar to those obtained by Reiter *el al.*[19], Rhodes *et al.*[20], Todd *et al*[25], Miles *et al*.[26], Tamer *et al*.[14] and Aracheta *et al.*[27], higher than those from Hoare and Warr[28], Polman *et al*.[29] and lower than those from Jensen and Larson[6], Tumilty and Darby[14], Colquhoun and Chad[30], Evangelista *et al*.[31] and Scott and Drust[32].

Conclusions

The development of female football, on the one hand requires actions aimed to promote the practice of this sport, and on the other, a specific knowledge of women as sportswomen and footballers. Some of the research carried out till now falls within the second field.

The differences found in our study between the first and second control, should not be over-valued, as they may be equally due to the process of maturity, growth and development that influences sporting performance, as well as training. Therefore, selecting sportswomen of this age for having higher oxygen consumption and/or a lower level of body fat as predictive performance factors may exclude players that mature later.

The fat percentages are difficult to compare with other studies, because the methodology used is not the same.

The maximum oxygen consumption obtained in the second control is similar to reference data from football players described in the literature.

The studies carried out with female football players, and the heterogeneity discovered regarding their characteristics, suggest that perhaps there are no features specific to female footballers.

Various publications[3,29] conclude that a combination of suitable training in volume, intensity and specificity, and balanced nutrition could lead to improvements in the physical composition and aerobic process of female football players.

Carrying out a comprehensive assessment protocol of the physical condition of the footballer at the start of the season becomes paramount if we wish to successfully plan and customise the responsibilities of the sportswomen when it comes to the competitive season.

The regular and developmental control of these female players is useful for, wherever possible, reaching reference values.

We believe that it would be interesting to study female footballers depending on their position on the pitch, in order to define the characteristics that are specific to female footballers in particular positions.

Bibliografía

1. Real Federación Española de Fútbol. Licencias emitidas durante las temporadas. Disponible en http//www.rfef.es/index.jsp?nodo=306 (consulta: 9/2/2015).
2. Drobnic F, González de Suso J, Martínez J. *Fútbol. Bases científicas para un óptimo rendimiento.* Madrid. Editorial Ergon; 2004.
3. Gorostiaga E. Fútbol Femenino: bases fisiológicas, evaluación y prescripción del entrenamiento físico. Instituto Navarro de Deporte y Juventud. *Cuadernos Técnicos de Deporte.* 2002;16-56.
4. Ekblom B. Applied Physiology of soccer. *Sports Med.* 1986;3:50-60.
5. Davis J, Brewer J, Atkin D. Pre-season physiological characteristics of English first and second division soccer players. *J Sports Sci.* 1992;10(6):541-7.
6. Jensen K, Larsson B. Variations in physical capacity among the Danish national soccer team for women during a period of supplemental training. *J Sports Sci.* 1998;10:144.
7. Juric I, Sporis G, Vatroslav M. Analysis of morphological features and placed team positions in elite female soccer players. *J Sports Sci Med.* 2007; Suppl 10:138-40.
8. Gómez M. ¿Existen un conjunto de características comunes y propias de las jugadoras de fútbol? Lecturas: Educación Física y Deportes (revista electrónica) 2006 enero (consultada 09/02/2015). Disponible en: http//www.efdeportes.com/indic92.htm.
9. Ritschard M, Tschopp M. *Physical Analysis of the FIFA Women's Wordl Cup Germany 2011.* Aesch. Rüegg Media AG; 2012.
10. Liparotti J. Aplicaciones prácticas de datos de composición corporal en futbolistas universitarios brasileños. *Training fútbol.* 2004;100:36-43.
11. Berral F. Composición Corporal. En: Moreno C, Manonelles P. *Manual de Cineantropometría.* Monografía FEMEDE 11. Badalona: Ed: FEMEDE; 2011. p.172-223.
12. Davis J, Brewer J. Applied physiology of female soccer players. *Sport Med.* 1993;16(3): 180-189.
13. Sedano S, Cuadrado G, Redondo J, De Benito A. Perfil antropométrico de las mujeres futbolistas españolas. Análisis en función del nivel competitivo y de la posición ocupada habitualmente en el terreno de juego. *Apunts Educació Física i Esports.* 2009; 98:78-87.
14. Tamer K, Günay M, Tiryaki G, Cicioolu I, Erol E. *Physiological characteristics of Turkish Female Soccer players.* Science and Footbal III. London: E and FN Sport; 1997. p. 37-39.
15. Tumilty D, Darby S. Physiological characteristics of Australian female soccer players. *J Sports Sci.* 1992;10:139-205.
16. Can F, Yilmaz I, Erden Z. Morphological characteristics and performance variables of women soccer players. *J Strength Cond Res.* 2004;18(3):480-5.
17. Scott D, Chisnall P, Todd M. Dietary analysis of English female soccer players. En Spinks W, Reilly T, Murphy A. *Science and Football IV.* Proceedings of the 4th World Congress of Science and Football. London: Routledge: 2002 .p. 245-250.
18. Rico-Sanz J. Body composition and nutritional assessments in soccer. *Int J Sport Nutr.* 1998;8(2):113-23.
19. Reiter L, Prouten L, Rigney L, Lambert S, Estel J, Barnsley L. *Physiological characteristics of female soccer players: laboratory and match-player assessments.* Australian Conference of Science and Medicine in Sport. 1996;424-5.
20. Rhodes E, Mosher R, McKensie D. Physiological profiles of the Canadian Olympic Soccer Team. *Can J Appl Sport Sci.* 1986;11:31-6.
21. Garrido R, González M, Félix A, Pérez J. Composición corporal de los futbolistas de equipos alicantinos. *Selección.* 2004;13(4):155-63.
22. Ramos J, Segovia J, López-Silvarrey F, Legido J. *El Fútbol. Valoración funcional. Test de campo y laboratorio.* Madrid. Fundación Institución SEK; 2007.
23. Clark M, Reed D, Crouse S, Armstrong R. Pre- and post-season dietary intake, body composition, and performance indices of NCAA Division 1 female soccer players. *Int J of Sport Nutr Exerc Metab.* 2003;13:303-19.
24. Bangsbo J. The physiology of soccer-with special reference to intense intermittent exercise. *Acta Physiol Scand.* 1994; Suppl 619:1-155.
25. Todd M, Scott D, Chisnall P. Science and Football IV. En Spinks W, Reilly T, Murphy A. *Science and Football IV.* Proceedings of the 4th World Congress of Science and Football. London: Routledge: 2002. p. 374-381.
26. Miles A, MacLaren D, Reilly T, Yamanaka K. *An analysis of physiological strain in four-a-side women´s soccer.* En Reilly T, Bangsbo J, Hugues M. Second Wordl Congress of Science and Football II. London: E. and F.N. Spon; 1993. p. 140-145.
27. Arecheta, C, Gómez M, Lucía A. *La importancia del VO_2max para realizar esfuerzos intermitentes de alta intensidad en el fútbol femenino de elite.* Kronos. 2006;9:4-12.
28. Hoare D, Warr C. Talent identification and women's soccer: an Australian experience. *J Sports Sci.* 2000;18:751-8.
29. Polman R, Walsh D, Bloomfield J, Nesti M. Effective conditioning of female soccer players. *J Sports Sci.* 2004;22(2):191-203.
30. Colquhoun D, Chad K. Physiological characteristics of Australian female soccer players after a competitive season. *Aust J Sci Med Sport.* 1992;18(3):9-12.
31. Evangelista M, Pandolfi O, Fanton F, Faina M. A functional model of female soccer players: Analysis of functional characteristics. Communications to the Second Wordl Congress of Science and Football. Eindhoven, Nederlands 22-25, May, 1991. *J Sports Sci (abstract).* 1992;10:165.
32. Scott D, Drust B. Work-rate analysis of elite female soccer players during match-play. *J Sport Sci Med.* 2007; Suppl 10:106-10.