Ramos-Sánchez, F.; Camina-Martín, M.A.; Alonso-de-la-Torre, S.R.; Redondo-del-Río, P. y de-Mateo-Silleras, B. (2018) Composición corporal y somatotipo por posición de juego en balonmano profesional masculino / Body Composition and Somatotype in Professional Men's Handball According to Playing Positions. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 18 (69) pp. 91-102
Http://cdeporte.rediris.es/revista/revista69/artcomposicion902.htm
DOI: https://doi.org/10.15366/rimcafd2018.69.006

ORIGINAL

BODY COMPOSITION AND SOMATOTYPE IN PROFESSIONAL MEN'S HANDBALL ACCORDING TO PLAYING POSITIONS

COMPOSICIÓN CORPORAL Y SOMATOTIPO POR POSICIÓN DE JUEGO EN BALONMANO PROFESIONAL MASCULINO

Ramos-Sánchez, F.[1]; Camina-Martín, M.A.[2]; Alonso-de-la-Torre, S.R.[3]; Redondo-del-Río, P.[4]; de-Mateo-Silleras, B.[5]

[1] Sports Medicine Area, Department of Health Sciences. Miguel de Cervantes European University, Valladolid (Spain) ramosanchez@gmail.com
[2] Nutrition and Food Science Area. Department of Pediatrics, University of Valladolid (Spain) aliciacamina@gmail.com
[3] Nutrition and Food Science Area, Department of Biotechnology and Food Science, University of Burgos (Spain) salonso@ubu.es
[4] Nutrition and Food Science Area, Department of Pediatrics, University of Valladolid (Spain) mpazredondorio@gmail.com
[5] Nutrition and Food Science Area, Department of Pediatrics, University of Valladolid (Spain) bdemateo@yahoo.com

Spanish-English translator: Ideas Need Communicating Language Services S. Coop. info@comunicareningles.com

Código UNESCO / UNESCO code: 3299 Medicina del Deporte / Sports Medicine.
Clasificación Consejo de Europa / Council of Europe classification: 9. Cineantropometría / Kineanthropometry.

ABSTRACT

A cross-sectional descriptive study was accomplished in 19 professional players from Valladolid Handball Club. Anthropometric measurements were performed according to standard protocol. Body fat and bone mass were estimated, and the somatotype was calculated.

As results, the line players were significantly the heaviest players; the wings were lightest and the backs, with the line players, the tallest. Nevertheless, no significant differences in BMI were observed. Regarding the body composition, the line players showed the highest values of fat-mass. No differences in BMI were observed in the groups. With respect to the somatochart, the center backs and backs were in the central area; wings and line players showed an endomorph-mesomorph development, and goalkeepers were in the ecto-endomorph area.

As conclusions, anthropometric variables, body composition data and the somatochart of the athletes evaluated confirm the basic morphological characteristics of the players for the position for which they are best suited.

KEYWORDS: Handball players, Anthropometry, Body Composition, Somatotype.

RESUMEN

Se realizó un estudio descriptivo transversal en 19 jugadores profesionales del Club Balonmano Valladolid. Las mediciones antropométricas fueron realizadas según el protocolo estándar. Se estimaron la masa grasa y ósea, se calculó el somatotipo y se analizaron las diferencias entre las variables en función de la posición.

Como resultados, se obtuvo que los pivotes fueron los jugadores más pesados (con mayor porcentaje de masa grasa); los extremos los más ligeros y los laterales, junto con los pivotes, los más altos. No se observaron diferencias en el IMC en los grupos. En la somatocarta los centrales y laterales se situaron en la zona central; los extremos y los pivotes en la endomorfa-mesomorfa y los porteros en la ecto-endomorfa.

Así se evidenció que las variables antropométricas, los datos de composición corporal y la somatocarta de los deportistas confirman las características morfológicas básicas de los jugadores para la posición para la que son más aptos.

PALABRAS CLAVE: Balonmano, Antropometría, Composición corporal, Somatotipo.

ABBREVIATIONS

BM Valladolid, Valladolid Handball Team
SD, standard deviation
BMI, body mass index
FM, fat mass
FFM, fat-free mass
MM, muscle mass
BM, bone mass
RM, residual mass

INTRODUCTION

In handball, there are five distinct game positions: 1) the goalkeeper: responsible for stopping the ball, who is not allowed to leave the 6-meter area with the ball in hand, but allowed to touch it if he passes the ball to a teammate; 2) the center back: the team leader, organizer of the attack and defense, who directs the play, in both defense and attack, decides on the tactics, and sets players up in shooting positions; 3) the left and right backs: who break the defenses from the goal area and assist, in most cases, the wings; 4) the pivot: who, in close partnership with the centre back, tries to exploit gaps and weaknesses in the opponent's defense, but also a scorer when he receives a good pass and speedily turns toward the goal; and 5) the wingers: who begin static attacks, stretching the opponent's defense and creating scoring chances, when possible[1].

There are a set of morphological characteristics that can be considered constitute basic attributes required for each playing position to enable teams to play effectively[2]. Specifically, the goalkeepers, the center backs and left/right backs are generally noted for their high stature, the center backs for being the most athletic (greater muscle mass) and the left/right backs for making powerful shots. The wings need to be fast, agile, and good at jumping, and in line with this, tend to have a lower fat percentage and be somewhat shorter and lighter than other players. Pivots need to be robust players (with a greater weight, fat mass and volume) who work well in one-to-one play. These features are routinely measured when new players join a team, since morphological optimization is essential for optimal athletic performance of each player.

These characteristics can be analyzed by defining the somatotype and its graphical representation, the somatochart, and measuring body composition[3,4]. Analysis of somatotype and body composition allows us to make comparisons between different sports, sexes and ages, as well as monitoring of individual athletes throughout their sporting career and at different points in each sporting season. At the same time, these tools help to guide nutritional interventions and/or individualized training plans in order to maximize player performance[5,6].

Given all this, the aim of the study was to assess body composition and somatotype in a professional men's handball team as a function of playing position of its members.

SUBJECTS AND METHODS

We conducted a cross-sectional descriptive study including 19 professional players of BM Valladolid (the first team) in the 2007 - 2008 season, aged between 20 and 36 years old and of four different nationalities (1 Montenegrin, 1 Serbian, 2 Slovenian and 15 Spanish players). The study was approved by the Ethics Committee of the center. All subjects were duly informed of the purpose of the study, and gave written informed consent to participate.

Anthropometric measurements were all taken by the same physician in January 2008 (about half way through the season), after the first week of fitness training and immediately after a two-week period in which players had had three weekly muscle strengthening sessions (explosive strength and resistance) and two weekly sessions with a medicine ball and running with body weights. The protocols of the National Health and Nutrition Examination Survey[7] and the World Health Organization[8] were followed.

Specifically, the physician measured body weight with a SECA scale (Hamburg, Germany) to the nearest 100 g; height with a SECA stadiometer (Hamburg, Germany), to the nearest 0.1 cm; skinfold (triceps, biceps, subscapular, suprailiac, abdominal, thigh and calf) thickness, with a Holtain skinfold caliper (Holtain, UK) with a constant pressure (10 g/mm^2); body circumferences (arm and calf), with an inextensible metallic tape (Lufkin Executive Thinline W 606); and bone diameters (biestiloid, humeral and femoral), with a Cescorf bone caliper(Cescorf, Brazil).

From the anthropometric measurements, the body mass index (BMI) and body composition were calculated, using the equations of Yuhasz modified by Carter[9], Rocha[10] and Würch[11] to estimate fat mass (FM), bone mass (BM) and residual mass (RM), respectively. Muscle mass (MM) was calculated by subtracting the sum of the FM, BM and RM (kg) from body weight (kg), and fat-free mass (FFM) by summing the BM, RM and MM. The Heath & Carter equations[12] were used to estimate the somatotype components.

The statistical analysis of the data was performed using IBM SPSS Statistics for Windows, version 22. Parametric variables were described as mean (standard deviation -SD-) and the variables that did not follow a normal distribution, as median (interquartile range). The normality of the data distribution was assessed by the Kolmogorov-Smirnov or Shapiro-Wilk test, depending on the sample size analyzed. To examine differences between the variables studied as a function of playing position (central back, left/right back, wing, pivot or goalkeeper), we used analysis of variance , with post hoc Scheffe tests when data followed a normal distribution, and the Kruskal-Wallis test and subsequent pairwise comparisons with the Mann-Whitney U test (with Bonferroni correction)

for non-parametric variables. Values of $p<0.05$ were considered statistically significant.

RESULTS

The mean height and weight of the team members were 192.2 (8.9) cm and 92.1 (11.7) kg, respectively. The mean BMI was 24.9 (2.9) kg/m^2, indicating a normal nutritional status according to the World Health Organization classification[8].

Table 1 shows the general characteristics of the players as a function of playing position. As can be seen, despite the small size of the groups (4 center backs, 7 left/right backs, 3 wings, 2 pivots and 3 goalkeepers), statistically significant differences were observed in weight, pivots being the heaviest players; they also had a higher BMI, although differences did not reach statistical significance. Left/right backs were the second heaviest players and significant differences were observed between the wings, pivots and this group. As would be expected, the wings were somewhat smaller and lighter. Goalkeepers were also lighter than the backs and pivots, and were the players with the lowest BMI.

Table 1: general characteristics of players as a function of playing position.

Position	Height (cm)	Weight (kg)	BMI (kg/m^2)
Central back	191.2 (186.5 – 192.5)	88.8 (83.6 – 90.5)[a]	24.5 (23.0 – 25.6)
Left/right back	196.8 (193.5 – 201.9)	96.7 (90.7 – 102.3)[a.b]	24.6 (23.6 – 25.3)
Wing	177.6 (177.1 – 178.3)	80.2 (79.7 – 81.7)[a]	25.4 (25.2 – 25.9)
Pivot	195.2 (188.6 – 201.7)	114.5 (105.0 – 121.4)	30.3 (26.4 – 34.1)
Goalkeeper	194.2 (192.5 – 197.6)	82.9 (82.3 – 88.1)[a]	22.4 (21.5 – 23.6)

The results are describes as median (P25-P75).
[a]$p<0.05$ with respect to pivots; [b] $p<0.05$ with respect to wings.

Skinfold thicknesses, and body diameters and circumferences are reported in Table 2 as a function of playing position. Arm circumference was larger among the pivots and smaller among the goalkeepers than all the other groups of players, differences being statistically significant in all cases. Higher values of mean biestiloid diameter were found in left/right backs and pivots (groups with the highest body weight), values being similar across the other groups.

Table 2: Anthropometric characteristics as a function of playing position.

	Central back	Left/right back	Wing	Pivot	Goalkeeper
Skinfolds (mm)					
Triceps	7.0 (6.0 – 8.0)	8.0 (5.0 -10.0)	8.0 (7.5 – 8.5)	15.5 (10.0 – 21.0)	10.0 (9.5 – 10.5)
Subscapular	8.5 (6.0 – 11.5)	9.0 (6.5 – 12.5)	12.0 (9.5 – 12.5)	20.5 (16.0 – 25.0)	9.0 (7.5 – 11.0)
Suprailiac	16.5 (10.0 – 19.0)	12.0 (10.5 – 21.5)	19.0 (16.0 – 26.0)	27.0 (15.0 – 39.0)	18.0 (12.0 – 20.5)
Abdominal	17.5 (9.5 – 23.5)	12.0 (9.5 – 17.5)	21.0 (18.0 – 21.5)	26.5 (20.0 – 33.0)	13.0 (11.5 – 17.0)
Thigh	11.0 (6.0 – 15.5)	10.0 (9.0 – 16.5)	17.0 (15.5 – 19.5)	18.5 (11.0 – 26.0)	11.0 (11.0 – 11.5)
Calf	6.5 (3.5 – 9.0)	9.0 (4.0 – 11.0)	7.0 (5.5 – 7.0)	15.5 (12.0 – 19.0)	6.0 (5.5 – 8.0)
Bone diameters (cm)					
Humeral	6.8 (6.4 – 7.1)	7.2 (6.9 – 7.3)	6.8 (6.7 – 6.9)	6.9 (6.7 – 7.1)	6.8 (6.7 – 6.8)
Biestiloid	5.8 (5.8 – 5.9)	6.2 (6.1 – 6.3)[b.c.e]	5.8 (5.7 – 5.9)	6.1 (5.9 – 6.3)	5.9 (5.8 – 6.0)
Femoral	8.9 (8.5 – 9.2)	9.4 (8.9 – 9.9)	8.6 (8.3 – 8.8)	9.8 (9.6 – 10.0)	8.7 (8.7 – 9.3)
Body circumferences (cm)					
Relaxed arm	32.4 (31.1 – 32.8)	33.4 (33.2 – 34.0)	33.3 (33.2 – 33.4)	36.7 (35.4–37.9)[a.b.c.e]	29.2 (28.2 – 29.6)[a.b.d.e]
Calf	38.7 (38.1 – 39.5)	39.2 (38.5 – 40.8)	40.0 (38.7 – 40.6)	43.6 (43.2 – 44.0)	39.2 (36.7 – 39.3)

The results are described as median (P25-P75).
[a]p<0.05 respect to left/right backs; [b]p<0.05 respect to wings; [c]p<0.05 respect to goalkeepers; [d]p<0.05 respect to pivots; [e]p<0.05 respect to center backs.

Body composition as a function of playing position is shown in Table 3. We found statistically significant differences between pivots and other players for all body compartments. Specifically, pivots are the players with the highest percentage of FM and lowest percentage of FFM, MM and BM. Body composition varied little between the other groups of players.

Table 3: Body composition as a function of playing position.

	Central back	Left/right back	Wing	Pivot	Goalkeeper
BM (%)	14.4 (13.7 – 15.0)	15.0 (14.6 – 15.3)	13.8 (13.4 – 14.1)	12.8 (11.3 – 14.3) [a.c.e]	15.7 (15.2 – 16.1)[b]
RM (%)	24.1 (24.1 – 24.1)	24.1 (24.1 – 24.1)	24.1 (24.1 – 24.2)	24.1 (24.1 – 24.1)	24.1 (24.1 – 24.1)
FM (%)	10.3 (7.6 – 12.0)	10.6 (8.2 – 11.7)	10.8 (10.7 – 12.3)	15.6 (11.8 – 19.5) [a.b.c.e]	10.3 (9.6 – 11.0)
FFM (%)	89.7 (88.0 – 92.4)	89.4 (88.3 – 91.8)	89.2 (87.7 – 89.3)	84.4 (80.5 – 88.2)[a.b.c.e]	89.7 (89.0 – 90.4)
MM (%)	51.5 (50.1 – 53.3)	50.4 (49.5 – 52.6)	51.1 (49.6 – 51.6)	47.5 (45.1 – 49.8) [a.b.c.e]	49.6 (49.4 – 50.5)

BM, bone mass; RM, residual mass; FM, fat mass; FFM, fat-free mass; MM, muscular mass. The results are described as median (P25-P75).
[a]p<0.05 respect to left/right backs; [b]p<0.05 respect to wings; [c]p<0.05 respect to goalkeepers; [d]p<0.05 respect to pivots; [e]p<0.05 respect to center backs.

Table 4 shows the endomorphy, mesomorphy and ectomorphy values of the BM Valladolid players grouped by playing position. Statistically significant differences in mesomorphy were found comparing central backs with wings, and wings with goalkeepers.

Table 4: Somatotype as a function of playing position.

	Central back	Left/right back	Wing	Pivot	Goalkeeper
Endomorphy	2.7 (1.2)	2.8 (1.3)	3.9 (1.1)	5.3 (2.5)	3.1 (1.1)
Mesomorphy	*3.0 (2.1–3.4)[a]*	*2.5 (2.2–3.0)[a]*	*4.6 (4.3–4.7)*	*4.1 (3.0 – 5.3)*	*2.2 (0.9–2.2)[a.b]*
Ectomorphy	2.7 (1.1)	3.1 (0.9)	1.5 (0.3)	1.3 (1.7)	3.8 (1.2)

The results are described as average (SD) and *median (P25-P75)*.
[a]p<0.05 respect to wings; [b]p<0.05 respect to pivots.

Finally, Figure 1 is a somatochart for the players grouped by playing position.

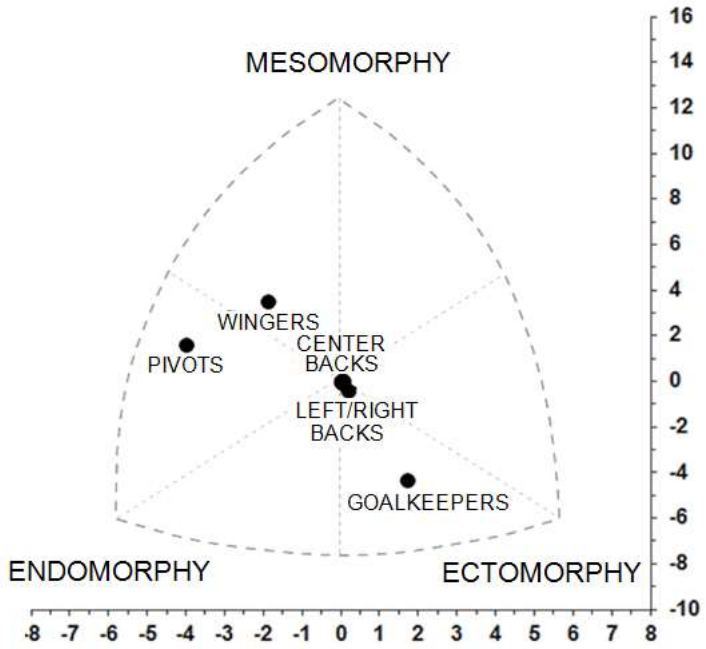

Figure 1: Somatochart with player ratings grouped by playing position.

DISCUSSION

The BM Valladolid players were similar in age, weight and BMI to the national teams of Germany, France and Iceland[13]. Regarding height, the team profile only resembles that of the Spanish and Russian national teams, the players being shorter than those of the national teams of Germany, Croatia, Denmark, Poland and Belarus[13].

Overall, results are consistent with those of other authors, such as Eston et al.[14], who note that appropriate values in height and weight are critical (in left/right backs) for achieving optimal levels for shooting and Bayer[15], Seco[16] and García et al.[17], who observed that the best elite teams are those with the greatest mean height. Higher BMIs are also essential, especially in one-to-one situations, and hence, it is desirable that pivots have the highest BMI values.

As expected, in our study, it was observed that pivots were significantly heavier players. Further, although differences were not statistically significant, probably because of the small sample sizes, wings were the least heavy and left/right backs, together with pivots, the heaviest (Table 1), this pattern conforming with the basic morphological characteristics that can be considered optimal for each position. Regarding BMI, the pivots had the highest values and the goalkeepers the lowest, but none of the differences between groups reached significance.

Values of height, weight and BMI obtained in this study based on the playing position are generally comparable to those of players in a study of the players of

24 national teams participating in the 2013 Men's Handball World Championship[13]. Notably, however, the BM Valladolid players were taller than the 2013 World Championship players in all positions except for the wings. Regarding body weight, we found lower values in our study in all groups except wings and goalkeepers, the difference being most marked in the case of goalkeepers (82.0 kg in the BM Valladolid team vs. 95.6 kg in the 2013 World Championship). Finally, in relation to BMI, the distribution was similar in the two studies, except in the case of goalkeepers (higher in 2013 World Championship players) and pivots (higher in the BM Valladolid team). We should note, however, that in our study the mean BMI in the pivots is influenced by an outlying value in one of the pivots, making it difficult to compare this variable with data from other studies[18].

Nikolaidis et al.[19] reported similar values of these variables to those obtained in our study, except for central backs and right/left backs, which were included in the same group, and hence, comparisons cannot be made. In contrast, the results of Urban et al.[19], who analyzed 256 players from 16 national European handball teams of the European Handball Federation (EHF), show more differences with our study in terms of weight and BMI for different positions.

Regarding other anthropometric parameters, the most notable pattern was the variation in arm circumference as a function of playing position (Table 2). This measure is associated with the volume of the biceps and triceps brachii muscles. As expected, the most notable differences were found between the pivots and the goalkeepers. This is attributable to the fact that the pivots, given their defensive function, must develop this muscle through resistance training, while goalkeepers require explosive strength (without developing growth in volume -hypertrophy-) to gain reaction speed in their limbs and improve their performance in ball interception[21]. Arm circumference values in our study were similar to those reported by Urban et al.[22], except in the case of goalkeepers for whom we found lower values. Regarding body composition, the values obtained for FFM, MM and BM in our team are also similar to those of the teams of Portugal, Iceland and Slovenia[20].

Moreover, the somatotype study showed significant differences in endomorphy, mesomorphy and ectomorphy components as a function of playing position (Figure 1). Specifically, wings can be categorized as endomorph-mesomorph; and the pivots as mesomorph. The mesomorphic component was the least dominant in the goalkeepers, and this may be related to the type of training they tend to do in the gym (hypertrophy and toning workouts – resistance training), working to strengthen their explosive force through sport specialization. Finally, no significant differences were observed between components for either the central or the left/right backs in the somatochart, and both can be categorized as having a central somatotype.

For comparison, we have found few studies that have built a somatochart to analyze players in professional handball teams. Exceptions include Urban et al.[23], who published a somatochart of players of the 2010 U20 European Cup Championship with very different results from those obtained in the present work. In addition, Canda et al.[4], from a sample of 1250 top Spanish male

players of various different sports (15 of them being handball players) and Pons et al.[24], analyzing a group of 17 high-level handball players, obtained similar values to those of the 2010 U20 European Cup Championship[23] and considerably different from those observed in our sample of BM Valladolid players. In this regard, we should consider the differences in the age of these various samples; the mean age of the BM Valladolid players was 27 years (range: 23-35 years), while the other studies focused on younger players, Urban et al.[23] having studied a group aged 19 to 20 years, Canda et al.[4] a group with a mean age of 23.6 years, and finally, Pons et al.[24] a group with a mean age of 21.9 years. Although the level of specialization is the same in these teams (elite teams), differences in age hinder comparisons between the BM Valladolid sample and other teams.

On the other hand, regardless of age, the somatotypes and anthropometric characteristics observed in BM Valladolid players are not very different from the usual anthropometric characteristics of each playing position[22], as set out below:

- Central backs: athletic mesomorphic morphotype with high stature. BM Valladolid central backs have a mean height of 191.2 cm (second tallest after the left/right backs) and are the team members with the highest percentage of muscle mass (> 51%). Their morphotype is central; and probably the differences with players from other studies can be attributed to height.

- Left/right backs: taller, larger arm span and with a larger bone diameter. They are the tallest players on the team (196.8 cm).

- Wings: shorter, lighter and lower fat percentage. In our sample, the wings are those with the lowest height (177.6 cm) and least weight.
-
- Pivots: heaviest, higher fat mass and greater body volume.

- Goalkeepers: longer and larger diameter bones, and tall. BM Valladolid goalkeepers have a high stature (194.2 cm), although differences in bone diameters observed were not significant with respect to other playing positions.

CONCLUSION

Observing the results obtained, we can say that the anthropometric variables, body composition results and somatochart of the athletes of the professional team of BM Valladolid during the 2007-2008 season conform with the pattern of basic morphological characteristics commonly observed in handball players, differences between players being consistent with the roles of each position.

REFERENCES

1. International Handball Federation (IHF). Regulations for IHF Competitions [Internet]; 2007. [updated sept 2007; accessed 05 Nov 2015]. Available at: http://www.ihf.info/upload/Manual/IHF_STATUTS_CHAP_05_GB.pdf
2. Srhoj V, Marinovi M, Rogulj N. Position specific morphological characteristics of top-level male handball players. Collegium Antropologicum. 2002; 26(1):219–27.
3. Martin EA. Concise Medical Dictionary (Oxford Quick Reference). Oxford: Oxford University Press; 2010.
4. Canda AS. Variables antropométricas de la población deportista española. Madrid: Consejo Superior de Deportes; 2012.
5. Borms J. Ross WD, Duquet W, Carter JEL. Somatotypes of world class body builders. En: Day JAP. Perspectives in kineanthropometry. Champaign III: Human Kinetics; 1986. P.81-90.
6. Fernández JA, Rubiano PA, Hoyos LA. Perfil morfológico de voleibolistas de altos logros. Revisión / Volleyball Players Morphological Profile of High. Review Article. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte; 201x (pending publication).
7. NHANES CDC. Anthropometry Procedures Manual; 2007.
8. World Health Organization (WHO). Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Geneva: WHO Technical Report Series; 1995.
9. Carter JEL. Body composition of Montreal Olympic athletes. In: Anonymous Physical Structure of Olympic Athletes Part I the Montreal Olympic Games Anthropological Project. Switzerland: Basel, 1982; 107-16. DOI: https://doi.org/10.1159/000406783
10. Rocha MSL. Peso ósseo do brasilerio de ambos os sexos de 17 a 25 años. Arquivo de anatomia e antropología. 1975; 1:445.
11. Würch A. La femme et le sport. Médecine Sportive Francaise. 1974; 4(1).
12. Carter JEL, Heath BH. Somatotyping: Development and Applications. Cambridge: Cambridge University Press, 1990.
13. Ghobadi H, Rajabi H, Farzad B, Bayati M, Jeffreys I. Anthropometry of World-Class Elite Handball Players According to the Playing Position: Reports From Men's Handball World Championship. Journal of Human Kinetics. 2013; 39:213–20. DOI: https://doi.org/10.2478/hukin-2013-0084
14. Eston R, Reilly T. Kinanthropometry and exercise physiology laboratory manual: Tests, procedures and data (1st). London: Routledge. 2001.
15. Bayer C. Técnica del Balonmano La Formación del Jugador (1st). Barcelona: Editorial Hispano Europea SA. 1987.
16. Seco JDR. Ideas para un juego de ataque moderno y atractivo. En Documentos en balonmano. Madrid: INEF, Universidad Politécnica de Madrid. 1993.
17. García LA, Moreno MA, García JG. Análisis del XII campeonato del mundo de balonmano. Real Federación Española de Balonmano. 1991.
18. Massuça, L, Fragoso I. Morphological Characteristics of Portuguese Handball Players. Collegium Antropologicum. 2015; 39:109–18.
19. Nikolaidis PT, Ingebrigtsen J, Póvoas SC, Mossm S, Torres-Luque G. Physical and physiological characteristics in male team handball players by

playing position - Does age matter? Journal of Sports Medicine & Physical Fitness. 2015; 55(4):297-304.
20. Urban F Kandráč R, Táborský, F. Position-related anthropometric profiles of top level handball players [Internet]; 2011. [accessed 05 Nov 2015]. Available at: http://home.eurohandball.com/ehf_files/Publikation/WP_PositionRelated%20Anthropometric%20Profiles%20of%20Top%20Level%20Handball%20Players.pdf
21. Chirosa LJ, Chirosa I, Padial P. Planificación y secuenciación de un modelo de entrenamiento integrado dentro del juego complejo del balonmano. Lecturas: Educación física y deporte. Revista digital. 1998; 3:11.
22. Urban F, Kandráč R, Táborský F. Position-related changes in anthropometric profiles of top male handball players: 1980 and 2010. In: EHF Scientific Conference 2011. Science and Analytical Expertise in Handball (Scientific and practical approaches).Vienna, Austria; 2011.
23. Urban F, Kandráč R, Táborský F. Anthropometric Profiles and Somatotypes of National Teams at the 2010 Men's 20 European Handball Championship. [Internet]; 2010. [accessed 05 Nov 2015]. Available at: http://home.eurohandball.com/ehf_files/Publikation/WP_Anthropometric%20Profiles%20and%20Somatotypes%20of%202010%20ECh%2020%20Mens%20Teams.pdf
24. Pons V, Riera P, Galilea A, Drobnic F, Banquells M, Ruiz O. Características antropométricas, composición corporal y somatotipo por deportes. Datos de referencia del CAR de San Cugat, 1989-2013. Apunts Medicina de l'Esport; 2015.

Número de citas totales / Total references: 24 (100%)
Número de citas propias de la revista / Journal's own references: 1 (4,16%)