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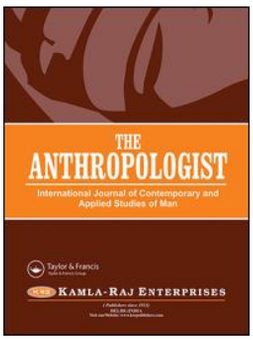

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Position Specific Morphological Characteristics of Top-level Male Macedonian Handball Players

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KEYWORDS Athletes. Anthropometry. Anthropometric Indices. Somatotype

ABSTRACT The research was realized on a sample of 133 top handball senior players with the main objective to analyze the anthropometric characteristics and somatotype components in terms of the position at which they play in the team. Within the statistical analysis the basic descriptive parameters are being calculated and a univariate analysis of variance and post-hoc analysis are applied. A general mesomorphic athletic is obtained with obvious longitudinal dimensionality of the skeleton, even compared to the bone and muscle tissue and slightly higher values of fat and endomorphic component especially for goalkeepers and the pivot. The external lateral players and the goalkeepers are characterized by dominant pronounced longitudinal dimensionality, bone composition and voluminosity. The wing players have lower longitudinal dimensionality, while the central players are characterized with pronounced voluminosity and somewhat larger amounts of fat tissue.

INTRODUCTION

Performances and success in the sport depend on many factors and specific features, such as genetic predispositions, fitness, motor and mental abilities, tactical training and anthropometric profile. Physical parameters, such as stature, body composition (muscle to fat ratio) somatotype components can inûuence performance and success in competition besides other factors. In that context, the somatotype components give significant information about her/his anthropometric proûle; combining fatness, skeletal muscle mass and linearity or slenderness of a physique (Carter and Heath 1990). In a number of studies, somatotype and anthropometric characteristics were analyzed in collective sports, such as basketball (Vaquera et al. 2015; Ramos-Campo et al. 2014; Gutnik et al. 2015; Peña et al. 2016), handball (Sibila and Pori 2009; Ghobadi et al. 2013; Massuça and Fragoso 2013; Vaquera et al. 2015; Ramos-Campo et al. 2014; Gutnik et al. 2015; Nikolaidis et al. 2015; Peña et al. 2016), or rugby (Holway and Garavaglia 2009; Zemski et al. 2015), and also in individual sports, for example, tennis (Sánchez-Muñoz et al. 2007), gymnastics (Massidda et al. 2013) or cycling (McLean and Parker 1989). Observing the morphology of players, in terms of the position they play at, is of key importance for coaches for the purpose of successful planning, programming and organizing trainings and matches.

Handball is an intense team contact sport. Its structure contains elements of movements such as running, jumping, sprinting, swinging, hitting, blocking and pushing in interactive contact with an opponent during the game (Vrbik et al. 2011). The specifics of the handball game from technical-tactical and physical aspect, requires, anthropological model of "top player" in which the level and structure of motor and morphological characteristics should be optimally aligned. Recent scientific research dealing with the morphological profile of top players suggest that the model of an ideal player is characterized by athletic structure in prevailing mesomorphic somatotype component with a certain amount of ectomorph component, which is emphasized in the longitudinal dimensionality of the skeleton (Srhoj et al. 2001; Massuça and Fragoso 2013; Vaquera et al. 2015; Ramos-Campo et al. 2014; Gutnik et al. 2015; Nikolaidis et al. 2015; Peña et al. 2016).

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Yet, in handball, as in other team games, the court - field zones and phases of the game dictate the space phase position-specific repertoire of technical and tactical elements a player should perform in a particular moment of a match game (Srhoj et al. 2001).

Assuming that the players of the highest rank will be discriminated against each other in morphological space as a gaming position, the authors of this study realized research whose main objective is to analyze the characteristics of quality male handball players in comparison to the position at which the team play (backs, center backs, wings, pivot and goalkeeper).

METHODOLOGY

Subjects

The research is realized in theLaboratory of Functional Testing, Department of Physiology and Anthropology at the Medical Faculty in Skopje, where all sportsman form the Republic of Macedonia are obliged to have a regular medical-sports examination at least twice a year.

The sample consisted of 133 players who play in the best clubs of the first Macedonian league at the age of 24.1 ±3.9 years. Distribution of the players across the playing positions was: back court players (backs) – 43, wing players (wings) – 33, circle runner attack players (pivots) – 16, goalkeepers – 20 andc entreback–21.The respondents were proceeded in accordance with the Helsinki Declaration.

Protocols and Equipment

All measurements were implemented by high skilled, trained and experienced technicians. Height and weight were measured by using a stadometer (Seca, Leicester, UK) and electronic scales (HD-351, Tanita, Illinois, SAD). The skin folds were measured by the help of John Bull calipers. The volumes were measured by standard elastic band, while the diameters by using sliding calipers (GPMc).

Besides height and weight were measured following anthropometric measures: four diameters (elbow, wrist, knee and ankle); five circumferences (upper arm, both relaxed and flexed, forearm, the calf and the thigh) as well as seven skin folds (biceps, triceps, forearm, thigh, calf, subscapular and supra-iliac). Anthropometric parameters were analyzed by a special software program that utilizes all Mateigka's formulas intended for calculations of all body components (Cattrysse et al. 2002). Somatotyping components (endomorphy– mesomorphy-ectomorphy) were calculated according to Carter and Heath method (1990), using the somatotype software (Somatotype V.1_2_5).

Statistical Methods

The data were analyzed using the Statistical Package for Social Sciences software (SPSS v. 22.0 for WINDOWS; SPSS Inc., Chicago, IL, USA), and values of $p<0.05$ were considered statistically significant. Basic descriptive parameters of anthropometric variables were calculated: arithmetic mean, standard deviation (SD), minimum and maximum value of the results registered (MIN, MAX). The normality of distribution was verified following the Kolmorgor-Smirnov test. The between positions differences were computed by the univariate analyses of variance (ANOVA) and LSD test was used as a post-hoc test.

RESULTS

The results of the basic descriptive analysis (Table 1) indicate that most of the applied variables are normally distributed. The table shows the parameters of the univariant analysis of the variance. From the review of the table it can be seen that the statistically significant univariant between group differences in the anthropometric measures and measures for assessing body composition among the players who play different position set out in: Height (F= 13.76, p=.000), Weight (F= 8.25, p=.000), BMI (F= 5.13, p=.001), Diameter elbow (F= 3.00, p=.021), Circumference upper arm (F= 3.69, p=.007), Circumference upper arm flex (F= 3.02, p=.020), Circumference thigh (F= 4.97, p=.001), Circumference forearm (F= 3.81, p=.006), Circumference calf (F= 2.45, p=.049), Skin fold forearm (F= 2.38, p=.055), Skin fold triceps (F= 3.49, p=,010), Skin fold subscapular (F= 4.56, p=.002), Skin fold calf (F= 3.69, p=.007), Skin fold supra-iliac (F= 4.67, p=.001), MMkg (F= 2.92, p=.024), Bone mass - BMkg (F= 3.25, p=.014), Fat mass - FMkg (F= 4.25, p=.003), percent of body fat - FM% (F= 7.42, p=.000), and Lean body mass - LBM (F= 7.44, p=.000).

Table 1: Descriptive statistics and results of univariate analysis of variance for morphological variables in 133 handball players

	N	*Mean*	*SD*	*Min*	*Max*	*F*	*Sig.*
Height	133	186.84	5.99	175.50	198.00	13.76	.000
Weight	133	91.41	10.31	69.50	115.50	8.25	.000
BMI	133	26.19	2.77	20.08	34.47	5.13	.001
			Diameters (mm)				
Wristdiameter	132	58.81	3.41	52.00	68.00	2.03	.095
Knee diameter	133	106.07	6.25	95.00	126.00	1.02	.400
Elbow diameter	133	86.96	6.13	72.00	102.00	3.00	.021
Ankle diameter	133	76.27	5.22	64.00	88.00	0.55	.703
			Circumference (mm)				
Circumference of upper arm	133	324.85	25.99	245.00	370.00	3.69	.007
Circumference of upper arm flex	133	359.16	27.85	234.50	420.00	3.02	.020
Circumference of thigh	132	615.42	43.66	500.00	730.00	4.97	.001
Circumference of forearm	133	294.70	20.21	250.00	350.00	3.81	.006
Circumference of calf	133	400.19	27.64	320.00	490.00	2.45	.049
			Skin Fold (mm)				
Biceps skin fold	132	5.81	1.90	3.10	12.60	1.80	.134
Forearm skin fold	133	7.54	2.45	4.00	17.30	2.38	.055
Triceps skin fold	133	10.79	3.93	5.10	25.80	3.49	.010
Thigh skin fold	132	17.32	6.26	5.80	38.00	1.98	.101
Subscapular skin fold	133	13.67	5.26	6.40	32.10	4.56	.002
Calf skin fold	133	12.95	4.33	5.10	28.00	3.69	.007
Supra-iliac skin fold	133	11.50	5.58	4.00	37.40	4.67	.001
			Body Composition				
MMkg (Muscle mass)	133	49.87	7.47	17.03	65.12	2.92	.024
BMkg (Bone mass)	132	15.12	1.77	11.32	20.19	3.25	.014
MM% (% of muscle mass)	133	54.56	5.40	20.51	63.37	0.70	.594
BM% (% bone mass)	132	16.53	1.93	4.59	21.41	1.31	.271
FMkg (Fat mass)	133	16.72	6.59	6.81	40.57	4.25	.003
FM% (% of body fat)	133	15.34	3.88	8.93	27.56	7.24	.000
LBM (Lean body mass)	133	76.07	7.37	59.93	91.07	7.44	.000
			Somatotype				
Endomorphic	133	3.12	1.08	1.41	6.54	.090	.090
Mesomorphic	133	5.75	1.15	2.94	7.94	.158	.158
Ectomorphic	133	2.12	0.86	1.00	4.77	.140	.140

The between positions differences were obtained by the post-hoc analysis of variance (Table 2). The results from the analysis indicate that there are differences in the morphological profile among the players who play at different positions in the team. The biggest differences are established between external lateral attackers (backs), wingers and pivots. Wingers have statistically significantly lower body height in terms of the players who play at other positions in the team. Pivots have statistically higher body weight in terms of the back, central back and wings. Pivots have statistically significantly bigger upper arm and calf circumference in terms of the goalkeeper. Wingers have statistically significantly smaller forearm circumference in terms of the players who play at other positions in the team and statistically significantly smaller elbow diameter compared to the back or pivot. Pivot have statistically significantly larger skin folds on the triceps, subscapular and suprailiac, compared to backs, wingers and the central back

Table 2: Mean values, SD and post-hoc analysis of variance (LSD - test) for morphological variables in six groups of handball players

	Goalkeepers	*Backs*	*Wings*	*Pivots*	*Centre back*
Height	187.90±5.03	190.62±5.53	182.03±4.16	186.69±6.52	185.79±4.19
Weight	94.68±11.57	92.80±8.84	84.91±7.18	99.69±10.66	89.36±9.96
BMI	26.83±3.35	25.54±2.16	25.62±1.97	28.69±3.65	25.87±2.62
Diameters (mm)					
Wrist	58.30±3.69	59.88±3.75	57.75±2.93	58.88±2.39	58.67±3.38
Knee	105.65±4.83	106.12±6.36	105.70±6.21	108.81±8.56	104.86±5.14
Elbow	86.95±4.50	87.91±5.89	84.21±5.88	89.88±5.84	87.14±7.32
Ankle	76.90±5.96	76.86±5.54	75.27±4.67	76.50±4.50	75.86±5.31
Circumference (mm)					
Upper arm	322.25±23.87	325.23±24.81	315.00±22.81	343.75±27.36	327.62±27.78
Upper arm flex	358.25±24.51	360.56±23.13	349.39±24.77	377.81±24.29	358.31±39.49
Thigh	628.75±40.06	609.88±42.88	599.09±34.81	652.00±51.26	613.57±40.41
Forearm	297.50±15.94	295.58±20.65	284.24±18.16	304.38±18.25	299.29±22.26
Calf	392.00±29.71	402.44±28.36	396.36±25.13	417.50±30.77	396.19±20.85
Skin Fold (mm)					
Biceps	6.28±2.28	5.50±1.94	5.44±1.41	6.69±2.21	5.87±1.73
Forearm	8.51±3.09	7.18±2.38	6.98±2.03	8.64±2.61	7.38±2.02
Triceps	12.27±4.64	10.37±3.79	9.72±3.44	13.28±4.76	10.00±2.35
Thigh	18.56±7.70	17.32±5.45	15.39±6.07	20.43±6.49	16.98±5.84
Subscapular	16.55±7.50	12.37±3.49	12.83±4.05	16.88±7.10	12.49±4.09
Calf	15.12±4.46	12.38±4.05	11.47±4.14	15.10±4.98	12.71±3.41
Supra-iliac	13.86±7.14	10.17±3.66	10.19±4.10	15.62±7.83	10.87±5.46
Body Composition					
MMkg	50.68±5.37	50.70±8.16	46.46±5.28	53.29±10.58	50.16±6.45
BMkg	15.10±1.68	15.66±1.91	14.33±1.47	15.64±1.39	14.92±1.86
MM%	53.74±3.53	54.50±6.29	54.70±3.73	53.47±9.01	56.09±3.21
BM%	16.07±2.01	16.62±2.42	16.92±1.48	15.78±1.45	16.74±1.53
FMkg	18.79±7.82	16.14±6.33	14.51±5.16	21.65±8.20	15.67±4.23
FM%	17.29±5.18	14.99±2.96	13.63±2.50	18.61±4.95	14.39±2.98
LBM	77.39±7.56	77.81±6.76	71.27±5.53	81.08±7.05	74.97±7.36
Somatotype					
Endomorphic	3.71±1.50	2.91±0.94	3.00±0.93	3.30±0.99	3.06±1.04
Mesomorphic	5.42±1.05	5.51±1.08	6.02±1.10	6.03±1.41	5.98±1.22
Ectomorphic	2.04±0.83	2.39±0.88	1.92±0.70	1.88±1.00	2.06±0.92

and statistically significantly larger skin folds on the calf on terms of the back and wingers. Goalkeepers have statistically significantly larger subscapular skin folds in terms of the back, winger and central back, statistically significantly larger skin folds on the triceps and forearm, in terms of the winger and suprailiac skin fold in terms of the back and wingers. Pivots and goalkeepers have the highest percentage of fat tissue, while wingers have the lowest percentage thereof. Pivots also have statistically significantly higher BMI compared to the players who play at other positions in the team. Mesomorphic component of the somatotype is the most apparent for wing players and the pivot. Endomorphic component of the somatotype is most apparent for the goalkeeper and the pivot, and least apparent for the backs. Ectomorphic component of the somatotype is most apparent for the backs and least apparent for pivots.

DISCUSSION

The current research suggests that the morphological characteristics and body composition can influence the selection of sportsman in many sports (Hasan et al. 2007). To be successful in a particular sport discipline it is very important for the sportsman to have adequate anthropometric characteristics - morphological structure (Ziv and Lidor 2009; Massuça and Fragoso 2013; Vaquera et al. 2015; Ramos-Campo et al. 2014; Gutnik et al. 2015; Nikolaidis et al. 2015; Peña et al. 2016). Handball is a game characterized by frequent contacts with the body and

high intensity of activity during the match (Póvoas et al. 2012). Knowledge of the physical characteristics of handball players can provide insight into the individual factors which influence the players' performance in the game (Hasan et al. 2007).

Certain anthropological characteristics have significant influence on the position related to performance in sports (Sibila and Pori 2009). The results of this research indicate that some differences exist with anthropometric characteristics, body composition and components of the somatotype between the players who play different positions in the team. The differences are most emphasized in body height, weight, skin folds, some volumes and percentage of body fat. The results somewhat overlap with the results realized so far on the male and female handball players (Chaouachi et al. 2009; Sibila and Pori 2009; Srhoj et al. 2002).

Players who play the external position (side backs) have the highest body height and their volumes of all segments of the body are relatively high. A strong body and a strong constitution, the high stature and generally greater body mass are more important for backs in terms of the wings. The main function of backs seen from the kinesiology aspect is the most complex of all positions in the handball game. During the competition, they possess the ball most of the time and with the central backs participate in organizing the game, kick on the goal from distance and in defense hinder the players from the opponent team. Greater longitudinal dimensions and longer levers are important because they allow strong and efficient kicking to the goal through the opponent area. Furthermore, greater height allows better visual control of the terrain and position of players on it. Greater heights are also desirable for more efficient cooperation with the line players (wings and pivot).

The wing players have less body height, a lower volume of the forearm compared to the players who play other positions, lower body mass compared to the goalkeeper, side backs and the pivot, lower volume of the upper arm compared to pivot and smaller skin fold and the percent of the fat tissue. Great body mass is less important for the wing players because they operate in specific situations, seldom have direct contact with the opponent players, that is opposite in terms of the pivot. Yet because their wing players act in the attack in a limited place and unfavorable conditions for kicking the goal (under certain angles) main feature of their game is dynamism and agility in the movement without the ball and with the ball. Therefore, lower percentage of fat is a desired characteristic. A greater longitudinal dimensionality, especially of the hands is also important because it can facilitate and improve the efficiency of kicking the goal.

The pivot significantly differs in terms of the players that play other positions in the team for its morphological profile. The pivot has higher body mass index compared to the players who play other positions, greater weight of the side backs, wings and central backs, a larger volume of the upper arm in terms of the goalkeepers, side backs and wings, a larger volume of the forearm compared to goalkeepers, wings and central backs. Also, the pivot has larger skin folds of the upper arm, triceps, forearm regarding side backs and wings and larger skin folds on the tigh, shin, suprascapular, suprailliac and total percent of fat tissue in terms to the side backs, wings and central backs. Pivot in attack usually play with back or lateral facing the goal of the opponent. He must be able to capture and hold a stable position in constant contact with the opponent players and to fight for more advantageous position. These actions are followed by pushing, resisting, turning, often with an opponent players on back, in a word a great static tensions in a very short and dyniamic actions. These morphological characteristics allow the pivot to carry out the tasks required form him. The low center of gravity of the body, a strong upper body which is longer than the bottom allows obtaining and maintaining of stability, the greater muscle mass helps to control resistance and weight of the opponent player and relatively great total body mass is needed in terms of constants disruption and establishing the balance. Central backs vary in body height in terms to the side backs and goalkeepres. In the modern handball the anthropometric characteristics of these players should be similar to side backs, which is not the case in this study or Macedonian central backs are lower than the side backs. This is probably due to the decision of the coaches to set higher position players on the side backs. This research is consistent with some previous research that has found that the central backs are the shortest players in the team after wings players (Chaouachi et al. 2009).

The goalkeeper has greater skin fold of the scapula in terms of backs, wings and the central backs and greater skin fold of the shin and abdomen in terms of the side backs and wing players. The goalkeeper usually acts on a limiter place, and focuses on fast and explosive simple movements performed in a split second, that are not so demanding from the energy point of view. The goalkeeper is an athletic figure with emphasized longitudinal dimensionality of the skeleton. Top class goalkeepers should be tall enough and with substantial upper and lower extremities in order to cover a vaster area of their goalpost (Srhoj et al. 2002).

CONCLUSION

In order to determine the morphlogical characteristics of the elite Macedonian handball players and to analzye whether there are differences depending on the position that play, 29 anthropometric measures are applied to assess the longitudinal dimensionality, transvewrsal dimensionality, voluminosity and fat tissue (skin folds) and indirectly the body composition and the somatotype component is calculated. It is obtained a general mesomorphic athletic type with emphasized longitudional dimensionality of the skeleton, even compared to the bone and musle tissue and slightly higher values of fat tissue and endomorphic component espeacially for goalkeeper and pivot. The external laterla players and goalkeepers are characterized by dominant emphasized longitudinal dimensionality, bone composition and voluminosity. The wing players have lower longitudinal dimensionality, while the circular players are characterized by emphasized voluminosity and slightly larger amounts of fat tissue.

The researchers' results point to the fact that the choice of the players in handball for specific gaming positions must be based on the morphological characteristics of the players. Trainers should have a good knowledge of general and specific tasks that should be carried out by the player in the game. In the top, it is strictly recommended for certain positions in handball to select players with their morphological characteristics which are as much as possible compatible with requirements of the gaming place.

The obtained results can serve as normative anthropometric indicators for regular sports - medical examinations of the top players in the country. The data can also be used a template for comparison of the anthropometric and somatotype data of the top players from different countries.

REFERENCES

Carter JL, Heath BH 1990. *Somatotyping: Development and Applications*. Volume 5. Cambridge University Press.

Cattrysse E, Zinzen E, Caboor D, Duquet W, Roy PV, Clarys JP 2002. Anthropometric fractionation of body mass: Matiegka revisited. *Journal of Sports Sciences*, 20(9): 717-723.

Chaouachi A, Brughelli M, Levin G, Boudhina NBB, Cronin J, Chamari K 2009. Anthropometric, physiological and performance characteristics of elite team-handball players. *Journal of Sports Sciences*, 27(2): 151-157.

Ghobadi H, Rajabi H, Farzad B, Bayati M, Jeffreys I 2013. Anthropometry of world-class elite handball players according to the playing position: Reports from men's handball World championship 2013. *Journal of Human Kinetics*, 39(1): 213-220.

Gutnik B, Zuoza A, Zuozienë I, Alekrinskis A, Nash D, Scherbina S 2015. Body physique and dominant somatotype in elite and low-profile athletes with different specializations. *Medicina*, 51(4): 247-252.

Hasan AAA, Rahaman JA, Cable NT, Reilly T 2007. Anthropometric profile of elite male handball players in Asia. *Biology of Sport*, 24(1): 3-12.

Holway FE, Garavaglia R 2009. Kinanthropometry of group I rugby players in Buenos Aires, Argentina. *Journal of Sports Sciences*, 27(11): 1211-1220.

Massidda M, Toselli S, Brasili PM, Calo C 2013. Somatotype of elite Italian gymnasts. *Collegium Antropologicum*, 37(3): 853-857.

Massuça L, Fragoso I 2013. A multidisciplinary approach of success in team-handball. *Apunts. Medicina de l'Esport*, 48(180): 143-151.

McLean BD, Parker AW 1989. An anthropometric analysis of elite Australian track cyclists. *Journal of Sports Sciences*, 7(3): 247-255.

Nikolaidis PT, Ingebrigtsen J, Povoas SC, Moss S, Torres-Luque G 2015. Physical and physiological characteristics in male team handball players by playing position: Does age matter. *Journal of Sports Medicine and Physical Fitness*, 55(4): 297-304.

Peña J, Moreno-Doutres D, Coma J, Cook M, Buscà B 2016. Anthropometric and fitness profile of high-level basketball, handball and volleyball players. *Revista Andaluza de Medicina del Deporte*. DOI: 10.1016/j.ramd.2016.03.002.

Póvoas SC, Seabra AF, Ascensão AA, Magalhães J, Soares JM, Rebelo AN 2012. Physical and physiological demands of elite team handball. *The Journal of Strength & Conditioning Research*, 26(12): 3365-3375.

Ramos-Campo DJ, Martínez Sánchez F, Esteban García P, Rubio Arias JÁ, Bores Cerezal A, Clemente-Suarez VJ, Jiménez Díaz JF 2014. Body composition features in different playing position of professional team indoor players: Basketball, handball and futsal. *Int J Morphol*, 32(4): 1316-1324.

Sánchez-Muñoz C, Sanz D, Zabala M 2007. Anthropometric characteristics, body composition and somatotype of elite junior tennis players. *British Journal of Sports Medicine*, 41(11): 793-799.

Šibila M, Pori P 2009. Position-related differences in selected morphological body characteristics of top-level handball players. *Collegium Antropologicum*, 33(4): 1079-1086.

Srhoj V, Marinovic M, Rogulj N 2002. Position specific morphological characteristics of top-level male handball players. *Collegium Antropologicum*, 26(1): 219-227.

Srhoj V, Rogulj N, Katic R 2001. Influence of the attack end conduction on match result in handball. *Collegium Antropologicum*, 25(2): 611-617.

Vaquera A, Santos S, Villa JG, Morante JC, García-Tormo V 2015. Anthropometric characteristics of Spanish professional basketball players. *Journal of Human Kinetics*, 46(1): 99-106.

Vrbik I, Èi•mek A, Gruic I 2011. Morfološke karakteristike izmeðu igraèkih pozicija kod vrhunskih rukometaša [Morphological characteristics between playing positions in elite handball players]. *Hrvatski Športskomedicinski Vjesnik*, 26(2): 94–99.

Zemski AJ, Slater GJ, Broad EM 2015. Body composition characteristics of elite Australian rugby union athletes according to playing position and ethnicity. *Journal of Sports Sciences*, 33(9): 970-978.

Ziv G, Lidor R 2009. Physical characteristics, physiological attributes, and on-court performances of handball players: A review. *European Journal of Sport Science*, 9(6): 375-386.

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