MORPHOLOGICAL DIFFERENCES OF ELITE CROATIAN FEMALE HANDBALL PLAYERS ACCORDING TO THEIR GAME POSITION

RAZLIKE U MORFOLOŠKIM KARAKTERISTIKAMA IZMEĐU VRHUNSKIH HRVATSKIH RUKOMETAŠICA OBZIROM NA IGRAČKU POZICIJU

Andrea Čižmek, Katarina Ohnjec, Vlatko Vučetić, Igor Gruić

Faculty of Kinesiology, University of Zagreb, Croatia

SUMMARY

This study presents morphologic characteristics of 37 elite Croatian female handball players. A set of 21 anthropometric measures was carried out on 12 wing attack players, 6 pivots, 6 goalkeepers and 13 back court players. Body fat percentage and BMI were also calculated. ANOVA showed statistically significant differences in variables of longitudinal skeletal dimensions, body volume and body fat. Post hoc analysis showed the most statistically significant differences in aforementioned variables between goalkeepers and wing attack players. Wing attack players are found to be with the lowest height and weight values, whereas goalkeepers are the tallest and the heaviest among all players according to their game position. Differences between wing attack players and back court players have been found in variables of longitudinal skeletal dimensions, thigh skinfold measures and upper leg and upper arm circumference, latter being the only variable of difference between wing attackers and pivot players.

Key words: female player, handball, morphological characteristics, playing position

SAŽETAK

U ovom radu predstavljene su morfološke karakterisitke 37 vrhunskih hrvatskih rukometašica. Mjerenja su provedena putem seta od 21 antropometrijske mjere na 12 krilnih igračica, 6 kružnih igračica (pivota), 6 golmanica i 13 vanjskih igračica. Postotak tjelesne masti i ITM (Indeks tjelesne mase) također su izračunati. Univarijatna analiza varijance (ANOVA) pokazala je statistički značajne razlike u varijablama longitudinalne dimenzionalnosti skeleta, volumenu tijela i tjelesnoj masti. Post hoc analiza pokazala je najveće statistički značajne razlike u prethodno navedenim varijablama imeđu golmanica i krilnih igračica. Krilne igračice opisuju najniže vrijednosti visine i mase tijela, za razliku od golmanica koje opisuju najviše vrijednosti u visini i masi tijela u usporedbi s ostalim igračicama i pozicijama u igri. Statistički značajne razlike između krilnih igračica i vanjskih igračica pronađene su u varijablama longitudinalne dimenzionalnosti skeleta, bedrenom kožnom naboru, te opsegu natkoljenice i nadlaktice. Između krilnih igračica i pivota pronađene su statistički značajne razlike u opsegu nadlaktice.

Ključne riječi: rukometašice, morfološke karakteristike, pozicije igračica

INTRODUCTION

Completing the sport success mosaic is unquestionably a present imperative for sport coaches, kinesiologists and sport scientists all over the globe. Having further information in any field of sport success enables coaches and athletes moving forward towards better overall results. Morphological characteristics play a highly important role when discussing sport success and results. Morphological diagnostics in sport supply coaches and sport/athlete managers with various information concerning the present athlete (body status and structure during different stages of training periodization) and a potential athlete (inter and intra sport selection procedures). Morphological characteristics of athletes in various sports have been an interest of study for many researchers,[11,12,17] as well as morphological differences between playing positions in team sports such as volleyball, basketball and football.[3,9,10,13] Some research of morphological differences has also been made between playing positions in male handball.[2,7,15]

Handball is described as an arduous body contact team sport, comprised of distinctive explosive movement patterns (forward, backward, and side to side shuffles), different intensity runs and various activities of jumping and throwing with the interactive requirements to hit, push and hold during the game.[5,6,8] According to some investigations a handball player during one game does 485 different high intensity movements on average, out of which 190 rhythm changes, 279 directions changes and 16 jumps.[4]

Being a complex team sport, handball differentiates four main playing positions: goalkeeper (defence), back court player, wing attack player and circle runner player or pivot (offense). Each playing position has specific technical and tactical demands, which are consequential to field zones and phases of the game.[14] Differences between positions have been found in crossed distances in a single male handball game.[1] Also, differences between female handball players according to playing position have been confirmed in a study (in motor abilities and psychological characteristics) where wing attackers predominated in speed strength, agility, movement frequency and were covering the largest field area. Adversely, goalkeepers had poorer results in all motor abilities, except for flexibility.[16]

Considering the above-mentioned, hypothesis was made assuming the existence of differences in morphological characteristics between playing positions in female handball. Having insufficient published female handball morphological data, a research was conducted with the purpose of thorough analysis of the anthropometric characteristics of the high quality female players in relation to their basic playing position.

MATERIALS AND METHODS

The sample included 37 elite female handball players all members of first league clubs in Croatia or national representatives. There were 12 wing attackers, 13 back court players, 6 pivots, and 6 goalkeepers. Average age of all subject was $24,49 \pm 4,14$ years.

The study was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb, Croatia. The players were fully informed of all the experimental procedures prior to giving their written consent of participation.

According to the instructions of the International Biological Program the following anthropological measures were taken: body height, body mass, arm span, leg length, arm length, shoulder width, knee diameter, elbow diameter, skinfolds of back, upperarm, thigh, chest, shank, suprailiocristal and abdomen and circumference of upper arm (extended and flexed), forearm, upperleg, lower leg and abdomen. The percentage of body fat (body fat %) in female handball players was determined by Jackson and Pollock anthropometric method.

The statistical package Statistica for Windows 7.0 was used for statistical analysis. Basic descriptive parameters of anthropologic variables were calculated: mean (X), standard deviation (SD), minimum and maximum value of the results registered (MIN,MAX). The normality of distribution was tested with Kolmogorov Smirnov test (MaxD). The differences between team positions (wing attackers, back court players, pivots and goalkeepers) were analyzed by analysis of variance (ANOVA). The statistical significance was set at $p<0,05$.

RESULTS AND DISCUSSION

Values presented in Table 1. show descriptive parameters of all (n=37) female handball players in measured morphological variables, and distinctively for every game position.

The results shown indicate goalkeepers as the tallest and the heaviest players in the team. Consequently, goalkeepers have the widest arm span together with length measures of the extremities. Moreover, higher values in back, upper arm, thigh, chest and abdomen skinfolds together with upperarm, forearm, upper leg and abdomen circumferences indicate specific morphology connected with the goalkeeper's play demands. Goalkeepers' movement patterns include covering short distances (between goal bars and inside goalkeeper's field area), together with explosive situational reactions on the ball (while defending the goal) and when throwing the ball in the game (while initiating counterattack or a „fast centre"). Compared to other playing positions, goalkeepers have different and decreased functional demands (specific endurance) because of their fairly low attack phase participation.

Statistically significant differences between game positions have been found in variables of longitudinal skeletal dimensions (shown in Figure 1-4), body fat (shown in Figure 5-7) and body volume (shown in Figure 8-9).

Table 1. Descriptive statistic parameters of morphological characteristics of female handball players
Tablica 1. Deskriptivni parametri morfoloških karakteristika rukometašica

	Descriptive statistic parameters				
	ALL (n= 37)	Wing (n=12)	Pivot (n=6)	Back (n=13)	Goal (n=6)
	Mean ± Std.Dev Min-Max	Mean ± Std.Dev Min-Max	Mean ± Std.Dev Min-Max	Mean ± Std.Dev Min-Max	Mean ± Std.Dev Min-Max
Age (yrs)	24,49 ± 4,14 17,25 - 34,00	24,43 ± 4,12 19,00 - 34,00	23,47 ± 4,97 17,25 - 29,58	25,14 ± 4,25 21,17 - 33,67	24,21 ± 3,93 20,67 - 30,00
Body height (cm)	174,74±6,75 159,60 - 189,90	169,32±5,37$^{\&\&\#\#}$ 159,60 - 178,30	174,50±6,78 163,30 - 183,80	177,04±5,82$^{\$\$}$ 170,30 - 189,90	180,83±2,87$^{\$\$}$ 175,70 - 184,00
Body mass (kg)	69,46±8,57 49,30 - 92,80	62,17±5,95$^{\&\&\#\#}$ 49,30 - 72,50	71,25±8,15 60,00 - 82,00	71,95±6,58$^{\$\$}$ 59,00 - 81,50	76,88±8,16$^{\$\$}$ 69,50 - 92,80
Arm span (cm)	175,57±7,24 160,50 - 191,80	170,51±4,41$^{\&\#\#}$ 161,00 - 176,80	173,82±8,83 160,50 - 186,30	178,18±5,89$^{\$}$ 170,50 - 187,10	181,80±6,61$^{\$\$}$ 171,50 - 191,80
Leg length (cm)	98,89±4,54 90,00 - 108,10	95,41±3,30$^{\&\#}$ 90,00 - 100,30	98,77±5,25 90,30 - 105,70	99,90±3,66$^{\$}$ 96,50 -108,10	103,80±2,08$^{\$}$ 100,80 - 106,20
Arm length (cm)	75,47±3,32 68,60 - 81,20	72,95±2,15$^{\#\#}$ 68,60 - 75,80	74,97±4,38 68,70 - 81,00	76,35±2,46 73,00 - 81,20	79,10±1,36$^{\$\$}$ 77,20 - 81,10
Shoulder width (cm)	38,67±2,39 32,00 - 42,50	37,86±1,79 34,80 - 40,50	38,43±3,72 32,00 - 42,10	39,64±1,77 36,20 - 42,50	38,43±2,95 33,50 - 41,50
Knee diameter (cm)	9,20±0,45 8,40 - 10,40	8,99±0,43 8,40 - 9,70	9,23±0,37 8,70 - 9,70	9,35±0,42 8,50 - 10,10	9,28±0,60 8,80 - 10,40
Elbow diameter (cm)	6,34±0,36 5,70 - 7,40	6,23±0,33 5,70 - 7,10	6,37±0,27 6,00 – 6,70	6,45±0,21 6,00 - 6,80	6,30±0,67 5,70 - 7,40
Skinfold back (mm)	11,80±4,02 6,10 - 26,00	9,55±2,39$^{\#}$ 6,10 - 14,73	11,52±2,39 9,27 - 15,53	12,32±4,06 7,47 - 20,30	15,48±5,45$^{\$}$ 10,60 - 26,00
Skinfold upper arm (mm)	14,96±4,36 7,00 - 24,00	13,11±3,91$^{\#\#}$ 7,00 - 19,93	12,52±2,27 9,27 - 15,07	15,74±4,34 9,60 - 23,90	19,44±3,39$^{\$\$}$ 15,30 - 24,00
Skinfold thigh (mm)	22,87±6,44 9,20 - 39,70	18,95±6,74$^{\&}$ 9,20 - 29,57	20,46±2,75 16,60 - 24,60	25,78±6,17$^{\$}$ 15,60 - 39,70	26,82±3,89 23,40 - 32,80
Skinfold chest (mm)	8,67±2,99 4,20 - 17,17	7,01±2,88$^{\#}$ 4,20 - 14,30	7,91±2,52 4,80 - 12,17	9,47±2,98 6,20 - 17,17	11,00±1,71$^{\$}$ 9,10 - 13,60
Skinfold shank (mm)	12,97±3,93 5,20 - 22,50	10,96±4,45 5,20 - 20,47	12,87±2,08 10,27- 15,40	14,18±2,92 9,30 - 19,00	14,48±5,15 10,10 - 22,50
Skinfold suprailiocristal (mm)	10,79±5,92 4,10 - 33,50	8,23±2,76 4,10 - 12,43	10,24±3,44 5,97	12,33±7,74 5,83 - 33,50	13,13±7,15 7,53 - 25,80
Skinfold abdomen (mm)	18,24±7,48 6,20 - 34,40	13,70±5,65$^{\#}$ 6,20- 21,60	20,01±5,68 13,70 - 29,23	19,12±7,97 11,90 - 33,50	23,66±7,54$^{\$}$ 15,73 - 34,40
Circ. upperarm ext. (cm)	28,60±2,25 23,00 - 32,50	26,88±2,27$^{*\&}$ 23,00 - 31,10	30,07±1,96$^{\$}$ 27,00 - 32,30	29,22±1,76$^{\$}$ 25,90 - 32,50	29,23±1,65 26,50 - 31,00
Circ. upperarm flex. (cm)	30,20±2,26 25,00 - 34,20	28,78±2,62 25,00 - 34,20	31,05±1,79 28,00 - 33,20	30,82±1,72 27,90 - 34,10	30,83±2,03 28,20 - 33,00
Circ. forearm (cm)	24,69±1,33 21,30 - 28,00	23,88±1,38 21,30 - 26,70	24,93±1,03 23,50 - 26,60	24,92±1,04 22,50 - 27,00	25,55±1,47 23,50 - 28,00
Circ. upper leg (cm)	58,67±3,57 49,70 - 66,50	55,36±3,15$^{\#\#}$ 49,70 - 61,50	59,28±2,98 55,30 - 63,40	59,78±2,78 56,00 - 64,70	61,13±2,90$^{\$\$}$ 59,10 - 66,50
Circ. lower leg (cm)	37,19±2,09 32,70 - 44,00	35,95±1,90 32,70 - 39,40	38,35±1,78 35,50 - 40,40	37,46±1,38 35,60 - 40,00	37,95±3,12 35,20 - 44,00
Circ. abdomen (cm)	81,74±6,48 69,70 - 98,50	77,45±6,17$^{\#}$ 69,70 - 86,00	81,85±4,52 75,50 - 89,30	83,75±6,78 75,00 - 98,50	85,85±3,63$^{\$}$ 79,00 - 89,10
Body fat %	19,39±4,50 11,10 - 31,08	16,50±3,38$^{\#\#}$ 11,10 - 22,15	18,65±2,73 15,63 - 23,42	20,67±4,83 15,71 - 31,08	23,15±3,89$^{\$\$}$ 20,24 - 29,79
BMI	22,70±1,99 19,35 - 27,41	21,69±1,90 19,35 - 25,15	23,34±1,57 22,06 - 26,10	22,97±2,08 19,94 - 27,23	23,48±1,96 22,25 - 27,41

Values are: $^{\#}$ - significant difference p<0,05 in relation to a goalkeeper, $^{\#\#}$ - significant difference p<0,01 in relation to a goalkeeper, $^{\&}$ - significant difference p<0,05 in relation to a back court player, $^{\&\&}$ - significant difference p<0,05 in relation to a back court player, * - significant difference p<0,05 in relation to a pivot, $^{\$}$ - significant difference p<0,05 in relation to a wing attacker, $^{\$\$}$ - significant difference p<0,01 in relation to a wing attacker.

Vrijednosti su: $^{\#}$ - značajna razlika p<0,05 u odnosu na golmana, $^{\#\#}$ - značajna razlika p<0,01 u odnosu na golmana, $^{\&}$ - značajna razlika p<0,05 u odnosu na vanjske igračice, $^{\&\&}$ - značajna razlika p<0,05 u odnosu na vanjske igračice, * - značajna razlika p<0,05 u odnosu na pivota, $^{\$}$ - značajna razlika p<0,05 u odnosu na krilo, $^{\$\$}$ - značajna razlika p<0,01 u odnosu na krilo.

Figure 1-4. Differences among playing position in variables of longitudinal dimensionality
Slika   1-4. Razlike prema poziciji u igri u varijablama longitudinalne dimenzionalnosti
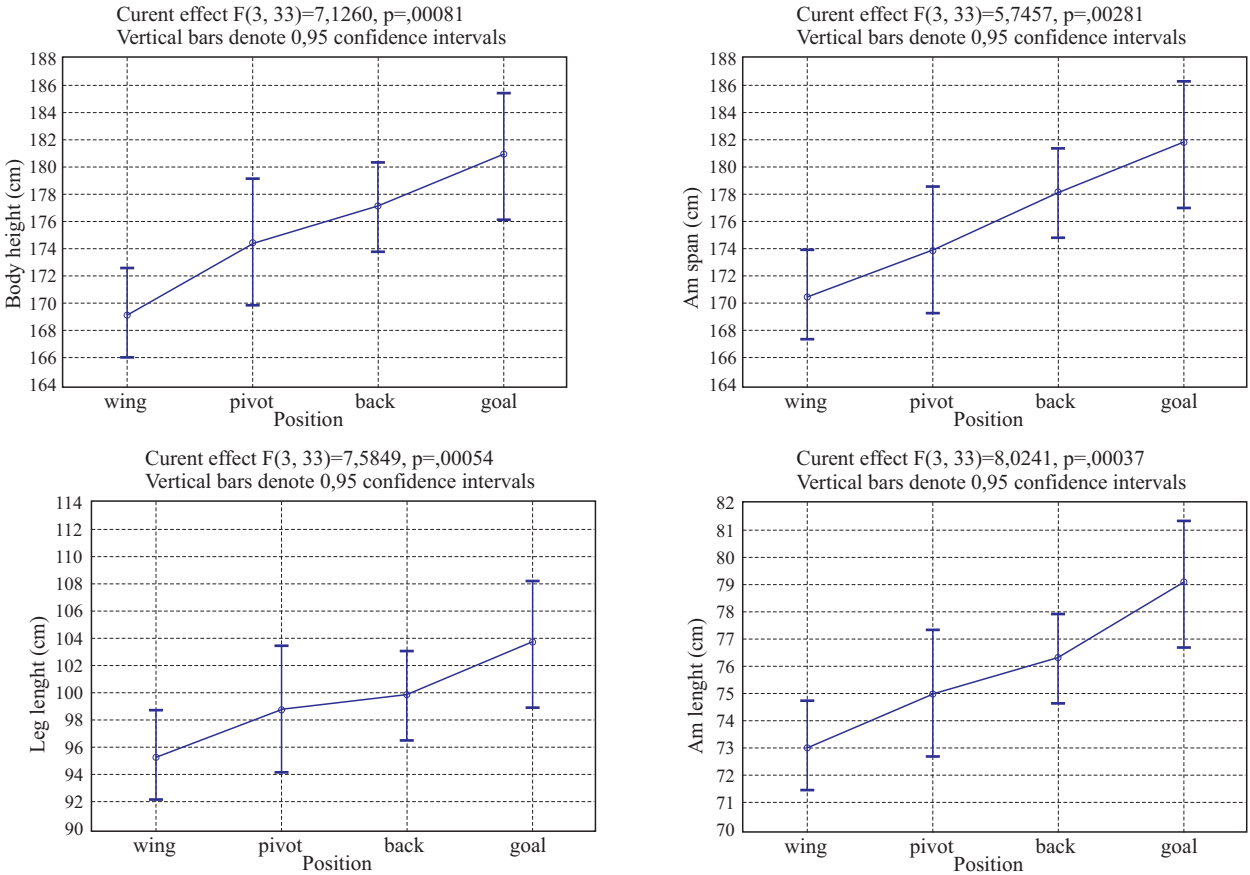
Curent effect F(3, 33)=7,1260, p=,00081
Vertical bars denote 0,95 confidence intervals

Curent effect F(3, 33)=5,7457, p=,00281
Vertical bars denote 0,95 confidence intervals

Curent effect F(3, 33)=7,5849, p=,00054
Vertical bars denote 0,95 confidence intervals

Curent effect F(3, 33)=8,0241, p=,00037
Vertical bars denote 0,95 confidence intervals

Figure 5-7. Differences among playing position in variables of body volume
Slika 5-7.   Razlike prema poziciji u igri u varijablama volumena tijela

Curent effect F(3, 33)=4,8353, p=,00674
Vertical bars denote 0,95 confidence intervals

Curent effect F(3, 31)=6,3204, p=,00180
Vertical bars denote 0,95 confidence intervals

Curent effect F(3, 33)=8,0241, p=,00037
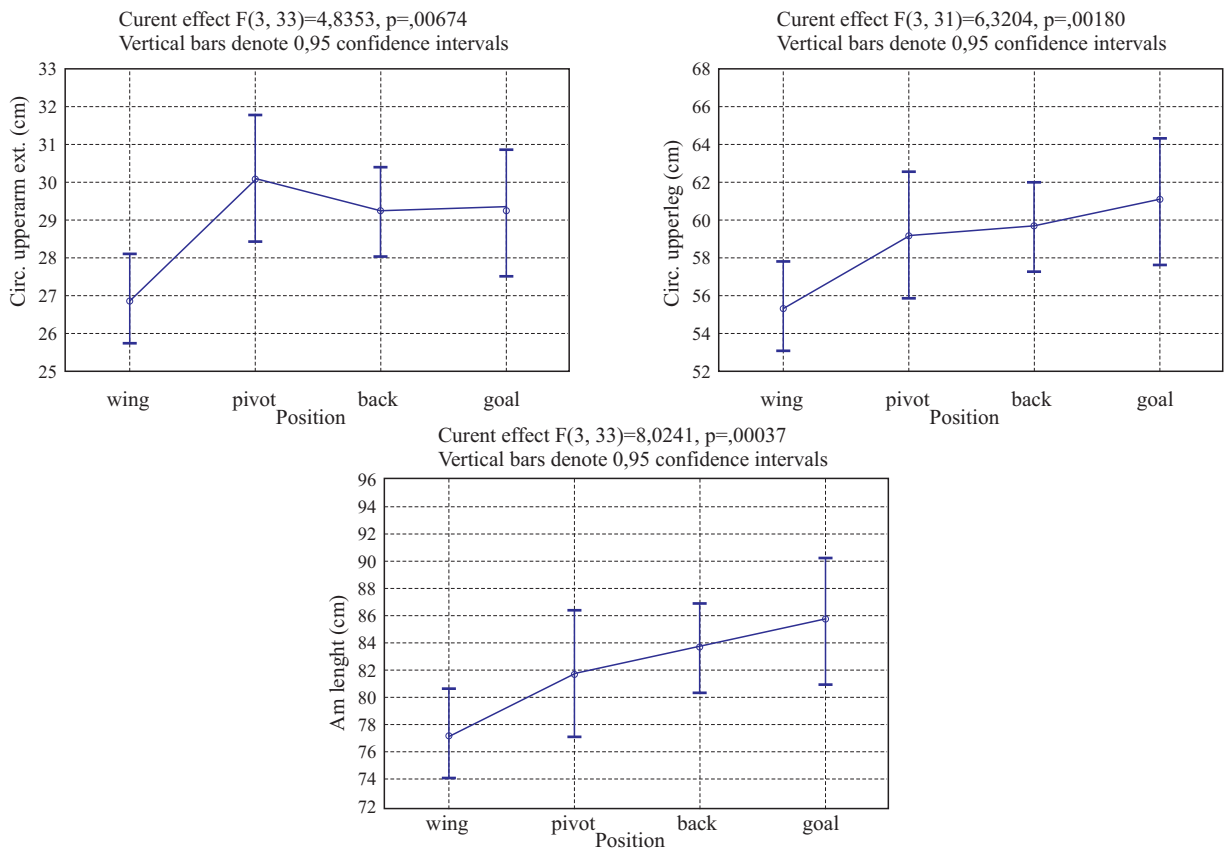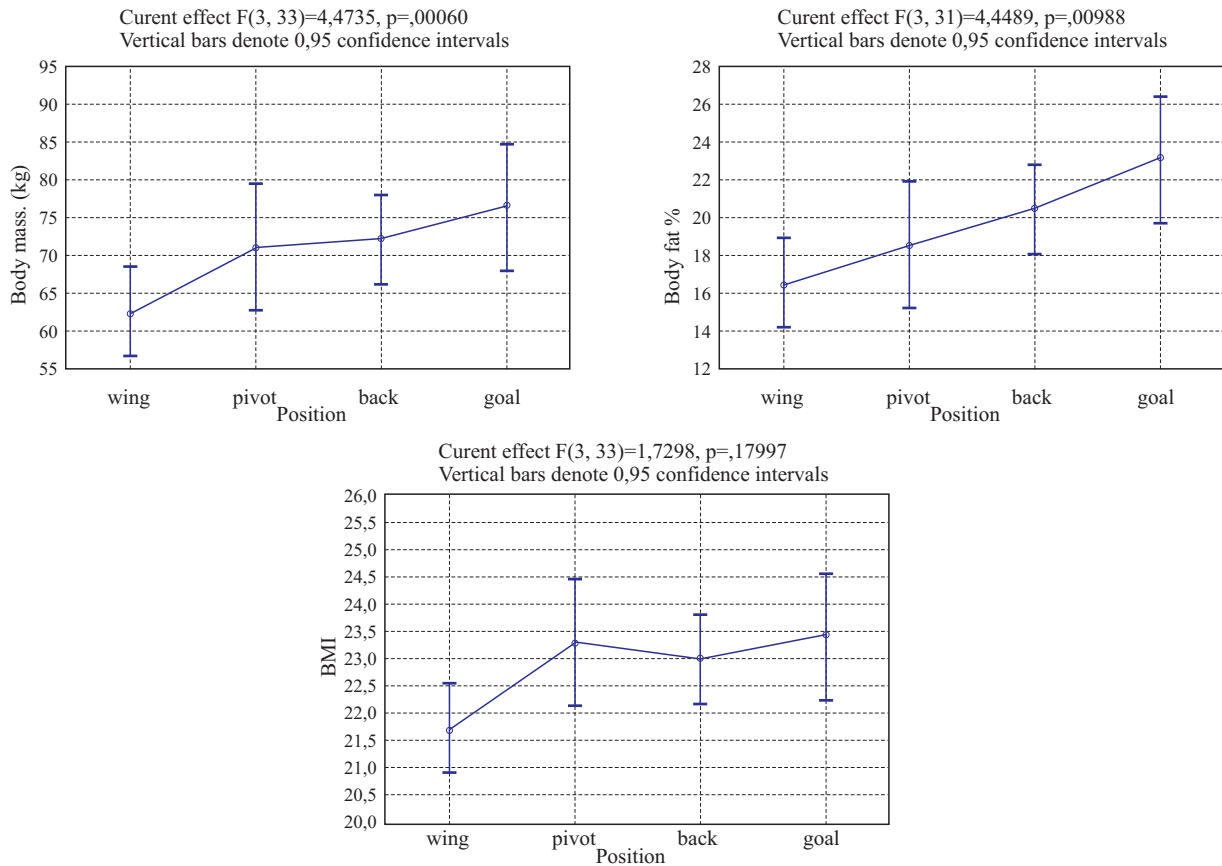Vertical bars denote 0,95 confidence intervals

Figure 8-10. Differences among playing positions in variables of body mass, body fat and BMI.
Slika 8-10.   Razlike prema poziciji u igri u varijablama tjelesne mase, postotka tjelesne masti i ITM.

The significant difference between positions (wing and goalkeeper game position) was found in the leg (p<0,1) and arm length measures (p<0,1). Aforesaid indicates importance of longitudinal dimensionality of goalkeepers since it facilitates more efficient coverage of the goal area. Wing attackers usually perform their shoots at the goal aside the opponent's blocks, having no specific needs in arm length for shoot execution, although longer upper extremities enable broadening shooting angle. Wing attack players are found to be with the lowest values in body height, hence the lighter weight and lower values in all body measures except for the upper arm skinfold. Considering specific game demands according to the position of play, wing attack players require swift and frequent movements from the defence to attack phase of play, also very frequently participating in counterattacks or preventing ones. The abovementioned indicates that wing attack players cover the largest area of play, for which very high amount of speed strength is needed[14]. Generally, smaller and lighter players are more efficient in quick movement changes, fine performance and sprints which are characteristical elements of wing attack players.

Thorough post hoc analysis showed statistically significant differences between wing attack players and back court players in variables of longitudinal skeletal dimension (body height, body weight, arm span, arm length and leg length, all p<0,01), upper arm (p<0,5) and upper leg circumference (p≤ 0,01) and thigh skinfold (p<0,5). Position of a back court attacker is found to be the most complex one in the game of handball from the kinesiological aspect. Back court attackers are in charge of game organisation and players coordination, hence a tall figure enables also better visual game control. They have the longest periods of ball possession and their offense performance is mainly described by powerful over and through opponents' defence wall shooting[14]. Therefore, significant body height and consequently larger qualitative body mass are very important for matching desirable game demands.

The only significant difference between wing attack players and pivots appeared in the variable of upper arm circumference (p<0,5), although a certain tendency appears in the variable of body mass as well (p≈ 0,08). Circle runner player or a pivot has a specific offence game position, being the only mainly back faced or side faced offence player in the team. As an offence line player, a pivot either tries to find a good line position for oneself tackling and resisting opponents defence, or makes some space for other teammates on their way to score the goal. Hence, immense amount of static power and a stable stance are needed. Considerably larger body mass of a pivot player allows and provides easier line duels and more efficient balance support.[14]

No statistically significant differences have been found between pivot positions and back court players. A possible explanation for this could lie in today's expanded play demands of both pivot players and back court attackers. Realization and blocking functions aside,

today's pivot player contributes and participates more in ball distribution towards back court and wing attack players during attack and shot realization as well as being a ground base of „fast center".[18] On the other hand, different attack strategies of back court players include a lot of position shuffles for all three back court attackers, and also on a pivot position. No statistically significant differences have been found between pivots and goalkeepers. Furthermore, no statistically significant differences have been found between back court players and goalkeepers.

CONCLUSION

Results of this study confirmed statistically significant existence of morphological differences between female handball players according to their game position. The most significant differences have been found among wing attack players and goal keepers in variables of longitudinal skeletal dimensions, body volume and body fat. Differences between wing attack players and back court players have been found in variables of longitudinal skeletal dimensions, thigh skinfold measures and upperleg and upper arm circumference, latter being the only variable of difference between wing attackers and pivot players.

Handball differentiates four main game positions, each having specific requirements which dictate types and structures of movements performed by players. Wing attack players are considered to be the ones covering the biggest field area and performing most of the counterattacks, therefore in need of lighter, swift bodies with the ability of fast movement changes and agility. On the other hand goalkeepers have, due to the function of saving the goal, more static role in the game, therefore in need to have considerably elongated and flexible extremities. This study confirmed wing attack players to be with the lowest height and weight values, whereas goalkeepers the tallest and the heaviest. Position specifics of the back court players propose tall and strong players who are required to perform different tactical and game assignments towards opponent's defence zones, while pivots have relatively large body mass with respectively higher values in upper extremities.

Refferences

1. Bon M, Šibila M, Pereš J, Kovačič, S. Analiza gibanja igralca med tekmo. Ljubljana: Fakultet za šport, Institut za šport, 2002.
2. Chaouachi A, Brughelli M, Levin G, Boudhina NB, Cronin J, Chamari K. Anthropometric, physiological and performance characteristics of elite team-handball players. J of Sport Sci, 2009; 27: 151-157.
3. Erčulj F, Blas M, Čoh M, Bračić M. Differences in motor abilities of various types of European young elite female basketball players. Kinesiology 2009; 41 2:203-211.
4. Garcia, C. Specifična fizička priprema s naglaskom na izdržljivost. In: Proceedings of 25th handball coaches semminare, Pula, Croatia, Hrvatski rukometni savez, 2001; 17-25.
5. Gorostiaga E, Granados C, Ibáñez J, González-Badillo J, Izquierdo M. Effects of an entire season on physical fitness changes in elite male handball players. Med Sci Sports Exerc., 2006; 382: 357-366.
6. Granados C, Izquierdo M, Ibanez J, Bonnabau H, Gorostiaga EM. Differences in Physical Fitness and Throwing Velocity Among Elite and Amateur Female Handball Players. Int J Sports Med 2007; 28: 850-867.
7. Hasan AAA, Rahaman JA, Cable NT, Reilly T. Anthropometric Profile of elite male Handball Players in Asia. Biology of Sport, 2007; 24: 3-12.
8. Kalinski MI, Norkowski H, Kerner MS, Tkaczuk WG. Anaerobic power characteristics of elite athletes in national level team-sport games. European Journal of Sport Science, 2002; 2: 1-21.
9. Marelić N, Đurković T, Rešetar T. Differences in fitness level and morphological characteristics between female volleyball players of different team status. HŠMV 2008; 23: 30-34.
10. Matković BR, Mišigoj-Duraković M, Matković B, Janković S, Ružić L, Leko G, Kondrič M. Morphological Differences of Elite Croatian Soccer Players According to the Team Position. Coll. Antropol. 2003; 27 Suppl. 1 167-174.
11. Mikulić P, Vučetić V, Matković BR, Oreb G. Morphological characteristics and somatotype of elite Croatian rowers. HŠMV 2005; 20: 15-19.
12. Mišigoj-Duraković M, Vučetić V, Duraković Z, Wolf-Cvitak J, Matković BR., Ćorović N, Bonevski A. Body Physique and composition in young premenarcheal ballerinas and female athletes in aesthetic sports. Medical Problems of Performing Artists, 2005; 20: 75-179.
13. Sporiš G, Čanaki M, Barišić V. Morphological Differences of Elite Croatian Female Soccer Players According to the Team Position. HŠMV 2007; 22: 91-96.
14. Srhoj V, Marinović M, Rogulj N. Characteristics of male Handball players. Coll Antropol. 2002; 26: 219-227.
15. Šibila M, and Pori P. Morphological Characteristics of handball players. Coll Antopol. 2009; 33: 1079-1086.
16. Rogulj N, Srhoj V, Nazor M, Srhoj Lj, Čavala M. Anthropologic Variation in Handball According to Position. Coll Antropol. 2005; 29 : 705-709.
17. Vučetić V, Matković BR, Šentija D. Morphological Differences of Elite Croatian Track-And-Field Athletes. Coll. Antropol, 2008; 32 : 315-320.
18. Vuleta D, Gruić I, Milanović D. Mjerenje i vrednovanje funkcionalnih sposobnosti vrhunskih rukometaša i rukometašica u pripremnom periodu, In: Kondicijska priprema sportaša, Zagreb, Kineziološki fakultet Sveučilišta u Zagrebu, 2009; 327-331.