Coll. Antropol. **33** (2009) 4: 1079–1086
Original scientific paper

Position-Related Differences in Selected Morphological Body Characteristics of Top-Level Handball Players

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ABSTRACT

We aimed to establish the main morphological characteristics of Slovenian junior and senior national handball team players. Morphological characteristics for various player subgroups (goalkeepers, wings, back players and pivots) were also determined so as to establish whether they had distinct profiles. The subjects were 78 handball players who were members of the Slovenian junior and senior national team in the period from 2000 to 2007. A standardised anthropometric protocol was used to assess the subjects' morphological characteristics. The measurements included 23 different anthropometric measures. Data were processed with the SPSS computer programme. First, basic statistical characteristics of anthropometric measures were obtained for all subjects together and then for each group separately. Somatotypes were determined using Heath-Carter's method. Endomorphic, mesomorphic and ectomorphic components were calculated by computer on the basis of formulas. In order to determine differences in the body composition and anthropometric data of the subjects playing in different positions, a one-way analysis of variance was employed. The results show that on average the wings differ the most from the other player groups in terms of their morphological body characteristics. The values of their body height, body mass and the quantity of subcutaneous fat are statistically significantly lower than those of players in the other groups. Goalkeepers are relatively tall, with high values of body mass and low values of transversal measures. Their skin folds are the most pronounced among all groups on average and their share of subcutaneous fat in total body mass is the highest. Consequently, their endomorphic component of the somatotype is pronounced. Pivots and back players are becoming increasingly similar in terms of their morphological body characteristics. Pivots maintain greater robustness, have a higher quantity of muscle mass as well as more pronounced transversal measures and a mesomorphic component of the somatotype. The results of our study confirm that groups of handball players occupying different positions differ amongst themselves in terms of many measurements. This is a result of specific requirements of handball play which are to be fulfilled by players.

Key words: *anthropometry, body composition, somatotype, handball*

Introduction

Morphological characteristics of the body certainly have a great influence on an outstanding performance in handball[1–4]. That is particularly typical of top handball, where the advantages of players with a suitable morphological structure are evident[5]. Recent research studies dealing with morphological profile of a top-level handball player highlighted that he is characterized with prevailing mesomorphic somatotype with a touch of ectomorfy, that is with a pronounced longitudinal dimensionality of the skeleton[6]. In general, more successful teams are taller and have lower body fat than less successful teams[7]. Previous research also indicates that groups of players who occupy different playing positions significantly differ from each other in terms of many morphological parameters. This is particularly true for the values denoting body height and the quantity of subcutaneous fat[8,9]. The correlation between some morphological body characteristics of handball players and their playing position is therefore evident. This is attributed to the different technical and tactical tasks which players occupying different playing positions must execute. Also related to the above is the process of orienting the players to the most appropriate playing positions[6,8]. Researchers have also established a statistically significantly positive cor-

Received for publication November 6, 2008

relation between the throwing velocity of the handball shot and body mass, lean body mass, arm span, hand length and width of the hand with the fingers abducted[10]. For those reasons, we tried to establish the main morphological characteristics of Slovenian junior and senior national handball team players. Morphological characteristics for various subgroups of players (goalkeepers, wings, back players and pivots) were also determined so as to establish whether they had distinct profiles.

Subjects and Methods

The subjects were 78 handball players who were members of the Slovenian junior and senior national team in the period from 2000 to 2007 (average height ($\bar{X}$±SD)=88.5±5.46 cm, average body mass ($\bar{X}$±SD)= 89.56±8.42 kg, average age ($\bar{X}$±SD)=25.1±4.3 years). The sample of subjects consisted of players occupying different positions. We measured 12 goalkeepers (G), 34 back players (B), 18 wings (W), and 11 pivots (P). Data were collected during the training camps of the national teams. A standardised anthropometric protocol was used to assess the subjects' morphological characteristics. The measurements included 23 different anthropometric measures covering all (four) morphological dimensions: longitudinal measures, diameters, circumferences and skin folds (Table 1).

TABLE 1
SAMPLE OF VARIABLES DEFINING ALL MORPHOLOGICAL DIMENSIONS

Morphological dimension	Description of variable	Unit
Parameters of longitudinal dimension:	Body height	cm
	Biacromial diameter	cm
	Biiliocristal diameter	cm
Parameters of transversal dimension:	Humerus diameter	cm
	Wrist diameter	cm
	Femur diameter	cm
	Ankle diameter	cm
	Circumference of upper arm (relaxed)	cm
	Circumference of upper arm (contracted)	cm
Parameters of body volume and body mass:	Circumference of forearm	cm
	Circumference of thigh (subgluteal)	cm
	Circumference of thigh (medial)	cm
	Circumference of calf	cm
	Body mass	kg
	Subscapular skin fold	mm
	Abdominal skin fold	mm
	Suprailiacal skin fold	mm
	Chest skin fold	mm
Parameters of body fat:	Triceps skin fold	mm
	Biceps skin fold	mm
	Forearm (volar) skin fold	mm
	Thigh (subgluteal) skin fold	mm
	Calf skin fold (medial)	mm

Data were processed by the SPSS computer programme. First, basic statistical characteristics of anthropometric measures were obtained for all subjects together and then for each group separately. Somatotypes were determined using Heath-Carter's method[11]. Endomorphic, mesomorphic and ectomorphic components were calculated with a computer on the basis of formulas[12].

$$\text{ENDO}=-0.7182+0.1451*((\text{Triceps skin fold}+\text{Subscapular skin fold}+\text{Suprailiacal skin fold})/10)-0.00068*((\text{Triceps skin fold}+\text{Subscapular skin fold}+\text{Suprailiacal skin fold})/10)*((\text{Triceps skin fold}+\text{Subscapular skin fold}+\text{Suprailiacal skin fold})/10).$$

$$\text{MESO}=(0.858*(\text{Humerus diameter}/10)+0.601*(\text{Femur diameter}/10)+0.188*(\text{Circumference of upper arm (contracted)}/10\text{-Triceps skin fold}/100)+0.161*\text{Circumference of calf}/10\text{-Calf skin fold}/10)-(\text{body height}/10*0.131)+4.5.$$

$$\text{ECTO}=\text{Body height}/10(\text{EXP}(1/3*\text{LN}(\text{body mass})/10)*0.732)-28.58.$$

Body density (BD) was calculated using the Jackson and Pollock[13] formula and the quantity of body fat (BF) using the Siri[14] formula:

$$\text{BD}=1.109380-((0.0008267*(\text{Chest skin fold}+\text{Thigh skin fold}+\text{Abdominal skin fold}))+(0.0000016*(\text{Chest skin fold}+\text{Thigh skin fold}+\text{Abdominal skin fold})^2)-(0.0002574*\text{age}).$$

$$\text{BF}=((4.950/\text{BD})-4.500))*100.$$

Bone (BM) and muscle (MM) mass were calculated using the formulae of Drinkwater, Martin, Ross and Clarys[15]:

$$\text{BM}=(\text{Humerus diameter}+\text{Femur diameter}+\text{Wrist diameter}+\text{Ankle diameter}/4)^2*\text{body height}*0.92.$$

$$\text{MM}=(0.0546*\text{Circumference of thigh}^2+0.119*\text{Circumference of forearm}^2+0.0256*\text{Circumference of calf}^2)*\text{Body height}.$$

Body surface (BS) was calculated using following formula[16]:

$$\text{BS}=71.84*\text{mass}^{0.425}*\text{height}^{0.725}.$$

In order to determine differences in the body composition and anthropometric data of the subjects playing in different positions, a one-way analysis of variance (one-way ANOVA) was employed. A probability level of 0.05 or less was taken to indicate significance.

Results

In Table 2 the basic statistical characteristics of the selected anthropometric variables are presented. The table shows average values, standard deviations, minimum and maximum values and significance of Kolmogorov-Smirnov test.

TABLE 2
BASIC STATISTICAL CHARACTERISTICS OF ALL PARAMETERS

Parameter	$\overline{X}$	SD	Min	Max	pK-S
Longitudinal dimension (lengths)					
Body height	188.44	5.46	172.9	201.0	0.900
Transversal dimension (diameters)					
Biacromial diameter	42.79	0.18	39.0	46.7	0.771
Biiliocristal diameter	29.64	1.61	24.0	33.3	0.828
Humerus diameter	7.45	0.33	6.6	8.4	0.207
Wrist diameter	6.00	0.30	5.2	6.6	0.264
Femur diameter	10.22	0.45	9.3	11.3	0.338
Ankle diameter	8.16	0.36	7.1	9.1	0.600
Body volume (circumferences)					
Circumference of upper arm (relaxed)	33.03	1.84	27.3	37.2	0.573
Circumference of upper arm (contracted)	36.09	2.04	29.3	40.7	0.867
Circumference of forearm	29.09	1.34	25.2	32.0	0.851
Circumference of thigh (subgluteal)	62.66	4.47	54.0	71.1	0.724
Circumference of thigh (medial)	59.24	3.43	52.4	68.1	0.761
Circumference of calf	40.94	1.75	37.3	44.2	0.961
Body mass	89.56	8.41	72.4	113.60	0. 802
Body fat (skin folds)					
Subscapular skin fold	10.90	2.95	6.4	21.2	0.144
Triceps skin fold	7.43	2.49	3.2	18.0	0.130
Biceps skin fold	4.63	1.27	2.8	9.2	0.219
Forearm (volar) skin fold	6.14	1.60	3.8	11.4	0.410
Abdominal skin fold	16.33	6.96	6.2	33.4	0.618
Chest skin fold	8.37	3.59	4.4	22.2	0.002
Suprailiacal skin fold	11.98	4.14	5.2	22.6	0.636
Thigh (subgluteal) skin fold	13.63	4.81	4.8	26.2	0.396
Calf skin fold (medial)	7.84	2.84	4.0	16.2	0.106
Body indexes					
Relative body mass	0.47	0.04	0.4	0.6	0.064
% of body fat	11.29	2.43	6.4	17.8	0.488
Body surface	2.17	0.12	1.8	2.5	0.473
Muscle mass	46.58	4.25	35.9	56.3	0.814
% of muscle mass	52.09	2.52	47.0	61.5	0.670
Bone mass	18.02	1.07	15.5	20.6	0.782
% bone mass	20.19	1.15	17.1	22.7	0.825
Somatotype					
Ectomorphic components	2.29	0.75	0.6	4.1	0.763
Mesomorphic component	4.85	0.82	3.3	6.5	0.888
Endomorphic component	3.01	0.81	1.3	5.4	0.354

Min – minimum values, Max – maximum values, pK-S – significance of Kolmogorov-Smirnov test

The following tables show the results of the one-way analysis of variance based on which we established whether there were any statistically significant differences between the handball players – with respect to their playing position in attack – in terms of an individual manifest variable. The analysis was carried out by individual morphological sub-spaces (longitudinal measures, diameters, circumferences and skin folds).

The tallest players in our sample are those playing in the B position and they are statistically significantly taller than W and G (Table 3). On average, the goalkeepers and pivots are statistically significantly taller than

TABLE 3
DIFFERENCES IN BODY HEIGHT (LONGITUDINAL MORPHOLOGICAL DIMENSION) AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Body height	187.91*	191.11*	183.68*	188.60*

*p<0.05, G – goalkeepers, B – back players, W – wings, P – pivots, W<P, G and B, P>W, G>W, G<B; B>W and G

the wings. Therefore, in our sample the wing players are the shortest players on average.

On average, in the morphological sub-space of transversal dimensions the least robust players in our sample are those playing in wing positions, while more prominent transversal dimensions are those of B and P (Table 4). P's average values are statistically significantly higher than those of W in terms of biacromial, femur and ankle diameter. On average, when compared to other players, Ps have a statistically significantly higher value of their ankle diameter compared to Gs. In other variables, P does not differ statistically significantly from G, which is somewhat surprising. They do not differ from B players in any of the variables. B's average values are statistically significantly higher in comparison with those of W in terms of biacromial, wrist and ankle diameter. B's wrist diameters are statistically significantly longer than those of G. There were no statistically significant differences among the player groups in values of biiliocristal and humerus diameters.

It is somewhat surprising that very few statistically significant differences between the players were reported in terms of their body voluminosity (Table 5). In the basic parameter – body mass – W's values are statistically significantly lower than those of the other player groups. This is quite logical since the value of body mass is distinctively related to the value of body height, where the wings achieved statistically significantly lower values on average. Players from the other groups did not differ statistically significantly in terms of this parameter. Of all circumferences, statistically significant differences were

TABLE 4
DIFFERENCES IN DIAMETER MORPHOLOGICAL DIMENSION PARAMETERS AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Biacromial diameter[a]	42.60	43.17*	41.95*	43.95*
Biiliocristal diameter[b]	29.62	29.85	28.99	30.08
Humerus diameter[c]	7.47	7.49	7.31	7.56
Wrist diameter[d]	5.88*	6.10*	5.86*	6.09
Femur diameter[e]	10.20	10.24	10.01*	10.53*
Ankle diameter[f]	8.11*	8.22*	7.92*	8.40*

*p<0.05, G – goalkeepers, B – back players, W – wings, P–pivots, [a]W<B and P, B>W, P>W, [b]no statistically significant differences, [c]no statistically significant differences, [d]W<B, G<B, B>W and G, [e]P>W, [f]W<P and B, P>W and G, G<P, B>W

TABLE 5
DIFFERENCES IN CIRCUMFERENCE AND BODY MASS PARAMETERS AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Circumference of upper arm (relaxed)[a]	32.42	33.18	32.75	33.70
Circumference of upper arm (contracted)[b]	35.50	36.15	36.06	36.60
Circumference of forearm[c]	28.00*	29.25*	29.11*	29.78*
Circumference of thigh (subgluteal)[d]	62.40*	62.66	60.33	62.78*
Circumference of thigh (medial)[e]	59.26	59.69	57.93	60.01
Circumference of calf[f]	40.50	40.94	39.88	41.30
Body mass[g]	89.99*	91.57*	83.80*	92.29*

*p<0.05, G – goalkeepers, B – back players, W – wings, P – pivots, [a]no statistically significant differences, [b]no statistically significant differences, [c]W>G, P>G, B>G, G<W, P and B, [d]no statistically significant differences, [e]no statistically significant differences, [f]no statistically significant differences, [g]W<P, G and B, P>W, G>W, B>W

only identified in the circumference of forearm. In these parameters, the goalkeepers achieved statistically significantly lower values than players from the other groups. In all other circumferences, the players in our sample who occupy different playing positions did not differ in a statistically significant way. It is clear that the majority of circumferences in a very highly selected sample of handball players does not differentiate significantly between the players in different playing positions. The circumference of the forearm is the only one that matters.

As a rule, the goalkeepers' skin folds are the most pronounced, which means they have the biggest quantity of subcutaneous fat among all the player groups. The goal-

TABLE 6
DIFFERENCES IN BODY FAT PARAMETERS AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Subscapular skin fold[a]	13.08*	10.63*	9.26*	12.01*
Triceps skin fold[b]	9.36*	7.37	6.60*	6.87
Biceps skin fold[c]	5.08	4.68	4.14	4.80
Forearm (volar) skin fold[d]	6.88*	6.01	5.50	6.81*
Abdominal skin fold[e]	21.03*	15.87*	13.76*	16.81
Chest skin fold[f]	11.58*	8.07*	6.76*	8.41*
Suprailiacal skin fold[g]	14.85*	11.82	10.53*	11.72*
Thigh (subgluteal) skin fold[h]	13.80	14.15	11.85	14.74v
Calf skin fold (medial)[i]	7.31	8.31	7.24	7.94

*p<0.05, G – goalkeepers, B – back players, W – wings, P – pivots, [a]W<G and P, P>W, G>W and B, B<G, [b]W<G G>W, [c]no statistically significant differences, [d]W<P and G, P>W, G>W, [e]W<G, G>W and B, B<G, [f]W<G, P<G, G>W, P and B, B<G, [g]W<G, G>W and B, B<G, [h]no statistically significant differences, [i]no statistically significant differences

keepers thus recorded statistically higher values of subscapular, abdominal and suprailiacal skin folds compared to the wings and back players (Table 6). The values of the chest skin fold are statistically significantly higher in the goalkeepers than for all the three other groups of players. The triceps skin fold is statistically significantly higher only in comparison with that of the wings. On average, the wings' skin fold values are the lowest. The pivots have statistically significantly higher values of subscapular and forearm skin folds than the wings. However, their chest skin fold is statistically significantly less than that of the goalkeepers. The pivots did not differ statistically significantly from the other groups in terms of other skin fold parameters. The back players have statistically significantly lower values of subscapular, abdominal, chest and suprailiacal skin folds compared to the goalkeepers. As regards the skin folds of the biceps, thigh (subgluteal) and calf, there were no statistically significant differences between the groups.

In terms of relative body mass, there were no statistically significant differences between individual groups of players (Table 7). The share of fat tissue in total body mass was statistically significantly higher in the goalkeepers than in the wings. A comparison between the other groups revealed no statistically significant differences in terms of this variable. The wings have a statistically significantly smaller body surface than the other three groups of players, which do not differ statistically significantly amongst themselves. With the wings, the absolute quantity of muscle mass is statistically significantly lower than with the pivots and back players. The pivots have a statistically significantly higher quantity of muscle mass than the wings, but do not differ from the other groups. The same applies to the back players. The goalkeepers did not differ statistically significantly from the other groups of players in terms of muscle mass. The percentage of muscle mass in total body mass was statistically significantly greater with the wings than with the goalkeepers. Other comparisons between the groups showed no statistically significant differences in terms of the share of muscle mass in total body mass. As regards the absolute quantity of bone mass, the wings achieved statistically significantly lower values than all the other groups. The pivots, goalkeepers and back players have a statistically significantly higher bone mass than the wings, but do not differ amongst themselves. As regards the share of bone mass in total body mass, there were no statistically significant differences between the groups.

In terms of the endomorphic component, statistically significant differences are primarily seen in G. Therefore, Gs' values are statistically significantly higher than those of B and W (Table 8). W and B have statistically significantly lower values of the endomorphic component than G. In this parameter, P do not differ statistically significantly from the other groups. In the mesomorphic component of the somatotype, differences only occurred between the pivots and back players – with the pivots recording higher values. In the ectomorphic component, there were no statistically significant differences between the groups.

TABLE 7
DIFFERENCES IN BODY INDEXES AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Relative body mass[a]	0.473	0.479	0.461	0.489
% of body fat[b]	12.56*	11.40	10.06*	11.69
Body surface[c]	2.18*	2.21*	2.06*	2.20*
Muscle mass[d]	45.40	47.77*	44.38*	47.80*
% of muscle mass[e]	50.50*	52.27	52.96*	51.81
Bone mass[f]	17.87*	18.38*	17.15*	18.45*
% of bone mass[g]	19.96	20.17	20.50	20.01

*p<0.05, [a]no statistically significant differences, [b]W<G, [c]W<P, G and B, P>W, G>W, B>W, [d]W<P and B, P>W, B>W, [e]W>G, G<W, [f]W<P, G and B, P>W, G>W, B>W, [g]no statistically significant differences

TABLE 8
DIFFERENCES IN SOMATOTYPE PARAMETERS AMONG THE VARIOUS PLAYER SUBGROUPS

Parameter	G	B	W	P
Somatotype-endo[a]	3.65*	2.97*	2.62*	3.06
Somatotype-meso[b]	4.75	4.61*	5.06	5.34*
Somatotype-ecto[c]	2.17	2.50	2.16	1.99

*p<0.05, G – goalkeepers, B – back players, W – wings, P – pivots, [a]W<G, G>W and B, B<G, [b]P>B, B<P, [c]no statistically significant differences

Discussion and Conclusion

Our results indicate that in a highly selective sample of elite handball players there are considerably fewer dif-

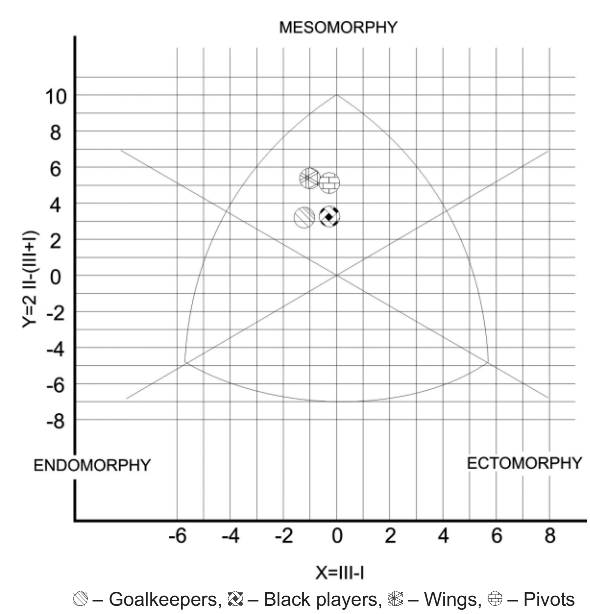

Fig. 1. Somatotype of players in individual playing positions.

ferences in morphological characteristics than in a less selective sample[8]. In spite of the above, the results of our study confirm that groups of handball players occupying different positions differ amongst themselves in terms of many measurements. This is a result of specific requirements of handball play which are to be fulfilled by players.

Characteristic tasks of back players are organising attacks and participating in their completion. Body height plays an important role in ensuring that back players carry out their tasks successfully and efficiently. It enables them to take a good shot from a distance, which is why defence players move closer to them towards the middle of the court and leave behind an empty space which facilitates the penetration of other attacking players towards the goal and shooting at it. Most often the entire team's play depends largely on the back players' ability to shoot and their creativity. It is typical that back players have to master the ball, make unexpected and accurate passes and thus create good opportunities for the other players to shoot. Body height is also important for pivots and goalkeepers. During the attack, pivots must also catch high balls and are hindered by the tall defence players – thus, high values of body height can bring them an advantage over defence players. Goalkeepers must cover the maximum of the goal area so as to prevent shooters scoring a goal from different attacking positions. Their body height primarily helps them stop shots directed at the upper corners of the goal. Evidently, body height is not a decisive factor for the wings. One of their fundamental tasks is to organise rapid counter-attacks and complete them, and their crucial ability is speed.

Body robustness facilitates the performance of various actions that involve body contact, which is typical of many actions in handball. It is particularly important for players who are playing in the P and B positions and are in body contact with defenders while executing their attack tasks. Most often, these players take up the most exposed defending positions in defence, too. In this case, robustness and the previously mentioned body height are extremely important as they facilitate players in blocking the opponent with their body and arms. Gs have low values of transversal measures. They do not differ statistically significantly from the other groups of players in terms of circumferences. The only exception is the forearm circumference, where they recorded statistically significantly smaller values than the other three groups. This is an interesting result as it reflects the needs of actual play. The forearm circumference and related manifestation of strength in this body segment is much less important for goalkeepers than for field players (especially when taking a shot). Specific activities of the handball goalkeeper mainly involve fast short acyclic actions, whereas cyclic activities are relatively scarce and involve running at different speeds. Thus aerobic endurance is of little importance for the goalkeeper's performance[17]. The specificity of their morphological status most probably stems from described special role in the handball game. Goalkeepers' skin folds are the most pronounced among all groups on average and their share of subcutaneous fat in total body mass is the highest. Similar findings were also reported by football researchers[18]. Their study subjects were football players of younger age categories and the goalkeepers there recorded the highest values of subcutaneous fat among all player groups. In terms of the endomorphic component of their somatotype, the Gs in our sample recorded the highest values – they statistically significantly differed from the wings and back players. Bs skin fold values are relatively low and so is the percentage of their subcutaneous fat. However, it is interesting that, when compared to the other groups, their ectomorphic component of their somatotype is relatively highly expressed, while the mesomorphic component is the weakest. In view of certain previous research[8], it is interesting that Ps values of skin folds and total percentage of subcutaneous fat are relatively low and do not differ statistically significantly from those of the other field players (W and B). We can speculate that this is related to the so-called modern model of handball play in which Ps cover larger distances than they used to[19] as well as the modern playing model of pivots who in the game engage during an attack more than they used to[20]. However, they recorded a high quantity of muscle mass and a highly pronounced mesomorphic component of their somatotype. Along with the pivots, the wings have the most pronounced mesomorphic component of their somatotype and a high percentage of muscle mass. A comparison of the results of the main morphological characteristics of the players in our sample with the results reported by some other authors show that our players are comparable to high-level international players. Their average body height and body mass as well as their average share of fat tissue and somatotype characteristics slightly exceed this level in some cases[21–23].

Elite handball players, in keeping with many other elite athletes, tend to be lean and muscular. If we compare the players from our sample with very selected samples of players from sport games which have similar performance requirements – volleyball and basketball – we can see that volleyball players vary in body fat from 10.5% to 14%[24–26] and basketball players from 7.1% to 13.5%[27,28]. Roughly the same also applies to collegiate baseball players[29]. A somewhat different situation was reported with American football players whose percentage of body fat and somatotype was slightly above that level, while their mesomorphic component was particularly pronounced[30]. The authors of this study also established differences between players in different playing positions in many morphological parameters. Volleyball players occupying different positions differ in many morphological parameters[31]. Although these figures are useful for providing reasonable guidelines for the percentage of body fat in these sports, caution must be exercised when interpreting such data due to the methods of assessing body fat. All of the above studies (including ours) used skin fold thickness measures, but varied in the use of skin fold sites.

Our results show that in handball the selection of players for individual playing positions has to also be based on in the players' morphological characteristics. Coaches should have good knowledge of the general and specific tasks that are to be executed by players in the game. At the same time, they have to be familiar with the morphological body characteristics that players should have to perform the tasks required by individual playing positions with the greatest efficiency. The tallest players should thus be oriented to back player positions. As regards pivots, the coaches must, besides body height, consider robustness. For goalkeepers, body height is very important; however, the robustness criteria are slightly lower. For wings, body height is not a decisive factor and smaller players can also occupy this position. Both of the above (also taking other criteria into account) facilitate coaches' decisions when orienting players to their playing positions.

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RAZLIKE U ODREĐENIM MORFOLOŠKIM KARAKTERISTIKAMA TIJELA POVEZANE S IGRAČKOM POZICIJOM KOD VRHUNSKIH RUKOMETAŠA

SAŽETAK

Cilj je bio ustanoviti glavne morfološke karakteristike slovenskih juniora i seniora državne rukometne reprezentacije. Određene su morfološke karakteristike različitih podgrupa igrača (vratari, krila, vanjski igrači, pivoti) kako bi se utvrdilo postoje li razlike. Ispitivano je 78 igrača slovenske juniorske i seniorske rukometne reprezentacije u periodu od 2000.–2007. godine. Koristio se standardizirani antropometrijski protokol prilikom mjerenja morfoloških karakteristika. Podaci su uneseni i procesirani SPSS računalnim programom. Prvo su izračunate osnovne statističke karakteristike antropometrijskih mjera svih igrača, a nakon toga posebno za svaku podgrupu igrača. Somatotipovi su određeni pomoću Heath-Carterove metode. Endomorfne, mezomorfne i ektomorfne komponente izračunate su računalno, na bazi formula. Kako bi se odredile razlike u tjelesnoj kompoziciji i antopometrijskim podacima igrača koji igraju različite pozicije, koristila se jednosmjerna analiza varijance. Rezultati pokazuju da se, u morfološkim tjelesnim kompozicijama, od ostalih igrača najviše razlikuju igrači koji igraju pozicije na krilu. Vrijednosti njihove tjelesne visine i težine te vrijednosti njihovog potkožnog masnog tkiva, statistički su značajno niže od vrijednosti ostalih igrača iz drugih podgrupa. Vratari su relativno visoki, s visokim vrijednostima tjelesne težine i niskim vrijednostima transverzalnih mjera. Njihovi kožni nabori su u prosjeku istaknutiji od kožnih nabora ostalih igrača te im je udio potkožne masti u cjelokupnoj tjelesnoj težini najveći. Posljedično, njihove endomorfne komponente somatotipa su naglašene. Pivoti i vanjski igrači su u svojim morfološkim tjelesnim karakteristikama vrlo slični. Pivoti su robusni, imaju veću mišićnu masu te više naglašene transverzalne mjere i mezomorfnu komponentu somatotipa. Rezultati našeg istraživanja potvrđuju da se grupe igrača koji igraju različite pozicije međusobno razlikuju po mnogo karateristika i mjera. Ovo je rezultat specifičnih zahtjeva kojima su igrači izloženi na pojedinim igračkim pozicijama.