

Position Specific Morphological Characteristics of Top-Level Male Handball Players

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ABSTRACT

With the aim of determining the common morphological features of senior male handball players and of analyzing their specificities i.e. the probable variation between the four playing positions (back court players, wings, pivots, goalkeepers), 25 anthropometric measures were applied to the sample of 49 players, members of three top-quality handball teams. The basic descriptive parameters were calculated and then an analysis of variance and a cluster analysis were performed. A mesomorphic, athletic body-type was obtained with a marked longitudinal skeleton dimensionality, but also with a balanced ratio between the skeletal system and muscle mass and with low values of subcutaneous fat tissue. Back court players and goalkeepers are superior in terms of outstanding skeletal dimensions and circumferences. Line players, i.e. wings and pivots, have somewhat lower longitudinal measures, whereas pronounced voluminosity and a slightly higher fat tissue value differentiate pivots from players in other positions. Cluster analysis revealed a greater homogeneity in the morphological profiles of the samples of line players (wings and pivots) than in the profiles of backs or goalkeepers. The obtained position-related differences in morphological characteristics of players suggest that the experienced players from the sample were earlier successfully subjected to the selection process and oriented to a particular playing position because of the observed correspondence between their body-type and specific kinesiological demands of the position in question. Therefore, in top-quality team-handball it would be recommendable to select players whose morphological profiles are as compatible as possible with positional specificities in the demand for the game.

Introduction

Team sport games appear to be an ideal medium in satisfying basic human aspirations for mobility, co-operation, and competition. They demand a thorough physical, emotional and cognitive engagement of participants who tend to become winners of the game and outplay the rivals. The so defined success in the team game depends on numerous external and internal factors (with regard to an individual), among which anthropological characteristics of a player have a fairly important role. One of the important anthropological components are, undoubtedly, morphological characteristics of a player which are supposed to be compatible with the game specific kinesiological demands. An opinion that certain anthropological characteristics, among them the morphological as well, have significant influence on the situation-related and overall performance in sport has been sustained by experts' empirical knowledge over decades, but it has been recently confirmed in a number of research studies, too^{1–6}.

Hence, anthropometric diagnostic procedures become very important from the aspect of selection of athletes, for the sake of which the sport-specific morphological models or profiles have being created. The »model« somatic patterns are primarily based on those anthropological dimensions that are strongly determined genetically (e.g. skeletal dimensions). Further, the findings regarding anthropometric status of players are indispensable in the training process modeling and management. To be effective, training process must consider both the current and targeted anthropometric status of players, on the one hand, and the game specific demands and desirable results, on the other⁷.

Handball pertains among complex and demanding team games with the ball.

Specific physical conditions and movement structures of the handball technical and tactical elements are implicitly presented in the general characteristic anthropological model of »the top-quality handball player« in which the level and structure of motor and morphological attributes should be optimally harmonized. Recent research studies dealing with morphological profile of a top-level handball player highlighted that he is characterized by the athletic body build and prevailing mesomorphic somatotype with a touch of ectomorphy, that is with a pronounced longitudinal dimensionality of the skeleton^{8–12}.

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-game¹³. Due to that, the between positions variation of morphological profiles have been determined for a number of sport games with the ball (rugby, basketball, football)^{14–20}.

Assuming that top-level handball players can be discriminated among themselves in the morphological space with respect to a particular playing position, the authors of the present study conducted a research the purpose of which was to analyze anthropometric characteristics of the high quality senior male handball players in relation to their basic playing positions (back court player, wing attack player, circle runner attack player or pivot and a goalkeeper).

Material and Methods

Sample

The sample of entities was comprised of 49 senior male handball players, who were in the year 2000 members of the three top-quality handball teams: »Met-

ković Jambo«, Metković, Croatia (the winner of the EHF Cup in the season 2000/2001), »Brodamerkur« from Split, Croatia (the third place in the Croatian Championship League in the season 2000/2001, the participants in the quarter-final matches of the EHF European Cup in the same season), and »Ljubuški« (champions of the Bosnia and Herzegovina national league and the participant in the Champions League in the season 2000/2001). Quite a large number of international quality players (mean age 24.49; average handball training experience 11 years and 5 months) from several European countries (Croatia, Bosnia and Herzegovina, Slovakia and Hungary) was included in the sample. Distribution of the players across the playing positions was: back court players (backs) – 23, wing players (wings) – 13, circle runner attack players (pivots) – 6, and goalkeepers – 7.

Variables

The set of 25 morphological variables has been chosen: 14 variables are chosen from the International Biological Protocol (IBP)²¹ variables list and all the measurements were taken according to the IBP standards; additional 11 variables are chosen from relevant literature dealing with analysis of anthropometric parameters of athletes^{22–23} (Tables 1 and 2). The measurement procedure followed the International Biological Protocol (IBP)²¹ standard instructions. All the measures regarding one side of a player were taken on his dominant side (on the right for the right-handed players and on the left for the left-handed players). In this way, the differences caused by greater engagement of the dominant side of the body in the training process are annulled.

Data processing methods

Basic descriptive parameters of anthropometric variables were calculated: arithmetic mean (\bar{X}), standard deviation

(SD), minimum and maximum value of the results registered (MIN, MAX). The normality of distribution was verified following the Kolmogor-Smirnov test (Max D). The between positions differences were computed by the univariate analyses of variance. Homogeneity of particular positions was determined by cluster analysis under the K-means clustering model. By minimizing the within the groups variability and by maximizing between the groups variability, the procedure enabled classification of players into four independent groups.

Results

The results of the basic descriptive analysis (Table 1) make it obvious that distribution of all the variables is normal. In the same table the basic parameters of the univariate analyses of variance are presented.

The examinees were mostly differentiated in the measures of longitudinal dimensionality and in the circular measures. Considerably lower differences occurred in the measures of subcutaneous fat tissue and transversal dimensionality, except for the variable shoulder breadth.

The between positions differences were obtained by the post-hoc analysis of variance (Table 2). It is obvious that the greatest differences in morphological profile occurred between the positions of the back court players and the wing attackers, all in favor of the backs. They are particularly manifested in the circular measures (all the variables), longitudinal dimensionality and transversal dimensionality of the lower body. No statistical difference was registered in the fat tissue variables.

Differences between the morphological profiles for the wing and pivot positions are manifested in the circular measures and in body weight, all in favor of

TABLE 1
 DESCRIPTIVE STATISTICS AND RESULTS OF UNIVARIATE ANALYSIS OF VARIANCE
 FOR MORPHOLOGICAL VARIABLES IN 49 HANDBALL PLAYERS

No	Variable	X	Min	Max	SD	Max D	F	p
1	Body weight (kg) ^a	91.29	65.00	106.00	7.57	0.11	5.70	0.00
Length (cm)								
2	Stature ^a	190.79	175.30	205.00	6.59	0.07	9.05	0.00
3	Sitting height ^a	98.63	89.80	105.10	3.41	0.07	8.38	0.00
4	Arm span ^b	196.53	181.40	212.50	6.58	0.09	2.10	0.12
5	Hand length ^b	22.26	19.60	25.40	1.01	0.11	5.87	0.00
Girth (cm)								
6	Upper arm ^a	33.31	28.90	39.30	2.22	0.09	3.85	0.02
7	Forearm ^b	29.46	25.50	32.70	1.49	0.08	4.18	0.01
8	Chest ^a	102.27	90.60	113.00	5.55	0.08	4.20	0.01
9	Waist ^b	84.67	70.80	94.10	4.82	0.08	1.27	0.30
10	Hip ^b	102.94	91.30	110.30	4.32	0.08	3.94	0.01
11	Thigh ^a	61.57	52.00	67.20	3.28	0.07	2.02	0.12
12	Calf ^a	40.07	35.20	44.90	2.34	0.08	5.24	0.00
Breadth (cm)								
13	Biacromial ^a	41.95	36.00	45.40	2.08	0.07	4.24	0.01
14	Biiliocrystal ^b	30.45	27.70	33.50	1.44	0.10	2.40	0.08
15	Bitrohanther ^b	34.87	24.10	38.00	2.19	0.11	2.29	0.09
16	Hand ^a	8.90	8.00	9.50	0.35	0.14	2.36	0.08
17	Elbow ^a	7.59	5.90	8.50	0.52	0.15	2.36	0.09
18	Knee ^a	10.54	9.40	11.60	0.50	0.12	3.42	0.03
Skinfold (mm)								
19	Biceps ^b	5.33	3.50	11.20	1.56	0.21	0.89	0.45
20	Triceps ^a	9.21	5.30	20.40	2.95	0.11	0.68	0.57
21	Subscapular ^a	12.14	7.30	23.30	3.22	0.12	0.60	0.62
22	Abdominal ^a	16.60	5.80	33.50	6.29	0.08	1.86	0.15
23	Supraspinale ^b	12.44	4.40	28.20	5.87	0.13	1.19	0.33
24	Front thigh ^b	13.54	5.20	28.40	4.45	0.14	1.12	0.35
25	Medial calf ^b	7.99	4.00	16.00	2.68	0.14	0.64	0.60

a = variables measured according to the IBP²¹; b = variables chosen from relevant literature²²⁻²³

the pivots. The measures of longitudinal dimensionality did not differentiated between these two playing positions.

The wings and the goalkeepers were differentiated by the transversal skeletal dimensionality measures, by the certain

TABLE 2
MEAN VALUES AND POST-HOC ANALYSIS OF VARIANCE (LSD TEST) FOR MORPHOLOGICAL
VARIABLES IN FOUR GROUPS OF HANDBALL PLAYERS

No	Variable	Mean values				Significant differences					
		W	B	P	G	W-B	W-P	W-G	B-P	B-G	P-G
1	Body weight (kg) ^a	85.12	94.28	92.58	91.79	**	*	*			
Length (cm)											
2	Stature ^a	187.02	194.42	183.85	191.86	**			**		**
3	Sitting height ^a	96.52	100.53	95.53	98.99	**			**		*
4	Arm span ^b	193.87	199.31	192.92	195.22						
5	Hand length ^b	21.69	22.80	21.68	21.99	**			**		*
Girth (cm)											
6	Upper arm ^a	31.78	33.73	35.02	33.33	**	**				
7	Forearm ^b	28.66	29.87	29.93	29.27	**					
8	Chest ^a	99.07	103.68	103.95	102.16	*					
9	Waist ^b	81.99	85.40	87.43	84.86	*	*				
10	Hip ^b	99.18	104.21	103.98	104.83	**	**	**			
11	Thigh ^a	58.90	62.16	61.70	63.00	*		*			
12	Calf ^a	38.62	40.50	41.77	39.90	*	**				
Breadth (cm)											
13	Biacromial ^a	40.85	41.86	42.45	43.84				**		
14	Biiliocrystal ^b	29.42	31.03	30.40	30.49	**					
15	Bitrohanther ^b	33.31	35.71	34.48	35.34	**		*			
16	Hand ^a	8.75	8.97	8.88	8.96						
17	Elbow ^a	7.20	7.75	7.77	7.63		*				
18	Knee ^a	10.28	10.67	10.68	10.49	*					
Skinfolds (mm)											
19	Biceps ^b	4.89	5.30	6.10	5.59						
20	Triceps ^a	8.38	9.43	8.95	10.26						
21	Subscapular ^a	11.38	12.08	12.58	13.34						
22	Abdominal ^a	15.60	15.45	21.70	17.84		*	*			
23	Supraspinale ^b	10.87	12.16	16.20	13.04						
24	Front thigh ^b	14.20	13.92	13.97	10.71						
25	Medial calf ^b	7.92	8.36	8.18	6.76						

* p < 0.05; ** p < 0.01

W = wing; B = back; P = pivot; G = goalkeeper;

a = variables measured according to the IBP²¹; b = variables chosen from relevant literature²²⁻²³

measures of voluminosity: upper-arm and hip circumferences, and by body weight, all in favor of the goalkeepers. Also, their abdominal skinfold measures were significantly higher.

The only statistically significant difference between the profiles of backs and pivots regarded variables of longitudinal dimensionality of skeleton, in which measures the back court players were superior.

Just the hand length differentiated significantly the back court players from the goalkeepers.

Two measures of longitudinal dimensionality – body height and sitting height – distinguished the pivots from the goalkeepers in favor of the latter.

According to the cluster analysis results (Table 3), five out of six pivots (83.3%) and nine out of 13 wings (69.3%) were classified into the group 3 and 4, respectively. Ten backs, out of 23, or 43.5% were classified in the same group (2), whereas goalkeepers found their place in all four groups and only two out of 7 (28.6%) were classified in the second group with the 10 backs.

Discussion

Comparison of the results obtained by descriptive analysis in the present study

with the results of the similar investigations on the samples of top-level handball players in Croatia and other countries reveals similar and practically identical values in large number of anthropometric variables^{8–12}, particularly in the measures of longitudinal dimensionality and body weight. When comparing the obtained morphological profiles of handball players to the results registered for athletes from other sports, certain similarities and differences become recognizable. For example, the general morphological profile obtained in this study is similar to the model of the top Croatian rower²⁴, but it differs considerably from the profile of football player²⁵.

A characteristic morphological profile was determined in the present study being appropriate for top-quality handball players – athletic body build, emphasized longitudinal dimensionality of the skeleton, proportional ratio of the skeletal system and muscle mass, and reduced fat tissue. Such a morphological profile supports handball players to effectively perform technical-tactical structures of the game under the actual competitive conditions of confronting the opponents. It also sets a rational energy demands to move the individual's body mass around the playing court.

With regard to the between playing positions variation, it can be said that the

TABLE 3
RESULTS OF CLUSTER ANALYSIS

Position	Group 1		Group 2		Group 3		Group 4	
	N	%	N	%	N	%	N	%
Wing	1	7.7	1	7.7	2	15.3	9	69.3
Pivot	0	0.0	0	0.0	5	83.3	1	16.7
Back court	4	17.4	10	43.5	6	26.1	3	13.0
Goalkeeper	2	28.6	2	28.6	2	28.6	1	14.3

N = number of classified players; % = percentage of classified players

differences between the back court players and wing attackers are the biggest as manifested in the skeletal longitudinal and transversal dimensionality, as well as in the circular measures.

Players on the back court positions are considerably taller, with wider hips and pelvis; and their circular measures of all the observed body segments are rather high. Strong stamina (body constitution), tall stature and generally greater body mass are more important to the backs than to the wings. Namely, the prime playing function of the backs is, from the kinesiological aspect, the most complex one of all the positions in the handball game. During the match-game they possess the ball for the most of the time and their responsibility for both the organization of the team play and closing actions performance, especially by shooting from distance, is the greatest. Greater longitudinal dimensions and longer levers are important because they insure the powerful and efficient shooting at the goal over and through the defensive wall. Further, the taller backs have better visual control over the court and position of players on it. Their body height is also desirable for more efficient co-operation with the line players (pivots and wings).

Wing players differ from pivots in reduced voluminosity. Strong body constitution (large body mass) is less important to wings because they usually operate in clear situations, that is, they rarely have contact with the rival defensive players, which is quite contrary with the pivots. Yet, considering that the wing player acts on an attack within limited space and under unfavorable shooting and passing angle, the basic characteristic of their play is dynamism and agility of moving with and without the ball. Hence, reduced ballast fat tissue is a desirable characteristic. Somewhat higher measures of longitudinal dimensionality are also important

because they may facilitate and enhance shooting effectiveness.

It is obvious that there is no significant difference between the wings and pivots in dimensions of the skeleton or longitudinal dimensions. Since they operate in vicinity of the goal-area line, these two types of players are usually referred to as the line players. The unifying, common characteristic for both positions is the type of shooting at the goal: they perform short-range shots over the goal area as either a dive, falling, or curved jump shot. In that case longitudinal dimension is not that important as for the players on the back court positions.

A circle runner or pivot differs considerably from players on all the other positions considering his morphological profile. The pivots have a greater voluminosity, in term of both the muscle mass and fat tissue, and skeletal transversal measures. The pivot plays within the opposing defensive formation with his back or side to the goal and the rivals. Therefore, he must be able to assume and maintain stable stances and he must sustain constant contact with the defenders and fight for the favorable position. These actions are accompanied by pushing, resisting, pulling, turning with the opponents on his back, in a word, by tremendous static strains and very short dynamic actions. Certain morphological attributes may help him to accomplish the assigned playing role – low center of gravity, strong upper part of the body that is longer than the lower part for gaining and maintaining stability, bigger muscle mass to control the resistance of the opponent's body mass, and a relatively great total body mass are needed under the conditions of constant balance disturbing and restoring.

The goalkeeper is a player that differs mostly from the wing player considering the transversal dimensions and the circular measures of the skeleton, and from

the pivot in terms of longitudinal dimensions. Morphological constitution connects goalkeepers and back court players. The goalkeeper is the most specific player among his teammates considering the performance of technical and tactical elements because he is the ultimate defender on his team. He acts individually in limited space and he is concentrated on quick and explosive implementation of simple movements in a fraction of a second, which is not so demanding in terms of energy supply. Therefore, the top goalkeeper is athletically built with an emphasized longitudinal dimension. Biacromial and biliocrystal breadths may contribute considerably to covering bigger goal area and to implementing save movements in farther parts of the goal more efficiently.

Evidently, the between positions differences do exist in the morphological profile of players. The finding is confirmed by the results of cluster analysis. The wing and pivot players are more homogeneously grouped than the back court players, and especially the goalkeepers. In other words, the line players, pivots in particular, have more common anthropometric characteristics than the back court players and the goalkeepers.

Conclusion

With the purpose of determining the morphological characteristics of top-quality players and analyzing the between positions differences in morphological profile of players, 25 anthropometrical measures, aimed at assessing skeletal dimensionalities, circumferences and subcutaneous fat tissue, were applied to the sam-

ple of 49 experienced senior male handball players of international quality. The athletic, mesomorphic constitution type was determined with the emphasized longitudinal dimensions of the skeleton, balanced ratio of the bone and muscle mass, and reduced fat tissue.

The differences in anthropometric measures considering 4 positions (back court, wing, pivot, and goalkeeper) are manifested considerably in the circular measures of the body volume and in dimensions of the skeleton. Back court players and goalkeepers are superior in the mentioned measures. Wings and pivots have somewhat lower values of longitudinal dimensionality, whereas the circle runner has outstanding circular measures and somewhat higher values of fat tissue.

Although it is well known that the sport specific kinesiological activities and training process may influence to a certain extend morphological status of players, especially in the measures of circumferences and lean – fat body mass ratio, the findings of the study are primarily caused by the selection and orientation of the players to particular positions and roles in the handball game to which their morphological attributes are mostly compatible. Morphological characteristics constitute players' basic aptitude for a certain playing position on which they can be effectively employed in the game. Therefore, in top-quality team-handball it would be sensible to select players whose morphological profiles are mostly compatible with positional specificities in the demands of the game.

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SPECIFIČNOSTI MORFOLOŠKIH KARAKTERISTIKA VRHUNSKIH RUKOMETAŠA S OBZIROM NA IGRAČKU POZICIJU

S A Ž E T A K

Na uzorku od 49 vrhunskih rukometaša seniorskog uzrasta primijenjeno je 25 antropometrijskih mjera radi utvrđivanja njihovih zajedničkih morfoloških obilježja i analize specifičnosti, tj. vjerojatnih razlika s obzirom na 4 igračke pozicije (vanjski, krilni i kružni napadač te vratar). U okviru statističke obrade izračunati su osnovni deskriptivski parametri te je provedena post-hoc analiza varijance i klasterska analiza. Dobiven je opći mezomorfní, atletski tip građe s izraženijom longitudinalnom dimenzionalnošću skeletnog sustava, uravnateženim odnosom koštanog i mišićnog sustava te nižim vrijednostima potkožnoga masnoga tkiva. Vanjski igrači i vratari su dominantni i naglašeno dimenzionirani u mjerama koštanog sustava i opsezima. Linijski igrači, tj. krilni i kružni napadači, slabije su longitudinalno dimenzionirani, dok se kružni napadač posebno izdvaja zbog naglašene voluminoznosti te nešto veće količine masnog tkiva. Klusterskom analizom utvrđena je veća homogenost morfoloških profila linijskih igrača (krilni i kružni napadači) od profila vanjskih napadača ili vratara. Prisutne razlike u morfološkoj građi ukazuju na diferenciranje i selekcioniranost igrača s obzirom na specifične kineziološke zahtjeve pojedinog igračkog mjesta. U vrhunskom je rukometu stoga preporučljivo da se za određene pozicije odabiru igrači koji su svojim morfološkim obilježjima što kompatibilniji zahtjevima tog igračkog mjesta.