

RELATIONS BETWEEN MORPHOLOGICAL CHARACTERISTICS, BASIC AND SPECIFIC MOTOR SKILLS IN YOUNG HANDBALL PLAYERS FROM THE TERRITORY OF NOVI SAD

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Abstract

The research was conducted on a sample comprising 65 handball players from the territory of Novi Sad of the average age of $15,45 \pm 0,15$ from two handball clubs, RK "Metalac" from Futog and RK "Jugović" from Kač. The average height of the players was $174,48 \pm 8,19$ cm, the average weight was $63,90 \pm 11,15$ kg, and the average body mass index was $BMI = 19,44 \pm 3,15$ kg/m². The aim of the paper is to use the determined relations so as to improve work in handball clubs and achieve better quality of selection through monitoring of young players in further development. Body height, body mass index, arm span, and hand length were measured. The motor skills evaluated comprised explosive strength of leg muscles, repetitive strength of body muscles, flexibility of the upper leg hamstrings and lower back, general strength) and specific motor skills (specific agility, curvilinear movement with the ball, and shooting precision) were performed using standardized tests. By implementation of regression analysis, it was established that there is statistically significant impact of the system of predictor variables on the following criteria variables: Standing long jump ($P=0,02$) and Dynamometry of the hand of the dominant arm ($P=0,02$). The common variability ranged between 39% for the criterion Dynamometry of the hand of the dominant arm and only 2% for the criterion Body raises in 30 s. The values of the standardized regression coefficient Beta point to individual negative and statistically significant impact of the variable Body mass ($p_{\text{beta}}=0,02$) on the criterion Standing long jump and positive statistically significant impact ($p_{\text{beta}}=0,01$) of the same variable on the criterion Dynamometry of the hand of the dominant arm. The results of the research point to the supposition that there is mutual connection between morphological variables for assessment of longitudinal properties of the skeleton and body mass index and basic motor skills in handball players, and that training needs to be conducted with utmost attention and control of the body composition, as well as further reduction of mass in young handball players.

Key words: handball, relations, basic, specific motor skills.

Introduction

By its structure, handball is a very complex and sophisticated game, thus belonging to the group of poly-structural and acyclic movements. This is a sports game characterized by various and numerous kinesiological activities which, besides acyclic, also comprises high-intensity cyclic movements (e.g. top-speed running during a counterattack). The current level of handball development is characterized by intense dynamics and intense rhythm of the game which calls for exceptionally high level of conditioning skills, high level of technique in motion, tactical maturity, and physical stability. High level of conditioning skills may be only achieved through systematic training in conditioning preparation, which implies development and training of all skills needed to achieve top sports results. Kinanthropological analysis of the game of handball (structural, biomechanical, functional morphological, motor, cognitive, and conative) gives us information on requirements handball players were faced with in the course of competing activities. The players who are well-prepared in terms of conditioning will be able to resolve handball tasks throughout the match in an efficient manner.

The aim of the game of handball is to score a goal by throwing the ball into the goal defended by the handball goalkeeper. Scoring is achieved by throwing the ball from the hand, i.e. shots defined within the two main groups, standing shots and jump shots. The very aim of the game, which is manifested as a shot in the goal and scoring a goal, is classified among the most important elements which determine success in scoring in handball. It is logical to expect, and it has also been proven by research conducted so far (Elias, 1996; Foretić, Erceg, Bradić, Torcilj, 2005), that players to whom the ball is flying faster will have a greater opportunity to score a goal, while to be more likely to experience this opportunity, the player both needs to be sufficiently tall and have exceptionally high explosive strength of legs and explosive strength of arms and the shoulder belt. Most shootings and throwing activities depend on motor skills, mostly of explosive strength of the muscle zone of arms and the shoulder belt. The positive impact of strength and height on the speed of movement of the ball was confirmed in a number of researches (Kotzamanidis, Karahekgas, Kiparos, Giavroglov & Tsaarouhas, 1995; Bayios i Boudolos, 1999), same as the positive impact of longitudinal skeleton on basic and specific motor skills of handball players aged 14-15 (Visnapuu & Jürimäe, 2008; Visnapuu & Jürimäe, 2009; Debanne & Laffaye, 2011).

The game of handball is characterized by exceptionally fast actions, with explosive and multiply cyclic and acyclic movements which call for complex skills in players and a high level of coordination, functional, and cognitive capabilities as a base for a strong, fast, and accurate action (Demir, 1998; Demir i Stanković, 2007). All this also calls for corresponding height and corresponding strength of the arms and the body (general strength) as well as good physical preparedness of players. Height makes it possible for the player to shoot the ball over the block, while strength of the arms and the shoulder belt allows him to throw the ball very fast and precisely. This is why height and explosive strength of the arms and the shoulder belt are directly correlated in properly selected handball players.

In modern handball, it is interesting to note that players at different positions have different morphological characteristics. Comparing only wing players with backs or pivots, we will observe that wing players are shorter, with smaller longitudinal dimensions, smaller in mass. Unlike them, players on pivot positions are somewhat taller (nowadays in modern handball, close to 200 cm in height), strong, with pronounced mass and voluminous skeletons. They are exceptionally strong, massive, with broader shoulders and pelvises, and larger torso circumference (thus creating a larger and stronger block for their back shooters in an attack) (Šibila, & Pori, 2009). It needs to be noted that there is significant positive correlation between the body height and breadth of the hand, thus tall handball players also have hands of the needed size which allows them better control of the ball and greater strength while shooting (which means that backs, or possibly pivots, should have the longest hands) (Stanković, Malacko, Bojić, Ilić, 2013). Taking a sample of 90 top juniors of the average age of 17.5, Šibila at al. (2011) calculated correlation between subcutaneous fatty tissue and certain indicators of the motor-functional space. The research confirmed negative impact of subcutaneous fatty tissue onto all tests of motor skills.

The aim of this paper is to improve work with young handball players based on the obtained relations, to upgrade quality of selection and monitoring of young handball players in their further development, while the results obtained will be used for the purpose of better planning and programing of training.

Method

The sample of respondents comprised 65 male handball players ($AS=15,45\pm 0,15$ YRS) from two handball clubs at the territory of the city of Novi Sad, RK "Metalac" from Futog and RK "Jugović" from Kač. ($TV=174,48\pm 8,19$ cm, $TM=63,90\pm 11,15$ kg and $BMI=19,44\pm 3,15$ kg/m²). The respondents had at least three years of experience in sports, with training sessions three times a week, and the weekly total of about 4.5 hours of training.

The research comprised measuring of morphological characteristics of the respondents (comprising predictor variables in the research, except for BMI):

1. Body height (cm),
2. Arms span (cm),
3. Length of hand (cm),
4. Body mass (kg) used to calculate
5. BMI (kg/m²).

When it comes to basic motor skills, the following skills were evaluated using standardized tests (comprising criterion variables in the research):

1. Standing long jump (cm) – explosive strength of leg muscles,

2. Toe touch on a bench (cm) – flexibility of the upper rear leg hamstrings and the lower back,
3. Dynamometry of the hand of the dominant arm (N/m) – general strength, and
4. Body raising in 30 s (freq.) – repetitive strength of the body muscles.

For evaluation of specific morphological characteristics, the following motor skill tests were conducted (criterion variables in the research) in handball, as they fulfil the validity, reliability, and objectivity criteria (Goranović, 1998).

1. Ball dribbling around 9 stands 9 (s) – specific agility (curvilinear movement with ball) and
2. Precision of standing shots from the distance of 7 m (point) – shooting precision.

The measurements were implemented in an indoor handball playing court in Novi Sad, and were conducted by the author of this paper in cooperation with coaches of handball clubs operating within the Handball Alliance of Vojvodina. In the course of measurement of morphological characteristics, instructions were issued to both measuring assistants and respondents so as to obtain the measurement results as relevant as possible. The measurements were performed by professional and skilled persons who were always measuring one skill (one test) or one morphological characteristic, or calibration of measuring instruments.

Ball dribbling in slalom around 9 stands – evaluation of specific agility (curvilinear movement with the ball) and evaluation of ball dribbling using specific movement structures. The test is performed at the length of 20 m with a stand marking each meter; the player must perambulate them dribbling the ball all the time. The scored result is in seconds.

Precision of standing shots from the distance of 7 m – Specific precision where the goal may be divided in 6 areas, while the highest scores are achieved in the corners of the goal (left and right, top and bottom). Alternatively, the respondents (handball players) were shooting at a textile target (50 x 50 cm in dimensions) placed within the goal posts using a handball ball no. 2 from the distance of 7 meters from the goal. Each respondent took the described test three times, with mean values taken for statistical processing.

In the statistical method of data processing, the basic descriptive statistics of motor variables was determined: arithmetic mean (AM), standard deviation (S) of minimum (MIN) and maximum (MAX) values of results of measurements, and coefficient of variation (CV). Shapiro-Wilk test was used for testing of distribution normality. Linear regression analysis will be applied with the aim to determine the impact of the system of predictor variables on criterion variables, as well as individual contribution of predictors in definition of criterion variables.

Results

The results of descriptive statistics (Table 1), primarily all values of coefficients of variation, point to homogeneity of the results in morphological variables for evaluation of longitudinal properties of the skeleton, Body height, Arm span, and Length of hand and relative homogeneity in the variables Body mass and BMI. The respondents were at a similar level of in displaying explosive strength of leg muscles (Standing long jump), repetitive strength of body muscles (Raising of body in 30 s), specific motor variables for assessment of specific agility (Ball dribbling in slalom around 9 stands). Relatively similar display of strength is observable through the variable Dynamometry of the hand of the dominant arm. Significant differences were observable in the display of precision of shooting the ball into the goal using the dominant hand, Precision of standing shots from the distance of 7 m and flexibility of the upper rear leg hamstrings and lower part of the back, Toe touching on the bench.

Based on statistical significance of the Shapiro Wilk coefficient, it may be stated that normality of distribution is found in 10 out of 11 analyzed variables ($S-W < 0,05$) (Table 1). Only in one variable, Precision of standing shots from the distance of 7 m, there is observable discrepancy from normal distribution due to exceptionally large differences in the results obtained ($S-W = 0,01$).

Upon examination of the results of Linear regression analysis of criteria for evaluation of the basic motor skill *Standing long jump* (Table 2), it may be observed that there is a statistically significant impact of the system of predictor variables onto the criterion variable ($P = 0,01$). The obtained values of the multiple correlation coefficient $R = 0,43$ explain the 19% of common variability.

Upon individual analysis with application of the standardized regression coefficient Beta, it may be observed that the respondents with larger body mass ($Beta = -0,40$) recorded statistically significantly worse results in the course of the testing (the predictor variable had statistically significant negative impact ($p_{beta} = 0,01$)) and that the large values of body mass diminished the explosive strength of their leg muscles.

Based on linear correlations (Pearson coefficient) it may be concluded that the predictor variables *Body height* and *Arm span* were in positive, statistically significant correlations ($p=0.01$) with the analyzed criterion. Based on the analyzed sample and age of respondents, it may be assumed that the respondents with longer skeletons achieved better results in standing long jump.

Table 1. Descriptive statistics of analyzed variables

Variable	MIN	MAX	AM	S	CV	S-W
Body height (cm)	157.00	192.00	174.48	8.19	4.69	0.77
Body mass (kg)	41.00	94.00	63.90	11.15	17.44	0.28
Arm span (cm)	153.00	185.00	167.60	7.63	4.55	0.53
Length of hand (cm)	17.50	21.00	19.31	0.74	3.83	0.84
BMI (kg/m ²)	15.62	28.69	20.66	3.15	15.24	0.28
Standing long jump (cm)	150	239	197.51	20.87	10.56	0.82
Toe touching on a bench (cm)	0	32	15.56	7.53	48.39	0.55
Dynamometry of the hand of the dominant arm (N/m)	24	53	40.25	6.82	16.94	0.97
Body raising in 30 s (freq.)	20	44	29.75	4.15	13.94	0.19
Ball dribbling in slalom around 9 stands (s)	7.36	11.33	9.36	0.81	8.65	0.94
Precision of standing shots from the distance of 7 m (point)	0	6	1.74	1.91	109.77	0.01

Legend: MIN – minimum values of measurement results; MAX – maximum values of measurement results; AM – arithmetic mean; S – standard deviation; CV – coefficient of variation; S-W – level of significance of Shapiro Wilk test

When observing the values of the partial coefficient of correlation for the variable *Body mass* ($r_{\text{part}}=-0.31$), it may be observed that correlation in this predictor variable is statistically significant ($p_{\text{part}}=0.01$), thus it may be assumed that the remaining variables (observing each variable individually) contributed to better performance of standing long jump in heavier respondents (Table 2).

Table 2. Regression analysis of Standing long jump

Varijable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body height	0.29	0.01	0.21	0.10	0.34	0.10
Body mass	-0.01	0.50	-0.31	0.01	-0.40	0.02
Arm span	0.29	0.01	0.18	0.16	0.23	0.16
Length of the hand	0.19	0.07	0.09	0.47	0.10	0.47

R=0.43 R²=0.19 P=0.02

Legend: r – Pearson correlation coefficient; p – level of statistical significance for r; r_{part} – value of partial correlation coefficient; p_{part} – level of statistical significance for r_{part} ; Beta – regression coefficient; p_{bete} – level of statistical significance of regression coefficient; R – multiple correlation coefficient; R² – determination coefficient; P – significance of multiple correlation coefficient

Based on the results of Linear regression analysis of *Toe touching on the bench* (Table 3) it was established that there is no statistically significant impact of the system of predictor variables onto the give criterion ($P=0.58$). The value of the multiple correlation coefficient was $R=0.21$, which explained the 4% of common variability of the predictor system and criteria. No predictor variables indicated to statistically significant impact onto the analyzed criterion.

Table 3. Regression analysis of Toe touching on a bench

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body height	0.10	0.21	-0.04	0.76	-0.07	0.76
Body mass	0.14	0.13	0.08	0.51	0.11	0.51
Arm span	0.06	0.32	-0.01	0.95	-0.01	0.95
Length of the hand	0.19	0.06	0.16	0.21	0.19	0.21
		R=0.21	R ² =0.04		P=0.58	

Interpretation of the results in Table 4 points to existence of statistically significant impact of the system of predictor variables onto *Dynamometry of the hand of the dominant arm* ($P=0.00$) at the multiple correlation coefficient value of $R=0.63$, which explained the 40% of common variability.

Observing each predictor variable individually, it may be concluded that only the variable for evaluation of the body mass, *Body mass*, points to statistically significant impact on the criterion ($p_{\text{bete}}=0.01$), i.e. the larger the body mass in the handball player, the better the results achieved.

If we also take into account values of Pierson coefficient, it may be assumed that the sportsmen with greater body height ($r=0.54$), body mass ($r=0.57$), greater arm span ($r=0.37$), and longer hands ($r=0.42$) achieved statistically significantly ($p\leq 0.05$) better results in the test which assesses general strength. Bigger and taller respondents of stronger build scored larger values in the test of general strength.

Observing the partial correlation coefficient of the predictor variable *Body mass* ($r_{\text{part}}=0.34$), it may be observed that the coefficient is reduced in comparison with Pearson coefficient and that it remained statistically significant ($p_{\text{part}}=0.00$), thus it may be assumed that the remaining predictor variables contributed pa se to scoring better results in the test.

Table 4. Regression analysis of Dynamometry of the hand of the dominant arm

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body height	0.54	0.00	0.18	0.16	0.25	0.16
Body mass	0.57	0.00	0.34	0.01	0.38	0.01
Arm span	0.37	0.00	-0.05	0.67	-0.06	0.67
Length of hand	0.42	0.00	0.17	0.19	0.16	0.19
R=0.63		R²=0.39 P=0.02				

Regression analysis of *Body raising in 30 s* (Table 5) showed that there is no statistically significant impact of the system of predictor variables onto the give criterion ($P=0.98$) with the value of multiple correlation coefficient of $R=0.07$, which explained the only 1% of common variability of the predictor system and criteria. In the analyzed sample, some other characteristics and abilities had greater impact on the display of repetitive strength of body muscles.

Table 5. Regression analysis of Body raising in 30 s

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body height	0.03	0.41	-0.01	0.98	-0.01	0.98
Body mass	0.04	0.38	0.02	0.87	0.03	0.87
Arm span	0.01	0.49	-0.02	0.88	-0.03	0.88
Length of hand	0.07	0.30	0.07	0.66	0.07	0.66
R=0.07		R²=0.02		P=0.98		

Regression analysis of *Ball dribbling in slalom around 9 stands* (Table 6) showed that there is no statistically significant impact of the system pf predictor variables on the given criterion ($P=0.15$) with the multiple correlation coefficient value of $R=0.32$, which explains the value of 10% of common variability of the predictor system and criteria. In the analyzed sample, some other characteristics and abilities had greater impact on the display of the speed of ball dribbling (agility and curvilinear movement).

Even though the variable for assessment of longitudinal properties of the skeleton, *Body height*, had statistically significant impact on the display of agility, it may be regarded as an incidental phenomenon only, as the system was not statistically significant in relation to the analyzed criteria.

Table 6. Regression analysis of Ball dribbling in slalom around 9 stands

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body height	-0.01	0.48	-0.26	0.04	-0.45	0.04
Body mass	0.18	0.07	0.22	0.08	0.29	0.08
Arm span	0.14	0.12	0.19	0.12	0.27	0.12
Length of hand	0.07	0.49	0.10	0.45	0.11	0.45
R=0.32		R²=0.10		P=0.15		

Regression analysis of the criterion *Precision of standing shots from the distance of 7 m* (Table 7) showed that there is no statistically significant impact of the system of predictor variables ($P=0.90$) with the multiple correlation coefficient value of $R=0.13$, which explained the only 2% of common variability

of the predictor system and criteria. In the analyzed sample, some other characteristics and abilities had greater impact on the display of precision.

Table 7. Regression analysis Precision of standing shots from the distance of 7 m

Variable	r	p	r _{part}	p _{part}	Beta	p _{beta}
Body height	0.06	0.31	0.13	0.31	0.23	0.31
Body mass	-0.01	0.47	-0.05	0.68	-0.07	0.68
Arm span	-0.01	0.48	-0.01	0.56	-0.11	0.56
Length of hand	-0.02	0.43	-0.07	0.59	-0.08	0.59
R=0.13		R ² =0.02		P=0.90		

Discussion

The results of the research point to the existence of statistically significant relations in two criteria, *Standing long jump* and *Dynamometry of the hand of the dominant arm*, while in remaining cases the system was not statistically significantly related to the criteria. It may be stated that the predictor system which mostly comprised variables for longitudinal properties of the skeleton and body mass was statistically significant in relation to the criteria from the area of basic motor skills, while in two analyzed criteria of specific motor skills there was no observed statistically significant relation between the predictor system and criteria. Justification for the implemented research may be found in results of researches carried out so far, where the need for selection of morphological characteristics in the diagnostic process was established (Šibila and Pori, 2009; Chelly et al., 2011; Chiara et al., 2011; Vila et al., 2012; Urban & Kandrač, 2013; Lijewski et al., 2019; Lijewski et al., 2021; Leuciuc et al., 2022). Also, based on the obtained research results, it may be stated that within the sport of handball, body mass and longitudinal properties of the skeleton have their role in selection of handball players by quality, which confirms the results of Šibila and Pori (2009) and Chelly et al (2011) i Lijewski et al., 2021 only on a somewhat older sample.

When it comes to the criterion of basic motor skills, the obtained results of Linear regression analysis, or more precisely common variability, are rather low and range from 1% to 40%, thus it is possible to say that some other variables have stronger impact on motor skills such as explosive strength of legs, repetitive strength of the body, flexibility of the upper rear leg hamstrings, and general strength. This primarily implies other morphological characteristics such as the condition of subcutaneous fatty tissue, body composition (total amount of muscles, water, and fat), the length of limbs, but also the condition of muscles (inter and intra-muscular coordination).

It needs to be emphasized that there were individual negative statistically significant impacts of the variable *Body mass* onto explosive strength of leg muscles (Beta=-0,40), which leads to the conclusion that it might be about fatty mass in this population of adolescents who change their morphology under the influence of the training process, environmental factors, and genetics. Even though these were potentially the most talented handball players of cadet age, we should not neglect the fact that these were players at different playing positions (goal keepers, pivots, backs, and wingers) who differ by their body mass. Their constitution has already at least partly determined their playing position (Šibila & Pori, 2009) which could have impact on significant differences and heterogeneity of results in the variable for assessment of precision (*Precision of standing shots from the distance of 7 m*). Positive correlation of variables with the analyzed criterion was observed for the same criteria for evaluation of longitudinal properties of the skeleton, *Body height*, and *Arm span*, which may be explained from the standpoint of parabolic movement and position of the barycenter in taller respondents. The respondents whose barycenter is higher move farther and jump longer.

Analyzing the results of the second criterion, *Dynamometry of the hand of the dominant arm*, it is possible to observe positive impact of *Body mass* on higher, better results in the test of general strength. The very body mass also enables display of more pronounced powers in sportspersons and general population alike. Having in mind that the three remaining predictor variables were in positive statistically significant correlation with the criterion, it may be assumed that taller, heavier, and stronger handball players, with longer hands, also possessed greater general strength. Based on the obtained research results, it may be assumed that, from the standpoint of morphology, the boys selected in the first round were taller, with longer arm spans, and larger body mass, while from the aspect of motor skills, those with greater explosive strength and general strength were dominant. It is possible that the current technical level of handball and techniques of the element of the game of handball were decisive, while selection of children

who not only have good technique but certain motor skills as well is expected in several years. Such results confirm the results of research carried out so far by foreign scientists Visnapuu & Jürimäe (2008, 2009), Visnapuu & Jürimäe and Debanne & Laffaye (2011) who also determined positive impact of longitudinal properties of the skeleton onto basic motor skills in handball players aged 14-15. Unlike those researches, in this particular case no impact of longitudinal properties of the skeleton onto specific motor skills were found, even though similar (though not the same) tests were used.

Nowadays, as a sports game, handball is experiencing changes which mainly relate to its speed, strength, and explosivity. This is why selection and inclusion of children in handball takes places earlier increasingly. Choice of the most appropriate position and role of each individual player is conducted based on monitoring of the player's abilities, (motor and functional) properties, knowledge, and skills important for successful completion of tasks in a game. Recognition and successful steering to the individual position in a game is a process which lasts and which is based on knowledge, experience, and invested effort. Practical value of the paper is reflected in the data obtained on the sample of the best selected young handball players from AP Vojvodina who passed the first round of selection, and impact of certain parameters of morphological space onto specific and basic motor skills. The obtained data may contribute to improvement of selection and better planning and programming of training in further work with this population of sportsmen, while the greatest value of the paper lies in the fact that it provides the initial condition of certain basic and specific motor skills. Based on the obtained data, it was pointed to the need for further correction of physical build (however, in view of morphological changes which occur in the period of adolescence) and further planning of training work. In theory, this paper should contribute to better understanding of selection in handball and emphasizing of morphological characteristics in early adolescence, however taking into account the genetic potential and the period of maturing for each individual (following Tanner stages of growth and development of the body)

Conclusion

The results of the research point to the supposition that there is inter-relation between morphological variables for evaluation of longitudinal properties of the skeleton and body mass, and basic motor skills in handball players, and that training needs to be approached with a great deal of attention and control of body composition and further reduction of mass in young handball players. Further research needs to be conceived on distribution of players in different positions within a team (goal keeper, back, winger, pivot) and monitoring of these players in the following period, to obtain a clear picture on changes in morphological characteristics and their impact on basic and specific motor skills. The results may help coaches in monitoring and further planning and programming of training processes with young handball players.

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