FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 5, Nº 1, 2007, pp. 65 - 74

Scientific Paper

THE INFLUENCE OF BASIC MOTOR ABILITIES AND ANTHROPOMETRIC MEASURES ON THE SPECIFIC MOTOR SKILLS OF TALENTED WATER POLO PLAYERS

UDC 796.1034: 612.17

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Abstract. *The purpose of this research is to determine the influence of basic motor abilities and anthropometric measures on the specific motor skills of water polo players in latent space. The subject sample consisted of a total of 89 water polo players aged 12 years ± 6 months who have been training water polo for at least 2 years and who partook in at least 1 federal tournament of the Water Polo Association of Serbia and Montenegro. The ascertainment of the morphological characteristics (14 tests), of the basic (12 tests) and specific (6 tests) motor skills level was performed by applying standardized tests. Factor analysis has been calculated to determine the space structure of the morphological, basic and specific characteristics of motor skills. A regression analysis was performed in order to determine the correlation between the influences of manifest basic motor skills as well as the morphological ones on the latent space of specific motor skills. A statistically relevant correlation between the whole predictor and the criterion has been confirmed.*

Key words: *water polo, basic motor skills, morphology, specific motor skills*

1. INTRODUCTION

Water polo is a swimming poly-structural team sport, a sport game with an aerobic-anaerobic character (Topouzov, 2001).

Basic motor skills are the foundation of every motor skills doctrine. They are defined as the complex characteristics that are being detected during movement, irrespective of whether they are innate or acquired. The training process has a bigger influence on the

Received February 19, 2007

motor skills that are less genetically provisional (Beunen & Malina, 2005). Water polo training affects basic motor skills improvement in prepubescent children (Bratuša, 2000). In the age prior to puberty and in accordance to any sensitive periods, water polo training stimulates significant changes in the precision and coordination of the indicators of explosive strength (Šimenc & al., 1997).

Kukolj (1998) used a research sample of 325 water polo players, aged 8-15 to examine the connections between basic motor skills and swimming results. The researcher concluded that the mechanisms which enable a quick exchange of alternative movements appeared to be relevant and were responsible for the successful results in the 10-meter swim. Successful results in the 25-meter swim were due to the mechanisms of full body coordination and muscle elasticity and length (the distribution of body speed, the reorganization of movement stereotype and agility). Successful results in the 50-meter swim were influenced by the strength of the flexor muscles in the hip joint, explosive strength and repetitive strength of the torso flexor muscles, agility and percent of quickly-contracting muscle fibers. Finally, successful results in the 100-meter swim were influenced by agility, repetitive strength of the torso flexor muscles, the percent of quickly contracting muscle fibers and body height. According to the author, the obtained results are relevant for the prognosis and evaluation of growth and development as well as for the selection and individualization of load during the training of younger water polo players.

It is considered that the optimal age to start training water polo is between 9 and 11 because the records show that the majority of top water polo players started training precisely at that age (Donev, 2001). Even in the youngest competitive categories, morphological characteristics are the relevant success factor in water polo (Đurašković et al., 2002). A significant difference in morphological characteristics between long time water polo players and their non-sportsmen coevals can be found as early as in the prepubescent age (Aleksandrović & al., 2005). The longer the training and the older the players, the more perceptible the difference (Aleksandrović & al., 2003).

When casting the players at a match, body dimensions play the main role. The players with higher values of body height and weight are given preference because they occupy better positions in the pool and do the technical and tactical game tasks more efficiently (Tsekouras & al., 2005). Seniors have the following dominant factors: a general growth and development factor, the longitudinal skeleton dimensionality, which is inversely proportional to the subcutaneous fatty tissue measurements (Lozovina, 1981). The middle somatotype of top water polo players is endomorphic - mesomorphic with highly developed muscle-skeleton tissue, with a moderate presence of subcutaneous fatty tissue and longitudinal skeleton dimensionality (Toteva & al., 1989). The specific characteristics of the morphological traits of top water polo players depend on the differences in age and the duration of specific sport loads (Matković, 1982).

In relation to many other athletes, water polo players have a significantly higher body mass and fatty tissue percentage, while showing a lower percentage of bone and muscle mass (Meszarosz & al., 1998).

Research shows a significant difference among the measurements of circular and longitudinal skeleton dimensionality between the sample of water polo players and the population sample. It is thought that high values of body weight are not an obstacle for practicing high profile water polo (Lozovina & Pavičić, 1999). In generations of top water polo players (cca. a period of 15 years) a numerically positive trend in skeleton measures and a negative trend in adiposity but not in body mass and the body mass index tend

to occur. This is a consequence of the population's secular trend and that of sport (Lozovina & Pavičić, 2004).

Unlike individual sports, in team games (and in water polo) it is difficult to define the criterion for success, i.e. the group of anthropological indicators that would represent the axiom of success. Any new information is of great significance for any definition. Therefore, special attention should be given to that research which deals with the specific motor space of water polo players because it is assumed that that space is in high correlation with the success achieved playing water polo. The intermittent nature of sport along with the limits provoked by the water environment make the evaluation of the specific motor skills of water polo players more difficult, so one should be very careful when creating tests within this domain (Štirn & al., 1996).

Bratuša & al. (2003) think that considering the structure of motor activities and time spent in a vertical position, it is necessary to restructure water polo training so that it benefits the situational elements of the game.

Matković & al. (1998) suggest using specific tests on land and in water. Through training and selection, an early specialization takes place and those boys who are more skillful in specific conditions stand out. Falk & al. (2004) recommend using fewer swimming tests in the selection process of young water polo players, but paying more attention to the evaluation of swimming intelligence.

Top water polo players have to be able to stand alternate efforts during the game, which apply load intensively to an aerobic and anaerobic energy mechanism. During long periods of time, interrupted by longer and shorter breaks, water polo players bear the strain of the variety in intensity well, along with frequent changes in direction (Dopsaj & Matković, 1994).

Bratuša (2003) was investigating the possibilities of an evaluation of water polo players, of their specific fitness in the water, by testing the players before and after a 3-month training treatment. Seven motor skills tests were applied on a research sample consisting of 20 water polo players age 11, 5. A positive transformation of the results for all of the motor skills variables has been identified. The author suggests using 3 tests in any further training practice: tossing the ball in the water, swimming 3x5 m crawl with the ball and swimming 4x5 m back crawl.

Successful water polo is the result of expertise and a good selection process where we recruit future top water polo players (Donev, 2001). According to the plan of the Yugoslav school of water polo, which is well-know the world over, in order to achieve the highest results, it is necessary to start training at 10 years of age at the latest (Vičević, 2001), i.e. the age of young schoolchildren. 12-year-old water polo players with 3 to 5 years of training at the national level have enviable knowledge of techniques and tactics as well as serious technical-fitness capabilities.

In high profile water polo, using manifest anthropometric and motor skills variables, it is possible to make a prognosis of how successful any defense/offence will be (Lozovina, 1983). However, there are no data about the correlation, i.e. influence of the abovementioned morphological space variables on the percent of success in the younger categories. The purpose of this research is to determine the prediction of basic motor skills and anthropometry on the specific motor skills of water polo players in latent space.

2. METHODS

The subject sample

The subject sample consisted of a total 89 water polo players aged 12 years ± 6 months, who have been training water polo for at least 2 years and who have taken part in at least 1 federal tournament of the Water Polo Association of Serbia and Montenegro. The water polo players that took part in this research were members of the following water polo clubs: "Partizan-Reiffeisen", "Red Star", "Niš" and "Zemun".

Measuring instruments sample

The process of ascertaining the basic level of any motor skills was performed by applying standardized tests (Kurelić & al., 1975; EUROFIT, 1988): agility in the air (MAG), leg tapping (MLT), hand tapping (MHT), hyperextensions on the bench (MDFBB), hyperextensions with a forward reach while seated (MDFBS), diagonal standing on a balance beam (MDSB), a 20-meter run with a flying start (M20R), the triple jump from a standing start (MTJ), the long jump from a standing start (MLJ), hanging on the high bars (MHHB), sit-ups in 30 secs (MTE), push ups (MPS).

The process of ascertaining the level of morphological characteristics was performed using parameters that define longitudinal and transversal skeleton dimensionality, body mass and volume and subcutaneous fatty tissue. All of the anthropological measurements were performed by an experienced research team with standardized instruments (GPM, Swiss), methods and procedures (Eston & Reilly, 2005). The following measurements have been used: body height (ABH), body weight (ABW), arm length (AAL), leg length (ALL), hand length (AHL), shoulder span (ASS), pelvic span (APS), hip span (AHS), upper arm scope of reach out arm (AUAS), average chest volume (AACS), abdomen size (AAS), upper arm skinfold thickness (AUAT), abdominal skinfold thickness (ABST), back skinfold thickness (ABSW).

The process of ascertaining the specific motor skills level was performed by applying measuring instruments recommended by Volčanšek & Grčić-Zubčević (1984), Pivač & al. (1996) and Bratuša (2000): swimming a distance of 25 m water polo crawl (S25), swimming a distance of 50 m crawl (S50), swimming a distance of 100 m crawl (S100), swimming 4x5 m back crawl (S4x5), leading the ball 3x5m (S3x5) and tossing the ball from the water (STBW).

Statistical methods

In order to determine the level of the manifest space of the analyzed water polo players' motor skills, we calculated the basic statistic parameters: mean (Mean), minimal results (Min), maximal results (Max), standard deviation of mean (SD).

A regression analysis was applied in order to determine the correlation between the influences of manifest morphological and basic motor skills space onto the latent space of specific motor skills.

The following coefficients were calculated: correlations (R), partial correlations (PART R), standardized regression coefficients (BETA), the level of significance (p), the coefficient of multiple correlation (R), the coefficient of determinations (R2), the level of significance (P).

A factor analysis has been calculated to determine the criterion variables (specific motor skills). In order to determine the morphological characteristics of space structure, the following methods were applied: Pearson's correlation (R), Hoteling's main components method (the main components or latent dimensions were defined by the Guttman-Kaiser criterion (GK), whose characteristic roots (λ) are equal or greater than 1.00), the percent of explanation of the main component (%) of the shared features (h2).

3. Results and Discussion

The resulting mean values of the water polo players' motor skills (Mean) indicate a good discrimination of the measurement (Table 1). Those values are shown through the variability and distribution of results. As for variability, it can be concluded that the results for the standard deviation (SD) (in 8 out of the 12 applied morphological variables) are contained at least 3 times in the mean of the results (Mean). This goes for the variables that represent agility (MAG), segmental speed (MHT, MLT), flexibility (MDFBB), explosive strength (M20R, MTJ, MLJ), repetitive torso strength (MTE). The results of the standard deviation of the mentioned tests are good and show good sensitivity.

Table 1. Main statistical parameters of the basic motor skills of water polo players

Variable	Mean	SD	Min	Max
MAG	4.77	1.22	2.50	8.23
MHT	44.30	5.73	31.00	63.00
MLT	30.90	4.21	22.00	44.00
MDPK	40.51	7.73	12.00	58.00
MDFBS	22.63	8.75	3.00	47.00
MDSB	2.62	2.76	.75	27.00
M20R	3.42	.36	2.63	5.00
MTJ	4.67	.62	3.80	6.45
MLJ	1.56	.19	1.15	2.10
MHHB	18.18	16.57	1.00	79.60
MTE	22.74	3.85	14.00	32.00
MPS	16.28	9.76	2.00	50.00

The obtained average values of the tested morphological characteristics of the water polo players (Mean) indicate a good measuring discrimination (Table 2). Those values are shown through the variability and distribution of the results. When it comes to variability, it is noticeable that the results for standard deviations (SD) (in 11 out of the 14 applied morphological variables) are contained at least 3 times in the mean of the results (Mean). Those are the variables that represent skeleton longitudinal dimensionality (ABH, AAL, AHL, ALL), skeleton transversal dimensionality (ABW, ASS, APS, AHS) and skeleton circular dimensionality (AACS, AAS, AUAS). The results for standard deviation of the mentioned tests show good sensitivity.

The obtained means results for the tested specific motor skills of the boys (Mean) indicate good measuring discrimination. Those values are shown through the variability and distribution of the results. As for variability, it can be concluded that the results for the standard deviations (SD) in all of the applied variables are contained at least 3 times in the

mean of the results (Mean). The results for standard deviation of the mentioned tests are good and show good sensitivity (Table 3).

Table 2. Main statistical parameters of the morphological characteristics of water polo players

Variable	Mean	SD	Min	Max
ABH	156.98	8.36	136.00	179.30
ABW	51.02	11.19	31.20	85.20
AAL	67.59	4.44	57.80	80.30
AHL	15.38	1.74	11.00	19.20
ALL	89.53	5.69	75.70	106.70
ASS	29.43	5.43	20.40	40.20
APS	24.13	4.23	16.00	34.00
AHS	26.20	2.50	21.00	31.20
AACS	79.82	8.73	64.90	99.00
AAS	72.33	10.34	56.20	96.00
AUAS	24.25	3.37	15.30	32.00
AUAT	16.81	8.81	3.00	45.20
ABST	21.15	14.94	4.20	58.80
ABSW	14.33	8.99	4.40	45.20

Table 3. Main statistical parameters of the specific motor skills of water polo players

Variable	Mean	SD	Min	Max
S25	18.05	1.80	14.60	22.80
S50	38.81	4.46	30.95	51.45
S100	85.90	9.73	63.40	113.00
S4X5	22.15	2.04	16.88	27.33
S3X5	16.31	1.64	12.64	21.07
STBW	14.89	2.82	7.00	24.50

The correlations among the variables of specific water polo space are relevant in cases when the correlation coefficients have values higher than .27 at the 99% level (Table 4). Out of the 21 correlations in total, all of them are relevant at the 99 % level (p= .01). Individually, the only high inter-correlations in the situational motor skills of the water polo players (above .700) have the S50 variable (the correlation between the variables S50 and S25 is .724, and between S50 and S100 is .841).

Table 4. The correlation matrix of the situational motor skills variables of water polo players

Variables	S25	S50	S100	S4X5	S3X5	SBACL
S25	1.000					
S50	.724	1.000				
S100	.655	.841	1.000			
S4X5	.328	.484	.385	1.000		
S3X5	.667	.682	.599	.503	1.000	
STBW	- .441	- .560	- .488	- .522	- .501	1.000

After the factorisation of the specific motor skills of water polo players by applying Hoteling's main components method which consists of 6 manifest variables (Table 5), only one main component was obtained (Vector K1) – the general factor of specific motor skills (GFSM). The projections of the variable onto the main component are bipolar. The obtained result is a consequence of a well-chosen and homogeneous sample, as well as of a good selection of tests in the battery. The percent of the explanation for the first and only main component is average (63.85%). The shared features of the variables are average which means errors had been made during the measuring. The lowest percent of validity in the groups of situational motor skills variables have the variables of S4x5 and STBW.

Table 5. The factorisation of the tests for the situational motor skills of water polo players by applying Hoteling's main components method and their shared features

Variables	1	h^2
S25	.812	.658
S50	.912	.831
S100	.846	.715
S4X5	.645	.416
S3X5	.832	.691
STBW	- .719	.516
Lambda	3.83	
%	63.85	

The correlation between the whole predictor set of basic motor skills variables and GFSM, i.e. the multiple correlation coefficient, is relatively high (R= .678) (Table 6). The common variability between the predictor set and the criterion variable is around 46% (R^2= .460). This kind of correlation is statistically relevant at the 99 % level (p= .000). The remaining 54% in explaining the total GFSM variability can be assigned to the qualities and characteristics of other players, which have not been taken into account in this regression analysis (for example other motor skills variables, as well as morphological, functional, conative, cognitive, motivational and others), as well as the testing conditions. By analyzing the individual influence of the variables, it can be concluded that the variables with the highest statistical influence are MTE (BETA= -.642), MTJ (BETA= .538) and MLJ (BETA= - .408), which is relevant at the 99% level or .01 (Table 6).

It can be concluded that certain manifestations of explosive legs strength and repetitive strength have influenced the specific motor skills of 12-year-old water polo players.

The correlation between the whole predictor set of morphological variables and the GFSM, i.e. the first factor of the situation motor skills latent space of water polo players (the multiple correlation coefficient), is relatively high (R= .525). The common variability between the predictor set and criterion variable is around 28 % (R^2= .275). This kind of correlation is statistically relevant at the 95 % level (p= .022). The remaining 72% in explaining the total GFSM variability of the specific motor skills latent space of water polo players can be ascribed to the qualities and characteristics of other players (Table 7). However, an analysis of the influence of individual variables showed that none of the anthropometric variables is statistically relevant for the first factor of the specific motor skills latent space of water polo players.

Table 6. The results of the basic motor skills manifest space of water polo players and the first factor of their specific motor skills latent space (GFSM) obtained by the regression analysis

Variables	R	Part R	BETA	t(79)	p
MAG	.122	- .116	- .109	- 1.042	.300
MHT	- .312	- .080	- .084	- .710	.480
MLT	- .278	- .133	- .133	- 1.195	.236
MDFBB	- .077	.089	.076	.792	.431
MDFBS	.179	.033	.031	.296	.768
MDSB	.049	.200	.160	1.815	.073
M20R	.302	.204	.237	1.855	.067
MTJ	- .262	.354	.538	3.366	.001
MLJ	- .413	- .326	- .408	- 3.064	.003
MVZG	- .147	.077	.072	.682	.497
MTE	- .512	- .504	- .642	- 5.193	.000
MPS	- .077	.201	.192	1.826	.072

R= .678 R^2= .460 **p= .000**

Table 7. The results of the manifest morphological space of water polo players and the first factor of their specific motor skills latent space (GFSM) obtained by a regression analysis

Variable	R	Part R	BETA	t(77)	p
ABH	- .353	- .060	- .207	- .530	.597
ABM	- .186	- .027	- .089	- .233	.816
AAL	- .378	- .073	- .166	- .643	.522
AHL	- .361	- .055	- .103	- .482	.631
ALL	- .296	.166	.399	1.474	.144
ASS	- .244	- .023	- .037	- .200	.842
APS	- .291	- .160	- .213	- 1.427	.158
AHS	- .328	- .113	- .156	- .997	.322
AACS	- .136	- .066	- .163	- .579	.564
AAS	- .081	.117	.283	1.038	.302
AUAS	- .137	- .112	- .257	- .993	.324
AUAT	.081	.025	.047	.217	.828
ABST	.106	.142	.298	1.260	.211
ABSW	.099	.064	.117	.562	.575

R= .525 R^2= .275 **p= .022**

4. CONCLUSION

The correlation between the whole predictor set of basic motor skills manifest variables and the GFSM is relevant. The variables representing repetitive torso strength and explosive leg strength have the biggest individual influence on the criterion. Boys with emphasized repetitive torso strength and explosive leg strength had better specific motor

skills in general. The presence of energetic leg movements in some specific motor skills variables (S4X5, S3X5, STBW) has influenced this phenomenon.

The statistically relevant correlation between the whole predictor set of morphological variables and the GFSM has been confirmed. An analysis of the influence of individual variables has shown that none of the variables are statistically relevant for the criterion variable. Therefore, the relevant influence of selected anthropometric measures is such that only their set creates the effect that is relevant for the given GFSM criterion. The applied battery of anthropometric tests represents the ideal predictor for the given GFSM of 12-year-old water polo players.

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UTICAJ BAZIČNOMOTORIČKIH SPOSOBNOSTI I ANTROPOMETRIJSKIH MERA NA SPECIFIČNE MOTORIČKE VEŠTINE TALENTOVANIH VATERPOLISTA

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Cilj je utvrditi uticaj bazičnih motoričnih sposobnosti i antropometrijskih mera na specifičnu motoriku vaterpolista u latentnom prostoru. Uzorak ispitanika sačinjavalo je ukupno 89 vaterpolista, uzrasta od 12 godina ± 6 meseci, koji su se najmanje dve godine bavili vaterpolom i nastupali na najmanje jednom turniru saveznog ranga u okviru Vaterpolo saveza Srbije i Crne Gore. Utvrđivanje nivoa morfoloških karakteristika (14 testova), bazično (12 testova) i specifično (6 testova) motoričkih sposobnosti izvršeno je primenom standardizovanih testova. Korišćena je faktorska analiza za određivanje morfološke, bazično i specifično motoričke strukture. Za utvrđivanje povezanosti uticaja manifestnog morfološkog i bazično-motoričkog prostora na latentni prostor specifične motorike, primenjena je regresiona analiza. Ustanovljena je statistički značajna povezanost prediktora i kriterijumske varijable.

Ključne reči: *vaterpolo, bazična motorika, morfologija, specifična motorika*