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ASSOCIATION BETWEEN MORPHOLOGICAL DIMENSIONS OF WATER POLO PLAYERS AND PLAY PERFORMANCE INDICATORS

INTRODUCTION

Water polo is a team sport game that pertains to the group of complex kinesiological activities according to its typical movement patterns resulting from its collision or invasion nature. This means complex movement patterns with the ball and without it prevail in the phases of defence, transitions and attack. High performance and efficiency of match-playing in water polo depends on players' technical-tactical proficiency and a high level of physical fitness, training of which is based on certain morphological, motor, socio-psychological and other relevant characteristics (Colville, J.M., & Markman, B.S. 1999).

A scientific approach to the determination of sport performance factors Milanović, D., & Heimer, S.1997). and sports training contributed comprehensively to the evolution of modern water polo (Lozovina, V., & Pavičić, L. 2004). According to it, the first group of water-polo performance relevant factors includes basic anthropological characteristics (physiological capacities — motor, cardio-respiratory and energy producing ones; morphological characteristics (Mišigoj-Duraković, M. 2008) etc.); technical-tactical skills pertain to the second group of performance factors and the third group consists of actual (match-playing) performance indicators.

Goodwin and Cumming monitored, back in 1966, heart rate of water-polo players during match-play and obtained values between 156 (min) and 186 (max) beats/min. Maximal oxygen uptake (VO_2max) of fourteen water-polo players was determined by means of the cycle ergometer test and amounted the value of 53.3 ml/kg/min.

Dopsaj and Aleksandrović (2009) investigated position-related anthropological characteristics and significant differences among elite Serbian water-polo players. The authors concluded that selection procedures should single out players with the pronounced body height, whereas body mass and BMI (body mass index) can be developed (and modified) in the later phases of sports specialization.

Ferragut et al. (2011) determined water-polo-specific body composition of elite players playing at different positions and ball release speed under various conditions (empty goal, against a goalkeeper, with shot position variations). They obtained higher values of body mass, BMI and lean muscle mass in hole sets than in wings, as well as higher values of foot length in attacking backs than in wings. No differences were found in circumferences. The differences were obtained in somatotype characteristics of players. In wings the balanced mesomorphic type predominated, whereas in hole sets and backs endo-mesomorphic type of body constitution was found. The authors

established associations between the explored anthropometric characteristics and ball release speed.

Melchiori et al. (2010) established the differences in functional (physiological) abilities of water-polo players of different playing quality. The authors used the Station Swimming Test (SST) and classic lactic acid test. The obtained heart rates were from 164 to 178 beat/min. No differences were found among the three groups of water-polo players in swim speed at the aerobic or anaerobic threshold, neither in lactate values.

The aim of the paper was to determine any association between anthropometric variables and performance grades given for water-polo players play in the phases of attack and defence.

MATERIALS AND METHODS

2.1. Sample of subjects and measurement procedure

The research was conducted with 104 water polo players, aged 17-19 years, members of the teams competing in the Adriatic League, one of the most quality water polo leagues in the world. This fact speaks in favour of high quality players. Testing procedures were conducted in Dubrovnik, Split, Šibenik, Rijeka, Zagreb, Herceg Novi and Kotor. The final analyses included only the results of players who had been healthy and willing to participate in the planned experimental procedure.

2.2. Sample of variables

The sample of variables consisted of the set of predictor variables represented by the anthropometric variables (body mass, body height, arm length, arm span, leg length, chest skin fold, triceps skin fold, subscapular skin fold, abdominal skin fold, and upper leg skin fold) and of the set of criterion variables.

Two criterion variables incorporated the evaluation of players' quality in water polo match-play in the following two game phases:

a) phase of defence: versatility in all defensive elements performance – the ability of a player to play multiple defensive playing positions, with the accent on playing at the back playing position upon the other hole set has swam in; activity in defence – a high level of mobility; and efficiency in defence – a high level of sporting intelligence, motor coordination.

b) phase of attack: versatility in all attack elements performance – the ability of a player to play multiple attacking playing positions; activity in attack – a level of mobility; and efficiency in attack – goal scoring, assists.

Quality of play in defence and attack of the sampled subjects was evaluated by three water polo experts who gave their grades on the five-point scale for each player. After the analysis of inter-judges agreement (objectivity), the final grade was established by simply summing up all individual experts' grades.

2.3. Data processing methods

In the first phase analytical methods for central and dispersive parameters of anthropometric variables and efficiency/performance grades given for play in defence

and attack were applied. Afterwards, linear correlation analysis was used to determine the relations between predictor anthropometric variables and two criterion variables of play performance in water polo game defence and attack.

RESULTS AND DISCUSSION

Table 1 shows basic descriptive statistical parameters of the set of predictor variables and the Cronbach's alpha reliability coefficient of each and every variable.

1. The anthropometric variables' measurement reliability coefficients are high, ranging from 0.75 to 0.96. The skin-fold measures have slightly lower values of reliability than the measures of longitudinal dimensionality. A series of authors who treated this issue

(Fourie, Damstra, Gerrits, & Ren, 2011;
Siatras, Skaperda i Mameletzi, 2010;
Sicotte, Ledoux, Zunzunegui, Ag Aboubacrine i Nguyen, 2010

1. Theophanis Siatras, Malamati Skaperda and Dimitra Mameletzi. Abstract. Body dimensions ... Spanish journal of psychology (13)2 2010 •
2. Perceptions of ..... Game activity and blood lactate in men's elite water-polo players. Giovanni Melchiorri ...

suggested that, during anthropometric characteristic measurements, a special attention should be paid to the measurement of skin folds because even a tiny error in skin-fold grip, or in obtained values reading can result in a considerable measurement errors.

Table 1. *Descriptive parameters of the predictor variables and measurement reliability coefficient*

Variable	Mean	Min	Max	SD	CA
Body height	186.92	173.00	204.60	6.31	0.96
Body mass	84.31	63.00	112.00	9.46	0.95
Arm length	80.98	69.50	93.00	4.73	0.91
Arm span	194.99	177.50	212.50	7.60	0.90
Leg length	99.15	86.00	121.00	6.31	0.85
Chest skin fold	9.47	5.00	20.00	2.76	0.79
Triceps skin fold	11.27	6.00	19.20	3.32	0.80
Subscapular skin fold	12.57	6.80	22.60	3.37	0.80
Abdominal skin fold	14.05	5.00	29.00	5.39	0.77
Upper leg skin fold	9.82	6.00	16.20	2.16	0.75

Legend*: N – number of subjects; Mean – arithmetic mean; Min – minimum value; Max – maximum value; SD – standard deviation; CA – Cronbach's alpha, reliability coefficient.*

Table 2 shows descriptive statistical parameters of reliability measures of the grades given for the quality of technical-tactical activities of the observed water-polo players in defence and attack. The reliability of the grades given by the water-polo experts (Cronbach's alpha coefficient) are satisfactory, ranging from 0.74 to 0.84. Therefore, these variables can be used as an objective indicator of match-playing performance.

***Table 2**. Descriptive parameters and reliability coefficients of play performance grades*

Variable	Mean	Min	Max	SD	CA
Age	17.7	19	15	0.99	
Versatility in defensive elements performance	2.53	1.00	5.00	1.31	0.80
Activity in defence	2.72	1.00	5.00	1.36	0.84
Efficiency in defence	2.48	1.00	5.00	1.30	0.79
Versatility in attacking elements performance	2.84	1.00	5.00	1.34	0.75
Activity in attack	2.68	1.00	5.00	1.28	0.76
Efficiency in attack	2.70	1.00	5.00	1.34	0.74
Play in defence — performance grade	7.73	3.00	15.00	3.33	
Play in attack — performance grade	8.22	3.00	15.00	3.12	

Legend: *N – number of subjects; Mean – arithmetic mean; Min – minimum value; Max – maximum value; SD – standard deviation; CA – Cronbach's alpha, reliability coefficient.*

Simple linear correlation analysis was employed to compute relations between the set of predictor variables and two criterion variables — performance in defence and performance in attack (Table 3).

Performance in defence was defined with two significant correlation coefficients (abdominal skin fold -.30 and upper leg skin fold -.21), whereas performance in attack was defined with only one significant correlation coefficient (abdominal skin fold -.27).

***Table 3.** Linear correlation analysis of relations between anthropometric measures and performance grades for play in the phases of attack and defence*

Variable	DEFENCE	ATTACK
Body height	0.00	-0.08
Body mass	-0.09	-0.12
Arm length	0.06	0.00
Arm span	-0.02	-0.06
Leg length	0.00	-0.04
Chest skin fold	-0.15	-0.14
Triceps skin fold	-0.07	-0.12
Subscapular skin fold	-0.15	-0.19
Abdominal skin fold	**-0.30***	**-0.27***
Upper leg skin fold	**-0.21***	-0.16

Here we are dealing with the negative affect of skin folds, as the measures of subcutaneous fatty tissue, on the young water-polo players' performance. The linear correlation coefficients of other anthropometric measures were not significant. This means the differences in measures of longitudinal dimensionality (body height, arm length, arms span, leg length), body mass (body weight), as well as three measures of skin folds (chest, triceps and subscapular) were neutral as regards influence on match-playing performance in defence. It should be pointed out that the amount of ballast mass (abdominal and upper leg skin folds) is a significant limitation factor of performance in defence play. It affects agility, that is, mobility in the phase of defence, which is responsible for restricting the opposing attackers' dynamics of play. In this a special role seems to be attributed to the abdominal skin fold, which considerably hinders space and players covering, as well as shot blocking, being the main defensive tasks in water polo.

When coefficients of correlation of anthropometric variables with play performance in defence and attack are compared, then it becomes obvious that the level of association is very similar, almost identical.

The single significant correlation coefficient with a negative sign is the abdominal skin fold (-0.27). This practically means that the differences among players in body mass, body height, arm span, and leg length have no effect on match-play in attack (Lozovina, Đurović, & Katić, 2009). The abdominal ballast mass only limits water-polo players in performance of technical-tactical tasks in attack. The finding is in contrast with the findings of previous research (Aziz. Lee & Teh, 2002; Cvjetičanin & Marinković, 2009), in which no negative correlation was obtained with performance of attacking activities.

CONCLUSION

In this research one relevant component of water-polo players' fitness was analysed, expressed as the anthropometric variables that assessed longitudinal dimensionality and subcutaneous fatty tissue. On the highly selected sample of subjects, made of the junior members of the water-polo teams competing in one of the most quality water-polo leagues in the world, the correlation was determined between anthropometric variables and performance grades given for play in the phases of defence and attack. Both the predictor and criterion multi-item variables were reliable enough.

The findings indicate the amount of subcutaneous fatty tissue is directly detrimental to the quality of play in defence. It can be explained by the fact that the players with high values of subcutaneous fatty tissue perform poorly when fulfilling polyvalent (versatile) defensive tasks since their level of agility (mobility) is lower, thus causing lower defensive efficiency. A similar conclusion can be drawn on the basis of correlations between anthropometric variables and performance grades given for play in the phase of attack. Although the negative correlation is somewhat less pronounced, it still demonstrates the pronounced amount of abdominal subcutaneous fatty tissue hinders to a considerable extent the ability of players to perform well at

versatile playing positions, as well as the level of mobility and effectiveness, expressed as goal scoring and assists in the phase of attack in water-polo game.

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The goal of the paper is to determine relevance of certain morphological parameters, understood as the dimensions of morphological status of water polo players, in relation to their game performance in the phases of defence and attack. The sample of subjects embraced 104 (aged 17–19 yrs) top-quality water polo players, members of junior selections from eight water polo clubs, who participated in the Adriatic League competition.

The total variable sample consisted of the predictor variables (10) and two criterion variables based on the expert evaluations of the subjects' play in attack and defence. The associations between the predictor variables and play performance grades were established using regression analysis. The obtained results suggest the quantity of subcutaneous fat directly affects quality of playing in the phase of defence, meaning that the players with larger quantities of subcutaneous fat perform poorly in polyvalent defensive actions and demonstrate a low level of agility, both resulting in less effective play in defence. Although the quantity of subcutaneous fat has been recognized as the factor affecting play quality in attack as well, we obtained that it has smaller effect than in the case of defence. The probable cause of the afore-mentioned may be found in water polo players with a relatively greater amount of fatty tissue (hole sets), who are still highly efficient in attack tasks performance. Their situation-related efficiency is manifested in better positioning and position keeping, as well as in larger number of forced exclusions of the opponents, which contributes comprehensively to attack efficiency.

Key words: *water polo, morphological characteristics, relations, play performance, defence, attack.*