

## THE CANONICAL RELATIONSHIP BETWEEN MORPHOLOGICAL CHARACTERISTICS AND PERFORMANCE OF TECHNICAL ELEMENTS OF GOAL SHOOTING IN WATER POLO GAME

Nermin Nurković, Dženana Imamović – Turković, Edin Mirvić

**ABSTRACT:** The main goal of this research is to determine and explain the connection between morphological characteristics and derivation of technical elements of goal shooting in water polo. The sample of respondents includes 80 water polo players from Water Polo Clubs Sarajevo City Club, Vapolo Club Torpedo, Water Polo Club Academy, and Water Polo Club Dabar. The test included a sample of 80 water polo players, registered in Bosnian-Herzegovinian clubs. The selection of manifest measures for the assessment of individual latent traits is presented according to the following: Variables for assessing the longitudinal characteristics of the human body: Body height (VISTJ), Leg length (DUZNG), Arm length (DUZRK). Variables for assessing the transference characteristics of the human body: Hand width (SIRSA), Wrist diameter (DIRZG), Elbow diameter (DILAK). Variable for estimating human body mass (weight): Body mass (MASTJ). Variables for assessing circular characteristics of the human body: Upper arm circumference (OBNDL). Medium chest circumference (OBGRU). Variables for the assessment of subcutaneous adipose tissue of the human body: Skinfold of the upper arm (NBNDL), Skinfold of the back (NBLED), and skin fold of the abdomen (NBTRB). A sample of variables to assess the performance of the technical elements of goal-scoring in a water polo game. Goal shot accuracy test: Shooting from the left-wing, from a static position from six (6) meters - STLK, shooting from the center, from a static position from six (6) meters - STC and shooting from the right-wing, from a static position from six (6) meters - STDK. It can be said that the canonical-correlation analysis obtained a significant and homogeneous structure of the connection between a set of morphological characteristics and a set of deriving technical elements of goal shooting.

**Keywords:** *water polo, canonical-correlation analysis of morphological characteristics, and goal shooting*

### INTRODUCTION

The morphological characteristics of the human body have been the subject of research since ancient times. Even from then until today, there have been attempts to classify people into certain constitutional types. The level of muscle mass increased concerning adipose tissue. The observed changes are a consequence of the trend of acceleration and sports-morphological adaptation (optimization) (Lozovina, Lozovin, and Pavičić, 2012). Many researchers have tried to make a unit of specification in different sports. Čolakhodžić, Rađo, and Alić (2009) investigate quantitative changes in morphological dimensions in football players aged 12-15, caused by programmed situational training. The authors conclude that the situational model of work lasting six months had a positive effect on the transformation of almost all morphological dimensions, and especially on the variables that manifest subcutaneous adipose tissue. However, for us, the most interesting in this project are the usual morphological measures or characteristics of the human body. Thus, we have four basic morphological dimensions, which are: longitudinal dimensionality of the skeleton, transfer dimensional dimensionality of the skeleton, volume of the body, subcutaneous adipose tissue. From complex actions, the water polo player must apply for all positions on and in the water, and therefore a large lung capacity is required to withstand this rhythm of swimming (Lupo, Capranica, Cugljari, Gomez, & Tessitore, 2015). Kondić D. and Š. Dorica (2016) aimed to determine the differences in swimming abilities between groups of water polo players according to the four primary positions in the game (center, wing, left or right outer, middle outer). Swimming abilities were found to be differentially related to positions in the game. While the wings are excellent in sprinting,

the mid-outer ones dominate in short-distance swimming. There are no significant differences in anaerobic or aerobic swimming abilities. According to the arrangement of places in the fan, there are two wings (left and right), two outside (left and right) players, one defender, and one anchor (under the new names 1,2,3,4,5,6). Each player shoots with his safer hand (right or left) and thus we determine on which side he plays, but he will also perform the shot with a weaker hand depending on the situation during the game itself. Players are distributed according to abilities that determine morphological and motor characteristics when talking about top players. When it comes to the lower rank of the competition, then the schedule of players depends on whether we have covered all positions with players or not. Melchiorri, G., Viero, V., Tancredi, V., Roberto Del Bianco, R. and M. Bonifazi (2020). The playing time of water polo players by positions in the competition is so diverse, that it is very important to make a good training and recovery strategy for each player and adjust it individually to each water polo player. Aleksandrović, M.; Jorgić, B.; Georgiev, G.; Ozsari, M.; Arslan, D. (2015). In their research, they pointed out the significant influence of anthropological dimensions on the specific motor abilities of selected young water polo players. This enables a proper process of selection of young water polo players. Information that may indicate changes in the specificity of the relationship between anthropometric indicators and physical performance of elite water polo players, and according to the authors, there is no scientific record of such studies (Idrizović et al., 2014). The main goal of this research is to determine and explain the connection between morphological characteristics and the performance of technical elements of goal shooting in water polo.

## RESEARCH METHODS

### Definition of the sample of respondents

The sample of respondents includes 80 water polo players from Water Polo Clubs Sarajevo City Club, Varepolo Club Torpedo, Water Polo Club Academy, and Water Polo Club Dabar. All respondents are active members of water polo clubs and are therefore subject to regular medical examinations. The test included a sample of 80 water polo players, registered in Bosnian-Herzegovinian clubs.

### A sample of variables to assess morphological characteristics

Within the morphological space, a battery of twelve morphological characteristics was selected, which were monitored according to the instructions and in the manner recommended by the International Biological Program (IBP). The list and selection of manifest measures for the assessment of individual latent characteristics are presented according to the following: Variables for the assessment of longitudinal characteristics of the human body: Body height (VISTJ), Leg length (DUZNG), Arm length (DUZRK). Variables for assessing the transference characteristics of the human body: Hand width (SIRSA), Wrist diameter (DIRZG), Elbow diameter (DILAK). Variable for estimating human body mass (weight): Body mass (FAT). Variables for assessing circular characteristics of the human body: Upper arm circumference (OBNDL). Medium chest circumference (OBGRU). Variables for the assessment of subcutaneous adipose tissue of the human body: Skinfold of the upper arm (NBNDL), Skinfold of the back (NBLED), and Skinfold of the abdomen (NBTRB).

### A sample of variables to assess the performance of the technical elements of goal-scoring in a water polo game

- Shot accuracy test

1. Shooting from the left wing from a static position from six (6) meters – STLK

2. Shooting from the center from a static position from six (6) meters - STC

3. Shooting from the right-wing from a static position from six (6) meters - STDK

(The test is performed from three different positions, ie two wings and one central. Each subject performs one shot from each position.)

- Shooting from the left wing from a static position from six (6) meters - STLK respondent comes to the left-wing, a distance of 6 meters and takes a basic position, and shoots at the goal with a basic shot in water polo. Only the scored goal is recorded.

- Shooting from the center from a static position from six (6) meters - STC respondent comes to the center, a distance of 6 meters, and takes a basic position, and shoots at the goal with a basic shot in water polo. Only the scored goal is recorded.

- Shooting from the right-wing from a static position from six (6) meters - STDK The respondent comes to

the right-wing, a distance of 6 meters and takes a basic position, and shoots at the goal with a basic shot in water polo. Only the scored goal is recorded.

### Research description

- Mentoring supervision from the Faculty of Sports and Physical Education,
- The assistance of experts in the field of sports and physical education (verified pedagogues) in the implementation of the project,
- All subjects under the same conditions were subjected to measurement and testing (the entire survey was conducted in the morning, from 08 to 12 h, the temperature was 18 to 24 degrees Celsius, the place of testing was the Olympic swimming pool of the island (indoor 50-meter pool ).
- The research was conducted in such a way that the morphological characteristics of the subjects were first measured, and only then were the goal shooting tests performed.
- Respondents have explained acceptably before the measurement and testing process what awaits them during the research period and what is required of them in the work, and the main motive for work will certainly be curiosity and understanding of that testing as an opportunity to test their knowledge and knowledge of their capabilities,
- Measurement was performed in groups of 20 to 25 respondents, up to 80 respondents during the day,
- There was one measurer and one recorder at each measuring point,
- During the measurement, the subjects were in the prescribed testing equipment
- The team of surveyors consisted of professors of sports and physical education who are familiar with the research project, measurement lists, and how to fill them,
- Measurements were performed according to the following schedule:

from 08 to 10 h during five days, morphological characteristics were measured,

from 08:00 to 12:00 in five days, goal shooting tests were performed,

- After data collection, the measurement lists were completed and the data were processed in the appropriate program.

### Data processing methods

To determine the connection between morphological characteristics and the derivation of technical elements of shooting on goal in a water polo game, basic canonical-correlation analysis was applied using the statistical package SPSS 12 for windows.

## RESULTS

Canonical-correlation analysis (Table 1) isolated one significant and positive canonical function (Canonical R) which explained the general connection between morphological characteristics and technical elements of goal shooting, at the level of significance  $p = .048$ .

The only isolated canonical function of these two sets of variables is quite high (Canonical R) = .54, which could explain (Canonical R-SGR.) = 29% of the total variability of the set of morphological variables, and the set of variables for success in performing goal shots. The significance of the connections of the investigated spaces is (Chi-SGR.) = 51.9. Canonical factor (Table 2), in the space of variables for the assessment of morphological characteristics, it can be seen that the largest number of variables (seven out of twelve) has significant correlations with the isolated canonical dimension. Correlated variables can be divided into three groups:

- A group with a relatively high connection of conative space, in which we have a coefficient of .61 to .58, and a negative -.86, which is understandable, because the morphological space shows the expected connection when shooting at goal.

- In the group with moderately significant correlation, in which we correlate .20 to .19 in the positive sense, and in the negative only one variable -.26, where the variables DUZNG, OBNDL, and NBTRB belong.

Canonical correlation analysis of morphological characteristics and performing technical elements of goal shooting.

**Table 1.**

	Canonid R	Canonid R-sgr.	Chi-sgr.	df	p	Lambda Prime
0	0,54	0,29	51,92	36	0,04	0,48
1	0,47	0,22	27,90	22	0,18	0,68
2	0,37	0,14	10,60	10	0,39	0,86

**Table 2.**

	KF 1
VISTJ	-,06
UZRK	,58
DUZNG	,20
SIRSA	,18
DIRZG	,01
DILAK	-,12
OBGRU	-,86
OBNDL	,19
MASTJ	-,03
NBNDL	-,06
NBLED	-,26
NBTRB	,61

**Table 3.**

	KF 1
STLK	,85
STC	-,33
STDK	,60

- Small correlation in other variables moving in the positive state, 01 and negative from -, 01 to -, 06.

Considering that the representatives of the upper extremity of the body have the most frequent projections on the first canonical factor in the space of morphological characteristics, this factor can be called a general factor of longitudinal dimensionality of skeleton and volume. The canonical factor in the space of performing technical elements of shooting on goal in a water polo game (Table 3) is best defined by the variable shooting from the left wing from a static position from six (6) meters - STLK with a coefficient of 85, then shooting from the right-wing from a static position from six (6) meters - STLK, 60 and shooting from the center from a static position from six (6) meters - STC (-, 33). This factor can be called the precision factor of the right-hand shot. The association of the first pair of significant canonical dimensions suggests the conclusion that morphological characteristics have a negative impact on the performance of the technical elements of goal-scoring in a water polo game. By engaging in a discussion of the relations of the isolated canonical function and the variables of both spaces, and depending on the height of the mutual correlation (relations with the canonical function) the following relations can be defined:

The greatest correlation exists between the variables of morphological characteristics of the "High Connectivity Group" (DUZRK, OBGRU, NBTRB, STLK, STDK, and STC) and with most of the left-wing shots. Statistically, a slightly lower correlation exists between the variables of morphological characteristics in the second group "Group with significant correlation" (DUZNG, OBNDL, and NBTRB).

## DISCUSSION

It can be said that the canonical correlation analysis obtained a significant and homogeneous structure of the connection between a set of morphological characteristics and a set of the derivation of technical elements of goal shooting. These connections are real and significant, with medium and small projections of the correlation coefficients on the isolated canonical factor, both in the space of morphological characteristics and the derivation of technical elements of goal shooting. Such statements can be supported primarily by reviewing the results of canonical correlation analysis of two sets of variables used, and then by knowing the complexity of the structure of movement that undoubtedly has an impact here, by knowing the complexity of deriving variables from deriving technical elements of goal shooting and morphological characteristics. Due to certain fatigue during testing, we tried to achieve as little fatigue as possible, while gaining game efficiency in our research (Melchiorri, G. et al. 2020) and to prove that differences in the player playing time are significant for the occurrence of fatigue that automatically can affect the general motor preparation of the player and the development of the chest. This also depends on the coach's

strategy, and in most cases, preference is given to more experienced players who have fully developed their performances, which is not the case with younger players. Gardasevic, J. et al. (2020) proved in which case players have better statistics on subcutaneous adipose tissue: triceps skinfold, biceps skin fold, and thigh skin fold, showed a better result of the Montenegrin national team compared to the Croatian national team. Dopsaj, M. et al. (2018). have proven that morphological parameters (body height and body weight) are of great importance in the selection of U15 water polo players. Popo et al., (2018). In the research, it was stated that water polo can be successfully played by different morphological types/profiles of players, which means that perspective is not determined based on individual anthropometric measures, which can vary due to different biological processes, ie uneven growth rate and development of certain morphological dimensions in water polo players. According to specific positions, central strikers are players who show higher hand-grabbing values, but these differences only gain statistical significance when central strikers are compared to wings and goalkeepers (Ferragut, Abalades, Machado, & Vila, 2015). Concerning subcutaneous adipose tissue, it was determined that skin folds are significantly more prominent in water polo players who play in the center position, in contrast to water polo players who play in other positions (Lozovina, Đurović, Katić, 2009). Of course, indicators are not adequate without motor ability no matter how many morphological characteristics individually have a connection and impact. This research work shows us a guideline for determining the equation of specification of morphological characteristics, selection of water polo players, positions in water polo, etc. It is known that one can start with a water polo school from the age of 12, at which time one can roughly see the development of morphological characteristics only by the measurements of the parents. Probably, if the same research were done in another country that has a long tradition and better results, we would certainly get more accurate results.

## CONCLUSION

The connection of the first pair of significant canonical dimensions suggests the conclusion that morphological characteristics have a negative impact on the performance of the technical elements of goal-scoring in a water polo game. Such statements can be supported primarily by reviewing the results of canonical correlation analysis of two sets of variables used, then by knowing the complexity of the structure of movement that undoubtedly has an impact here, further, by knowing the complexity of deriving variables from deriving technical elements of goal shooting and morphological characteristics. By engaging in the relations of the isolated canonical function and the variables of both spaces, and depending on the height of the mutual correlation (correlations with the canonical function), the following relations can be defined: The greatest correlation exists between the variables of

morphological characteristics, "Group with high correlation" (DUZRK, OBGRU, NBTRB, STLK, STDK, and STC) and with most of the shooting from the left-wing. Because from that position, shooting is done with a better right hand, and most of the younger water polo players are right-handed. Statistically, a slightly lower correlation exists between the variables of morphological characteristics in the second group "Group with significant correlation" (DUZNG, OBNDL, and NBTRB).

## REFERENCES

1. Aleksandrović, M.; Jorgić, B.; Georgiev, G.; Ozsari, M.; Arslan, D. (2015). Anthropological dimensions as a predictor of specific motor skills of young water polo players. *Physical Education and Sport* Vol. 13, No 3, pp. 411 - 418
2. Dopsaj, M., Mijalkovski, Z., Vasilovski, N., Čopić, N., Brzaković, M., Marković, M., (2018). Morphological parameters and handgrip muscle force contractile characteristics in the first selection level in water polo: differences between u15 water polo players and the control group. *Human. Sport. Medicine* 14, vol. 18, no. 3, pp. 5-15
3. Čolakhodžić, E., Rađo, I., Alić, H. (2009). Processes of transformation of morphological dimensions among youth category soccer players caused by situational training. *Sarajevo: Homosporticus*, vol. 11., 18 - 22.
4. Ferragut, C., Abalades, J.A., Machado, C., & Vila, H. (2015). Water polo throwing speed and body composition: an analysis by playing positions and opposition level. *Journal of Human Sport & Exercise*, 10(1), pp.81-94. doi:10.14198/jhse.2015.101.07
5. Idrizović, K., Calleja-González, J., Kontić, D. (2014). Povezanost između morfoloških parametara i brzine štuta, maksimalne snage i brzine plivanja kod elitnih vaterpolista. *SportLogia*, 10(1), 11-20. doi: [10.5550/sqja.141001.se.0021](https://doi.org/10.5550/sqja.141001.se.0021)
6. Kondić, D.; I Šajber D. (2016). Swimming Capacities in High-Level youth Water Polo; Playing-Position Specifics. "Naše more" 63(2) 65-69.
7. Lozovina, M., Lozovina, V., & Pavičić, L. (2012). Morphological changes in elite male water polo players: Survey in 1980 and 2008. *Acta Kinesiological*, 6(2), 85-90.
8. Lozovina, M., Đurović, N., Katić, R., (2009). Morfološke značajke vrhunskih vaterpolista u odnosu na poziciju u igri. *Collegium antropologicum*, 33 (3), 781-789. <https://hrcak.srce.hr/41818>
9. Lupo, C.; Capranica, L.; Cugliari, G.; Gomez, M. A.; Tessitore, A. (2015). Tactical, swimming activity, and heart rate aspects of youth water polo game". *J Sports Med Phys Fitness*. Melchiorri, G., Viero, V., Tancredi, V., Bianco, R., Del., Bonifazi, M.(2020). Actual Playing Time of Water Polo Players in Relation to the Field Position. *Journal of Human Kinetics* volume 73, 241-249
10. Melchiorri, G., Viero, V., Tancredi, V., Roberto Del Bianco, R. i M. Bonifazi (2020). Actual Playing Time of Water Polo Players in Relation to the Field Position, *Journal of Human Kinetics* volume 73, 241-249 DOI: 10.2478/hukin-2019-0148
11. Gardasevic, J., Bjelica, D., Vasiljevic, I. (2020). Differences in Body Composition between Water

- Polo Players of National Teams of Montenegro and Croatia Participating in the European U15 Championship 2019. *Int. J. Morphol.*, 38(3):720-725.
12. Popo, A., Đedović, D., Novaković, R., Čolakhodžić, E., Korjenić, A., Skender, N. (2018). Quantitative differences in morphological characteristics of water polo players are classified according to different positions in the game. 16th Annual International Conference "Fitness Training of Athletes", Proceedings. Faculty of Kinesiology, University of Zagreb, Croatian Association of Fitness Trainers, Zagreb, p. 104 - 107.

**AUTHOR(S) INFORMATION**

Nermin Nurkovic  
Patriotske lige 41, 71000 Sarajevo, Bosnia and Herzegovina, e-mail: nermin.nurkovic@fasto.unsa.ba

Dzenana Imamovic – Turkovic  
Patriotske lige 41, 71000 Sarajevo, Bosnia and Herzegovina, e-mail:  
dzenana.imamovic@fasto.unsa.ba

Edin Mirvic  
Patriotske lige 41, 71000 Sarajevo, Bosnia and Herzegovina, e-mail: edinmirvic@gmail.com