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ORIGINAL RESEARCH

Influence of motor abilities on the performance of technical elements of goal shooting in a water polo game

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Abstract. Training and coaching water polo players requires systematic and continuous work throughout the year. Given the specifics of water polo as a water sports game, in addition to training various elements of technique, tactics, and theory of the game, in the training process, special attention is paid to training specific locomotor movements in the water, as well as the development of all psychomotor abilities that stand out in that game. The sample of respondents includes 80 water polo players from Water Polo Clubs in Sarajevo, and all respondents are active members of water polo clubs. The test included a sample of 80 water polo players, registered in BiH clubs. To determine the level of basic motor skills, the following tests were used: Mechanism for structuring movement: agility in the air, hand tapping, foot tapping. Mechanism of synergistic regulation and regulation of tone: deep inclination on the bench, inclination with reaching in the seat, transverse standing on the beam. Mechanism of regulation of excitation intensity: running at 20m with flying start, triple jump from the starting point, long jump from the starting point. Mechanism of regulation of excitation duration: endurance in the joint, torso lift in 30 seconds, push-ups. In a sample of variables to assess the performance of technical elements of shooting on goal in a water polo game, shot accuracy tests were used: shooting from the left wing from a static position from 6 meters, shooting from the center from a static position from 6 meters, shooting from the right-wing from a static position from 6 meters. By analyzing the influence of individual motor variables, it can be seen that the largest and statistically significant influence on the criterion variable has a variable GRED - transverse standing on beams at levels up to .05. It can be concluded that without good coordination, there is no efficiency in the technical elements of a goal shot.

Keywords. Motor skills, technical elements of goal shooting, water polo game.

Introduction

Motor abilities are those human abilities that participate in solving motor tasks, and thus condition successful movement, regardless of whether they were acquired through genetics, training, teaching, or not (Malacko, 2002). If the movement is more complex, the number of particles that make it is higher. The elements on which different movements depend are intertwined, so with more complex movements, there is a greater possibility of connecting with other movements. The risk of injury during fitness training can be minimized by adequate professional supervision, appropriate training instructions, an appropriate training program, and careful selection of training equipment (Jukić et al., 2007). Training and coaching of water polo players require systematic and continuous work throughout

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Received: February 25, 2022 - ***Accepted:*** March 31, 2022 - ***Published:*** April 10, 2022
To Cite: Nurkovic, N., Imamovic-Turkovic, D., Mirvic, E., Bajric, & S., Guzina, B. (2022). Influence of motor abilities on the performance of technical elements of goal shooting in a water polo game. *Turk J Kinesiol*, 8(1), 15-22. **DOI:** 10.31459/turkjkin.1079114

the year. Considering the specifics of water polo as a sports game in water, with the training of various elements of technique, tactics, and theory of the game, in the training process special attention is paid to training specific locomotor movements in water, as well as the development of all the psychomotor abilities that stand out in that game. Training methodology determines and studies the laws of ways, types, and forms of training. Training methods are specific ways and forms of work, which are used for the development and maintenance of fitness abilities and learning methods that are used in the acquisition and improvement of technical - tactical knowledge. Following the target orientation, different types of training were applied: basic endurance training, anaerobic threshold training, overload endurance training, speed training, lactate tolerance training, general physical strength training, specific strength training, and technical and tactical training (Hraste, 2004). The sports result is influenced by several factors. The basic analysis of the essence of the training process indicates that the basic goal of training influences is the development of physiological potentials, thanks to which the swimmer can swim faster and with less effort. This assessment indicates two basic aspects of the goal of the training process: the impact on the quality of energy processes and the impact on the musculature. So, every work is energetically covered in the very beginning, until other "sports" mechanisms are activated (Matković, 2004). By training the appropriate characteristics, it is possible to influence the level of energy phosphate reserves in the muscle. Therefore, such contents of the work should be planned in the year-round cycle. To this end, it is necessary to plan the swimming of sections of 25 meters, with maximum speed with twice as long breaks between sections (Matković, 2004). For athletes, all food components are equally important, ie carbohydrates, fats, proteins, and water (Jaredić, 2015). The amount of lactic acid produced is expressed in mmol and it is considered that the value of 4 mmol indicates the moment when the aerobic regime changes to anaerobic, and when the lactate concentration increases sharply (Matković, 2004). Water polo players endure intense efforts of anaerobic and aerobic work, partially interrupted by short and long breaks with a high frequency of rapid changes of tasks, swimming intensity, as well as the direction of movement and position of the player (Kovačević, 2000). The main goal of this research is to determine the significance of the influence of some motor skills on the success in performing elements of shooting, in water polo players in water polo clubs of Sarajevo Canton aged 12 to 14 years (cadets).

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, ages 12 to 14 years, registered in BiH clubs. All subjects were healthy and could participate in the testing process. Since participants were juveniles, a written contest was signed by their legal guardians, allowing for participants to withdraw from the study at any time. Procedures were done according to the declaration of Helsinki and approved by the ethical committee of the Water polo Federation of Bosnia and Herzegovina.

A sample of Variables for Assessing Motor Skills

Determination of the level of basic - motor abilities was performed using measuring instruments recommended by Kurelić et al. (1975) and Eurofit battery tests. Movement structuring mechanism: Air maneuverability (MOKZ), Hand taping (MTAP), Foot taping (MTAN), Synergistic and tone regulation mechanism: Deep bench press (MDPK), Leaning with reach in sitting (MSJED), Transverse beam standing (MGRED), Excitation intensity control mechanism: Running at 20m flying start (M20M), Triple jump from a place (MTRS), Long jump from places (MDALJ), Excitation duration regulation mechanism: Hinge height (MVZG), Hull lifting in 30 seconds (MDT30), Push-ups (MSKL).

A sample of Variables to Assess the Performance of the Technical Elements of Goal-Scoring in a Water Polo Game

The shot accuracy test. Shooting from the left wing from a static position from 6 meters – STLK, Shooting from the center from a static position from 6 meters – STC, Shooting from the right-wing from a static position from 6 meters – STDK, (*The test is performed from three different positions, i.e. two wings and one*

central. Each subject performs one shot from each position.), shooting from the left wing from a static position from 6 meters - STLK respondent comes to the left-wing, a distance of 6 meters, takes a basic position, and shoots at the goal with a basic shot in water polo. A goal is scored. Shooting from the center from a static position from 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. A goal is scored. Shooting from the right-wing from a static position from 6 meters – STDK. The respondent comes to the right-wing, at a distance of 6 meters, takes a basic position, and shoots on goal with a basic shot in water polo. A goal is scored.

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 study 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 examinees first measured motor skills, then situational - motor skills. Before the measurement and testing process, the respondents explained in an acceptable way what awaits them in the period of research implementation and what is required of them in their work. The main motive for the work will be curiosity and understanding of testing as an opportunity to check one's knowledge and cognition about one's abilities. Measurement was performed in groups of 20 to 25 respondents, up to 80 respondents during the day, One surveyor and recorder worked 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 12 h, during four days of motor ability, from 08 to 12 h, during five days, during five days of goal shooting tests, All subjects under the same conditions were subjected to measurement and testing (the entire survey was conducted in the morning, the temperature was 18 to 24 degrees Celsius, the place of testing was the Olympic swimming pool of the island (indoor 50-meter pool). After data collection, measurement lists were completed, and data were processed in the appropriate program.

Data Processing Methods

To determine the influence of some motor skills on the performance of technical elements of goal shooting in a water polo game, basic central and dispersion parameters were applied, as well as regression analysis using the statistical package SPSS 12 for windows.

Results

Central and Dispersive Parameters of Variables for the Assessment of Motor Abilities

By looking at Table 1, descriptive statistical methods processed the data, and it can be seen that in all variables there is no significant deviation from the normal distribution. The distributions of the respondents' abilities fit into the standards specific to the motor abilities of young water polo players, although this population is in the process of constant transformation which is the result of the influence of the specific age of the respondents, ages 12 to 14 years. So, there are no significant deviations in the distribution of results from the normal distribution for individual motor abilities, which can be seen from the table shown, which reflects our current state. The following can be determined by individual review and analysis of variables: Air maneuverability - MOKZ - as can be seen from the results obtained, the value of the arithmetic mean (Mean is 6.19) and the range (Max. - Min.) Is from 4.88 to 8.94, which is manifested by the good result, and confirms the standard deviation (SD) - 1.02. Skewness shows a slight grouping of results in the positive part of the coordinate system, and elongation (Kurtosis) is within the normal distribution. All this indicates that water polo players have good coordination due to large changes in water movement in the training process as well as in the matches themselves, it can be said that the distribution of the variable in this research is normal. Hand taping - MTAPR is a variable that accumulates the speed and coordination of hand movements, and it can be stated that it is in the first place in the distribution according to the normal distribution in

this study, which means that water polo has specific motor programs compared to others sports which contributed to good indicators in hand tapping. In this study, the distribution does not deviate from normal. Foot tapping- MTAPN is a variable with the expected normal distribution as well as the variable taping with the hand. Deep bench press- MDPK is a variable with normal distribution. Leaning with reach in sitting- MSJED is a variable with normal distribution. Transverse beam standing- MGRED is a variable with normal distribution. Running at 20m flying start - M20M is a variable with normal distribution. Triple jump from a place - MTRC this variable has a normal distribution, although it shows a slight negative curvature, probably because water polo players do not have an adequate number of training sessions in the gym. Long jump from place - MSDALJ is a variable with normal distribution. Hinge height - MVZG is a variable with excellent normal distribution. Hull lifting in 30 seconds- DT30 is a variable with normal distribution. Push-ups - MSKL is a variable with normal distribution.

Central and Dispersive Parameters of Variables for Estimating the Technical Elements of Goal Shooting

Shot from the left-wing (STLK) as can be seen from the results obtained (Table 2), the value of the arithmetic mean (Mean is 3.58) and the range (Max. - Min.) is from 1 to 7, which is manifested by a good result and is confirmed by the standard deviation (SD=1.54). Skewness shows a slight grouping of results in the positive part of the coordinate system, and kurtosis is within the normal distribution. Shot from the center - STC - as can be seen from the results, the value of the arithmetic mean (Mean is 5.73) and the range (Max. - Min.) Is from 3 to 9, which is manifested by a good result and is confirmed by the standard deviation (SD=1.57). Skewness shows a slight grouping of results in the positive part of the coordinate system, and kurtosis is within the normal distribution. Shot from the right-wing - STDK - as can be seen from the results, the value of the arithmetic mean (Mean is 4.48) and the range (Max. - Min.) Is from 1 to 9, which is manifested by a good result and is confirmed by the standard deviation (SD=1.88). Skewness shows a slight grouping of results in the positive part of the coordinate system, and kurtosis is within the normal distribution.

Table 1

Central and dispersive parameters of variables for the assessment of motor abilities.

Variables	n	Mean	Median	Minimum	Maximum	Range	Variance	SD	SE	Skewness	Kurtosis
MOKZ	80	6.19	5.78	4.88	8.94	4.06	1.05	1.02	.11	.33	-1.06
MTAPR	80	44.08	45	28	50	22	19.06	4.37	.49	-1.05	1.79
MTAPN	80	25.36	25	19	31	12	7,15	2.67	.30	-.09	.42
MDPK	80	.12	.07	.01	.30	.29	.01	.11	.01	.79	-1.00
MSJED	80	37.96	36.65	20	58	38	96.75	9.84	1.10	.02	-.38
MGRED	80	8.99	9	5.04	12.74	7.7	4.25	2.06	.23	.23	-.42
MM20M	80	3.27	3.09	2.81	3.84	1.03	0.15	0.38	.04	.25	-1.48
MTRS	80	598.56	625	.12	647	135	1933.97	43.98	4.92	-1.00	-.36
MSDALJ	80	200.19	212.25	122.5	226	103.5	691.98	26.31	2.94	-.77	-.71
MVZG	80	36.63	38.87	3	65.63	62.63	206.81	14.38	1.61	.71	.14
MDT30	80	20.84	22	14	26	12	11.53	3.40	.38	-.45	-1.06
MSKL	80	4.61	5	2	7	5	2.01	1.42	.16	-.18	-.04

MOKZ: Air maneuverability; MTAP: Hand taping; MTAN: Foot taping; MDPK: Deep bench press; MSJED: Leaning with reach in sitting; MGRED: Transverse beam standing; M20M: Running at 20m flying start; MTRS; Triple jump from a place; MDALJ: Long jump from places; MVZG: Hinge height; MDT30: Hull lifting in 30 seconds; MSKL; Push-ups.

Table 2
Central and dispersive parameters of variables for estimating technical elements of goal shooting.

	n	Mean	Median	Minimum	Maximum	Range	Variance	SD	SE	Skewness	Kurtosis
STLK	80	3.58	4	1	7	6	2.37	1.54	.17	.22	-.64
STC	80	5.73	6	3	9	6	2.46	1.57	.18	.03	-.89
STDK	80	4.48	5	1	9	8	3.52	1.88	.21	.13	-.57

STLK: Shooting from the left wing from a static position from 6 meters; STC: Shooting from the center from a static position from 6 meters; STDK: Shooting from the right-wing from a static position from 6 meters.

Regression Analysis of Motor Abilities and Performance of Technical Elements of Goal Shooting with the First Main Component

Regression analysis of the criterion variable of performing technical elements of goal shooting (Tables 3 to 5), provides sufficient information on the impact of applied motor variables on the performance of technical elements of goal shooting with the first main component. The correlation of the predictor with the criterion variable is R = .51, and 26% of the common variability with the criterion is explained. Such a connection is significant at the .042 level. By analyzing the influence of individual motor variables (Table 4), it can be seen that the largest and statistically significant influence on the criterion variable has a variable GRED - transverse standing on beams at levels up to .05. There are a small number of partial regression coefficients valid here, which indicate the need to observe the prediction of the system as a whole. The obtained results indicate the following: The performance of variables in the overall performance of technical elements of goal shooting in this study was influenced by the highest variable (GRED), the transverse standing on the beam partial correlation coefficient is -. 320 which is at the significance level of .013 in the specified space. The variable (GRED), the transverse state of the beam is, in fact, an indicator of the motor factor of balance, and this ability is very necessary for the specific balance of water polo in water at rest (positioning), but also their movement in the water. The second variable SJED (predilection with reaching in the seat) also has a significant partial correlation coefficient with the first main component (shooting) of - .225 and a significance level close to the milder criterion of .059. This is the motor factor of flexibility.

Table 3
Model summary- regression analysis in the performance of technical elements of goal shooting in the area of motor skills.

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
1	.510	.260	.127	.934

Table 4
ANOVA of motor abilities.

Model		Sum of Squares	df	Mean Square	F	p
1	Regression	20.538	12	1.712	1.961	.042
	Residual	58.462	67	.873		
	Total	79.000	79			

Table 5
Coefficients- of motor abilities.

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	OKZ	.134	.118	.137	1.136	.260
	TAPR	-.018	.036	-.079	-.505	.615
	TAPN	.053	.056	.141	.949	.346
	DPK	-1.097	1.086	-.123	-1.010	.316
	SJED	-.025	.013	-.225	-1.922	.059
	GRED	-.155	.061	-.320	-2.553	.013
	M20M	.594	.339	.226	1.753	.084
	TRS	-.001	.003	-.024	-.173	.863
	SDALJ	.003	.007	.087	.476	.635
	VZG	.012	.009	.176	1.370	.175
	DT30	.028	.036	.096	.776	.441
	SKL	-.049	.093	-.069	-.524	.602

GRED: Transverse standing on beams; SJED: Predilection with reaching in the seat

Discussion

If the sample is re-examined, the above characteristics come to the fore (where water polo players were influenced by the specific plan and program applied in the training process) and it is not surprising that motor skills showed a positive centroid grouping of results. Water as a medium in which kinesiological activity takes place, as well as most of the training process in water polo, represents a certain specificity concerning other sports (Hraste & Granić, 2003). Water polo as a polystructural and complex sport requires a high level of many motor skills, among which are fundamental strength, speed, and endurance (Garbolewski & Starosta, 2002). The impact and importance of coordination in water polo is still a rather unexplored part, but it is clear that it is important for the best possible performance of all technical - tactical elements of the water polo game (Modrić et al., 2011).

All this indicates that water polo players have good efficiency when shooting towards the goal when it comes to static shooting from all positions. Water polo is a very dynamic game and usually consists of the following technical elements: swimming short distances, guiding the ball, passing, blocking, and shooting. The element of shooting is very important because the result usually depends on it (Dizdar, 2014). Both of these motor factors are functionally subordinate to the mechanism for synergistic regulation and regulation of muscle tone. So, most likely, to achieve the best possible result, younger water polo players (ages 12 to 14) need good coordination of the complete body. It is known that we develop intelligence in humans through coordination, which we can conclude from the attached tables. This is another proof that water polo has a positive effect on the human body. Mirvić (2011) on a sample of 35 second-year students from Bologna, Faculty of Sports and Physical Education, University of Sarajevo, six variables were applied to assess flexibility (predictor system) and one variable for swimming speed crawl technique (criterion variable). The aim was to determine the impact of flexibility on the speed of swimming with the crawl technique at 50 meters planned in swimming lessons at the Faculty of Sports and Physical Education in Bologna, University of Sarajevo. With the help of regression analysis to the analysis of the influence of individual flexibility variables, it could be seen that the largest and statistically significant influence on the criterion

variable has the variables: MFRFP Retroflection of the arms - extension, elevation posterior - without rotation of the upper arm, inversion-rotation internal-supination. From the analysis, it turned out that retroflection of the arms - extension, elevation posterior - without rotation of the upper arm, twist, and inversion-rotation Internal-supination had an impact. After all that was said, it was concluded that without the flexibility of the complete body we cannot perform the correct crawl technique, and thus the maximum speed of swimming crawl technique in students of the Faculty of Sports and Physical Education, University of Sarajevo. Kontić et al. (2014) wanted to determine the latent dimensions of basic and specific indicators of motor abilities of junior national team members of Croatia aged 17 to 19 who participated in the 2010 World Junior Championships and won a gold medal. Of the 12 variables tested to assess the motor abilities of players, the authors identified four latent dimensions of fitness of water polo players, that is, motor factors, the first of which can be defined as a factor of repetitive strength, the second as a factor of shoulder girdle flexibility, the third as a factor of lower extremity strength, and the fourth as a factor of lower-body flexibility. Mirvić et al. (2016) in a similar study aimed to determine and explain the connection of some motor skills with the situational-motor abilities of the water polo game, water polo players 13 to 15 years of age. The canonical correlation analysis obtained a significant and homogeneous structure of the connection between the set of motor abilities and the set of performing the technical elements of shooting on goal in a water polo game. It has been shown that there is no high ability of precision when shooting and that more attention should be paid to the training process of precision in water polo players who are aged 12 to 14 years (Nurković et al., 2021).

In the area of motor skills, 12 tests were applied, which represent the basic motor skills of the water polo game, and in the area of situational-motor tests, 6 tests of the basic elements of water polo technique in the situational conditions of the game were applied. Based on the set goal of the research, as well as on the basis of the obtained results, it can be concluded that there are connections between the researched areas, i.e. between motor skills and situational-motor skills in the water polo game. Šimenc et al. (2009) dealt with the structural analysis of the positions of players in water polo based on the assessment of some anthropological characteristics. The basic positions of the water polo game: goalkeeper, winger, center, quarterback, and playmaker require a certain level of anthropological status of the players on whom success in the game depends. The importance of twelve motor skills, three functional and four morphological traits was assessed by five water polo experts. Their assessments show a high degree of agreement on the importance of motor, functional and morphological characteristics of water polo players in certain positions of the game. Two groups of players were defined through a hierarchical cluster analysis of the player's position.

The first group consists of the position: goalkeeper, defender, and winger, and the second of the center and playmaker. The basic characteristics of the first group are speed, precision, coordination, flexibility, agility, explosive power, and endurance. The basic characteristics of the second group are high longitudinal and transverse dimensionality of the skeleton, a large amount of muscle mass and adipose tissue, as well as all kinds of strength, on the one hand, and endurance on the other. Here are a small number of valid partial regression coefficients that indicate the need to observe the prediction of the system as a whole.

Conclusion

Regression analysis of the criterion variable of performing technical elements of goal shooting provides sufficient information on the influence of applied motor variables on the performance of technical elements of goal shooting with the first main component. The correlation of the predictor with the criterion variable is R = .51, and 26% of the common variability with the criterion is explained. Such a connection is significant at the .042 level. By analyzing the influence of individual motor variables, it can be seen that the largest and statistically significant influence on the criterion variable has the variable GRED - transverse standing on the beam at a level up to .05. The small number of valid partial regression coefficients here indicates the need to observe the prediction of the system as a whole. The obtained results indicate the following: The performance of variables in the overall performance of technical elements of goal shooting in this study was influenced by the highest variable (GRED) transverse standing on the beam in the specified space. So, most likely, to achieve the best possible result, it is necessary for water polo players from 12 to 14 years of age to

develop good factors of balance, flexibility, and explosiveness. This is just another proof that water polo has a positive effect on the young human body. Here are a small number of valid partial regression coefficients that indicate the need to observe the prediction of the system as a whole. This research achieves the set goal: to determine the influence of motor skills on the performance of technical elements of goal shooting. In general, it can be concluded that without good coordination, efficiency in the technical elements of the shot on goal will not be achieved.

Authors' Contribution

Study Design: NM, DIT, EM, SB, BG; Data Collection: NM, DIT, EM; Statistical Analysis: NM; Manuscript Preparation: NM, DIT, EM, SB, BG; Funds Collection: NM, EM.

Ethical approval

Procedures were done according to the Declaration of Helsinki and approved by the ethical committee of the Water Polo Federation of Bosnia and Herzegovina.

Funding

The authors declare that the study received no funding.

Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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