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Influence of morphological characteristics and motoric abilities
on the success of performing elements of volleyball in the high school student population

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Abstract

In terms of organization of sport and physical education lessons, volleyball can be considered the most popular for realization. The reasons for this organizational popularity lie in the fact that for the performance of educational contents of volleyball, very little material and technical equipment are needed, the game is easily applicable for the male and female population, and there is no contact between members of opposite teams so there is a small possibility of injury of participants. On this organizational level (lessons) it is also possible to oppose teams of different sexes, teams of different knowledge and motorical readiness or teams of different social statuses and which will not significantly affect the quality or result of the competition. On this occasion, a significant difference between opposite population does not have to be expressed, which again indicates on high organizational quality.

Sample examinees are defined by the male population of vocational high schools in Sarajevo, between the ages of 16-18. Variables of a predicator area consist of 12 morphological and 24 motoric variables, and the sample variables of the criterion area of 3 variables/elements of volleyball. The aim of this research is to determine the effect of morphological characteristics and motoric abilities on the performance of situational motoric elements of volleyball in terms of organization of sport and physical education. In this research, with the use of regression analysis the determined is a) influence of the morphological area on variables of the situational motorical area does not exist, like individually in the manifest area the same is represented by the first main component and b) the influence of variables from the motorical area on all situational- motorical variables in volleyball (manifest area) is achieved, just like those three elements derived the first main component.

Key words: **morphological characteristics, motorical abilities, high school population, volleyball, situational-motoric abilities**

Sažetak

U smislu organizacije nastave sporta i tjelesnog odgoja, odbojku možemo smatrati veoma popularnom za realizaciju. Razlozi za tu organizacijsku popularnost leže i u činjenici da je za izvedbu obrazovnog sadržaja potrebno vrlo malo materijalnih i tehničkih uslova i opreme, igra je lako primjenjiva za mušku i žensku populaciju, te nema kontakta između pripadnika suprotnih ekipa tako da je mala mogućnost ozljede sudionika. Na ovom organizacijskom nivou (nastava) također je moguće da se suprotstave timovi različitih spolova, timovi različitih znanja i motoričke spremnosti ili timovi različitih društvenih statusa, a što neće značajno utjecati kvalitetu ili rezultat takmičenja, što opet ukazuje na visoku organizacijsku kvalitetu. Uzorak ispitanika u istraživanju definisan je kao populacija učenika muškog spola srednje stručne škole u Sarajevu, starosti od 16-18 god. Uzorak prediktorskih varijabli sastoji se od 12 morfoloških i 24 motoričke varijable, a uzorak kriterijskih varijabli od 3 varijable/elementa odbojkaške igre. Cilj ovog istraživanja bio je utvrditi uticaj morfoloških karakteristika i motoričkih sposobnosti na uspješnost izvođenja situaciono motoričkih elemenata odbojkaške igre realizovane u nastavi sporta i tjelesnog odgoja. Uz primjenu regresijske analize utvrđeno je a) da ne postoji uticaj morfološkog prostora na varijable situaciono motoričkog prostora, kako pojedinačno u manifestnom prostoru tako predstavljene i putem prve glavne komponente i b) da je ostvaren uticaj varijabli motoričkog prostora na svaku od situaciono - motoričkih varijabli odbojkaške igre (manifestni prostor) kao i na od ta tri elemena izvedenu prvu glavnu komponentu

Ključne riječi: **morfološke karakteristike, motoričke sposobnosti, srednješkolska populacija, odbojkaška igra, situaciono-motoričke sposobnosti**

Introduction

In terms of organization of sport and physical education lessons, volleyball can be considered the most popular for realization. The reasons for this organizational popularity lie in the fact that for the performance of educational contents of volleyball, very little material and technical equipment are needed, the game is easily applicable for the male and female population, and there is no contact between members of opposite teams so there is a small possibility of injury of participants. In this light we can also observe the non occurrence and development of violence among participants of other teams, which is how Brackenridge, Fasting, Kirby and Leahu (2008) state, the frequent occurrence on realization of sport activities. On this organizational level (lessons) it is also possible to oppose teams of different sexes, teams of different knowledge and motorical readiness or teams of different social statuses (for ex.:

competition in non educational organization of work) and which will not significantly affect the quality or result of the competition, regardless of the research data conducted by Kovač, Leskošek and Strel (2007), for which is determined that the higher level of motorical abilities present in students of technical schools rather than in students from, for ex. Specialized schools, relatively the difference in social statuses will not be expressed. On this occasion, a significant difference between opposite population does not have to be expressed, which again indicates on high organizational quality. In the light of general-worldly popularity, we can say that volleyball by itself falls under four sport games which in this area (European continent) are usually represented on TV screens or in sport magazines (football-soccer, basketball, volleyball, handball). The given popularity contributes and continuous effort of structure

and association that follows development of volleyball, to improve and change of rules accelerates mutually, and thus, furthermore, interests as the mass increases, in the way that media structures do, for volleyball competitions - Kock and Tilp (2009). That presence of media turns the attention of the general public, and also the high school population, to volleyball. Turning this popularity into practical life and into lessons of sport and physical education of students, we can notice the initiation of greater representation of volleyball, from the pedagogues where, if we state the fact that for the concrete performance of educational contents of this game, very little space is needed (for ex.: volleyball in appliance by a smaller number of students in a team or volleyball 2 on 2 players or similar) like sport equipment (one volleyball) Šoše and Tomić (1998) then the practical part comes in the placement of things into "its place". In the following context the interest of researchers for specific rules, interactions and order of effects that happen in volleyball, should not be unusual. Research is particularly interesting when in context of the whole structure also introduce individual educational content which Najšteter (1997) and Findak (2001) advocate and which should be realized within lessons, but in the area since 1999, regardless of the large number of initiatives of both governmental and nongovernmental organizations, according to Hardman (2008) there is no practical progress.Therefore, a large number of researches have been done regarding analysis of correct relations and influences within morphological/situational-motoric and motorical-situational-motoric areas of volleyball and which have also shown a corresponding influence in terms of the research area (predicator/criterion). Thus, for ex.: Mekić (2001) on a sample of 110 basketball players of a municipal and regional rank proved that basic-motorical abilities affect the shooting of the ball into the basket, and the same author (2002) determines the corresponding high and significant degree of influences of basic motorical abilities on the preciseness of passing the ball in basketball. In the game of volleyball Marković (2002) on a sample of 100 handball players found a significant connection between basic-motorical and situational- motorical abilities. Miletić, Sekulić and Wolf-Cvitak (2004) have conducted research on 55 gymnasts, stated that a connection between motoric abilities and performance of nine different jumps without devices in rhythmical gymnastics, does exist. Vlašić, Oreb and Furjan-Mandić (2007) determined that a statistically significant connection of predicator morphological-motoric area with criterion specific situational motoric elements (folk dances) exists, and Guzel, Colakou, Karacn, Akyuz, Aslanolu (2008) determined that a difference between morphological characteristics and motorical abilities of volleyball and football players exists in terms that height and weight that are considerably expressed in volleyball players than in football players. The obtained results from previous research, both in volleyball as in other sports, suggests that for the aim in this research could be determined by testing influences of morphological and motoric abilities on performance of situational-motorical elements of volleyball, which are realized in the lessons of sport and physical education, which would contribute and individualize educational content and adapt lessons to students of vocational schools – Brettschneider and Naul (2004) determines that socio-economic statuses of families, educational level of parents and aspiration of an individual have a significant influence on the motorical status of adolescents.

Methods of processing data

Processing of data obtained was done by the software package SPSS 12.0 for Windows. At a multivariate level for determining the relation, a regression analysis was used, which represents

an extremely suitable mathematical-statistical procedure in cases where it is necessary to determine a relationship between two sets of different variables.

Sample Examinees

Sample examinees are defined by the male population of vocational high schools in Sarajevo, between the ages of 16-18. The survey included only those students, who during the process of testing and measuring were completely healthy. The total number of examinees in the sample consists of 151 students. All examinees had suitable conditions of regular attendance in the lessons of sport and physical education, which represented one of the fundamental requirements for conducting this research. The sample can not be selected by any criteria for entry into high school.

Sample Variables

The selection and definition of the investigated areas (morphological, motoric, situational motoric) in this order were made on the basis of standardized and empirically verified methods of measurement and testing, based on which came to specific information about the characteristics of the surveyed examinees.

Sample of predictor variables is defined as follows:

Variables for assessment of morphological characteristics:
1. Body height (VISTJ)
2. Leg length (DUZNG)
3. Arm length (DUZRK)
4. Hand width (SIRSA)
5. Wrist diameter (DIRZG)
6. Elbow diameter (DILAK)
7. Body mass (MASTJ)
8. Upper arm radius (OBNDL)
9. Middle thorax radius (OBGRU)
10. Upper arm skinfold (NBNDL)
11. Back skinfold (NBLED)
12. Abdominal skinfold (NBTRB)

Variables for assessment of motoric abilities:

Variables for assessment of coordination
1. Coordination with a bat (MKTKK3)
2. Slalom with three medicine balls (MKOS3M)
3. Figure eight with ducking (MAGOSS)

Variables for assessment of explosive strength
1. Throwing a medicine ball out of a back laying position (MESBML)
2. Standing long jump (MESSD)
3. Running 20M (MBR20M)

Variables for assessment of movement frequency
1. Foot tapping (MBFTAN)
2. Foot tapping against a wall (MBFTAZ)
3. Hand tapping (MBFTAR)

Variables for assessment of repetitive strength
1. Push-ups on a loom (MRASKR)
2. Raising body out of a lying position (MRSPTL)
3. Deep squats with weights (MRLDCT)

Variables for assessment of balance
1. Standing on one leg longitudinally on a bench with open eyes(MBAU1O)
2. Standing on one leg across from the bench with closed eyes(MBAU1Z)
3. Standing on one leg longitudinally on a bench for balance with closed eyes(MBAP1Z)

Variables for assessment of precision
1. Targeting with a long stick(MPCDŠ)
2. Targeting a vertical target by foot (MPGVCN)
3. Targeting a horizontal target by hand (MPGHCR)

Variables for assessment of flexibility
1. Flex with a bat (MFLISK)
2. Leg lift while laying facedown (MFLZLG)
3. Deep forward bend on a bench (MFLDPK)

Variables for assessment of speed
1. Running 20M out of a high start (MBR20M)
2. Running 20M out of a flying start (MBR20MLS)
3. Running 50M out of a high start (MBR50MVS)

Sample of criterion variables (situational-motorical) defined as follows:

Variables for assessment of volleyball
1. Hitting aim over a net from primary position(OOGCPMOS)
2. Block "hammer" circular shape (OOOČK)
3. Serve (OOSR)

Results and Discussion

Influence of morphological on situational-motorical area

On the volleyball variables OOGCPMOS (.485), OOOCK (.309) and OOSR (.671) there is no influence of the predicator-morphological variables, considering the previously determined level of significance of $P < .05$, and it is not on a statistically significant level. In accordance to this it can be stated that the morphological area does not have an effect on the given variable of volleyball in the manifest area and it is not necessary to go into a detailed analysis of these relations. It is believed that one of the causes for the lack of correlation can be defined by the level of performance values of situational motoric tests, in which the performance of the morphological area of the studied area did not play an important role. The following could have been the cause to the loss of variability and have an effect on the loss of relations between the predicator and criterion area. One of the reasons that could affect the lack of correlation may result from inadequate and insufficient acquisition of basic techniques, which is like such depends less on the predicator variable. There is a possibility that the elimination of these causes could arrive to the appearance of correlation of the predicator with the criterion area. On the game of volleyball, represented by the first main component that is performed on three elements of volleyball (OOGCPMOS, OOOCK, OOSR) there is no influence of the predicator variables, considering the previously determined level of significance of $P < .05$, on a statistically significant level (in this case is .415). In accordance to this it can be stated that the morphological area does not have an effect on the first main component of volleyball and it is not necessary to go into a more detailed analysis of these relations. The cause for

the lack of correlation can be defined by a set of situational motoric tests, by which the performance of the morphological area of the studied population did not have a significant affect. There is a possibility that by complicating the tests it could come to the appearance of correlation of the predicator with the criterion area.

Effects of motorical area on situational-motoric area

Examining the regression analysis of the criterion variable OOGCPMOS (Table 1.) we can determine the existence of statistically significant correlation, and the relation of the predicator and criterion variable provides sufficient information about the applied effects of motoric variables on the success of performance on the treated criterion variables. Correlation of the predicator with criterion variable is $R=.52$, with an explanation of about 27% of common variability with the criterion. The correlation is registered on a significance level to .05. Examination of the effects of individual motoric variables (Table 3.) it canbe seen that there was a logical and expected correlation between the predicator and criterion variables by the following: variable relation of explosive strength MESSD – standing long jump, which is logical and where explosiveness is necessary for the performance of a serve and strength and speed of serving a ball, variable correlation MRASKR – push-ups on a loom which represent strength of the upper extremities in this case is necessary for a greater number of serving repetition along with retention of quality of the derived technique, variable relation of balance MBAU1Z- Standing on one leg across from the bench with closed eyes which is necessary when stretching examinees during the performance of the technique itself, and relation two of three variables that represent speed of the motoric area MBR20MVS and MBR20MLS and considering the needed arm speed when performing a serve in volleyball. Therefore, proper stretching and maintaining a balanced position in preparation for a serve, in order to obtain the length in swing time, followed by rapid arm movements, causes the strength of the served ball along with attainment of correct precision for hitting the desired target (squares) in the field.

Table 1. OOGCPMOS (Volleyball - Hitting aim over a net from primary position)

Model	R	R Square	Adjusted R Square
1	.522	.272	.133

Table 2. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	163.480	24	6.812	1.961	.009
	Residual	437.606	126	3.473		
	Total	601.086	150			

Table 3. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
1		B	Std. Error	Beta		
	MESSD	.024	.010	.273	2.344	.021
	MRASKR	-.102	.037	-.307	-2.775	.006
	MBAU1Z	-.325	.138	-.226	-2.363	.020
	MBR20MVS	-3.060	1.260	-.268	-2.429	.017
	MBR20MLS	3.945	1.497	.316	2.636	.009

Table 6. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
1		B	Std. Error	Beta		
	MKTKK3	2.232	.869	.253	2.569	.011
	MBFTAZ	.577	.285	.207	2.028	.045
	MBAP1Z	-3.455	1.700	-.183	-2.032	.044
	MBR20MLS	18.302	7.433	.297	2.462	.015

Analyzing the obtained tables of the regression analysis in the manifest area for the criterion variable OOOCK (Table 4.) we notice certain information about the effects of the applied motoric variables on the performance success on the treated criterion variables. Relation of the predicator variable with the criterion variable is R= .50 and explanation is about 25% of common variability with the criterion. Such correlation is significant on a level of .01. Examination of individual effects of motorical variables (Table 6.) could be seen that four variables of the predicator area have influence (level of significance .00 to .05) on criterion variable according to the following: MKTKK3- coordination with a bat, MBFTAZ- foot tapping against a wall, MBAP1Z- standing on one leg longitudinally on a bench for balance with closed eyes and MBR20MLS- running 20M out of a flying start. In this placed relation of variables is expected considering that for the performance of lower blocking in volleyball, participants need to have proper coordination between lower and upper extremities, frequency of movement of speed for which the greater number of blockage in a shorter period of time, then they must maintain proper balance manipulating the body within a marked area (a circle in which blocking is preformed) and of coarse at the same time have proper speed, in the way the body will promptly be set up "under the ball". These facts indicate the possibility of poor adoption of the lower blocking technique in volleyball – hammer, in students of vocational schools, considering that among others motorical characteristics of balance came to the fore, suggesting the possibility that the blockage of the ball is constantly found at the border of falling out of the circle and in this way, loss of control on the ball while trying to "catch it" participants/students have especially used this motoric characteristic, which in combination with speed enabled the successful completion of the test.

Table 4. OOOCK (Volleyball - Blocking "hammer" in circular shape)

Model	R	R Square	Adjusted R Square
1	.509	.259	.118

Table 5. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3773.008	24	157.209	1.835	.017
	Residual	10794.700	126	85.672		
	Total	14567.709	150			

Review of the regression analysis of the criterion variable OOSR (Table 7. 8. and 9.), provides information on eight correlating variables with the criterion variable. Relation of the predicator with criterion variable is R= .60 and explains 37% of common variability with the criterion. The above relations are significant on a level of .00, along with an interesting fact that all the variables are practically double representatives of a certain area, reverently they correlate by two to three variables of one area. For instance MBFTAN- foot tapping and MBFTAR- hand tapping represent speed frequency of movement, MRASKR- push-ups on a loom and MRSPTL- raising body out of a lying position represent variables for the assessment of strength, MBAP1Z- standing on one leg longitudinally on a bench for balance with closed eyes and MBAU1O- standing on one leg longitudinally on a bench with open eyes represent variables for assessment of balance and MPGVCN- targeting a vertical target by foot and MPGHCR- targeting a horizontal target by hand represent variables for assessment of precision. Considering that the test is measured out of 12 attempts (6 attempts one half and 6 attempts second half of the court) for its complete performance proper strength of the upper extremities and body is needed, so where the abdominal muscles stretch 12 times upwards and backwards with explosive contraction after that, and on preparation for execution and performance of a serve. In the position for performing a serve, on tensing the muscles it is important to maintain the proper stance/position of equilibrium which manifests in the presence of the variable of balance along with maintenance of precision, which in the upper extremities is especially evident at change of serving area (6 attempts in one half of the court and 6 attempts in the second half of the court. Precision is also important in estimating the validity of a serve, considering that the ball has to fall in the marked area or touch the border line of the area. Therefore, the presence of the following variables allows faster hand movement, maintaining hand speed and body balance and attaining proper precise parabolas when performing a serve in volleyball and what is shown in this analysis.

Table 7. OOSR (Volleyball - Serve)

Model	R	R Square	Adjusted R Square
1	.609	.370	.250

Table 8. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	248.106	24	10.338	3.087	.000
	Residual	421.934	126	3.349		
	Total	670.040	150			

Table 9. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
1		B	Std. Error	Beta		
	MBFTAN	.318	.087	.378	3.680	.000
	MBFTAR	-.111	.058	-.181	-1.912	.058
	MRASKR	.072	.036	.207	2.007	.047
	MRSPTL	-.073	.031	-.238	-2.356	.020
	MBAP1Z	-.648	.336	-.160	-1.928	.056
	MBAU1O	.011	.005	.219	2.263	.025
	MPGVCN	-.026	.009	-.237	-2.824	.006
	MPGHCR	.029	.008	.291	3.425	.001

Insight into the regression analysis of the **first main component** in volleyball with mutual correlation from .62 (Table 10.), shows high multiple correlation and coefficient determinations (.38). This relation is registered and significant on a level of .00. Analysis of the influence on individual variables (Table 12.) can be concluded that out of eight variables with a statistically significant influence have been registered by two variable representatives out of three latent areas: MBR20MLS and MBR50MVS – speed from participants, MBFTAN and MBFTAR – speed frequency of movement and MBAP1Z and MBAU1O- balance that has statistically significant influence on the first main component of volleyball. From the following it can be concluded that speed balanced characteristics had a dominate influence on achieving better results in the game of volleyball. Areas that represent variables MKTKK3- coordination and MPGHCR- precision are in combination with the previously mentioned speed balanced characteristics gave suitable contribution to achieve quality results in performing elements of volleyball.

Table 10. Volleyball-First main component of sport games

Model	R	R Square	Adjusted R Square
1	.621	.386	.269

Table 11. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57.935	24	2.414	3.304	.000
	Residual	92.065	126	.731		
	Total	150.000	150			

Table 12. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
1		B	Std. Error	Beta		
	MKTKK3	.176	.080	.196	2.188	.031
	MBFTAN	.140	.040	.352	3.467	.001
	MBFTAR	-.057	.027	-.196	-2.103	.037
	MBAP1Z	-.470	.157	-.245	-2.993	.003
	MBAU1O	.005	.002	.190	1.982	.050
	MPGHCR	.012	.004	.251	2.989	.003
	MBR20MLS	1.894	.686	.303	2.759	.007
	MBR50MVS	-.679	.328	-.286	-2.070	.041

Conclusion

The influence of morphological and motorical abilities on the performance of situational-motorical elements of volleyball was analyzed by application of regression analysis on 151 examinees- students from vocational high schools. On the control sample 12 morphological and 24 motorical variables (predicator area) were analyzed versus 3 situational- motorical variables, or criterion area. The set aim in the research suggested that an influence of morphological characteristics and motorical abilities on the performance of situational-motorical elements of basketball existed. In this research, with the use of regression analysis the determined is a) influence of the morphological area on variables of the situational motorical area does not exist, like individually in the manifest area the same is represented by the first main component and b) the influence of variables from the motorical area on all situational- motorical variables in volleyball (manifest area) is achieved, just like those three elements derived the first main component. We can conclude that for realization of situational- motorical elements, like as success in volleyball- which can be indirectly assessed by the attained effects on the first main component, speed characteristics are primarily necessary, followed by balance and coordination. With this research it has been determined that the quality of performing situational-motorical tasks is greater when the level motorical abilities is in participants is greater. Finally, with the obtained results of this research, the influence of motorical abilities on performance of situational-motorical elements in volleyball, in part, presently for the relation of motorical/situational-motorical areas is determined and the set aim of the research is confirmed.

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