MOTOR ABILITIES OF STUDENTS AS PREDICTORS OF RESULT PERFORMANCE IN ATHLETIC DISCIPLINES

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Abstract

Motor abilities are undoubtedly very complex area and they participate in the organization of all types of movements, and in their base lies efficiency of organ systems, particularly neuromuscular, which is responsible for the intensity, the duration and the regulation of movement. It is often associated as a major factor of influence in the implementation of the results of athletic disciplines at the highest level. However, their impact on the realization of athletic disciplines is not negligible at school age. Exactly, being led by the assumption of the impact of motor abilities on the results for athletic disciplines of students was conducted this research. The study included the population of 65 male students, aged 14-15 years old from Mali Zvornik. The main objective was, by the application of regression analysis, to determine the size of the impact of the defined motor abilities (explosive strength, repetitive strength, speed, and flexibility) to success in athletic disciplines of three-team competition (60m running, long jump with a running start, shot put). The obtained results showed that the motor abilities generated a statistically significant effect in the result performance of all three athletic disciplines at the high significance level ($p<0.001$; $p<0.005$), which justified the statements and results of previous studies which analyzed the similar issues. The greatest impact of motor abilities is exerted on the results of running ($Ro=0.93$), followed by shot put ($Ro=0.89$), and the weakest in the long jump from the run-up ($Ro=0.82$).

Key words: *motor abilities, prediction, athletic disciplines, physical education.*

Introduction

Motor abilities are undoubtedly very complex area which is, despite numerous theories and research, relatively under-explored. They participate in the implementation of all types of movement, and in their base lies the efficiency of organ systems, particularly of neuromuscular, which is responsible for the intensities, the duration and the regulation of movement. These abilities provide a powerful, fast, durable, precise and coordinated implementation of various motor tasks (Pavlović, 2006). At today's level of scientific knowledge, it can be seen that motor abilities appear in a certain way, in very different tasks. Factorial approach of research in the motor space, during the time led to the relevant information, which confirms that there are more motor abilities (factors), which made the current issue of the structure of motor abilities, and question how many motor abilities in humans objectively exist, what are their mutual relations, what are their relations with the other segments of anthropological status and what is, due to the importance, their influence on individual sport activities. Motor abilities are the forms of motor activity that occur in movable structures which can be described with a parametric equivalent system and can be measured by the same set of measures in which there are analog physiological, biological and psychological processes, or mechanisms (Zaciorski, 1975). They are partly inherited and partly acquired primarily by the training process. There are possibilities of an influence on their development through specific training methods. Basic motor abilities are the basis of every learning motor tasks of a particular technique, so it can be considered that they represent a fundamental value in the overall area of human motor skills. Athletics in its comprehensive area of disciplines is an integral part of every school curriculum. Athletics disciplines are distinguished by motor movements that can be successfully applied in the course of the educational process or through other forms of exercise, which significantly influences the ability to improve the overall psychophysical abilities of an individual. In the educational upbringing, this coincides with school programs and greatly affects the development of children. The intertwining of athletics and physical education is of double benefit both for the athletics and the physical education. Except for individual cases, physical education is not given the importance it deserves, although it is the only school subject which contains a health component. Athletics is generally practiced as a competitive sport as well as an additional sport. Most of the movements in athletics, due to the nature of creation, belong to the phylogenetic forms. All these phylogenetic forms (walking, running, jumping, throwing), passing through the training process, receive the ontogenetic form of movement (e.g. in the form of athletic disciplines, with different movements in sports games, etc.). This ontogenetic form of movement is controlled again with the cybernetic approach to the training process leading up to the phylogenetic forms. By combining these basic shapes in the system of round competition allows gymnasts, especially beginners and young, pretty versatile development.

Round competition program provides the basic training for later special training in a particular athletic discipline, much more than any particular discipline of athletics separately (Pavlović, 2014). The impact of motor abilities on the athletic discipline was the subject of earlier research on the different populations of subjects. Puhanić, Hofman, Milanović, & Schneider (1986) on the sample of 194 students of sport in Zagreb, aged 21-25, on the basis of 15 morphological, 14 motor, 3 cognitive and 4 connative manifest predictor variables examined the influence on the results of the criterion set of variables of athletic events: high jump, long jump, running the 100 meters, running 1,500 meters, shot put and javelin. The authors pointed out that the anthropological space of all the manifest variables, considering all treated disciplines, is the most predictable compared to the results in the shot put.

The structure of the correlation and regression coefficients has confirmed that the dominant influence of the variance of the criterion variable have those motor manifestations which are under the influence of regulating structure which ensure the excitation intensity in the different topological region of the body (throwing a medicine ball from lying down, long jump from the position and running 20 m with high start), and the regulating mechanism for the structuring of movements (backwards polygon and side steps). It is also notable high and strong connection of the measure volume and mass of the body (in particular the weight of the body), and the transversal linear characteristics of the skeleton (especially leg length, body height, the width of the knee and pelvic width) with competition results in shot put. Koprivica (1996) on a sample of 236 candidates for the Faculty physical culture, aged 18-24, applied 15 anthropometric measures and 5 bio-motoric variables in order to determine the size of the interconnectedness of physical development and active body mass with bio-motoric abilities.

Using the regression analysis, the author concludes that relations between anthropometric variables and results in running the 100m are not statistically significant, i.e. running at 100m is independent of the morphological structure of the respondents. Also, the morphological dimensions have very little relevance to success in running the 1500m, high jump, rope-climbing. The author at the end concluded that the active body weight has no statistically significant association with any of the tested bio-motoric variable. In a sample of 136 students of physical education, aged 20, by the application of the regression analysis (Pavlović, 2006), was analyzed the impact of the action factors on the result of running the 800 meters. The results showed a negative correlation of all predictor variables (action factors) with the criterion, i.e. inverse proportionality of central and energy regulation mechanism. Such a relationship of variables explains that the high running speed is genetically conditioned (98%) and as such it is independent in the hypothetical space.

The study of Pavlović 2008 confirmed the influence of variables which estimated the sprint speed and speed-endurance with result performance of running the 100 meters at male physical education students. Very often, the object of the study included participants from an athletic school of different age groups. One such study was conducted on a sample of 39 girls, pioneering athletic school, aged 11 and 12 years, with the aim of influencing basic and specific motor variables on the results of the 60 meters sprint (Schneider, 1994). Based on 21 motor predictor variables and three athletic disciplines, the regression analysis showed that the system of predictor variables was significant in forecasting the performance results of running at 60 meters. According to indicators of partial correlation and regression coefficients, the result of running 60 meters depends on the results that students have achieved in running at 20 meters, the long jump from starting, running at 300 meters and a long jump from the place. Recommendation of the research has been in terms of the use of these tests in the system of preparing young athletes. Similar research was conducted on a sample of 36 boys enrolled in the school of athletics in Niš, aged 11-12 years (Branković, Stojiljković, & Lolić, 2003) in order to determine the predictive value of basic motor abilities with the results of running 20m with a high start.

In the motor area were defined six motor variables of different power outputs and criteria M20V. Regression analysis showed that the results of running 20mV depend on the explosive, general and repetitive strength, and the authors concluded that applied battery of motor tests can be useful for the purpose of selection and guidance to the children of this age for sprint disciplines. Hatzis, Branković, Stojiljković, Zeljković, & Jovanovic (2003) on a sample of 39 girls, aged 11-12 years, engaged in athletics, applied seven basic motor tests (MTR20V, MSDM, MBUST, MDPK, MČUČ, MDTK, MSKL) and three athletic disciplines (running 300m, high jump, long jump) with a primary aim to determine the effect of motor tests with 60m running with a high start. Regression analysis explained 87% of the variance, and as the most important predictors were singled - running 20m with a high start, long jump out of place, long jump with running start, running 300m.

The aim of the research of Malacko, & Fratrić, 2003, was to determine the influence of the predictor system (nine morphological and 14 motor variables) on the criterion variable of long jump, to form what rational procedures during planning and programming the teaching or the training content, as well as the effective development of those relevant motor abilities that contribute to achieving better results in the long jump at 104 boys aged 11-12 years. By means of regression analysis, the obtained results showed that of the systems of predictive morphological dimensions and motor abilities had a statistically significant effect on the criterion variable of the long jump. Pavlović, 2003, conducted a survey on a sample of 90 male

students, aged 11 years with the aim to determine the effect of predictor variables of strength (repetitive, explosive and static) on result performance of the long jump with running start. Data were analyzed by multiple regression analysis in which the relevant regression parameters were calculated, on the basis of which was confirmed the greatest impact of variable long jump with running start. The influence of the manifest variables of motor abilities on the result in the long jump was examined by Bronja, & Koničanin, 2005. On a sample of 40 male students, 12 years old, the results obtained by the multivariate regression analysis showed that the motor abilities statistically affect the result of the long jump. Similar research but on a sample of 35 girls, aged 13, was conducted by Stanković, & Radić, 2006.

For the purposes of this research were applied 12 motor tests (predictor system) and one specific motor test (long jump-criterion variable). The results showed a statistically significant correlation between motor abilities and performance in the long jump at elementary school students. Some authors have studied the impact of program content of athletics at increasing levels of motor abilities. Exactly one such study was conducted by Vuksanović (1999), which was aimed to investigate the impact of program content of athletics on the increased level of motor abilities and their impact on the result efficiency in running the 60 meters, long jump, high jump, shot put and running at 1000 meters.

The sample was represented by 431 respondents, 217 athletes and 214 non-athletes of the first, second, third and fourth year of the grammar school in Podgorica. The results confirmed the positive impact of programs on the results of athletic disciplines. Based on the previous studies that have analyzed the influence of some anthropological segments on the results of athletic disciplines, was realized this research. The main objective was to determine the influence of motor abilities with the result success in the athletic disciplines of three athletic disciplines (60m running, long jump with running start, shot put 4kg). The research of relations of specific athletic movements with the results of three athletic disciplines was realized as a transversal study in 2014.

Methods

The population from which was taken the sample of respondents was defined as a population of elementary school students from Mali Zvornik, aged 14-15 years, males, clinically healthy. The total included 65 pupils. During the selection of measurement instruments was taken into account their reliability, objectivity, and validity. For the purposes of this study were determined 15 motor variables which assessed explosive, repetitive, static strength, speed, flexibility and three disciplines of athletic three round competition (running 60m, long jump, shot put).

Motor abilities (predictors)

1. Explosive strength: Standing long jump (MSDM); Triple jump from the place (MTRS); throwing a medicine ball of 2kg (MBMD;

2. Repetitive strength: Push-ups (MSKLE); Raising body (MDTK); Squats 30"(MDČ30'');

3. Static strength: Hanging pull-ups (MVIS); Endurance crouch in 20kg (MPOČ); Endurance abs (MDTI)

4. Speed: 20m flying start (M20L); 30m high start (M30V); Taping foot (MTAN)

5. Flexibility: The deep reach on box (MDPK); A spark gap with a rod (MISP); Frontal splits (MŠPA)

Disciplines of athletic three round competitions (criteria)

Disciplines that have been verified by NESTLE athletic league of Serbia for primary schools as disciplines which are in competition program designed for this age group included:

1. Running 60m (M60)
2. Long jump (MSDZ)
3. Shot Put 4kg (MBKUG)

Applied set of motor variables was taken from the research by Kurelić, Momirović, Stojanović, Šturm, & Viskić-Štalec, 1975; Ivanić, & Ivanić, 1999. Measuring of athletic disciplines was carried out according to the rules of ASS.

Results and discussion

Table 1. Descriptive statistics of motor abilities

	Mean	Min.	Max.	Range	Std.Dev.	Skew.	Kurt.
MSDM	183,50	146,00	240,00	94,00	19,84	,28	,38
MTRS	575,19	402,00	690,00	288,00	68,02	-,41	-,20
MBDM	583,88	374,00	710,00	336,00	92,49	-,55	-,68
MSKL	12,73	3,00	28,00	25,00	6,27	,63	,38
MDTK	10,31	1,00	23,00	22,00	5,79	,13	-,75
MDČ30	24,83	16,00	32,00	16,00	2,99	-,37	,82
MVIS	49,66	9,00	91,00	82,00	22,87	-,17	-,85
MPOČ	83,12	42,00	210,00	168,00	34,04	1,27	3,36
MDTI	124,58	44,00	290,00	246,00	72,87	,92	-,27
M20L	3,18	2,70	4,00	1,30	,29	,50	,27
M30V	5,27	4,50	6,20	1,70	,39	,09	,08
MTAN	22,69	18,00	28,00	10,00	2,32	,30	-,13
MDPK	21,90	4,00	39,00	35,00	7,92	-,21	-,30
MISP	44,37	15,00	70,00	55,00	12,70	,42	-,16
MŠPA	159,63	137,00	188,00	51,00	12,97	-,20	-,76

Table 2. Descriptive statistics of disciplines

	Mean	Min.	Max.	Range	Std.Dev.	Skew.	Kurt.
M60	9,83	7,90	11,30	3,40	,71	-,71	,63
MSDZ	311,00	210,00	420,00	210,00	52,64	,13	-,62
MBKUG	695,00	420,00	1055,00	635,00	148,20	,07	-,54

In Table 1 were set the basic statistical parameters of the predictor (specific movements) of variables of the studied sample. For each variable were calculated relevant central and dispersion parameters and measures of variability. Most of the variables are in the range of normal Gaussian distribution. Since the motor area is highly genetically predisposed, i.e. the results of particular tests within their bases are highly result-related such a rearrangement was generally expected. In all of the variables were present the difference between the minimum and maximum results due to different motor abilities. The smallest differences were recorded in variables which estimated the speed, so it was logical to expect a minimum value of Std. Dev. This capability is highly genetically predetermined and is probably one of the reasons for this distribution. From strength variables, the maximum deviations from the mean were shown in the tests of the explosive strength (MSDM; MTRS, MBMD), then the static strength (MVIS, MPOČ, MDTI), and as the smallest deviations in variables of repetitive strength (MSKLE, MDTK, MDČ30).

In this case, the large differences relate to the variables with a high genetic component (explosive strength, over 85%) which, to a lesser extent, can be affected by a training process. Something different could be concluded for the variables of repetitive and static strength, in which the genetic causality is about 50-60%, so they are more susceptible to changes in the positive or negative sense. They can be a pure reflection of certain physical activities that some students do. In addition, we should take into account the morphological status of the individual (not included in the research). In general, all the results obtained in the motor tests (all forms of strength, speed, and flexibility) are probably a consequence of the turbulent psychosomatic change of a sample population of students, which are probably related to effects on the motor and morphological area.

Of course, for all of these defined variables, we should bear in mind the fact the previous motor experiences of each individual, as well as the possibility of early experience in performing a specific motor task. Basically, if the method of performing a specific motor task is known the possibility of its successful performance is higher. Other measures of the motor area are subject to the greater impact of the training on the basis of which initial state of mentioned capabilities may be changed, particularly in the case of repetitive strength, static strength, flexibility. In this regard, their representatives (variables) relate and exert their numerical values, as opposed to those that may be affected to a greater extent. Values of Std. Dev. are within the permissible value on the basis of which we can assess the significant sensitivity of tests. Of the total number of variables, most of them are in the limits of positive values. However, this does not apply to speed variables, where the positive value represents the weaker result. Significant differences between good and weak results in the motor tests (specific athletic movements) of students can be attributed to the fact that some factors played the critical role, especially doing some kind of physical activity, sports activity in a club, on the basis of which can be increased the result success of performing tests, then the prior motor experience, the maturation of the CNS, a number of exogenous and endogenous factors. Table no. 2 gives the basic statistical parameters and criterion variables, which are defined as the three athletic disciplines: running 60m (M60), long jump with running start (MSDZ), shot put (MBKUG). In *the event M60,* the medium value was 9.83 sec, min. result 7.90 sec. and max. result 11.30 sec., which in the range of 3.40 sec gives a picture of considerable heterogeneity of this sample. Std. Dev. is within the acceptable numerical values, and negative value of the skew shows a larger number of weaker results.

Since it is about the speed, it appears that in this case there is an inverse relationship, i.e. a bigger number of better results was present (lower numerical value represents a better result). In the discipline 60m was emphasized the speed as a motor ability that is largely saturated with explosive strength. The mean value of discipline MSDZ amounted 311,62cm, with a minimum score of 210cm and max. result of 420cm. The range of min. to max result was 210cm and it is a significant value that confirms the previous statement that it is a heterogeneous sample of students in this discipline. This high result range can be explained by the fact that the long jump, besides it is a technical discipline, depends on the running start speed and energy of reflection, especially of caudal extremities. Given that the pupils of this age probably poorly mastered the technique of performance, their result performance can be attributed to their motor abilities, particularly speed and explosive strength.

The last event of three athletic disciplines, shot put (MBKUG) confirmed the findings of the previous two that are related to the heterogeneity of the studied sample of the defined population of students. The mean value of shot put was 695cm, with a minimum achieved score of 420cm and max. result of 1055cm. The range from min. to max result was 635cm, and is an indicator of the heterogeneity of the students in this discipline. The high range of results can be explained by the fact that the shot put, especially at this age, which is

technically weaker, depends on the strength and body weight. Although this study did not define the morphological area, on the basis of such a large range of shot put results it can be concluded that there are significant differences in body mass of students. It follows that the max. result is the result of a student with a large body mass, and min. result belongs to students with low body weight.

Shot put is such a discipline in which the greater mass (body of the pitcher) acts on the lower mass (ball). In addition to the body mass, the significant impact is probably a consequence of longitudinally of students. In order to determine the effects of motor abilities on the results of athletic events at the multivariate level was applied the regression analysis and were calculated relevant regression parameters (Table 3).

Table 3. Regression analysis of disciplines (60m, MSDZ, MBKUG).

	M60 Ro= 0,93; R²= 0,86; Adjusted R²=0,80			**MSDZ** Ro= 0,82; R²=0,67 AdjustedR²=0,53			**MBKUG** Ro=0,89; R²= 0,79 Adjusted R²=0,69		
	BETA	**t(51)**	**p-level**	**BETA**	**t(51)**	**p-level**	**BETA**	**t(51)**	**p-level**
Intercpt		2,22	0,03		-,07	0,95		-,63	0,53
MSDM	-,01	-,05	0,96	,25	1,32	0,05*	,06	,37	0,71
MTRS	-,15	-1,01	0,32	,25	1,07	0,09*	,26	1,38	0,18
MBDM	-,06	-,54	0,59	,05	,28	0,78	,50	3,81	0,00**
MSKL	-,02	-,18	0,86	-,00	-,01	0,99	,18	1,22	0,23
MDTK	,04	,35	0,73	,19	1,22	0,23	,08	,64	0,52
MDČ30	-,07	-,77	0,45	-,21	-1,50	0,14	-,04	-,34	0,73
MVIS	-,05	-,41	0,69	,13	2,36	0,12	-,06	-,38	0,70
MPOČ	-,09	-1,05	0,30	-,20	-1,63	0,11	,29	1,82	0,00**
MDTI	,13	1,31	0,20	-,15	-,95	0,35	-,32	-2,52	0,00**
M20L	,45	5,33	0,00**	,35	1,20	0,04*	-,09	-,48	0,64
M30V	,74	6,13	0,00**	,32	1,12	0,09*	,09	,59	0,56
MTAN	-,12	-1,49	0,14	,04	,34	0,74	,01	,08	0,94
MDPK	-,07	-,98	0,33	-,07	-,64	0,53	,01	,15	0,88
MISP	,00	,04	0,97	,02	,19	0,85	,07	,74	0,47
MŠPA	,11	1,36	0,18	,13	1,03	0,31	,05	,50	0,62
	****p<0,001; F=14,32**			***p<0,005; F=4,81**			****p<0,001; F=8,42**		

Regression analysis of athletic discipline running 60 meters indicates a statistically significant correlation of the whole system of motor abilities with criteria variable, where multiple correlation coefficient is extremely high (Ro=0.93). The coefficient of determination (R²=,86), indicates that the common variability of the predictor system and the criterion variables M60 is conditioned by the predictor system with about 86%, while the remaining 14% are caused by other factors not included in this study. By analyzing the regression coefficients (BETA) in the system of predictor variables was evident the individual contribution of only two variables, running 30m with high start (BETA=,74), running 20m with flying start (BETA=,45). The remaining variables did not achieve noticeable and significant impact on the result achieved in running 60m.

Partial correlation of variable coefficients has also confirmed the impact of predictor sets to the criterion variable. The best connection is achieved with the same variables that cover the sprint speed, which justifies the fact that running 20L 30V have a direct impact on running 60 meters. Analyzing the biggest single contribution (t) in the explanation of the criteria of each variable, the sequence would be the same as for the regression coefficients and values of partial correlations. The largest single negative contribution achieved the variable running 30 meters with high start M30V (t=6.13) and running 20 meters with a flying start M20L (t=5.33). Based on the analysis of variance F (15, 41), we conclude that the regression variability is significantly higher than the residual variability at both levels (F>f.01=2.32, F>f.05=1.83) which indicates and guarantees the statistical significance of regression bond. This confirms the information that is provided by a slightly lower adjusted coefficient of determination (adjusted). Running 60 meters as an athletic discipline is largely subordinated to the speed which is high-genetically determined (over 95%) and, as such, is independent of the hypothetical area of motor abilities. The results of this research have just confirmed the assumption of high connectivity of speed within its manifest variables (M30V, M20L). Similar results have been confirmed in many previous studies (Zagorac, 1984; Puhanić et al. 1986; Schneider, 1994; Idrizović, 1990; Vuksanović, 1999; Malacko and Fratrić, 2003; Stojiljković, 2006; Pavlović, 2008).

Regression analysis of the motor variable long jump with running start MSDZ and the predictor system of variables shows that there is a statistically significant association with a confidence level of p<0.005 as confirmed by the analysis of variance (Table 3). Multiple correlation of these two conflicting system is also high (Ro=0.82), and accordingly this value has slightly lower coefficient of determination (R²=0.67) which with 67% of information explains the result of criterion variable long jump with the running start by the predictor system, and 33% of impact is achieved due to some other unidentified factors (morphological, motor, functional and other abilities). In the regression coefficients are evident lower values.

The highest coefficient was shown in the variable speed M30V (BETA=,32) and M20L (BETA=,35). A significant contribution was made in the variable explosive strength MSDM, MTRS (BETA=,25). Analyzing the impact of single predictor variables on the result performance of long jump with running start shows that motor skills dominate, presented in BETA coefficients. In this case, the speed and explosive strength have shown some positive impact on the long jump. This can be explained by the fact that the students who had better explosiveness and speed of running achieved better long jump. An examination of the table gives the values of the regression, i.e. residual variability through which we test the predictor and criterion set of variables and determine their significance.

Since the long jump is the discipline of speed-strength character then these results of regression function only confirm this. Although the research included a younger age of students, who did not technically master this discipline, the statements are justified. Similar results were obtained in previous studies (Hatzis, et al. 2003; Stanković, & Radić, 2006; Stojiljković, et al. 2007; Bronja, & Koničanin, 2005; Stanojević, 2008). The defined system of 15 motor tests (strength, speed, flexibility) achieved a significant correlation with the result performance in shot put (Ro=0.89), wherein was defined about 90% of the common information (R^2=0.79%), wherein it may be, with absolute certainty, assumed the existence of a high correlation between the predictor and the criterion variable of shot put at a high level of statistical significance p=.000 (Table 3).

Therefore the selected set of predictors is a good representative in the shot put. The remaining 21% of the total variability in explaining the criterion variable MKUG is attributed to other dimensions, above all morphological dimensions, primarily the likely volume and weight of the body as well as the longitude which were not covered by the survey. It is well known that in throwing disciplines a great impact has the body mass where the increased mass acts on the lower mass (ball), so that it exhibits the strength of absolute type (Pavlović, 2016). The obtained results provide a statistically significant effect in the explanation of the system using the criterion variable predictor (p =.000), and it can be concluded that the system has an influence on the results achieved in shot put.

A further analysis of the value of the regression coefficients (BETA), it is clear that for the results for prediction of the shot put are significant variables of static strength half squat (MPOČ=,29), lifting the trunk-endurance (MDTI=-,32). However, as a leading representative was distinguished the variable of explosive strength (MBDM=,50) and to a lesser extent triple jump (MTR=,26). The largest single contribution (t) in the explanation of the criteria was achieved by the variables that are pointed out in the beta coefficients among which the throwing of medicine ball was dominant (MBMD, t=3.81).

From the above, it follows that on the result of the shot put (MBKUG) a significant contribution made students with high values of the variables of explosive strength of arms and shoulders, then variables of static strength (MPOČ, MDTI). Also, the variance analysis confirmed the significant impact and differences between residual and regression variance, which confirms a direct linear stochastic model of the regression function. It can be assumed that it is a latent dimension which, in the previous studies (Babiak, 1979; Tončev, 1991), was identified as the strength factor of the absolute type, which is dependent on the functioning of the duration of the excitation regulation in the central and peripheral zones of the loco-motor apparatus.

It is obvious that results in shot put in a rational technique, according to the study results, in the most direct way dependent on the static and partly on explosive strength. However, although it is not represented in this study, we should not forget the fact that the latent dimensions of morphological area volume and body weight are an important factor in achieving success at a shot put results. The longitude of the skeleton also achieves a significant proportion. This can be seen if we analyze the top shot putters, their relationship of height and body weight. Throwers are of a large body height and correspondingly large weight. They have the absolute strength manifested when casting, when greater weight of thrower acts on smaller ball weight (Pavlović, 2010).

In height and body weight of the throwers, the leading are shot-putters, while for the hammer throwers it can be said that they have smaller body height and larger body weight. It has been observed that the higher body weight is evident in those throwers whose throwing device is of higher weight and it is in a positive correlation with the result performance (Stefanović, 1992).

The extremities are in most throwers long and with strong muscles. Athletic throws belong to the group of ballistic motions where athletic throwing devices are ejected in order to achieve long-range shots. Throws are initiated by explosive activation of the agonist muscles (Stojanović, & Radić, 2003), followed by a relaxation period thereof, ending with a period of the deceleration due to the action of antagonist muscles or passive stretching of the connective tissue. Similar studies which were carried out in the previous period obtained the same or similar results (Smajić, 1976; 1980, Idrizović, 1990).

Conclusion

The completed research was aimed to determine the impact of motor abilities (explosive strength, repetitive strength, explosive power, speed, flexibility) of students, age 14-15, on result performance in three athletic disciplines (60m running, long jump with running start, shot put). In total were applied 15motor abilities of different energy outputs. Based on the results of regression

analysis was confirmed a statistically significant and high impact of defined motor abilities on the results in all three disciplines of students. The biggest predictor impact was made in discipline running 60m (Ro=0.93) and shot put (Ro=0.89) for the level p<0.001. A somewhat smaller but positive effect was recorded in the long jump with the running start (Ro=0.82) for the level of significance of p<0.005. The obtained results confirmed the similar previous studies which have dealt with the problem of the impact of motor abilities on the results in some athletic disciplines.

References

Babiak, J. (1979). *Relacije između motoričkih sposobnosti i uspjeha u atletici.* [Relations between motor abilities and success in athletics. In Bosnian.]. *Fizička kultura, 33*(3), 261-266.

Branković, M., Stojiljković, S. & Lolić, V. (2003). *Prediktivna vrednost motoričkih sposobnosti na rezultat u trčanju na 20m visokim startom*. [The predictive value of motor abilities on the result of the run on the 20m high start. In Serbian.]. In: *Proceedings of Medicinal symposium, Knjaževac, Serbia.*

Bronja, A., & Koničanin, A. (2005). Uticaj motoričkih sposobnosti na rezultat u skoku u dalj kod učenika uzrasta 13 godina. [The impact of motor abilities on the result in the long jump at students aged 13 years. In Serbian.]. *SPORTMONT, 8*(3), 175-182.

Hatzis, D., Branković, M., Stojiljković, S., Zeljković, M., & Jovanović, M (2003). Povezanost motoričkih sposobnosti sa rezultatskom efikasnošću trčanja na 60 metara kod mladih atletičarki [The association of motor skills with the results, the efficiency of running at 60 meters in young athletes. In Serbian.]. In: *Proceedings of Medicinal symposium, Knjaževac, Serbia.*

Idrizović, Dž. (1990). *Povezanost između prediktorskih faktora morfoloških i motoričkih dimenzija dječaka od 10 godina i mlađih seniora sa rezultatima u nekim atletskim disciplinama* [The relationship between the predictor factors motor dimension boy of 10 years and younger seniors with results in some athletic disciplines. PhD thesis. In Serbian.]. Beograd: Faculty of Physical Education.

Ivanić, S., & Ivanić, V. (1999). *Predselekcija-kriterijumi za procjenu fizičkog razvoja i fizičkih sposobnosti dece i omladine uzrasta od 7-19 godina (normativi)* [Preselection-the criteria for the assessment of physical development and physical abilities of children and youth aged 7-19 years (norms). In Serbian.]. Beograd: City self-governing interest community of physical culture.

Kurelić, N. et al. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine* [The structure and development of the motor dimension of youth. In Serbian.]. Beograd: Institute of Scientific Research.

Krsmanović, R. (1984). *Uticaj programiranog rada na kvantitativne promjene funkcionalnih sposobnosti kardiovaskulranog sistema, psihomotornih sposobnosti i rezultata u trčanju na različitim dionicama kod studenata sarajevskog Univerziteta* [The impact of the programmed work on quantitative changes of functional abilities kardiovaskulranog system, psychomotor performance and results in running on different sections of students at Sarajevo University. PhD thesis. In Bosnian.]. Sarajevo: Faculty of Physical Education.

Malacko, J., & Fratrić, F. (2003). *Uticaj morfoloških karakteristika i motoričkih sposobnosti na skok udalj kod dečaka 11-12 godina* [Influence of morphological characteristics and motor abilities on the long jump in boys 11-12 years. In Serbian.]. Niš: Faculty of Physical Education.

Puhanić, S., Hofman, E., Milanović, D., & Šnajder, E. (1986). *The influence of morphological, motor, cognitive and conative characteristics on the results in the long jump.* Zagreb: Školska knjiga.

Pavlović, R. (2003). *Uticaj nekih varijabli snage na rezultat u skoku u dalj kod dječaka uzrasta 11 godina* [The influence of some variables forces to result in the long jump in boys aged 11. In Serbian.]. Niš: Faculty of Physical Education.

Pavlović, R. (2006). *Atletika-antropološka obilježja* [Athletics-anthropological characteristics. In Bosnian.]. Sarajevo: Faculty of Physical Education.

Pavlović, R. (2006). *Snaga kao faktor rezultatske uspješnosti trčanja 800 metara* [Power as a factor in success of results in running 800 meters. In Serbian.]. Niš: Faculty of Physical Education.

Pavlović, R. (2008). *Relacije varijabli brzine sa rezultatom trčanja 100m* [Relationships of speed variables with the result of running 100m. In Serbian.]. *SPORT MONT, 15*, 522-527.

Pavlović, R. (2010). *Atletika* [Athletics. In Bosnian.]. Sarajevo: Faculty of Physical Education and Sport.

Pavlović, R. (2014). *Atletika 1* [Athletics 1. In Serbian.]. Niš: SIA.

Smajić, M. (1976*). Povezanost nekih antropometrijskih i psihomotornih varijabli sa rezultatima u atletskim disciplinama*. [The association of some anthropometric and psychomotor variables with the results in the athletic disciplines /Master's thesis/. In Croatian.]. Zagreb: Faculty of P.E.

Smajić, M. (1980). *Povezanost nekih antropometrijskih i psihomotornih varijabli sa rezultatima u atletskom desetoboju* [The association of some anthropometric and psychomotor variables with the results in the athletic decathlon. In Bosnian.]*. Fizička kultura, 2*, 110-118.

Stefanović, Đ. (1992). *Atletika 2 - tehnika* [Athletics 2-technique. In Serbian.]. Beograd: SIA.

Stojanović, T., & Radić, Z. (2003). Eksplozivna snaga kao pokazatelj uspešnosti bacanja kugle. [Explosive strength as an indicator of performance shot put. In Bosnian.]. *Glasnik Antropološkog društva Jugoslavije*, *38*, 237-241.

Stanković, D., & Radić, Z. (2006). *Relacije između motoričkih sposobnosti i rezultata u skoku u dalj učenica osnovnih škola.* [Relations between motor abilities and results in the long jump schoolgirl elementary schools. In Serbian.]. Niš: Faculty of Physical Education.

Stojiljković, S., Pržulj, D., Branković, N., & Pavlović, R. (2006). The relations between motor abilities and the results of the 100 meter run. *Physical Culture* (*Skopje*), *34*(2), 130-132.

Stojiljković, D., Branković, N., Stojiljković, S., Milenković, D., & Joksimović, A. (2007). Relations between morphological characteristics and mobility in high jump at young athletes. *Physical Education (Skopje), 35*(1), 20-22.

Stanojević, I. (2008). *Relacije nekih segmenata antropološkog prostora sa rezultatima skakačkih i bacačkih disciplina kod sportista* [Relations between some segments of the anthropological area, the results of jumping and throwing disciplines in athletes /PhD thesis/. In Serbian.]. Pale: Faculty of Physical Education and Sport.

Šnajder, V. (1994). Utjecaj specifičnih i bazičnih motoričkih varijabli na rezultate sprinta kod učenica [Influence of specific and basic motor variables of the results of the student sprint. In Croatian.]. *Kineziologija, 26.*

Tončev, I. (2001). *Atletika - tehnika i obučavanje* [Athletics-technique and training. In Serbian.]. Novi Sad: Faculty of Physical Education and Sport.

Vuksanović, M. (1999). *Utvrđivanje efikasnosti nastave fizičkog vaspitanja u odnosu na postignute rezultate u atletici* [Determining the effectiveness of physical education in relation to the results achieved in athletics /PhD thesis/. In Serbian.]. Novi Sad: Faculty of Physical Education.

Zaciorski, V.M. (1975). *Fizička svojstva sportiste* [Physical properties of an athlete. In Serbian.]. Beograd: Physical Education Alliance.

Zagorac, N. (1984). *Relacije između antropometrisjkih i motoričkih karakteritika i rezultata u atletskim disciplinama: skok u dalj, skok u vis i trčanje na 60m kod djece starosne dobi 11-13 godina* [Relationships between anthropometric and motor characteristics and results in athletic disciplines: long jump, high jump and running on 60m of children aged 11-13 years /Master's thesis/. In Croatian.]. Zagreb: Faculty of Physical Education.

MOTORIČKE SPOSOBNOSTI STUDENATA KAO PREDIKTOR REZULTATSKIH POSTIGNUĆA U ATLETSKIM DISCIPLINAMA

Abstract

Motoričke sposobnosti nedvojbeno su vrlo složena područja i sudjeluju u organizaciji svih vrsta pokreta, a u njihovoj bazi leži djelotvornost organskih sustava, osobito neuromuskularnih, koje su odgovorna za intenzitet, trajanje i regulaciju kretanja. Često se povezuju kao glavni faktor utjecaja u provedbi rezultata atletskih disciplina na najvišoj razini. Međutim, njihov utjecaj na ostvarivanje atletskih disciplina nije zanemariv u školskoj dobi. Istraživanje je provedeno upravo na temelju pretpostavke utjecaja motoričkih sposobnosti na rezultate sportskih disciplina učenika. U istraživanju je sudjelovalo 65 muških učenika, od 14 do 15 godina starosti iz Malog Zvornika. Glavni je cilj primjenom regresijske analize utvrditi veličinu utjecaja definiranih motoričkih sposobnosti (eksplozivna snaga, ponavljajuća snaga, brzina i fleksibilnost) na uspjeh u tri atletske discipline (trčanje 60m, skok u dalj iz visokog starta, bacanje kugle). Dobiveni rezultati pokazali su da su motoričke sposobnosti statistički značajno utjecale na rezultate sve tri atletske discipline na visokoj razini značajnosti (p <0,001, p <0,005), što je opravdalo izjave i rezultate prethodnih studija koje su analizirale slične pitanja. Najveći utjecaj motoričkih sposobnosti dobiven je na rezultate trčanja (Ro = 0,93), nakon čega slijedi bacanje kugle (Ro = 0,89), a najslabiji u skoku u dalj (Ro = 0,82).

Ključne riječi: *motoričke sposobnosti, predikcija, atletske discipline, tjelesni odgoj.*

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