

Relations between motor abilities and results in 60m running, long jump, shot put of the pupils elementary school

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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 connectivity 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 canonical correlation analysis, to determine the size of the connectivity 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 connectivity 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.

Keywords: motor abilities, connectivity, 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 (Zaciorskij 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.

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 (Šnajder, 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.

The problems of relations within the anthropological area of students were often a source of earlier research. Exactly one such was realized by Krsmanović, 1978. He, on a sample of 200 students aged 12 and 120 athletes of different sports branches, explored the possibilities of functional capacity assessment based on the results of running. Running was evaluated on sections 50m, 6x50m, 60m. From the functional tests were applied: Harvard step test, physical working capacity-PWC 170 and Astrand test. Canonical correlation analysis generally found that the results of running have a medium correlation with functional tests. In addition to the functional area, morphology and mobility area was also investigated within the athletic disciplines of schoolchildren. Even in 1984, Zagorac researched the relationship between morphological and motor characteristics of 205 respondents, aged 11-13 and the results in athletic events (long jump, high jump, running at 60m). Using canonical correlation analysis and regression analysis he found a high correlation between morphological and motor dimensions and

results in athletic variables. The author explains this by the dominant share of explosive strength in the implementation of studied disciplines. Subcutaneous adipose tissue, as well as ballast mass, reduce the relative strength and adversely affect the results of the athletic disciplines. He confirmed that the motor abilities, particularly those of the mechanism under the management of the energy regulation, have much more influence on the accomplishment results in the athletic disciplines than the morphological characteristics.

A similar research was conducted by Malacko, Tončev, Zahorjević and Pejčić (1990), who examined the structure of the morphological characteristics and motor abilities of selected 103 athletic school boys, aged 11 years. The objective consisted in the fact to determine the structure of morphological characteristics and motor abilities within the group of selected boys in athletic schools and then make the selection and construction of measuring instruments batteries on the basis of which we could also be able to check the effectiveness of programmed training, as well as the assessment and monitoring of latent dimensions. The system of 36 variables was applied, of which 18 variables of morphological characteristics and 18 variables of motor abilities. In the area of morphologic characteristics were isolated three latent dimensions (dimensions of the skeleton, the subcutaneous adipose tissue and body volume) and in the area of motor abilities 8 latent variables (repetitive strength, frequency of movement, the speed of alternative movements, the speed of hand movements, the flexibility, the coordination of the hands and feet, the coordination of body and explosive strength). On the basis of the largest projection of the variables on the latent dimensions was performed the selection of the battery constructions of 14 measuring instruments (6 morphological and 8 and motor variables).

Stojiljković, Branković, Stojiljković, Milenković and Joksimović (2007) in a sample of 38 respondents, primary school students, which in addition to physical education teaching, participate in organized sports activities in the athletic club, applied 12 anthropometric measures for assessing morphological characteristics and 12 tests for assessing the motor abilities, with the main objective of determining the relationship between the morphological characteristics and motor abilities (as a predictor system) and the results in the high jump (as a criterion variable). The regression analysis showed that the anthropometric measures of body height, leg length and body mass significantly explain the results in the high jump. Tests of motor skills that define the mechanism of excitation intensity (running at 20 meters with flying start, jumping out and triple jumping out) significantly explain the results in the high jump. Also, some research study the effect of regular and additional physical education teaching on relationships within the anthropological area of students. Stanojević (2008) in a sample of 200 primary school students in the region Prokuplje, aged 13 and 14, who, in addition to regular physical education teaching, were involved in training work in sports clubs, set a goal to establish relations between the morphological characteristics, motor and functional abilities with the results of jumping and throwing disciplines at athletes, students of primary schools. The research results of the canonical correlation analysis showed that there are statistically significant interlinks of canonical factors of morphological, functional and motor dimensions, with the results of the specific motor abilities of respondents in the discipline - jumping with the running start. Stanković (2011) conducted a research on a sample of 75 students, male, high school students in Niš, aged 16 and 17, with the aim of determining the degree and the characteristic correlation between the morphological characteristics and motor abilities (explosive strength, repetitive strength, speed and flexibility) with the results of the high jump. 13 morphological and 12 motor variables were applied as predictors and high jump as a criterion. The results confirmed the impact of morphological and motor variables on the result performance of the high jump. Variables of explosive strength, speed, flexibility achieved the dominance.

In addition to the population of pupils studies often included the student population. It was Smajić (1980) who examined the association of some morphological and motor variables with the results in the athletic decathlon, measured 17 morphological measures and applied 21 motor variables on a sample of 126 students at Faculty of Physical Education in Sarajevo. 8 of the isolated factors the author defined as 3 latent morphological dimensions, and 4 as latent motor dimensions. Finally, the author concludes that the results of the research indicate the likelihood of the assumptions that somatic characteristics and motor skills are primary in explaining the individual athletic disciplines as well as in predicting the success in the athletic decathlon. Krsmanović (1984) on a sample of students in Sarajevo researched the association between the functional capacities of the cardiovascular system with motor skills. The tests that were applied were: resting heart rate, systolic and diastolic blood pressure, FRK at a pulse of 170, Astrand test of max. oxygen consumption, Harvard step test. From the motor variables were defined: jumping out, deep forward bend on the bench, raising torso, hinge on the shaft, push-ups on the horizontal bar, throwing a medicine ball and envelope test. The obtained results showed that the level of functional and motor abilities was at a higher level than the results obtained in the former Yugoslav youth research carried out by the Kurelić and associates in 1975.

Puhanić, Hofman, Milanović and Šnaider (1986) examined the relations between morphological, motor, cognitive and conative characteristics with the results of physical education students in athletics. The sample of predicting and anthropometric variables is composed of 15 morphological, 14 motor, 3 cognitive and 4 conative manifest variables. Criterion set of variables consists of the results for the respondents in 6 typical athletic events: high jump, long jump, running at 100m, running at 1500 m, shot put and javelin. The authors point out that the anthropological area of used 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 proves that a dominant influence on the variance of the criterion variables have those motor manifestations which are under the influence of regulating structures which ensure the excitation intensity in the different topological regions of the body (throwing a medicine ball from lying down, long jump from the position and running at 20 m with the high start) and the regulating mechanism for the structuring of movement (backwards polygon and the steps aside). Notable is, also, a high and significant correlation between measures of volume and body mass (in particular the weight of the body), transversal and linear characteristics of the skeleton (especially leg length, body height, the width of the knee and pelvic width) with competition results in shot put. Also, a comprehensive study was performed by Idrizović (1990) on a sample of 150 students of the Philosophy Faculty, and 150 schoolboys from Nikšić, where he conducted a survey in order to determine the relevant correlation between morphological and motor dimensions of boys aged 10 years and younger seniors with the results in some athletic disciplines. The total of 30 predictor variables was applied (15 morphological and 15 motor), and criterion were the disciplines 100m, shot put and long jump. The obtained results confirmed the statistically important correlation for both samples between the predictor variables and the athletic events. Krsmanović (2007) on a sample of 64 physical education students, males, conducted a study in order to determine the correlation between the physical working capacity and the mechanism of excitation duration in order to confirm the hypothesis of previous authors who claimed that results in long sections completely mobilize the oxidative capacities and depend on functional abilities. As predictors were defined the following variables: running 200m, 300m, 400m, 600m, 800m, 1000m, 1500m, 3000m, 5000m, Cooper test (12 minutes). Canonic and regression analysis was applied and the obtained results showed a medium correlation of the system.

Based on the previous studies that have analyzed the connectivity of some anthropological segments with 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). The research of relations of specific athletic movements with the results of three athletic disciplines was realized as a transversal study in 2014.

METHOD

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 students. 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 (MSKL) 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 competition (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 were included:

- Running 60m (M60)
- Long jump (MSDZ)
- Shot Put 4kg (MBKUG)

Applied set of motor variables was taken from the research by Kurelić, Momirović, Stojanović, Šturm and Viskić-Štalec, 1975; Ivanić, 1998. Measuring of athletic disciplines was carried out according to the rules of ASS.

RESULTS AND DISCUSSION

Table 1. Descriptive statistics of predictor variables

	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
MSPA	159,63	137,00	188,00	51,00	12,97	-,20	-,76

Table 2. Descriptive statistics of criterion variables (disciplines)

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 pupils.

Table 3. Correlation of predictor variables (p <0500)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSDM	1,00														
MTRS	,74	1,00													
MBDM	,48	,55	1,00												
MSKL	,50	,34	,27	1,00											
MDTK	,35	,47	,37	,41	1,00										
MDC30	,13	,01	,04	,47	,28	1,00									
MVIS	,48	,48	,25	,70	,54	,45	1,00								

MPOČ	,31	,19	,28	,35	,41	,14	,17	1,00							
MDTI	,06	,25	,31	,27	,46	-,12	,13	,45	1,00						
M20L	-,59	-,79	-,54	-,52	-,44	-,17	-,62	-,23	-,19	1,00					
M30V	-,56	-,62	-,43	-,52	-,38	-,26	-,60	-,27	-,26	,78	1,00				
MTAN	,25	,26	-,03	,36	,26	,24	,33	,01	-,09	-,41	-,38	1,00			
MDPK	,22	,18	-,07	,26	,24	,28	,24	,14	-,09	-,21	-,05	,24	1,00		
MISP	,24	,18	,41	,05	,05	-,23	-,13	,17	,11	-,15	-,03	,03	-,15	1,00	
MŠPA	,18	,28	,46	,09	,26	,29	,18	,11	,15	-,24	-,17	,02	,18	-,07	1,00

Table 4. Correlation of athletic disciplines

	M60	MSDZ	MBKUG
M60	1,00		
MSDZ	-,55	1,00	
MBKUG	-,55	,64	1,00

Table 5. Cross correlation of motor abilities and of athletic disciplines, (p<,05)

	M60	MSDZ	BKUG
MSDM	-,61	,61	,66
MTRS	-,62	,67	,66
MBDM	-,37	,41	,75
MSKL	-,55	,36	,41
MDTK	-,37	,43	,40
MDČ30	-,33	,07	,13
MVIS	-,62	,61	,38
MPOČ	-,27	-,02	,35
MDTI	-,10	,03	,08
M20L	,75	-,58	-,64
M30V	,89	-,48	-,46
MTAN	-,48	,28	,18
MDPK	-,19	,12	,15
MISP	-,04	,09	,37
MŠPA	-,10	,26	,36

In the inter-correlation matrix were presented the values of prediction variables (specific athletic movement-motor abilities). Out of the calculated 120 correlations, 80 made a statistically significant correlation, which amounts to 66% (Table 3). The range of the correlation coefficient ranges from low ,21 to high ,78 with a positive and negative sign. The largest number of significant correlations was observed in the variables of explosive strength (31), followed by repetitive strength (27) and the least static strength (11). From all the correlations only the strength did not make the connection with the measures of flexibility and some speed variables. A negative relationship between all strength variables with some variables of sprint speeds can be noted. These correlations are expected if one takes into account the low correlation of energy (strength) and central movement regulation (speed). Correlation matrix of athletic events in total extracted 6 middle-high correlations, two of which are the correlations with a negative sign (Table 4).

A negative ratio of the coefficients was exhibited in the variables running 60 meters with the long jump from running and shot put with a value of $-.55$ (M60-MSDZ, MBKUG). It follows that it is running at 60m inversely related to the long jump from running and shot put. However, if one takes into account that at a speed the smaller value represents a better result than a direct impact is achieved here. Based on these parameters we can conclude that a better result in running 60m means better result in the long jump and shot put. This can be explained by the fact that at students the long jump from running and shot put are the result of the accumulation of explosive leg and arm strength, and the achieved speeds during the run. The positive ratio of the long jump and shot put $.64$ (MSDZ-MBKUG) can also be attributed to the higher leg strength and the influence on the result of the throwing, which is particularly manifested in the phase of ejection.

By inspection of the inter-correlation matrix of motor variables (Table 5), in three blocks were recorded 45 correlations, of which 32 were statistically significant correlations (about 71%) in both levels of $p < .05 = .20$, while for the remaining 12 (29%) was not confirmed the statistical significance.

In relations of motor skills with all three criterion variables M60, MSDZ, MBKUG, it can be noted medium to a high bipolar connection of positive and negative sign. Correlations of discipline M60 with motor abilities are recorded at 11 significant connections, mostly of negative sign, with medium to high numerical value. A direct positive correlation was expressed with the variables of sprinting speed $.75$ (M20L) and $.89$ (M30), which was expected. The smaller numerical value is an indicator of better results in all racing disciplines and also in this case. All other variables of strength, especially long jump from position, triple jump, push-ups and pull-ups in the air showed a negative correlation with the running at 60m. Also, MTAN showed a high negative correlation $(-.48)$. This negative impact is expected, as better value in tests of strength represents a better result in the running, although they are inversely proportional. It appears that students who achieved a better result in these motor abilities also achieved a better result in running 60 meters. Only the variables for the evaluation of flexibility did not record the connection with running 60 meters.

In a second block was determined the correlative connection of the discipline long jump with the running start (MSDZ) with specific athletic movements-motor abilities. It is almost identical to the situation as in the first block, there was a total of 10 correlations. Mainly medium-high positive correlations of explosive and static strength were achieved ($.67$ MTRS), ($.61$ MSDM;MVIS). A somewhat lower numerical correlation strength was shown in tests for throwing a medicine ball, push-ups, lifting torso in the range ($.36$ to $.43$). This direct effect was confirmed in previous studies, and it refers to the direct impact of explosive, repetitive strength and some variables of static strength on the result performance of long jump with running start. In the case of variables of sprint speed which in the first block showed a high positive value, in this block those values are medium-high but negative ($-.48$ MSDZ-M30V; $-.58$ MSDZ-M20L). And here we have a situation of an inverse relationship between opposing sets of variables, which are expected. Also, low but direct connection made the variable of flexibility, twine ($.26$ MŠPA) which can be brought into connection with the swing phase during the bounce.

The third block defined the correlative connections between the throwing discipline - shot put (MBKUG) with the motor abilities of students. From a total of 11 significant correlations, the same as in the long jump, nine had a positive direct impact. Only the variables from the sprint speed recorded a negative value, which is the direct impact. Here the strength variables also showed the participation dominance in the result performance of shot put with a medium to high correlations. The leading representative is the variable of explosive strength - throwing a

medicine ball (.75MBDM) followed by the long jump and triple jump with identical numerical values (.66MSDM, MTRS). Somewhat lower values demonstrated the tests of pushup and raising the torso, with almost identical values (.40MDTK; .41MSKL). Static strength showed less impact, as well as measures of flexibility with reduced values (.36MSP-.38MVIS). Here, the variables of sprint speed have an inverse, negative ratio with the shot put in the range of (-.48 to -.64 M20L). If we take into account the fact that the shot put discipline is of strength-speed character, it follows that this fact was justified even though this was the middle school age of respondents, but also in this study was ignored the impact of body weight.

Canonical correlation analysis tested the relations between the motor abilities of the variables of athletic events M60, MSDZ, MBKUG. To obtain information about the extent to which, and how the motor abilities are involved in the measured criterion variables, and in response to the hypothesis, we applied canonical correlation analysis. This method is based on the principle of successive extracting of the maximum possible variance from the area which is common for analyzed sets. Namely, in every set of variables are established latent dimensions on such a linear combination of the manifest variables in individual groups that allow the maximum correlation of corresponding pairs.

For an explanation of common area set of motor abilities and the selected set of athletic disciplines were extracted three pairs of canonical functions. Data on the relations of the important functions are presented in tables (6-10). Cross correlations of motor abilities with the athletic disciplines are presented in Table 5. Global analysis of the cross-correlation matrix of these two sets of variables provides information about the relatively high multi-faceted group of tests for motor dimensions assessment. Due to the detailed insight, it is possible to observe certain blocks of somewhat higher correlative relations. On the basis of the canonical relation between the linear combination of the criterion and predictor variables were obtained three significant and high canonical functions (Table 6). The results of testing the significance of canonical equation root with Bartlett Chi-square test showed that only three canonical functions are significant. They are significant since their canonical correlation coefficients have a positive direction and relatively high intensities (1.CanonicalR=,93; 2.CanonicalR=,85; 3.CanonicalR=,74) at the error level of the first row or statistical significance ($p<,001$). Its circuit is reduced to the maximum number of the individual linear connections (different from zero) between the pairs of the predictor (specific athletic movement) and the criterion (athletic events) variables to a linear statistical coherence of the six canonical structures from both analyzed sets with the 99% of significance.

Table 6. Canonical correlation analysis canonical functions

	Canonic R	Canonic R-sqr.	Chi-sqr.	df	p
1	,93	,86	166,77	45	,000
2	,85	,72	85,42	28	,000
3	,74	,54	32,50	13	,002

Table 7. The factor structure (predictors)

	Root 1	Root 2	Root 3
MSDM	-,71	,52	,28
MTRS	-,72	,50	,37
MBDM	-,48	,73	,01

MSKL	-,61	-,05	,02
MDTK	-,43	-,18	,27
MDČ30	-,34	,09	-,19
MVIS	-,67	,11	,44
MPOČ	-,32	-,31	,48
MDTI	-,11	-,03	-,07
M20L	,84	-,48	-,14
M30V	,94	-,57	,04
MTAN	-,50	,21	,06
MDPK	-,21	-,03	-,02
MISP	-,10	-,50	-,09
MŠPA	-,16	-,39	,18

Table 8. The factor structure (criterion)

	Root 1	Root 2	Root 3
M60	,99	-,13	,03
MSDZ	-,61	,74	,27
MBKUG	-,66	-,23	,72

Table 9. The canonical load (predictor)

	Root 1	Root 2	Root 3
MSDM	-,02	-,02	,43
MTRS	-,20	-,20	,18
MBDM	-,14	-,70	-,28
MSKL	-,05	-,26	-,13
MDTK	,02	-,10	,32
MDČ30	-,06	,06	-,41
MVIS	-,05	,24	,79
MPOČ	-,11	-,26	-,55
MDTI	,18	,33	,03
M20L	-,04	,20	,11
M30V	,70	-,74	,51
MTAN	-,12	,10	-,01
MDPK	-,07	,02	-,20
MISP	-,01	-,11	-,00
MŠPA	,10	-,14	,28

Table 10. The canonical load (criterion)

	Root 1	Root 2	Root 3
M60	,90	-,71	,52
MSDZ	-,02	1,22	,35
MBKUG	-,15	-,28	-1,47

In the first pair of canonical functions (Table 6) of motor abilities and athletic events it is evident that they are extremely highly related (CanonicalR=,93), wherein the canonical coefficient

of determination with 86% explains the shared variance of the opposing systems (CanonicalR-sqr.=,86), with significant value of Chi-Sqr. (166,77) and the level of significance ($p=,000$). In this case, we can note the maximum quantity of 86% of the proportions of the explained standardized variance, in relation to the overall variability between the groups of the manifest variables. The residue of 14% of the sum of the squared deviations from the arithmetic mean draws attention to the presence of the unexplained variance i.e. other unexplored covariates in linear functions between the opposing sets.

The structure of the first pair of canonical functions in the mobility area is defined by vectors with high projections of variables, running 30 meters with high start (M30V=,94), running 20 meters flying start (M20L=,84). Based on these high projections can be concluded that sprint speed dominates in defining the first canonical factor with a direct impact. However, there is a negative impact of all other extracted motor variables on its structure. In the determination of canonical factor variance, the important place belongs to the variables of explosive strength, triple jump (MTRS=,72), jumping from position (MSDM=,71) and a smaller influence by the test of throwing a medicine ball (MBDM=,48). Of repetitive strength, the leading effect on the extraction of the primary factors is manifested with push-ups (MSKLE=,61) and the static strength in the variable hanging in pull-ups (MVIS=,67), i.e. segment speed of foot tapping (MTAN=,50). Other variables also with their slightly lower values enable clear extraction of the first pair of canonical factors by motor predictor variables. An inverse relationship of all variables of strength and flexibility is noted, even with running 60 meters. Only a direct relationship is manifested with the variable of speed, as expected. Also, this structure confirmed the correlation between sets of variables in the cross correlation matrix (Table. 5). This factor can be defined as a factor of sprint speed and explosive leg strength.

The structure of the first canonical factor of criterion variables (athletic disciplines) is determined by a variable of speed (M60=,99) of the positive numerical projection and slightly smaller correlation variables of the jump from the running start (-,61MSDZ) and shot put (-,66MBKUG). Both variables carry a significant value of negative sign. Analysis of corresponding canonical functions of the first pair leads to the conclusion that the result in athletic disciplines is under the direct positive influence of the speed. Students, who had a better result in running 20m with flying start and 30m with high start, also achieved a better result in running 60m. A negative ratio of the criterion is recorded in variables of strength, preferably explosive strength and some variables of repetitive and static strength, as well as the variable of foot tapping, where the higher the value of tapping is a better result is running. Mainly, those are abilities which are under the auspices of the energy regulation mechanism. Students with better results in mentioned strength tests i.e. with higher values in the long jump, triple jump, push-ups, endurance in hanging, etc. also achieved the better result in running 60m. From the sign of their coefficients it could not be concluded, we have a situation where the higher the length of the jump or the number of repetitions of a motor task enables better result in running 60m.

The second pair of canonical functions is determined by a slightly weaker but also high correlation (CanonicalR=,85), with 72% of the common variance of the system, that is, canonical determination factor (Table 6). The residue of 28% of the sum of the squared deviations from the arithmetic mean, suggests the presence unexplored variance i.e. other unexplored covariates in linear functions between the opposing sets. *The structure of the second pair of canonical dimensions* in the area of motor variables is determined by the somewhat larger projections of canonical burden variables of explosive strength, throwing a medicine ball (MBDM=,73), long jump from position (MSDM=,52), triple jump from position (MTRS=,50). Variable of speed in this factor had the most significant impact. Their values range from (-,48 M20L) to (-,57 M30V).

In this factor, the main carrier of the function is a variable from explosive strength area (throwing a medicine ball) which was saturated with the long jump and triple jump. In the second factor, in the area of motor variables, a significant contribution was shown by variables of flexibility, in particular, a spark gap with a rod (-50 MISK) and (-, 39 MSPA), indicating an inverse relation. Slightly lower saturation of the second pair of canonical factors in motor abilities may be prescribed to a significantly higher extraction of the variance of mentioned capacities during the formation of the first pair of canonical function. Another factor in the area of motor abilities can be defined as a factor of explosiveness and speed of movement. *The second canonical factor* of criterion variables is defined by the variable of the long jump from the running start (.74), while the other two events had a positive value but a lower intensity of correlation. That being said, it can be concluded that long jump from the running start (MSDZ) directly depends on the variables of explosive strength and speed. Dependence of long jump from speed and explosive strength is confirmed in previous research. After examining the weight of canonical factors it is noted that there is the highest value of the same variables which are the main carriers of the canonical defining functions. *Relations between the third pair of canonical functions* realized a slightly lower correlation, Canonic IR=.74, which still shows a good connection between these two sets of canonical dimensions ($R^2=.54$) on the level of significance of $p<.002$ (Table 6). The residue of about 46% of the sum of the squared deviations from the arithmetic mean leads to an unfamiliar variance or other non-defined variables of linear functions between the opposing sets.

In the area of motor (criterion) variables of *the third canonical factor* there are low, nearly zero correlations, as a result of maximum exhaustion of their variances in the two previous factors and the lack of the vector load. The motor space in the third canonical factor is defined primarily by static strength variables. The predominant motor parameter, which with its high projection is leading in defining the third pair of canonical functions in the set of predictor variables, is the endurance of the crouch (.48 MPOČ) and hanging pull-ups (.44 MVIS). The extraction of the third factor is substantially allowed by the variables of explosive strength, triple jump (.37 MTRS) and long jump from position (.28 MSDM). Repetitive strength exerted its influence over the variable – torso lifting (.27MDTK). This third dimension could be interpreted as a static strength of the legs. In the area of *the third canonical functions of motor dimensions* are observed high values of correlation tests for shot put (.72 MBKUG) (Table 8). It may be noted that in this pair higher values of static strength positively affect results in the shot put. The assumption is that the students who had a better static strength of legs and arms achieved a better result in the shot put. The obtained results of the canonical analysis confirm the results obtained in the cross-correlation matrix. Canonical factors that were isolated were also confirmed in a canonical load (see Table 9,10).

CONCLUSION

Three pairs of canonical functions that are significant at level $p <.001$ were obtained. The first canonical factor (Can.=0,93) for the motor area is largely defined by the speed, then the explosive strength. In the area of three-athletic disciplines, the first canonical factor is primarily determined by the running 60m, a little less in the long jump from running and shot put. It follows that the students who had good results in sprint speed, explosive strength were more successful in running 60 meters. The structure of the second pair of canonical functions (Can.=0,85) in the mobility area is defined by variables of explosive strength, while in the area of athletic events the best predictors are the long jump from the running start. These characteristics suggest that those are the students who had the good explosive strength of limbs and as such, they were able to achieve a greater length of the long jump.

The correlation between the third pair of canonical functions ($\text{Can.}=0,74$) differentiates the students with an extreme static strength of arms, shoulders and legs. In three-athletic disciplines, the function defines students with better results in the shot put. It follows that those students who achieved a better result in motor tests of static strength had longer, thus the better shot in the shot put.

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