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DIFFERENCES IN FUNCTIONAL-MOTOR ABILITIES IN EARLY ADOLESCENT ATHLETES AND NON-ATHLETES

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Abstract. *Functional and motor abilities of the adolescent population are preconditions for preserving and improving their psychophysical health, as well as for achieving successful results in physical education classes and sports trainings. The aim of this study was to examine differences in some motor and functional abilities of participants in the period of early adolescence. During September 2012, the examination included 178 male participants, 14-15 years of age (90 athletes and 88 non-athletes) from Valjevo. The sample of variables consisted of 9 motor abilities tests and four functional tests. Statistical was analyses were carried out using software Statistics for Windows, ver.6.0. The collected data were processed by basic methods of descriptive statistics, the Student's parametric t-test for small independent samples, and by a canonical disriminant analysis. The obtained findings showed that the subsample of athletes demonstrated a statistically significant difference, while the subsample of non-athletes manifested a higher level of explosive power, sprint speed, vital lung capacity, systolic and diastolic arterial blood pressure. This is the result of several years of training. The results in this discriminant study offer a wide range of information, which can have practical application with p <.005 in defining functional-motor model values, offer higher quality plan and work schedule development in both physical education and teaching, as well as in the operationalization of transformational behavior of eight grade elementary schoolboys.*

Key words: *motor abilities; functional abilities, differences.*

INTRODUCTION

The period of early adolescence represents a period of sexual maturing manifested in dynamic changes caused by the growth and development of all anthropological distinc-

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tions (anthropometric features and functional-motor abilities). A great number of movement structures and situations in physical education classes, as well as training in sports clubs, point to the fact that success in achieving results is determined by a considerable number of complex abilities, and some among them, such as functional and motor abilities, can be measured and analyzed. Determining the structure of certain anthropological dimensions, and the structure of their differences and developmental characteristics, enables higher quality planning, as well as the programming and controlling of the training process, but it also influences sports form improvement and the realization of adequate physical education teaching and sports training adapted to distinctive abilities of students and athletes (Višnjić, Jovanović, & Miletić, 2008). On the one hand, motor abilities are hereditary, but on the other they are acquired, in the first place, by the training process. They represent the base in every learning process of a certain technique motor task, as well as an essential value in the total domain of human motorics. Motor abilities enable the achievement of all the forms of movement, systems of organs efficiency, particularly of the nervous-muscular one, which regulates movement strength and its duration (Milanović, 2009). They provide the powerful, fast, long-lasting, precise or harmonized performance of various motor tasks. In the equation of sports result specification, a significant part, among others, is played by functional abilities. They directly influence the size and character of motor ability manifestation during the realization of program tasks of physical education teaching and training processes. Motor and functional abilities are one of the sub-systems which in interaction with others (morphological, cognitive, conative and sociological) build the complex structure of a human. All of these sub-systems act uniquely and harmoniously, while some of them dominate a particular person's phases of development. Diagnosis in sports and physical education indicates gathering useful information about the beginning, transformational and final condition of an athlete and a student's final abilities which are important for competitive success. It is also important to measure those abilities which to a considerable degree take part in success equation, within a distinctive motor task. During physical growth and development, certain functional and motor abilities achieve their maximum in various age periods. It is precisely through certain motor and functional abilities that athletes differ from individuals who do not train any sports and are not physically active. Functional and motor abilities in the adolescent population were examined by a great number of authors (Mraković, Findak, Metikoš & Neljak, 1996; Vračan, Sertić, & Baić, 2004; Sertić, Vračan, & Baić, 2005; Granić & Krstić, 2006; Cigrovski, Matković, & Krističević, 2006; Prahović & Protić, 2007; Bobić & Bobić, 2009). At the beginning of the 21st century, interest for engaging adolescents in physical exercise and sport increased, since the growing-up process is particularly sensitive to the manifestation of unfavorable outdoor environment influences, which has been shown in many studies (Aaron et al., 1995; Marcus et al., 2000; Malacko, 2002; Stewart, Dennison, Kohl & Doyle, 2004). In the last two decades, significant studies have been carried out here and in the world, which determined that regular sports activities influence the development of certain motor abilities. Motor abilities are most successfully developed in the so-called 'sensitive phases'. This fact has been proven by a considerable number of authors (Matvejev & Ulaga, 2000; Spamer & Caetzee, 2002; Foretić & Bjelac, 2009), pointing to a fact that these are biological periods when, according to natural laws, the fastest person's motor development is achieved. Regarding the lack of data in the Serbian professional environment, the aim of this study was to present some functional and motor abilities of early adolescent boys.

The essence of this research is directed toward analyzing the differences in functional-motor abilities of male participants, aged 14–15, depending on whether they only attend physical education classes or they have been playing some sport actively for at least three years.

In accordance with the defined object and problem of this study, the main aims of the research were examining the levels of differences among functional and motor abilities of adolescent athletes and non-athletes, as well as defining variables which make the highest contribution to the determined differentiation. According to the aims of the research the following hypothesis is stated: H - Statistically significant differences in functional and motor abilities among sports active and non-active elementary school eight-grade boys were expected.

Taking into account the small number of studies about differences in the functional and motor abilities of adolescents (athletes and non-athletes) in our country, the results of this study can have a theoretical and practical impact on the improvement of physical education classes and training in various sports disciplines. The results obtained in this research can be significant, because the overall lack of physical movement and exercise causes weaker values of anthropological characteristics, with direct consequences on health problems and increasing obesity in the period of early adolescence. It is also expected that information about the examined functional and motor features will facilitate the process of planning and programming physical education classes, choice of methods and organizational forms of training processes in sports clubs, according to which the aims of physical education and sport are achieved.

THE METHOD

The sample of participants

The examination was carried out on the sample of 178 male participants, 14 - 15 years of age (14.90±1.10, Mean±St.Dev.). The sample included two subsamples a population of elementary school eight-grade students from Valjevo, non - athletes (n = 88) taking part in regular physical education classes, and athletes (n = 90) who had been taking part in training processes for at least three years in a club (at least five times a week). The subsample of non-athletes includes boys who were previously interviewed in physical education classes for the sake of determining their status as non-athletes.

During the measuring, all of the participants were healthy and they voluntarily took part in the testing. The measuring took place during December 2012, simultaneously in the mornings (± 2 hours), in order to avoid the possibility of the day's oscillation influencing the test results.

The sample of variables

The sample of variables for the estimation of the levels of functional abilities was constructed from the following standard tests: pulse in immobility, systolic arterial blood pressure, diastolic blood pressure and vital lung capacity. Functional tests in this research were taken from the functional tests model (Heimer & Medved, 1997; Đurašković, 2001).

The sample of measuring instruments in motor space included a battery of 9 standard tests (Kurelić, Momirović, Stojanović, Radošević &Viskić-Štalec, 1975):

- explosive strength: the long jump (cm); triple jump (cm); small ball throw (cm);
- sprint speed: the 50 m run – high start (s); 20 m run – high start (s); 20 m run – flying start (s);
- movement coordination: coordination in the air (s); coordination with a stick (s); coordination on the ground (s).

The obtained results were entered into and statistically processed by the Program package SPSS 12.0 and Statistics 5.0. For data processing, the descriptive statistics method (means), analytical statistics (Student's Parametric t-test for small independent samples) and multivariate statistics (Canonical Discriminant Analysis) were applied. The obtained results were displayed in charts. In order to provide a description and explanation, the descriptive method and logical conclusion method were applied.

RESULTS WITH DISCUSSION

Differences in functional abilities

With an aim of determining whether there were any statistically significant differences in the level of functional abilities among students (adolescent athletes and non-athletes), the means of the studied variables were first calculated, and then the significance of the obtained differences (Table 1).

Table 1. The significance of the means and differences of the functional variables.

Variables	AS		*t*	*p*
	Athletes	Non - athletes		
–Resting heart-rate (frequency)	85.17	81.95	.97	.092
Systolic arterial blood pressure (mmHg)	11.04	11.00	2.19	.58
Diastolic blood pressure (mmHg)	7.72	7.93	2.21	.074
Vital lung capacity (cm^3)	3900.25	3503.56	3.96	.005

By analyzing the obtained values of arithmetic averages, it is obvious that athletes, with a 95% punctuation, have a statistically higher level of vital lung capacity in relation to non-athletes. With functional test systems according to which pulse frequency in non-motion is determined and systolic and diastolic arterial blood pressure as well, a statistically significant difference between the means of the two analyzed groups of participants was not determined.

Table 2. The parameters and significance of the functional abilities' discriminant function.

λ	λW	Rc	R^2	df	p
.401	.434	.365	.290	3	.005

Legend λ – characteristic root of the discriminant function; λW – coefficient value of Wilks Lambda test for centroid group equality; *Rc* – canonical correlation coefficient; R^2 – determination coefficient; *df* – degree of freedom; *p* – level of the discriminant function statistical significance

The differences in the structure of the functional abilities of the group of active and non-active students were analyzed using the Canonical Discriminant Analysis (Table 2).

The obtained results point to the fact that the discriminant power of Wilk's λ amounts to .434. That indicates that as regards to functional abilities, the results between the two groups of participants (athletes and non-athletes) statistically significant differences exist at the $p < .005$ level, although the canonical correlation coefficient is not high ($Rc = .365$). The calculated value of the determination coefficient also emphasizes that 29% of the functional abilities intergroup variance was explained by an isolated discriminant function.

Table 3, diplays the correlation coefficient of the discriminant function structure.

Table 3. The structure of the functional abilities' discriminant factor.

Variables	Coefficient correlation with discriminant function
Vital lung capacity (cm^3)	.613
Diastolic blood pressure (mmHg)	.296
Systolic blood pressure (mmHg)	.275
Resting heart-rate (frequency)	.194

The obtained results point to the fact that the original variable vital lung capacity (.613) is the only one which has the biggest influence on the linear discriminant function, that is, it completely makes up difference between the group of athletes and the group of non-athletes. The remaining three manifest variables: diastolic blood pressure, systolic arterial blood pressure and –resting heart-rate do not make a statistically significant contribution, because their correlations with the discriminant linear equation are lower than 0.3 and are not statistically significant.

The results in Table 4 represent a linear discriminant function of group centroid values based on all the functional tests. The displayed position of group centroids represents the means of the results of the two groups of participants. The centroids indicate that athletes have a positive result, and non-athletes a negative one on the discriminant function. According to the size and projection of the group centroids, it can be concluded that the athletes gained better results on the isolated discriminant factor.

Table 4. Group centroid of the discriminant function.

Participants	Centroid values
Athletes	.701
Non - athletes	-.136

Differences in motor abilities

The analysis of the differences in motor abilities between the groups was carried out based on means and the Student's parameter t - test (Table 5).

The average values in the motor tests obtained in the subsample of students which additionally and in an organized way played sports, ranged from 12.96 (coordination with a stick) to 465.13 (the triple jump), while with non-athletes they ranged from 3.59 (the 20 m run - flying start) to 438.53 (the triple jump). Therefore, for both groups the variables

which take the lowest and the highest position according to average value are approximate, but their numeric values are different, in favor of additionally engaged student athletes.

Table 5. Means and differences in motor variables.

Variables	AS		*t*	*p*
	Athletes	Non - athletes		
Long jump(cm)	190.24	161.97	4.58	001
Triple jump (cm)	465.13	438.53	4.27	.001
Small ball throw (sm)	319.75	263.93	3.75	.002
Run on 50 m – high start (s)	9.20	4.50	4.99	.003
Run on 20 m – high start (s)	3.99	4.21	3.58	.002
Run on 20 m – flying start (s)	3.48	3.59	4.37	.003
Coordination movement in air (s)	15.77	16.01	4.18	.058
Coordination with a stick (s)	12.96	12.98	5.27	.069
Coordination movement on the ground (s)	13.28	14.00	4.56	.087

By the means in motor space between student athletes and non-athletes, it can be noticed that the groups of participants differ significantly in six motor variables: the long jump ($t = 4.58$; $p < .001$), triple jump ($t = 4.\ 27$; $p < .001$), small ball throw ($t = 3.75$; $p < .002$), the 50 run m – high start ($t = 4.99$; $p < .003$), 20 run m – high start ($t = 3.58$; $p < .002$) and 20 m run – flying start ($t = 4.37$; $p < .003$). Such results are the result of the influence of genotypes on the development of explosive power, as well as of the systematic influence of regular training activities in clubs.

By analyzing the means of coordination movement factors, statistically significant differences were not confirmed between the two groups of participants (athletes and non-athletes). The reason for such a result can be found in the fact that these motor latent dimensions are to a high degree innate.

In relation to non-athletes, involved only in physical education classes, the higher level of motor ability development of the athletes is conditioned by endogenetic and exogenetic factors, that is, by transformational processes in sports clubs. It is a fact that sports training is distinguished by the gradual increase of loading up to the maximal level of motor-functional abilities. In that way super compensation athlete processes are enabled. They are at the same time the essential functional response of an organism as well, and factors on which adaptation processes, performances and training development are based.

Comparing the values of the results from this research with the research results obtained in numerous studies carried out by Mraković et al., 1996; Spamer & Caetzee, 2002; Vračan et al., 2004; Perišić & Knjaz, 2005; Prahović & Protić, 2007; Batričević, 2008; Milojević & Stanković, 2010, it can be concluded that the findings for younger adolescents vary within the range of expected and realistically possible values for the examined age.

The obtained statistically important linear discriminate function and its basic parameters are shown in Table 6.

Table 6. The parameters and significance of the motor abilities' discriminant function.

λ	λ W	Rc	R^2	df	p
.396	.391	.630	.560	3	.002

Legend λ – characteristic root of the discriminant function; λW coefficient value of Wilks Lambda test for centroid group equality; *Rc* – canonical correlation coefficient; R^2 – determination coefficient; *df* – degree of freedom; *p* – level statistical significance

The relatively low Wilk's - Lambda test value, which represents the relation within group variance and total variance, as well as the canonical correlation coefficient of moderate intensity (Rc = .63), point to a very high discriminant model intensity and the connection of variables in the motor abilities system. The isolated discriminant function explained 56% of the inter-group variance, which implies that more than ½ of the variance can be explained by belonging to a group. The remaining 44% of the factors by which motor abilities are conditioned is out of the range of the applied variables which describe motor space.

The isolated statistically significant linear discriminant function structure is displayed in Table 7.

Table 7. The discriminant function factor structure of motor abilities.

Variables	Coefficient correlation with discriminant function
Small ball throw (sm)	.602
Long jump (cm)	.578
Triple jump (cm)	.551
20 m run – high start (s)	.534
50 m run – high start (s)	501
20 m run – flying start (s)	.455
Coordination movement in the air (s)	.293
Coordination movement on the ground (s)	.286
Coordination with a stick (s)	.277

The given correlations of original and descriptive variables whose absolute correlations are with a function above 0.3 point out that motor tests of explosive power and sprint speed have the biggest influence on the discriminant function . The manifest variable the small ball throw has the highest contribution in defining the discriminant function (.602), while the variable the 20 m run - flying start has the lowest one (.455). On the other hand, the obtained value matrix structure coefficient in coordination movement tests in the isolated discriminant function indicates the non-existence of statistically significant differences among means of groups of athletes and non-athletes.

The results in Table 8 represent a linear discriminant function of group centroid values according to motor tests.

Table 8. Group centroids on the discriminant function.

Participants	Centroid values
Athletes	1.83
Non - athletes	-.29

The group of participants which has a positive centroid indicator gained better results for the manifest variables, which positively correlate with the discriminant function, and lower results on variables which correlate with the function negatively. The significance of the displayed centroids indicates that their distance (discrimination) is statistically significant. Taking into account the value and the indicator of the group centroids, the isolated discriminant function determined a statistically significant difference between the group of athletes and group of non-athletes.

By applying the Student's Parameter t-test for small independent samples and the Canonical Discriminant Analysis in this study, the previous findings (Batričević, 2008) on the differences among the four functional abilities and nine motor abilities of active and non-active boys 14 – 15 years of age were confirmed.

The results in this research proved the hypothesis about statistically significant differences in functional and motor abilities among boy athletes and non-athletes eight-graders.

CONCLUSION

Functional and motor abilities represent a relevant segment of younger adolescent anthropological status. The results of this discriminant study clearly pointed out that the obtained results of the subsample of athletes, with a certainty of ($p < 95\%$), indicate that they are different in a statistically significant manner by the higher level of motor and functional abilities from the subsample of non-athletes. The obtained results in this study enable a comparison with the results obtained in European countries, due to the use of unique methodology. Basic methodological restrictions in this transversal research are related to data gathering over a very short period of time, the demographic characteristics of the analyzed sample, the relatively small size and sample specificity of younger adolescents – the subsample of students and subsample of athletes -which enables the overall application of the results on the whole examined population.

According to the obtained results in this study it is concluded that further, more comprehensive and longitudinally designed studies are necessary in order to test the statistical differences between a greater number of functional and motor variables and a more representative sample (of athletes and non - athletes) in the period of early adolescence. In that way, with a very high percentage of certainty, the basis for a more elaborate understanding of the examined anthropological abilities of the adolescent population can be established, as well as an improvement of the physical education classes and training processes in sports clubs.

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RAZLIKE U FUNKCIONALNO–MOTORIČKIM SPOSOBNOSTIMA SPORTISTA I NESPORTISTA U RANOJ ADOLESCENCIJI

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Funkcionalne i motoričke sposobnosti adolescentske populacije preduslov su očuvanja i poboljšanja njihovog psihofizičkog zdravlja, kao i postizanja uspešnih rezultata na časovima fizičkog vaspitanja i sportskih treninga. Cilj rada bio je da se ispitaju razlike u nekim motoričkim i funkcionalnim sposobnostima ispitanika u periodu rane adolescencije. Tokom septembra 2012. godine, u istraživanju je

učestvovalo 178 ispitanika muškog pola, uzrasta 14–15 godina (90 sportista i 88 nesportista) iz Valjeva. Uzorak varijabli sastojao se od 9 testova motoričkih sposobnosti i 4 funkcionalna testa. Statistička obrada podataka rađena je u programskom paketu Statistica for Windows, ver. 6.0. Prikupljeni podaci obrađeni su osnovnim postupcima deskriptivne statistike, Studentovim parametrijskim t-testom za male nezavisne uzorke i kanoničkom diskriminativnom analizom. Dobijeni nalazi pokazali su da se subuzorak sportista statistički značajno razlikuje od subuzorka nesportista većim nivoom u eksplozivnoj snazi, sprinterskoj brzini, vitalnom kapacitetu pluća, sistolnom i dijastolnom arterijskom krvnom pritisku. To je posledica uticaja višegodišnjeg bavljenja trenažnim procesima. Rezultati u ovoj diskriminativnoj studiji daju niz informacija, koje sa verovatnoćom $p < .005$ mogu imati svoju praktičnu primenu u definisanju funkcionalno-motoričkih modelnih vrednosti, kvalitetnijoj izradi plana i programa rada u nastavi fizičkog vaspitanja i sportu, kao i u operacionalizaciji transformacijskih postupaka kod dečaka učenika VIII razreda osnovne škole.

Ključne reči: *motoričke sposobnosti; funkcionalne spsosobnosti, razlike.*