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DIFFERENCES IN COORDINATION AND ENDURANCE BETWEEN CHILDREN SELECTED FOR ATHLETICS AND NON-ATHLETES

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Abstract. *The study was conducted in order to determine the differences in coordination and endurance between girls selected for athletics and non-athletes. The sample of 36 participants was divided into two subsamples: girls selected for athletics (18) and girl non-athletes (18) who were not included in systematic athletics training, but only attended physical education classes. The sample of measuring instruments for assessing coordination and endurance consisted of: agility in the air (OKV), coordination with a baton (KOP), twenty steps twirling a baton (20IP), squats (ČUČ), push-ups (SKL) and the 800m run (TR800). An analysis of variance led to results which showed that there were no differences in coordination between the girls selected for athletics and the non-athletes, but in terms of endurance there were statistical differences in the squats (ČUČ) and the 800m (TR800) run, where the girls selected for athletics had better results.*

Key words: *coordination, endurance, girls, selection, athletics*

INTRODUCTION

Physical education represents the basis of school sport (Andrews, 1999). School sport and physical education classes are mutually connected through many complex relations and complement each other, sharing joint basic aims: to contribute to the health and the harmonious development of one's personality. It enables schoolchildren to acquire the

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basic movement skills and the necessary knowledge, to form positive attitudes towards physical activity and sport, and helps to prepare them for an active lifestyle. Taking part in school sport enables children and the young to improve their motor skills, social skills and self-respect through participation, and can represent a transition stage towards membership in sports clubs, with the aim of achieving top sports results. We should mention that the basic motor skills of children develop most in the period from the ages of 9 to 12. At this time, children should be taught basic fundamental skills such as running, throwing and jumping. These skills represent the so-called athletics alphabet (ABC - agility, balance, coordination, speed). Based on the development of motor skills, we can carry out a successful selection of children for participation in a particular sports discipline (Balyi & Hamilton, 1995; Russhall, 1998; Viru et al., 1998).

Selection in sport is a process which must be carried out continuously, in a controlled fashion, and is aimed at individuals who possess optimal health and morphological characteristics, functional, motor, conative and cognitive abilities, with the aim of achieving top scores in the sport of their choice. In athletics disciplines, there are numerous selection models; however, there is no universal method for initial athletic selection and orientation. In many sports clubs, the discovery and recognition of talented events takes place quite by accident, since a number of coaches believe that talent finds its own way to success. Only elite athletes working in a high-quality social environment are able to display and use their potential, while others are usually never given the opportunity to develop their potential, since not many people are searching for talented individuals.

The level of genetically conditioned characteristics, along with biological age and the optimal age at which to begin active involvement in sport, has a very important role to play in the selection process. We should especially point out that hereditary characteristics such as body height, length of the upper and lower extremities, endurance, speed and coordination are only slightly influenced by external factors (Matto, 1981). For physical education and sport, as a field of professional and scientific research, motor skills, which are susceptible to change, are very important (Kukolj, 2006). They are also very important for numerous other athletic disciplines, especially in the selection process of children for participation in athletics disciplines.

Coordination is the ability to control the movement of the entire body or the locomotor apparatus, which is responsible for the quick and precise performance of complex motor tasks (Metikoš & Hošek, 1972; Gredelj, Metikoš, Hošek & Momirović, 1975; Milanović, Jukić & Šimek, 1997). Coordination, according to some authors, belongs to the group of mechanisms responsible for the structuring of movement, including hand coordination, leg coordination, body coordination, the reorganization of movement stereotypes, agility, rhythm coordination, the speed of learning of new motor structures and the speed of limb movement frequency (Kurelić et al., 1975).

Endurance as a dimension of motor space can be defined as the ability to perform certain activities over extended periods of time without a decrease in effectiveness. It is a functional ability and is indelibly linked to the concept of fatigue. In the relevant literature, there is mention of endurance in long-term activities, medium duration activities, short-term activities, activities which involve speed as a deciding factor and strength activities (Gajić & Kalajdžić, 1986; Nićin, 2000). Certain authors refer to general and special endurance, where general endurance is defined as the ability to strain muscles over a longer period of time, but with moderate intensity, and where special endurance is the ability to perform intense muscle strain, depending on the intensity and

duration of work conditioned by the anaerobic abilities of the human body (Kukolj, Jovanović & Ropret, 1996). At the ages of 8 to 13, in the case of young girls, endurance can increase exponentially and reaches its peak at the age of 13. After that, this functional ability remains unaltered if it is not influenced by an appropriate training process (Armstrong & Welsman, 2001; Armstrong, 2006).

The aim of this paper is to determine the differences in endurance and coordination between girls selected for athletics disciplines and young girls who do not take part in sport, so as to evaluate the quality of the basic selection of children for athletics disciplines based on these two motor skills, and for which they are especially important.

THE METHOD

The sample of participants

In this study, the sample of participants numbered 36 female participants ages 9-10 $\pm$6 months, elementary schoolchildren attending the Vožd Karađorđe elementary school in Niš, who were divided into two sub-samples. The first sub-sample consisted of 18 female elementary school students selected for athletics disciplines (the experimental group - EG), who in addition to physical education classes were involved in the athletics training process, while the other 18 school girls were non-athletes (the control group - KG), and only participated in their regular physical education classes. The female participants met all the health criteria and took part in the experiment with the consent of their parents.

The sample of measuring instruments

The sample of measuring instruments consisted of six tests for the evaluation of coordination and endurance. The following tests were used for the evaluation of coordination: agility in the air (OKV), coordination with a baton (KOP) and twenty steps twirling a baton (20IP). For the evaluation of endurance, the following tests were applied: squats (ČUČ), push-ups (SKL) and the 800m run (TR800). All of the tests were measured following the guidelines set up by Kurelić et al. (1975).

The measuring was carried out in the Vožd Karađorđe elementary school and the Car Konstantin Athletics Club in Niš, under optimal weather conditions. The female participants wore the appropriate sports attire during the measuring, and prior to it warmed up for 15-20 minutes.

Statistical data analyses

Due to the nature of this research and the needs for planned selection, it was necessary to collected data from both subsamples. In order to determine the differences between the subsamples, we used the multivariate and univariate analysis of variance (MANOVA/ ANOVA). At the multivariate level, the following parameters were calculated: Wilks' Lambda – the value of Wilk's coefficient for group centroid equality; F – the value of the F-test coefficient for the significance of Wilks' Lambda; Effect df and Error df – the degrees of freedom; Q – the coefficient of significance of the differences in the group centroids, while at the univariate level we calculated the values of the F-test and the coefficient of

significance of the differences in the means (p) for each variable. The data were processed using the statistical package STATISTICA 7.0 for Windows (StatSoft, Inc., Tulsa, OK).

THE RESULTS

By analyzing the data in table 1, we can note that in the space of the coordination at the multivariate level there is no statistically significant difference between the groups of female athletes and school children, at a level of significance of the difference Q=0.306, and with a low value of the significance coefficient of Wilks' Lambda (F=1.26). In addition, it is to be expected that at the univariate level, there is no need to check the significance of the differences in the means, but in order to obtain the necessary information on the existence of numeric differences between the groups in terms of certain variables, an analysis of the differences will still be carried out at the univariate level as well.

Table 1 Multivariate difference between the groups - COORDINATION

Wilk's Lambda	F	Effect df	Error df	Q
0.89	1.26	3	32	0.306

Legend: Wilks' Lambda – the value of the coefficient for Wilks' test of the of group centroid equality; F – the value of the F-test coefficient for the significance of Wilks' Lambda; Effect df and Error df – the degrees of freedom; Q – the coefficient of significance of the differences between the centroids of groups.

Upon reviewing and analyzing the differences in the means in the space of coordination (table 2), differences were noted between the female athletes and school girls in all the tests. The differences were in favor of the population of female athletes, that is, they all achieved better results on all the tests of coordination. These included tests which were used to evaluate the coordination of the entire body: agility in the air (OKV), coordination with a baton (KOP) and stepping and twirling a baton (20IP).

Table 2 Univariate differences between the groups - COORDINATION

Variable	Mean + SD (EG)	Mean + SD (KG)	F	p
OKV	18.82 + 7.72	21.01 + 4.79	1.05	0.313
KOP	16.46 + 4.13	18.58 + 3.89	2.51	0.122
20IP	21.80 + 8.89	22.22 + 6.21	0.03	0.869

Legend: Mean – arithmetic means; SD – standard deviation; EG – experimental group; KG – control group; F – the value of the F-test, the significance of the difference in means; p – the coefficient of significance of the differences between the arithmetic means.

Upon reviewing the data in table 3, we can note that at the multivariate level there is a statistically significant difference between the groups of female athletes and school girls, at the $Q \leq 0.000$ level of significance, along with a high value of the coefficient of significance of Wilks' Lambda (F=35.94). In light of this fact, it is expected that at the univariate level we should check which of the variables in the space of endurance contributed to the significance of this difference, as well as which of the groups achieved better scores for these variables.

Table 3 Multivariate differences between the groups - ENDURANCE

Wilk's Lambda	F	df1	df2	Q
0.23	35.94	3	32	0.000*

Legend: Wilks' Lambda – the value of the coefficient for Wilks' test of the of group centroid equality; F – the value of the F-test coefficient for the significance of Wilks' Lambda; Effect df and Error df – the degrees of freedom; Q – the coefficient of significance of the differences between the centroids of groups; * - statistically significant difference.

By reviewing and analyzing the differences in the means in the space of endurance (table 4), statistically significant differences between the female athletes and school girls were noted for the tests of endurance and leg strength (ČUČ) and endurance during running (TR800), while for the test of endurance of arm and shoulders strength (SKL) no statistically significant difference was noted. The differences were in favor of the population of female athletes, that is, they all achieved better results for the endurance strength of the leg test, with a high level of significance and a somewhat lower level of endurance in running.

Table 4 Univariate differences between the groups - ENDURANCE

Variable	Mean + SD (EG)	Mean + SD (KG)	F	p
ČUČ	316.05 + 96.32	60.94 + 48.60	100.64	0.000*
SKL	17.83 + 5.43	19.16 + 7.23	0.39	0.536
TR800	4.35 + 0.32	4.91 + 0.63	10.98	0.002*

Legend: Mean – arithmetic means; SD – standard deviation; EG – experimental group; KG – control group; F – value of the F-test, the significance of the difference in means; p – the coefficient of significance of the differences between the arithmetic means; * - statistically significant difference.

DISCUSSION

The isolated differences in the arithmetic means are not extensive, but they are systematic and in favor of the female athletes, and are thus important, considering that coordination is genetically conditioned. The remaining part is compensated for by training, which is suited to the needs of the individual's abilities (Nićin, 2000). Even though coordination is present in other sports and sports games as well, it is interesting that even here the female athletes had better scores, even though it can be characterized as a well-guided training process, which at no point favors the development of one motor skill over any other. Similar results were obtained by other researchers who dealt with this problem (Smoll & Schutz, 2002; Katić, Maleš & Miletić, 2002; Bošnjak, Vindiš, Jakovljević & Sekulić, 2008; Pavlović & Raković, 2009). On the test used to evaluate endurance in arm strength and the shoulders, the school girls had numerically better values than the female athletes, but not at a statistically significant level. The differences in the means of endurance in running are not extensive, but were certainly significant, considering that endurance is genetically conditioned. The remaining part is compensated for by the training process which is suited to the individual skills of the children (Bouchard, Dionne, Simoneau & Boulay, 1992; Nićin, 2000). In sports, endurance skills gradually increase during biological development (Rowland, Varzeas & Walsh, 1991; Baxter-Jones, Goldstein & Helms, 1993). Even though the repeated motion for the

development of endurance in leg strength is present in other sports and sports games, it is interesting to note that even here the female athletes had significantly better results, which can be characterized as a result of their participation in a properly guided training process. Endurance in strength is not of a general nature and is suitable for the development of strength in activities where we come across a great number of repetitions of movements of the same or different amplitudes (Pavlović, 2010, Pavlović & Stojanović, 2012). We find similar results in the work of most authors (Kukolj, Bokan, Koprivica & Ugarković, 2001; Marković & Pivač, 2005; Krsmanović, Kovačević & Batez, 2008; Molnar, Smajić, Popović & Tomić, 2010) who studied the same or similar problems. If we were to make generalizations regarding the univariate differences in the motor skills between the female athletes and school girls, we are left with the conclusion that of the overall number of manifest variables (6), only in the case of two were statistically significant differences realized at the p=.000 and p=.002 level. In terms of percentages, this is a value of 33%, which is not a significantly high percentage. For all of the variables, the female athletes achieved better results, especially in the case of those variables which were dominant and significant for the athletics disciplines of running and jumping, but they were not better in a statistically significant manner. This refers in particular to the variables in the space of coordination, where female athletes scored higher results, but only on the numerical level. Only for the variable SKL from the space of endurance of arm and shoulder strength were better results not achieved. This is all the more significant for purposes of practical application, if we take into consideration the fact that the female school girls actively participated in the process of physical education, but in addition to it manifested weaker results in relation to the female athletes of the same age.

CONCLUSION

This research was carried out on a sample of 36 female participants aged 9-10 ± 6 months, with the aim of determining the differences between female athletes and school girls in the space of coordination and endurance. By analyzing the results of the arithmetic means of the tested measures in the motor space of the female athletes and school girls, we can clearly see that there is a difference in all the measurements. However, only in two of the tests was the difference statistically significant at a high level (p=0.00), which accounts for 33% of the differences in the overall number of measured variables. These differences were noted in all of the variables of coordination and endurance in favor of the athletes, except in endurance of the arms and shoulder strength. In all of the variables, the female athletes achieved numerically better results, with statistically significant results in those skills which were dominant and important for the athletics disciplines of running and jumping, such as endurance of leg strength and running endurance. It would seem that female athletes generally have a more able and mobile CNS, since coordination depends on the speed of afferent and efferent moto-neurons which transmit a stimulus to the activated muscle; however, the realized differences are not statistically significant. Considering that endurance in arm and shoulder strength does not play an important role in running and jumping disciplines, then the weaker results of the female athletes are not surprising, if we take into consideration that there is the possibility that there are some school girls who might take part in sports games or combat sports training, where endurance in arm and shoulder strength probably play an important role in the given activity.

PRACTICAL APPLICATION

The aim of this research was to indicate the differences in the endurance of girls selected for athletics disciplines and schoolgirls, as well as to indicate the high influence of extracurricular activities on the development of endurance and coordination among children who took part in sports activities, unlike the schoolchildren who only attended their physical education classes. This research meant to answer the following question: how and to what extent do extracurricular physical activities influence the development of the motor skills of coordination and endurance, and can physical education sufficiently make up for the physical inactivity of children in relation to children selected for athletics disciplines? Furthermore, this research was meant to indicate the necessity of increasing the number of classes, both in elementary and high schools, so that children could be educated and develop more properly. Physical education classes in grades 1 through 4 should be led by physical education teachers, so as to increase the influence of physical education on the development of children. It is very important to educate children in terms of inclusion in the training process, that is, taking part in athletics disciplines.

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RAZLIKE U KOORDINACIJI I IZDRŽLJIVOSTI DECE IZABRANE ZA ATLETIKU I NESPORTISTA

Cilj istraživanja bio je da se odrede razlike u koordinaciji i izdržljivosti devojčica izabranih za atletiku i njihovih vršnjakinja nesportista. Uzorak je činilo 36 ispitanika podeljenih u dve grupe: grupu devojčica izabranih za atletiku (18) i grupu nesportista (18) koji nisu trenirali atletiku već su samo pohađali redovne časove fizičke kulture. Instrumenti za procenu koordinacije i izdržljivosti bili su sledeći: okretnost u vazduhu (OKV), koordinacija sa palicom (KOP), dvadeste iskoraka sa palicom (20IP), čučnjevi (ČUČ), sklekovi (SKL) i trčanje na 800m (TR800). Rezultati dobijeni analizom varijanse ukazali su na to da ne postoje statistički značajne razlike u koordinaciji između ove dve grupe devojčica, ali da ih je bilo na testovima čučnja (ČUČ) i trčanja na 800m (TR800), gde su devojčice koje se bave atletikom imale bolje rezultate.

Ključne reči: *koordinacija, izdržčljivost, devojčice, selekcija, atletika*