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Effects of the Acrobatics Program on the Motor Skills of Elementary School Students

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Abstract*: The sample of respondents consisted of students of the "Alija Nametak" Elementary School in Sarajevo. The age of the respondents was 11-12 years ± 6 months, which was divided into two groups. The first, experimental group, consisted of 32 students, the other 32 students in the second, control group. The aim of the research was to determine the effect of the acrobatics program on the development of motor skills in elementary school students. A total of 9 tests were used to assess motor skills. Three tests for assessing repetitive strength, three tests for assessing coordination and three tests for assessing explosive strength. The experimental program was carried out within twelve weeks with a frequency of two training sessions per week and a duration of 60 minutes. Based on univariate analysis, ANOVA, statistically significant differences were found in all motor tests. The experimental program had a positive effect, so the selected battery of tests may be of particular importance for physical education teachers in other schools in order for them to successfully test their students, i.e. determine the state of motor skills and the effect of the acrobatics program on their development, and a more adequate approach to planning, programming, implementation and control of work in physical education classes and additional classes.*

Keywords— acrobatics; motor skills; students; elementary school

1. INTRODUCTION

Modern technological developments have brought numerous benefits, but at the same time have caused a significant decrease in the level of daily physical activity among children and youth. The digitalization of content and the transfer of play from outdoor to indoor spaces, through the use of computers, mobile phones, tablets and various consoles, have led to a decrease in natural forms of movement, which can negatively affect the growth and development of the locomotor system and increase the risk of various postural deformities (Arruda & Farinatti, 2007). In such an environment, physical education becomes an even more important factor in preserving and improving children's health, although in practice it is often neglected or underrepresented.

Given that physical activity is one of the key determinants of proper growth and development, it is necessary to improve the teaching process with additional contents, programs and forms of work that enable children to develop motor skills and acquire functional knowledge. Sports gymnastics, as a basic sport, especially contributes to the development of strength, flexibility, coordination and balance (Carrick et al., 2007), while gymnastic elements, due to their complexity, are among the most complex forms of motor movement (Ricotti, 2011). The dynamic development of contemporary sports gymnastics shows the constant shifting of the limits of human possibilities, through the continuous introduction of new and more demanding elements (Petković et al., 2010).

However, performing basic gymnastic elements within regular physical education classes alone is not enough to ensure the comprehensive development of relevant anthropological characteristics. Therefore, it is necessary to systematically plan specific motor preparation adapted to the sensitive stages of student development, and to include a greater number of contents and combinations of gymnastic and acrobatic elements (Salihović, 2009). Acrobatics stands out in this context as an optimal choice for the development of motor skills, as it represents a set of technically demanding exercises whose influence has been recognized in numerous sports (Petrović, 2011; Živčić, 2007).

Acrobatics is currently used in a wide range of areas – from physical education and top-level sports, through kinesitherapy programs and recreational activities, to professional artistic disciplines (Fulurija, 2019). Managing the learning process requires clear feedback between teachers and students, assessment of the initial and transit state of motor skills, as well as continuous correction of program content (Zaciorski, 1975; Ilić, 1980; Malcako, 2002; Pržulj, 2006; Fulurija & Tošić, 2013). Of particular importance is the individualization of tasks and adaptation of the program to the age, gender and specific characteristics of students (Kondrić et al., 2002).

Numerous studies confirm the fundamental role of acrobatics and gymnastics in the development of motor skills, where mastering technical structures to the level of automation enables easier and more efficient performance of other forms of motor activities (Madić, 2000; Željaskov, 2004; Markuš, 2006; Mićović, 2018). In this context, empirical testing of the effects of an acrobatic program can

provide significant insights into whether the application of specific learning and exercise methods, different forms of work and adequate workload can lead to statistically significant improvements in the motor skills of elementary school students. The results obtained can represent a valuable contribution to the improvement of the teaching process and a more rational application of acrobatics as a means of developing the motor potential of school-age children.

2. RESEARCH METHODS

The sample of respondents was made up of students from the "Alija Nametak" Elementary School in Sarajevo. The age of the subjects is 11-12 years ±6 months. Using the method of random selection of subjects, the sample was divided into two groups: The first group (EXPERIMENTAL) – N= 32 subjects and the second group (CONTROL) – N= 32 subjects.

The basic condition for testing was that the students in the experimental and control groups were healthy, without somatic difficulties. The health status was determined before the start of the experimental treatment and the final formation of the groups. All subjects voluntarily agreed to participate in the experiment. The experimental program was carried out within twelve weeks with a frequency of two training sessions per week and a duration of 60 minutes. The subjects in the experimental group gave their consent to participate in the acrobatics program and the development of motor skills in the gymnasium of the “Alija Nametak” Elementary School in Sarajevo. The students in the control group attended regular classes as prescribed by the curriculum.

The experimental treatment involved training in the mandatory components of the acrobatics program for school-age children, aged 11 to 12 years ±6 months. The experimental program was conducted over a period of twelve weeks. The frequency of training was twice a week for 60 minutes. The subjects in the experimental group agreed to participate in the acrobatics program and the development of motor skills in the gymnasium of the “Alija Nametak” elementary school in Sarajevo.

The training had a four-part structure:

- The introductory part included running and jumping, 5 min.
- In the preparatory part, shaping exercises and exercises to improve motor skills were carried out, 15 min.
- In the main part of the class, acrobatic exercises were performed (reactive stand-up exercises, falls and acrobatic elements / stance on the shoulder blades, head and hands; forward, backward and flying circles; straight from the shoulder blades and head "switch"; moving strangers, forward and backward and somersault forward and backward crouched), 35 min.
- In the final part of the class, exercises were performed to increase repetitive, explosive strength and movement coordination, 5 min.

A total of 9 tests were used to assess motor skills. Three tests to assess repetitive strength: Swedish bench press (MDTK); mixed pull-ups (MMZG); squats (MCU), Three tests to assess coordination: agility in the air (MOUV); coordination with the stick (MKSP); agility on the ground (MONT) and Three tests to assess explosive power: standing long jump (MSUD); standing triple jump (MTIM); long shot (MBLD). Measuring instruments for the assessment of motor abilities were taken according to Kurelić, & saranica, 1975. Univariate Analysis of Variance - ANOVA (Statistica 10.0) was used to determine statistical significance between the initial and final measurements.

3. RESEARCH RESULTS

Table 1.Descriptive parameters of motor abilities of the experimental group at initial measurement

Variable	N	Mean	Min.	Max.	Sd. Dev.	St. Error	Skew.	Kurt.
MDTK	32	24.53	12.00	34.00	5.38	1.53	-0.524	-0.584
MMZG	32	7.38	3.00	20.00	14.47	3.31	0.702	3,727
MČUČ	32	21.49	10.00	33.00	3.52	0.80	0.004	0.483
MOUV	32	18.47	11.40	27.20	7.18	1.62	-0.142	-1.004
MKSP	32	17.64	13.30	23.30	7.12	1.26	-0.120	-0.624
MEST	32	45.76	28.20	63.33	12.06	2.22	0.166	-0.646
MSUD	32	133.82	101.00	170.00	13.39	2.46	0.450	2,902
M.T.I.M.	32	350.22	341.00	466.00	46.21	9.24	0.482	3,714
MBLD	32	2966	2190	3932	0.40	0.16	-0.026	-1.128

The presented results of motor abilities in Table 1 show that by comparing the results of the standard deviation with the range of maximum and minimum results, the normal sensitivity of the selected tests can be concluded. There are at least five standard deviations in the intervals of the minimum and maximum results, which indicates significant dispersion, i.e. sensitivity of motor

tests. The skewness value shows that there are no significant deviations of the results from the normal distribution for any test, given that the values do not exceed 1.00. Kurtosis scores fall below the normal value of 2.75, making the distribution platokurtic or skewed. The results of two tests: the mixed pull-up 3.727, the triple jump from the place 3.714 and the long jump from the place 2.902 show a slightly higher compression of the distribution of the results compared to the other tests.

Table 2.Descriptive parameters of motor abilities of the experimental group at the final measurement

Variable	N	Mean	Min.	Max.	Sd. Dev.	St. Error	Skew.	Kurt.
MDTK	32	31.32	17.00	46.00	4.85	1.12	-0.325	0.660
MMZG	32	14.82	6.00	26.00	3.68	0.54	0.176	1,886
MČUČ	32	29.86	15.00	46.00	24.83	4.39	0.145	0.874
MOUV	32	15.54	12.40	28.60	4.73	0.78	0.015	-0.629
MKSP	32	13.22	10.20	24.50	3.17	0.59	-0.128	-1.554
MEST	32	39.67	26.10	54.80	11.50	2.23	0.142	-1.113
MSUD	32	152.34	118.00	180.00	12.20	2.39	0.526	0.292
M.T.I.M.	32	408.21	344.14	474.00	41.36	8.14	0.473	1,761
MBLD	32	3318	2262	4174	0.47	0.08	-0.047	-0.169

The presented results of motor abilities in Table 2 show that by comparing the results of the standard deviation with the range of maximum and minimum results, the normal sensitivity of the selected tests can be concluded. There are at least five standard deviations in the intervals of the minimum and maximum results, which indicates significant dispersion, i.e. sensitivity of motor tests. The skewness value shows that there are no significant deviations of the results from the normal distribution for any test, given that the values do not exceed 1.00. Kurtosis scores fall below the normal value of 2.75, making the distribution platokurtic or skewed.

Table 3.Descriptive parameters of motor abilities of the control group at initial measurement

Variable	N	Mean	Min.	Max.	Sd. Dev.	St. Error	Skew.	Kurt.
MDTK	32	23.38	11.00	33.00	4.85	1.13	0.781	1,824
MMZG	32	8.20	5.00	21.00	10.82	2.12	0.564	-0.872
MČUČ	32	19.44	11.00	38.00	4.96	0.82	0.744	3,262
MOUV	32	20.63	10.30	28.40	2.26	0.32	0.881	0.182
MKSP	32	22.24	15.84	34.40	1.68	0.38	-0.253	-1.278
MEST	32	42.48	31.80	56.20	1.63	0.39	0.683	0.783
MSUD	32	145.87	119.00	174.00	8.42	1.83	-0.373	0.470
M.T.I.M.	32	399.53	332.06	469.00	39.75	7.63	0.368	-0.979
MBLD	32	2989	2252	4062	0.46	0.16	-0.428	-0.825

The presented results of motor skills in Table 3 show that by comparing the results of the standard deviation with the range of maximum and minimum results, the normal sensitivity of the selected tests can be concluded. There are at least five standard deviations in the intervals of the minimum and maximum results, which indicates significant dispersion, i.e. sensitivity of motor tests. The skewness value shows that there are no significant deviations of the results from the normal distribution for any test, given that the values do not exceed 1.00. The kurtosis scores range below the normal value of 2.75, which makes the distribution platokurtic or diffuse, except for the squat test 3.262 whose score distribution is compressed.

Table 4.Descriptive parameters of motor abilities of the control group at the final measurement

Variable	N	Mean	Min.	Max.	Sd. Dev.	St. Error	Skew.	Kurt.
MDTK	32	24.71	14.00	34.00	4.34	1.22	-0.508	-0.867
MMZG	32	9.78	5.00	21.00	3.68	0.64	0.377	2,097
MČUČ	32	21.02	11.00	39.00	12.10	2.64	0.594	-0.638
MOUV	32	21.97	10.40	26.60	11.36	1.74	-0.354	-0.978
MKSP	32	29.40	26.20	55.70	10.43	1.61	0.072	-2.146
MEST	32	43.65	30.10	58.20	1.32	0.12	-0.350	-0.539
MSUD	32	147.27	122.00	176.00	8.40	1.83	-0.375	0.581
M.T.I.M.	32	412.92	333.02	478.00	46.24	8.78	0.217	-1.962
MBLD	32	3058.50	2252	4063	0.34	0.34	0.056	-0.743

The basic statistical parameters of motor abilities in Table 4 show that by comparing the results of the standard deviation with the range of maximum and minimum results, the normal sensitivity of the selected tests can be concluded. There are at least five standard deviations in the intervals of the minimum and maximum results, which indicates significant dispersion, i.e. sensitivity of motor tests. The skewness value shows that there are no significant deviations of the results from the normal distribution for any test, given that the values do not exceed 1.00. Kurtosis scores fall below the normal value of 2.75, making the distribution platokurtic or skewed.

Table 5.Univariate analysis of variance between E and K groups of subjects in motor abilities at initial measurement

Variable	Mean (E)	Mean (K)	MS effect	MS error	F-ratio	P-level
MDTK	24.53	23.38	78.62	45.56	2.07	0.268
MMZG	7.38	8.20	80.41	17.61	2.78	0.220
MČUČ	21.49	19.44	26.82	127.06	0.24	0.824
MOUV	18.47	17.63	378.06	3.43	1.45	0.344
MKSP	17.64	22.24	14.49	18.06	0.41	0.123
MEST	45.76	42.48	8.58	0.42	0.24	0.678
MSUD	133.82	145.87	1.42	137.68	1.92	0.116
M.T.I.M.	350.22	399.53	6216.21	2456.34	2.53	0.224
MBLD	2966	2989	0.12	0.12	0.61	0.563

Table 5 shows the univariate analysis of variance of motor ability tests by comparing the results of the arithmetic means of the experimental and control groups at the initial measurement. Based on the coefficient of the F - relationship and their significance P - level, it can be concluded that no statistically significant difference in level was determined between the experimental and control groups at the initial measurement in any of the motor ability tests.

Table 6.Univariate analysis of variance between E and K groups of subjects in motor abilities at the final measurement

Variable	Mean (E)	Mean (K)	MS effect	MS error	F-ratio	P-level
MDTK	31.32	24.71	249.07	31.93	7.86	**0.006**
MMZG	14.82	9.78	139.54	11.53	9.74	**0.001**
MČUČ	29.86	21.02	817.82	268.34	3.77	**0.034**
MOUV	15.54	21.97	2.08	12.04	11.52	**0.002**
MKSP	13.22	29.40	50.31	12.20	12.54	**0.000**
MEST	39.67	43.65	0.64	1.81	11.30	**0.007**
MSUD	152.34	147.27	1174.01	136.72	7.04	**0.022**
M.T.I.M.	412.21	404.92	3343.01	2363.01	11.67	**0.002**
MBLD	3318.00	3058.50	0.34	0.36	3.01	**0.001**

Table 6 shows the results of the univariate analysis of variance of motor ability tests by comparing the results of the arithmetic means of the experimental and control groups at the final measurement. Based on the coefficient of the F - relationship and their significance P - level, it can be concluded that a statistically significant difference in the level of motor abilities of the experimental and control groups was determined in repetitive strength tests: bench press (0.006), mixed pull-ups (0.001), squats (0.034); in coordination tests: agility in the air (0.002), coordination with a stick (0.000), agility on the ground (0.007) and in explosive strength tests: long jump from a standing position (0.022), triple jump from a standing position (0.002) and ball throwing (0.001).

4. DISCUSSION

The aim of this research was to examineThe impact of acrobatics on the development of motor skills in primary school students aged 11–12 years ±6 months. The results obtained indicate clear and statistically significant differences in favor of the experimental group at the final measurement, which confirms the justification of the applied exercise program.

By analyzing the descriptive statistical parameters on the initial measurements (Tables 1 and 3), it can be concluded that the experimental and control groups were equal in all examined motor variables. This statement is further confirmed by the results of the univariate analysis of variance (Table 5), where no statistically significant difference between the groups was determined in any motor ability test ($p > 0.05$). This fulfilled the basic methodological condition for monitoring the effects of the experimental treatment.

The distributions of results on all measurements showed normal test sensitivity, with skewness values within the allowed limits (±1), while kurtosis values generally indicated a platokurtic distribution, which is in line with the recommendations for the application of parametric statistical procedures (Bala, 1981). These findings confirm that the tests used were adequate for assessing the motor abilities of the subjects.

The results of the final measurement (Table 6) indicate statistically significant differences between the experimental and control groups in all examined segments of motor abilities. A particularly marked improvement was recorded in the tests of repetitive strength (lifting the torso on the bench, mixed pull-ups and squats), coordination (agility in the air, coordination with the bat and agility on the ground), as well as explosive strength (standing long jump, standing triple jump and throwing the ball). These results clearly indicate that the acrobatics program had a strong and systematic impact on the improvement of children's motor skills.

The findings are in line with theoretical assumptions about sensitive periods of motor development. Planinšec (2002) points out that during childhood there are phases of accelerated development of motor skills, which should be maximally utilized by adequately planned physical activities. Marković and Bradić (2008) state that the majority of basic motor skills are most efficiently developed in preschool and early school age, which confirms the justification for the sample selection in this study.

Also, Madić, Popović and Kaličanin (2009) emphasize that the period from the seventh to the eleventh year represents an extremely sensitive phase of biological development, and that the application of a program of sports gymnastics and acrobatics during this period is particularly effective for the development of strength, coordination and explosiveness. Similar conclusions are drawn by Bala, Kiš and Popović (1996), who emphasize that in sensitive phases, motor development must be stimulated with adequate intensity, volume and structure of exercise.

Compared to the experimental group, the control group showed significantly less progress at the final measurement, which can be explained by the lack of a systematic and planned physical exercise program. These results confirm that spontaneous physical activity is not sufficient for optimal development of motor skills, but rather requires professionally guided and methodically designed teaching or training process.

Based on all of the above, it can be concluded that the implementation of an acrobatics program significantly contributes to the development of motor skills in children aged 11–12. The results of this research are in line with previous scientific findings and further confirm the importance of planned physical activity in the sensitive period of children's growth and development.

CONCLUSION

The main objective of this research was to determine the effect of an acrobatics program on motor skills in primary school children. The experimental program was implemented for twelve weeks, with a frequency of two training sessions per week, lasting 60 minutes per session. The program had a clearly defined four-part structure that included an introductory, preparatory, main and final part of the lesson.

The research sample consisted of a total of 64 students from the "Alija Nametak" Elementary School in Sarajevo, divided into an experimental and a control group, with 32 subjects in each group. Students in the experimental group were included in the acrobatics program, while the control group was not subjected to the experimental treatment.

The analysis of the results showed that the applied experimental program led to statistically significant positive changes in all examined variables of motor skills in the experimental group students. Also, the differences found between the experimental and control groups at the final measurement confirm that the acrobatics program represents an effective model for improving and changing motor skills in primary school children.

Based on the results obtained, it can be concluded that acrobatics has significant pedagogical and developmental potential in physical education teaching. In future research, it would be useful to examine the impact of the same program on individual segments of motor skills, as well as its impact on specific motor actions.

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