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Research article

THE EFFECTS OF DEVELOPMENTAL GYMNASTICS ON THE DEVELOPMENT OF BOYS' MOTOR SKILLS

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Abstract. *The aim of the study was to determine the effects of the developmental gymnastics program on the motor skills development of boys of a younger school age. The total sample consisted of 107 boys (E-54; 10.07±0.91 years old; C-53; 10.36±0.68 years old), from the "Dušan Radović" Elementary school from Niš. The experimental program lasted 16 weeks (3x a week for 60 min) and included the training of the compulsory compositions of the development gymnastics program for younger school age children. The control group attended regular physical education classes. The following tests were used for motor skills assessment: the countermovement jump, squat jump, medicine ball throw, hanging pull-ups, sit-ups on the bench, push-ups, the 20m run from a high start, the backward polygon, and deep forward bend on the bench. The T-test revealed significant differences between the groups at the initial measurement, while all the observed differences in arithmetic means were statistically significant at the final measurement. The results of the univariate analysis indicate significant differences in six of the nine applied variables, whereas at the multivariate level, a significant difference (p=.000) can be observed. The obtained results exactly indicate that the experimental program contributed significantly more to the motor skills transformation than the current physical education program. The realized program of developmental gymnastics proved to be adequate and acceptable, so it is recommended for active application in practice, and the greatest contribution would be realized by its implementation in physical education classes*.

Key words: *developmental gymnastics, motor skills, improvement, male, youth*

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INTRODUCTION

The wide range of movement activities that children experience in developmental gymnastics can be categorized as locomotor, static, and rotation. Hence, early experiences should develop basic skills in time. Learning concepts of body awareness and spatial awareness help children develop a variety of movement responses to use with given challenges or tasks. As children develop physically, cognitively and socially, additional concepts focusing on effort actions and relationships are gradually added (Werner et al., 2012). Improving the body in early childhood, the child becomes capable of mastering the technique of certain sports disciplines, and it is necessary to facilitate the development of basic psychophysical characteristics in the child through supplementary exercises and trainings of various sports disciplines (Rudd et al., 2017). Children with higher motor competency levels have a higher chance of staying healthy, are more likely to participate in physical exercise, and have greater condition later in life (Barnett et al., 2008; Jaakkola et al., 2016; Lubans et al., 2010). Furthermore, regardless of strength, coordination, and flexibility development (Petković et al., 2013), developmental gymnastics also has a positive impact on personality traits, which gives special educational significance as well (Madić & Popović, 2012).

In that regard, early childhood years are ideal for beginning to adopt different training methods that are hard. Regardless of the activities, such as swimming and rhythmical coordination accompanied by music, gymnastics activities are also one of the important ones (Stojiljkovic & Pirsl, 2016). Developmental gymnastics includes actions such as balancing, rolling, step-like motion, "flight", where children raise the skill difficulty. As raising the skill difficulty, children use movement principles to vary skills, combine skills in sequences, and practice skills and sequences with other partners. Developmentally appropriate skill progressions allow youngsters to gradually obtain abilities of body control, while at the same time developing physical strength, endurance, and flexibility (Goodway et al., 2019). The fact that developmental gymnastics programs are an individual activity, in which it is often necessary to overcome fear, the desire to give up in contact with a previously unknown task, the need to master a new exercise more easily and the need to react in a timely manner undoubtedly promotes the development of positive personality traits of each individual (Madić & Popović, 2012). By strengthening the body during this sensitive period, the child becomes capable of mastering the technique of certain sports disciplines, and it is necessary to facilitate the development of basic psychophysical characteristics in the child through supplementary exercises and trainings of various sports disciplines (Werner et al., 2012).

Rudd (2016) presented that a gymnastics program has a more significant effect on the development of children's motor skills than the current curriculum of physical education, and also stated that more work should be done on the implementation of such programs in regular classes. During an 18-week basic gymnastics program, Culjak et al. (2014) revealed significant differences in fundamental movement skills (polygon), in seven-year-old children. Karachle et al. (2017) aimed to examine the effects of a 6-month program of recreational gymnastics on the development of children's motor skills. Although the experimental group showed nonsignificant improvements, the significant factor of "group" impact was revealed, after controlling the effect of the pre-test. The authors concluded that recreational gymnastics can be an effective tool for improving motor skills in early childhood. Another study by Rudd et al. (2017) assumed that the gymnastics intervention

group would demonstrate significant improvements beyond a physical education comparison group. Although no difference was identified in locomotor skills in higher grades, the authors emphasize that gymnastics is a great activity for improving stability and object control in lower grades, without interfering with the development of locomotor skills.

Bearing in mind that studies on this topic among the population of boys are scarce, we aimed to determine the effects of the developmental gymnastics program on the development of motor skills of boys of a younger school age.

METHODS

Participants Sample

The sample of participants for the E group was made up of 54 boys of a younger school age (10.07±0.91 years old), and all of them were involved in the development gymnastics program for at least three months. For the C group, a random stratified sample was formed, consisting of 53 boys (10.36±0.68 years old) from two classes of the 3rd grade and two classes of the 4th grade of the "Dušan Radović" Elementary school from Niš (Table 1).

Informed consent from parents was obtained before any measurement assessment, whereas all the measurements were obtained according to the Helsinki Declaration.

Table 1 Anthropometric characteristics and BMI

Variables	Group	Mean ± SD	Min	Max
Body height	E	139.55 ± 9.83	121.80	159.30
(cm)	C	145.96 ± 7.18	132.50	163.00
Body weight	E	33.46 ± 6.74	22.00	49.60
(kg)	C	41.33 ± 9.16	25.40	70.00
BMI	E	17.05 ± 2.03	14.17	24.09
(kg/m^2)	C	19.23 ± 3.05	14.37	26.34

Legend: BMI – body mass index, Mean – mean value, SD – standard deviation, Min – minimum value, Max – maximum value

Measurements

A total of 9 tests were used for motor skills assessment (strength, speed, coordination and flexibility), such as the countermovement jump (CMJU), squat jump (SQJU), the medicine ball throw (MBTO), hanging pull-ups (HIPU), sit-ups on the bench (SUPB), push-ups (PUUP), 20m run from a high start (20MR), the backward polygon (BAPO), and deep forward bend on the bench (DFBB).

Experimental Program

The experimental program lasted 16 weeks and included the training of compulsory compositions of the development gymnastics program for younger school age children (categories from 1st to 4th grade) (Veličković et al., 2016). The frequency of exercise was 3x a week for 60 min. during training sessions in the clubs for which they perform. The training sessions had a four-part structure. The introductory part included running and jumping. In the preparatory part, shaping exercises and exercises for raising the level of

motor skills were realized (the number of repetitions of exercises for raising the level of motor skills was gradually increased to every 2 weeks). In the main part of the training, exercises on all 6 apparatuses were realized. It is noteworthy to mention that all exercises on all apparatuses were compulsory and they consisted of the elements (2-6 elements) that were adapted in regard to the participants' age and training experience. In the final part of the training, flexibility exercises were done. The control group of participants attended regular physical education classes (3x a week), with no additional form of exercise.

Statistical Data Processing

The statistical data processing package SPSS v. 20 was used to process and analyze the raw data. For each applied variable, arithmetic mean (Mean) ± standard deviation (SD) and the significance of the Kolmogorov-Smirnov Z test (Sig K-S z) were calculated. In order to determine the differences between the groups at the initial and final measurement, the independent sample t-test was performed, with a difference significance (Cohen's d). In order to determine the difference between the initial and final measurement, the dependent sample t-test was performed with the effect size (Cohen Effect Size). For this purpose, the eta square (Eta^2) indicator was calculated as well.

The effects of the applied treatments on the experimental and control group were determined based on the MANCOVA. Within this analysis, the following parameters were calculated: Wilk's Lambda, the p–level of significance, effect size - Eta^2. Intergroup differences at the univariate level with neutralization at the initial measurement were determined with the ANCOVA, via adjusted mean values (Adj. Means). Testing of differences was performed using the F-test, and the level of significance was expressed as p.

RESULTS

Descriptives

The values of the Kolmogorov-Smirnov Z (Sig K-S z) test are in all cases greater than 0.05 (Table 2), which indicates that there is no significant deviation from the normal distribution and that further application of parametric tests is possible.

Differences at the Initial and Final Measurement

It can be seen that the differences between the arithmetic means are significant, except for the MBTO and 20MR at the initial measurement (Table 3). At the final measurement, all the observed differences are significant. By reviewing the obtained coefficients on the size of the differences (Cohen's d) at the initial measurement, it can be stated that there are mainly large differences in for the variables CMJU (1.01), SQJU (0.86), HIPU (1.88), SUPB (2.24), PUUP (0.87), BAPO (-1.17) and DFBB (1.92). At the final measurement, the differences are large, except the 20MR (-0.44).

Table 2 Initial and final measurement descriptives

Variables	Group	Initial		Final	
		Mean ± SD	Sig K-S z	Mean ± SD	Sig K-S z
CMJU	E	21.96 ± 4.50	.78	23.26 ± 4.31	.95
	C	17.84 ± 3.71	.85	17.73 ± 3.13	.96
SQJU	E	20.93 ± 4.23	.38	22.28 ± 4.23	.98
	C	17.69 ± 3.33	.98	17.21 ± 3.33	.95
MBTO	E	4.40 ± 0.85	.52	5.14 ± 0.81	.89
	C	4.30 ± 0.72	.49	4.45 ± 0.68	.60
HIPU	E	22.26 ±13.16	.69	29.51 ±14.89	.76
	C	5.39 ± 6.70	.08	5.58 ± 6.14	.08
SUPB	E	26.65 ±14.59	.41	36.35 ±17.53	.39
	C	6.81 ± 5.66	.39	9.49 ± 6.99	.18
PUUP	E	10.87 ± 5.25	.24	15.89 ± 5.86	.94
	C	6.25 ± 5.47	.25	5.85 ± 4.79	.11
20MR	E	4.32 ± 0.47	.24	4.14 ± 0.35	.42
	C	4.35 ± 0.34	.77	4.28 ± 0.30	.15
BAPO	E	16.32 ± 4.60	.39	12.64 ± 2.48	.68
	C	22.74 ± 7.15	.40	19.21 ± 6.73	.26
DFBB	E	47.20 ± 7.26	.61	49.53 ± 6.32	.89
	C	33.32 ± 7.37	.66	33.51 ± 7.90	1.00

Legend: Mean±SD–mean value±standard deviation, Sig K-S z - Kolmogorov-Smirnov Z test significance, E - experimental group, C - control group, CMJU - the countermovement jump, SQJU - squat jump, MBTO - the medicine ball throw, HIPU - hanging pull ups, SUPB - sit-ups on the bench, PUUP - push-ups, 20MR - the 20m run from a high start, BAPO - the backward polygon, DFBB - deep forward bend on the bench.

Table 3 T-test between groups at the initial and final measurement

Variables	Mean Diff. (E-C)		p		Cohen's d	
	Initial	Final	Initial	Final	Initial	Final
CMJU	4.12	5.53	.000**	.000**	1.01	1.48
SQJU	3.24	5.07	.000**	.000**	0.86	1.34
MBTO	.10	.69	.513	.000**	0.13	0.93
HIPU	16.87	23.93	.000**	.000**	1.88	2.11
SUPB	19.84	26.86	.000**	.000**	2.24	2.50
PUUP	4.63	10.04	.000**	.000**	0.87	1.89
20MR	-.03	-.14	.711	.036*	-0.08	-0.44
BAPO	-6.42	-6.57	.000**	.000**	-1.17	-1.65
DFBB	13.88	16.02	.000**	.000**	1.92	2.26

Legend: Mean Diff (E-C)–the differences obtained when the arithmetic mean of the E group is subtracted from the arithmetic mean of the C group, p - statistical significance of the t-test (*<0.05, **<0.01), Cohen's d - calculated Cohen's index of the size of the differences, CMJU - the countermovement jump, SQJU - squat jump, MBTO - the medicine ball throw, HIPU - hanging pull ups, SUPB - sit-ups on the bench, PUUP - push-ups, 20MR - the 20m run from a high start, BAPO - the backward polygon, DFBB - deep forward bend on the bench.

Differences Between the Initial and Final Measurement

Significant differences between the initial and final measurements were observed (Table 4). For all measured variables of the E group, numerical differences were recorded in favor of better results at the final compared to the initial measurement. According to the eta square results, it can be stated that the experimental treatment (in all variables) had a great positive impact on the motor skills transformation, whereas moderate impact was recorded for the variable DFBB (0.10).

Table 4 T-test between the initial and final measurement

Variables	Paired mean Diff.		p		Eta^2	
	E	C	E	C	E	C
CMJU	-1.31	.10	.000**	.651	0.34***	0.00
SQJU	-1.35	.49	.000**	.035*	0.39***	0.09**
MBTO	-.74	-.15	.000**	.062	0.84***	0.07**
HIPU	-7.24	-.18	.000**	.801	0.66***	0.00
SUPB	-9.70	-2.68	.000**	.000**	0.76***	0.20***
PUUP	-5.02	.40	.000**	.313	0.68***	0.02*
20MR	.17	.06	.000**	.085	0.37***	0.06**
BAPO	3.68	3.52	.000**	.000**	0.68***	0.43***
DFBB	-2.32	-.19	.021*	.753	0.10**	0.00

Legend: Paired mean Diff. - the difference between the arithmetic means between the initial and final measurement, p–statistical significance of differences (*<0.05, **<0.01, Eta^2 - effect size (*=0.01 (small), **>0.06 (moderate), ***>0.14 (large), E - experimental group, C - control group, CMJU - the countermovement jump, SQJU - squat jump, MBTO - the medicine ball throw, HIPU - hanging pull ups, SUPB - sit-ups on the bench, PUUP - push-ups, 20MR - the 20m run from a high start, BAPO - the backward polygon, DFBB - deep forward bend on the bench.

Experimental Program Effects

The numerical differences between the mean values are mostly in favor of the better results of the experimental group, except in the case of the 20MR. Significant differences at the .01 level are observed in over 50% of cases (6 out of 9 variables), namely: the CMJU (.000), SQJU (.008), MBTO (.004), HIPU (.000), PUUP (.000), and DFBB (.001). A significant difference at the .05 level is observed only in the case of the SUPB (.014). The experimental treatment did not produce significant differences for the 20MR (.677) and BAPO (.135), but for the BAPO numerical differences were found in favor of better results of the experimental group. For all variables, it was found that the experimental treatment contributed to a large (HIPU .149), moderate (CMJU .128, SQJU .072, MBTO .084, SUPB .062, PUUP .134, DFBB .115), and small (20MR .002, BAPO .023) positive differences, as indicated by the Eta^2 values. By examining the Eta^2 coefficient, it can be noted that the treatment had a large effect on the differences between the groups at the final measurement. More specifically, this means that the difference between the groups, and thus the applied treatments, explains as much as 68% of the variance in the results on the final measurement of motor skills.

Table 5 Univariate and multivariate analysis of covariance of motor skills between groups at the final measurement

Variables	Adj. Mean E	Adj. Mean C	Adj. Mean diff (E-C)	p	Eta^2
CMJU	21.48	19.55	1.94	.000**	.128**
SQJU	20.49	19.03	1.45	.008**	.072**
MBTO	5.01	4.58	.43	.004**	.084**
HIPU	21.31	13.93	7.39	.000**	.149***
SUPB	25.45	20.60	4.85	.014*	.062**
PUUP	12.89	8.90	3.99	.000**	.134**
20MR	4.23	4.20	.03	.677	.002*
BAPO	15.16	16.65	-1.49	.135	.023*
DFBB	44.78	38.34	6.44	.001**	.115**
Wilks' Lambda=.32; F=8.36; p=.000**; Eta^2=0.68**					

Legend: Adj. Mean–adjusted arithmetic mean (E - experimental group, C - control group), Adj. Mean diff. (E-C) - differences between adjusted arithmetic means, p–significance level, statistical significance of differences (**<0.01, *< 0.05, Eta^2 - size of impact (small*=0.01, moderate**>0.06, large***>0.14), Wilk's Lambda - Wilk's lambda test, F - F approximation, CMJU - the countermovement jump, SQJU - squat jump, MBTO - the medicine ball throw, HIPU - hanging pull ups, SUPB - sit-ups on the bench, PUUP - push-ups, 20MR - the 20m run from a high start, BAPO - the backward polygon, DFBB - deep forward bend on the bench.

DISCUSSION

The aim of the study was to determine the effects of the developmental gymnastics program on the development of motor skills of boys of a younger school age. The study findings are differences in motor abilities in favor of the experimental group already at the initial measurement. After the conducted developmental gymnastics program, even more significant differences were identified, whereas within-group differences between the initial and final measurement were more significant in regard to the experimental group.

Some authors (Coelho, 2010; Corbin et al., 2000) believes that engaging in gymnastics programs may serve as one of the most helpful methods to acquire many basic movements and skills. Since our experimental group revaled better results, our results can be relatable with other published studies (Rudd, 2016; Rudd et al., 2017), since gymnastics offers excellent opportunity for the motor skills development in children. The results of previously conducted studies (Culjak et al., 2014; Fallah et al., 2015; Garcia et al., 2011) also agreed with our results and showed that the gymnastics program has more significant effect on the development of children's motor skills than the current physical education curriculum. This is another example of an effective motor learning process, in which significant changes may be explained by the fact that the motor skills complexity affected the learning process. Furthermore, this sport has a significant amount of various forms of movement, which enables an influence on increasing the adaptive and creative abilities (Madić & Popović, 2012). Knowing that the period of the younger school age is a period of slowed growth and development, as well as a phase of intensive motor skills development (Madić et al., 2009), the participants' age used in the study is adequate and justified. Likewise, the experimental program length is more than appropriate and,

regardless of the motor skills complexity, the program should be considered in the physical education curriculum, as previously stated (Culjak et al., 2014).

In the curriculum for 3rd and 4th grade, the chapter "operational tasks" states: development of coordination, flexibility, balance and explosive strength (for the 3rd grade) and targeted development of basic motor skills, primarily speed and coordination (for the 4th grade) (Curriculum for the 2016/2017 school year). The foregoing implies that the possible reason for achieving lower results (for the control group) on the final measurement for the variables for evaluating repetitive strength of the upper extremities (PUUP) is precisely the curriculum, considering that the curriculum does not mention the development of repetitive strength. Although the curriculum emphasizes the development of explosive strength (in our case the explosive strength of the lower extremities - CMJU), the fact is that the teaching is carried out by teachers, not physical education professors. Hence, due to the insufficient professional teacher qualification (Atlagic et al., 2016), we can assume that the curriculum was not fully realized, and for the aforementioned reasons, the level of motor skills (which were not developed) decreased.

The univariate analysis results indicate significant differences in seven variables and numerical values of adjusted mean values (Adj. Mean) are better for E group participants in eight variables. The results obtained in earlier studies (Karachle et al., 2017) agrees with the our results, in terms of the multivariate and univariate covariance analysis and the results of the Eta^2 coefficient (Table 5). Contrary, that result is not in fully consistent with an earlier published study (Rudd et al., 2017). Nevertheless, it should be taken into consideration the fact that developmental gymnastics should be used as an enhancement of motor performance (Akın, 2013; Culjak et al., 2014), body control (Garcia et al., 2011), and fitness (Lyulina et al., 2013). The abovementioned characteristics are considered as markers of good health and resilience in youth, since they are associated with improved strength and endurance capacities, as a result of putting less effort into every given task (Trajković et al., 2016). In that regard, curriculum creators should pay close attention to the incorporation of physical fitness criteria into movement programs, particularly in early childhood education. Consequently, developmental gymnastics can be a useful and successful approach, particularly when they are planned to meet the developmental requirements of children and delivered by competent physical education teachers (Karachle et al., 2017).

Furthermore, since the recommended daily physical activity for children is 60min. i.e. 300min. a week (Bull et al., 2020), and if it is known that the physical education curriculum is realized 3x a week (135min.), it is inevitable to notice that it is insufficient. This is just another statement that supports the results obtained by this study.

This study has limitations that should be noticed. We did not control the participants' training process and their work/engagement in training sessions, since they exercised in their clubs with their coaches. Likewise, the age limit should be taken into consideration, as well as the fact that this study included male participants only.

CONCLUSION

The obtained results precisely indicate that the experimental program contributed significantly more to the transformation of motor skills than the current physical education program. The control group program provided a positive transformation, but it is not enough nowadays when, thanks to the development of information technology, our children

move less. Bearing in mind the modern way of life, hypokinesia and insufficient physical activity through physical education classes, especially at a younger school age, it is necessary to offer additional age-adjusted programs and compensate for the shortcomings of the modern way of life and inactivity of children. The realized program of developmental gymnastics proved to be adequate and acceptable, so it is recommended for active application in practice, and the greatest contribution would be realized by its implementation in physical education classes.

The conducted study can be of great importance for researchers, pedagogues and educators, who deal with this sensitive phase. Likewise, it is necessary to take a more serious approach to the problem of children's physical (in)activity, and in addition to the all previously mentioned, future studies should pay attention to the previously indicated participant sample structure.

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EFEKTI RAZVOJNE GIMNASTIKE NA RAZVOJ MOTORIČKIH SPOSOBNOSTI DEČAKA

Cilj istraživanja bio je da se utvrde efekti programa razvojne gimnastike na razvoj motoričkih sposobnosti dečaka mlađeg školskog uzrasta. Ukupan uzorak činilo je 107 dečaka (E-54; 10,07±0,91 godina; C-53; 10,36±0,68 godina) iz OŠ „Dušan Radović" iz Niša. Eksperimentalni program je trajao 16 nedelja (3 puta nedeljno po 60 min) i obuhvatao je obuku obaveznih kompozicija programa razvojne gimnastike za decu mlađeg školskog uzrasta. Kontrolna grupa pohađala je redovnu nastavu fizičkog vaspitanja. Za procenu motoričkih veština korišćeni su sledeći testovi: skok iz stojećeg stava sa rukama na kukovima, skok iz čučnja, bacanje medicinske lopte, zgib u visu, trbušnjaci na klupi, sklekovi, trčanje na 20 metara sa visokim startom, stazu sa preprekama unazad i hiperekstenzije na klupi. T-test je pokazao značajne razlike između grupa na inicijalnom merenju, dok su sve uočene razlike u aritmetičkim sredinama bile statistički značajne na finalnom merenju. Rezultati univarijatne analize ukazuju na značajne razlike u šest od devet primenjenih varijabli, dok se na multivarijantnom nivou može uočiti značajna razlika (p=.000). Dobijeni rezultati tačno ukazuju da je eksperimentalni program znatno više doprineo transformaciji motoričkih sposobnosti od dosadašnjeg programa fizičkog vaspitanja. Realizovani program razvojne gimnastike pokazao se adekvatnim i prihvatljivim, pa se preporučuje za aktivnu primenu u praksi, a najveći doprinos bi se ostvario njegovom primenom na časovima fizičkog vaspitanja.

Ključne reči: *razvojna gimnastika, motoričke veštine, napredak, dečaci, mlađi uzrast*