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Research article

THE EFFECTS OF THE "SPORTS IN SCHOOLS" PROGRAM ON THE MOTOR ABILITIES OF OVERWEIGHT AND OBESE CHILDREN

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Ivana Arsić[1], Marko Lasković[1], Slobodan Jovanović[2], Nenad Stojiljković[1]

[1]Faculty of Sport and Physical Education, University of Niš, Niš, Serbia
[2]Faculty of Business, Economics and Entrepreneurship, Belgrade

Abstract. *The aim of this study was to determine the effects of the "Sports in schools" program on the motor abilities of overweight and obese boys and girls. The sample involved 543 students, aged 6 to 11, from 30 elementary schools in the Republic of Serbia. The program was performed as an addition to regular Physical Education classes, twice per week for 45 minutes, during the period of one school year. The overweight (n = 377) and the obese (n = 166) children attended two testing sessions, where the battery of tests was used to assess speed, agility, aerobic endurance and strength. The Wilcoxon signed-rank test was used to determine a significant effect of the program in both groups (Sig. < 0.05). In overweight children, a large effect (r = 0.536 - 0.867) was observed for all variables except for frequent hand movement speed, where the effect was categorized as medium (r = 0.345). A medium effect size (r = 0.158 – 0.495) was noted in obese students for all variables except for the agility test, where the impact of the program was large (r = 0.583). These findings indicate that the "Sports in schools" program contributes to the development of motor abilities in overweight and obese elementary school students. Further research is needed in order to determine the impact of the program on the motor abilities of children with normal nutritional status.*

Key words: *obesity, students, elementary school, fitness, physical education*

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Corresponding author: Nenad Stojiljković
Faculty of Sport and Physical Education, University of Niš, Čarnojevića 10a, 18000 Niš, Serbia
E-mail: snesadif@yahoo.com

INTRODUCTION

Obesity, which is one of the most widespread diseases in numerous countries, is taking on increasing epidemic proportions in children and adolescents (Malik, Willet & Hu, 2020). Overweight and obesity, having serious, negative health consequences, are established predictors for chronic diseases such as CVD, type 2 diabetes, and certain malignancies (Gregor & Hotamisligil, 2011). Excessive weight gain in children and adolescents increases the possibility of hypertension (Lo et al., 2014). More precisely, overweight and obesity in youth is an associated increased risk for abnormal blood lipid levels, including elevated total cholesterol and low-density lipoprotein (LDL)-cholesterol, and low levels of high-density lipoprotein (HDL)-cholesterol (Anderson & Durstine, 2019). However, physical activity positively influences risk factors for the aforementioned chronic diseases (Anderson et al., 2016; Fogelholm, 2010). Moreover, the literature supports that lower morbidity and mortality rates are associated with maintaining moderate levels of physical activity (Warburton, Nicol & Bredin, 2006).

For more than a decade, the scientific literature has indicated an insufficient level of physical activity (Graffiths et al., 2013), as well as the level of engagement of children in Physical Education (PE) classes (Nettlefold et al., 2011; Simonsmorton, Taylor, Snider, Huang, & Fulton, 1994). Therefore, a high percentage of students who do not follow the recommendations regarding physical activity can be expected (Guthold et al., 2010). On the other hand, physical activity in schools should be a crucial component of the educational process and a key determinant in social, motor, emotional and cognitive development (Bailei, 2006). In this regard, PE has an important role, not only in fulfilling the need for movement, but also in developing healthy habits that can be maintained in older age (Milenković, 2018). Consequently, it remains unclear why PE classes have been shortened in many European countries (Hardman, 2008). As a result, new research suggests that regular PE classes do not contribute to the development of motor skills, that is, cardiovascular endurance, strength and mobility. Furthermore, the authors emphasize that the influence of PE classes on changes in body composition is insufficient (Packham & Street, 2019). Regarding the aforementioned, many institutions propose extracurricular programs of sports activities to schools and parents in an attempt to reduce a sedentary lifestyle and promote physical activity (Colella & Morano, 2011).

Bearing this in mind, as well as the fact that the level of physical activity is decreasing globally (Guthold, Stevens, Riley & Bull, 2018), the experts have been searching for alternative solutions in recent years. Thus, Colella & Morano (2011) observed that additional PE classes significantly contribute to the motor development of students, regardless of age and gender. Further, a group of authors (Seabra et al., 2016) compared the effects of school-based soccer, traditional exercise, and PE classes on body composition and aerobic endurance in obese children, where students from the experimental groups performed additional physical activities three times a week for 60 to 90 minutes. Significantly lower body fat percentage, waist circumference, and cholesterol levels were found in the experimental groups, while students who attended only PE classes had significantly poorer aerobic endurance. Cvetković et al. (2018) support these findings, given that after a 12-week experimental treatment, they determined that additional physical activity in the form of recreational soccer or interval training contributes to positive changes in body composition and motor skills in elementary school-age children. In addition, numerous studies highlight the benefits of increased volume of physical activity in youth, as well as the advantages of different programs

compared to regular PE classes (Aires et al., 2016; Datar & Strum, 2004; Jansen et al., 2011; Lau et al., 2015; Seabra et al., 2014; Thivel et al., 2011). The data do not differ when it comes to students from Balkan countries. A basic exercise program, consisting of athletic and gymnastic exercises, has a greater impact on children's motor skills and it is superior to regular PE classes, according to Škrkar (2021). Once more, there are numerous authors supporting this claim (Lasković, Marković & Stanković, 2022; Marković, 2015; Popovic, Arifi, Zarkovic & Corluka, 2021; Stanković, Veljković, Marković & Herodek, 2020; Škrkar, Madić, Popović & Radanović, 2020).

Although the authors agree on the disadvantages of PE classes, it is essential to find an approach to implement any prospective solutions. Therefore, the project "Sports in schools", supported by Ministry of Youth and Sports of the Republic of Serbia, offers to students an interesting, professionally led, sports program. The goal of the project is to provide students with a cost-free exercise program during their leisure time, near their homes, which is realized in the company of their peers. The content of the program focuses on the acquisition and improvement of motor skills, that is, the development of physical abilities, primarily coordination, mobility and endurance.

Therefore, the aim of this study was to determine the effects of the "Sports in schools" program on the motor abilities of overweight and obese school-age children.

METHODS

Study design

A design of two groups, a pretest and post-test, was utilized in this study. The experimental program lasted for one school year, i.e. 10 months, which was implemented as an addition to regular PE classes. Each week of the program consisted of 2 training sessions lasting 45 minutes each. Before the beggining of the program, the initial measurement was carried out by qualified specialists. After the intervention, the final measurement was conducted by the same assesors, using the same test order and procedure as on the initial measurement.

Participants

This study included 543 students, aged 6 to 11, from 30 elementary schools in the Republic of Serbia. The nutritional status of the participants was evaluated by inserting the calculated BMI values into corresponding BMI growth charts, specific for the age of the students. They were divided in two groups due to their BMI. The first group consisted of overweight boys and girls (n = 377; body height: 136.05 ± 9.03 cm; body mass: 37.18 ± 6.67 kg; BMI: 19.94 ± 1.47 kg/m^2). Obese students were in the second group (n = 166; body height: 135.05 ± 8.85 cm; body mass: 44.12 ± 7.92 kg; BMI: 24.03 ± 2.12 kg/m^2).

The benefits, risks and procedures involved with participation were explained to all the students prior to testing. Students provided consent for the participation in this study which was carried out in accordance with the Declaration of Helsinki. Permission was obtained from the school management as well as the parents, given that the participants were minors at the time when the study was bein conducted.

Procedures

Measurements of body height were carried out with an anthropometer to the nearest 0,1 cm (anthropometer according to Martin). Body mass was collected by using an electronic scale (HBF-511B-E; Omron Healthcare) to the nearest 0.1 kg, while participants were barefoot, wearing the clothes in which they practice (Đurašković, 2001).

The motor abilities, tested in this study, included speed, agility, aerobic endurance and muscle strength of the trunk and lower limb muscles. The hand tapping test was used to assess frequent hand movement speed (Kurelić et al., 1975). The standing long jump test was used to assess the strength of the lower limb muscles (Castro-Piñero et al., 2010), while the curl up test was used to assess the strength of the trunk muscles, which was conducted in accordance with the instructions previously provided (Meredith & Welk, 2010). The 10 x 5 m test was used to assess speed and agility (Kurelić et al., 1975), and the standardized 20m shuttle run test was used to assess aerobic endurance of overweight and obese children (Ramsbottom et al., 1988).

Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (v20.0, SPSS Inc., Chicago, IL, USA). The results are presented as Mean ± SD. Given that all data significantly deviate from the normal distribution (Table 1), in order to examine the effect of the program by groups on the change in the average values of the observed variables, the Wilcoxon signed-rank test was used. The Wilcoxon signed-rank test represents a non-parametric test procedure for the analysis of matched-pair data, based on differences (Woolson, 2007). Further, Rosenthal's formula was used to calculate the effect size (Rosenthal, Cooper & Hedges, 1994). The magnitude of the effect size was interpreted as: small (r = 0.1 – 0.3); medium (r = 0.3 – 0.5); large (r > 0.5) (Cohen, 1988).

Table 1 The normality of the data - the initial measurement (n = 543).

Variables	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
Body height (*cm*)	0.052	0.000	0.996	0.000
Body mass (*kg*)	0.081	0.000	0.953	0.000
BMI (kg/m^2)	0.095	0.000	0.934	0.000
Tapping test (*sec*)	0.059	0.000	0.969	0.000
Long jump (*cm*)	0.039	0.000	0.998	0.007
Sit ups (*repetitions*)	0.077	0.000	0.989	0.000
10x5 Shuttle test (*sec*)	0.096	0.000	0.896	0.000
Shuttle run test (*sec*)	0.193	0.000	0.909	0.000

RESULTS

The basic descriptive parameters of overweight boys and girls are presented in Table 2. In Table 3 the basic descriptive parameters of obese boys and girls are shown. Children in both groups had higher mean values of body height and body mass on the final measurement. The average BMI value was lower only in obese boys and girls after the intervention (initial: 24.03 ± 2.12, final: 23.69 ± 2.67). The improvement in motor abilities was made in both groups, considering that students achieved better results on all the tests.

Table 2 The basic descriptive parameters of overweight boys and girls (n = 377).

Variables	Mean ± SD		Min		Max		Range		Skewness		Kurtosis	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Body height (*cm*)	136.05 ± 9.03	139.83 ± 9.11	107	110.9	161	165.5	54	54.6	0.13	0.03	-0.25	-0.15
Body mass (*kg*)	37.18 ± 6.67	38.65 ± 8.52	20.5	29	57.4	61	36.9	32	0.39	-0.91	-0.16	3.67
BMI (kg/m^2)	19.94 ± 1.47	19.96 ± 1.91	14.6	14.26	24	26.25	9.4	11.99	0.32	-0.22	0.56	0.78
Tapping test (*sec*)	18.68 ± 4.79	18.19 ± 4.45	9	8.8	34	33	25	24.2	0.75	0.52	0.53	0.30
Long jump (*cm*)	118.10 ± 20.21	124.45 ± 20.09	50	60	187	178	137	118	-0.01	-0.15	-0.01	-0.20
Sit ups (*repetitions*)	16.38 ± 4.49	17.72 ± 4.44	2	4	30	31	28	27	-0.04	-0.02	0.33	0.53
10x5 Shuttle test (*sec*)	25.04 ± 3.72	24.13 ± 3.21	142	137	463	407	321	270	1.66	1.23	6.41	4.32
Shuttle run test (*sec*)	295.61 ± 135.07	327.78 ± 137.90	102	102	909	909	807	807	1.10	0.84	1.83	1.08

Table 3 The basic descriptive parameters of obese boys and girls (n = 166).

Variables	Mean ± SD		Min		Max		Range		Skewness		Kurtosis	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Body height (*cm*)	135.05 ± 8.85	139.12 ± 8.57	110	113	153	158.5	43	45.5	-0.27	-0.27	-0.20	0.09
Body mass (*kg*)	44.12 ± 7.92	45.69 ± 9.43	29	38	65.5	71.5	36.5	33.5	0.53	-0.65	-0.25	3.59
BMI (kg/m^2)	24.03 ± 2.12	23.69 ± 2.67	20.6	14.69	31.1	31.35	10.5	16.66	0.92	0.05	0.92	0.94
Tapping test (*sec*)	19.99 ± 4.96	19.09 ± 4.80	11	10	39	38	28	28	1.09	1.15	1.92	2.06
Long jump (*cm*)	111.03 ± 21.48	115.77 ± 21.07	54	59	160	172	106	113	-0.28	-0.13	-0.44	-0.17
Sit ups (*repetitions*)	14.47 ± 4.59	15.87 ± 4.57	2	3	30	31	28	28	0.18	0.27	1.07	1.47
10x5 Shuttle test (*sec*)	26.71 ± 4.58	25.68 ± 3.89	203	200	462	414	259	214	1.63	1.48	4.14	3.47
Shuttle run test (*sec*)	279.87 ± 105.87	304.60 ± 112.95	104	102	605	706	501	604	0.84	0.83	1.13	0.92

The effects of the "Sports in school" program on morphological characteristics and motor abilities in overweight and obese children are presented in Table 4 and Table 5. A significant effect of the program is observed in both groups (*Sig.* < 0.05). In the first group a *large* effect (r = 0.536 – 0.867) was noted in all the variables except for BMI and the Tapping test, where a *medium* effect was obtained (r = 0.113, r = 0.345). In the second group, the magnitude of the effect size was categorized as *medium* in all variables (r = 0.158 – 0.495) except for body height, body mass and the 10x5 shuttle test, where the impact of the program was *large* (r = 0.583 – 0.867).

Table 4 The effects of the "Sports in school" program on the morphological characteristics and motor abilities of overweight children – the Wilcoxon signed rank test.

Variables	Z	Sig.	r	Magnitude
Body height	-14.997	0.000	0.772	Large
Body mass	-16.826	0.000	0.867	Large
BMI	-2.191	0.028	0.113	Medium
The tapping test	-6.699	0.000	0.345	Medium
The long jump	-12.438	0.000	0.641	Large
Sit ups	-10.410	0.000	0.536	Large
10x5 Shuttle test	-10.805	0.000	0.556	Large
Shuttle run test	-10.452	0.000	0.538	Large

Table 5 The effects of the "Sports in school" program on the morphological characteristics and motor abilities of obese children – the Wilcoxon signed rank test.

Variables	Z	Sig.	r	Magnitude
Body height	-9.649	0.000	0.749	Large
Body mass	-11.175	0.000	0.867	Large
BMI	-2.038	0.042	0.158	Medium
The tapping test	-6.373	0.000	0.495	Medium
The long jump	-6.067	0.000	0.471	Medium
Sit ups	-5.987	0.000	0.465	Medium
The 10x5 Shuttle test	-7.515	0.000	0.583	Large
Shuttle run test	-6.205	0.000	0.482	Medium

DISCUSSION

This study investigated the effects of the "Sports in schools" program on the motor abilities of overweight and obese elementary school students. After 10 months of the experimental program, significant improvements were observed in both groups. The magnitude of the effect size ranged from medium to large, indicating that exercises, performed in the program, contributed considerably to the development of muscle strength, speed, agility and aerobic endurance. However, the impact of the program on particular motor abilities differed between groups.

Notwithstanding that the present study is the first to examine the effects of the program, as part of the "Sports in schools" project, the findings are in accordance with the previous research regarding the effects of extracurricular exercise programs. As Yuksel et al. (2020) pointed out, interventions in school-age children that focus more on the content,

quality and duration of physical activity have a greater potential for obesity prevention and development of motor abilities. Thus, a basic exercise program, properly implemented, can have a positive effect on children's development. Škrkar (2021) carried out a program that consisted of athletic and gymnastic exercises, which significantly improved the tested motor abilities, while that was not the case with the control group that attended regular PE classes. In addition, it has been shown that different programs of physical activity have a positive effect on the morphological characteristics and motor abilities of overweight and obese children (Carrel et al., 2005; Kovács, Fajcsák, Gabor & Martos, 2009). The exercise program, which was a supplement to the regular PE classes, led to a significant improvement not only in aerobic, but also in anaerobic abilities (Thivel et al., 2011). Moreover, a large increase in the volume of physical activity is not necessarily required for ensured progress. Adequate content of the program has an important role in the development of children's motor abilities. Thus, Chang et al. (2020) increased the muscle strength of students by implementing a 10-minute warm up in PE classes, focusing on the activation of the core muscles.

Apart from the research examining the effects of specific exercise programs, a group of authors (Ardoy et al., 2011) investigated whether simply increasing the volume and intensity of PE classes would contribute to the motor development of elementary school children. It was determined that the increased volume of PE classes would improve students' aerobic endurance and mobility. Further, if both the volume and the intensity were increased, a significant effect on the speed and agility would be achieved as well. It seems that there are numerous methods in which children's motor development can be positively influenced, given that the effect of the team sports program has also been determined. The results of the meta-analysis confirmed that team sports improve children's body composition, aerobic endurance, and muscle strength (Oliveira, Monteiro, Jácome, Afreixo & Marques, 2017). Therefore, the traditional form of exercise in PE classes may not be the optimal tool for the motor development of school-age children.

Despite the fact that it was previously stated that excess body weight might inhibit obese children from developing their motor abilities (Castetbon & Andreyeva, 2012), the findings in this study, along with the aforementioned, show the opposite. However, several shortcomings of this study need to be emphasized. Given that the children could have participated in extracurricular physical activities, besides the experimental program, comprehending the results becomes difficult. Therefore, the lack of a control group represents the main drawback of this research. Additionally, a larger number of participants, who will be normally distributed by groups, is desirable. For a better understanding of the impact of the program on motor development, it is important to ascertain how it affects students with different nutritional status, hence future research should examine differences between groups, including children with normal nutritional status. Conclusively, in order to determine which is superior, future research should consider comparing the effects of the "Sports in schools" program and traditional PE classes on the motor abilities of younger school-age children.

CONCLUSION

The findings in this study indicate that the physical activity program , as a part of the "Sports in schools" project, has a positive effect on the motor abilities of overweight and obese children. It can be concluded that a well-designed and professionally led exercise

program, as an addition to regular PE classes, represents an adequate tool for the overall motor development of younger school-age students. Moreover, involving children in additional physical activity programs increases the probability of preventing obesity. Therefore, parents and PE teachers should encourage children to participate in additional physical activity programs in order to raise awareness of its importance.

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EFEKAT PROGRAMA "SPORT U ŠKOLE" NA MOTORIČKE SPOSOBNOSTI GOJAZNIH

Cilj ovog istraživanja bio je da se utvrdi efekat programa "Sport u škole" na motoričke sposobnosti gojaznih dečaka i devojčica. Uzorak ispitanika činilo je 543 učenika, uzrasta od 6 do 11 godina, iz 30 osnovnih škola Republike Srbije. Program se realizovao kao dodatak regularnoj nastavi fizičkog vaspitanja, dva puta nedeljno u trajanju od 45 minuta, tokom jedne školske godine. Učenici sa prekomernom telesnom masom (n = 377) i gojazni učenici (n = 166) testirani su pre i nakon eksperimentalnog tretmana, gde je procenjen nivo brzine, agilnosti, aerobne izdržljivosti i mišićne snage. Wilcoxon-ov test ranga je sproveden, nakon čega je utvrđen statistički značajn efekat programa kod obe grupe ispitanika (Sig. < 0,05). Kod dece sa prekomernom telesnom masom, utvrđen je veliki uticaj programa (r = 0,536 - 0,867) na sve varijable, osim na brzinu pokreta ruku, gde je ostvaren efekat srednje veličine (r = 0,345). Efekat srednje veličine (r = 0,158 - 0,495), kod gojaznih učenika, ostvaren je na sve motoričke sposobnosti, osim na agilnost, gde je efekat programa bio veliki (r = 0,583). Rezultati istraživanja potvrđuju da program "Sport u škole" doprinosi motoričkom razvoju gojaznih učenika mlađeg školskog uzrasta. Dodatna istraživanja potrebna su kako bi se utvrdili efekti programa na motoričke sposobnosti dece sa normalnim telesnim statusom.

Ključne reči: *gojaznost, učenici, osnovna škola, fitnes, fizičko vaspitanje*