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Physical Education Curriculum is Effective in Development of Motor Abilities in 9th grade School Children?

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Abstract

Physical education plays an important role in developing motor abilities, skills and competence in children. Main objective is to evaluate the effectiveness of physical education curriculum by assessing in 9th grade schoolchildren: (1) abdominal muscle strength; (2) lower back muscle strength; (3) upper limbs muscle strength; (4) lower limbs muscle strength; (5) explosive leg power; and (6) flexibility of the lower back and hamstring muscles, at the beginning, and at the end of the school term. Basic mathematical and appropriate statistical methods were used in order to calculate descriptive statistical parameters, Skewness and Kurtosis values, as well as Kolmogorov-Smirnov test, were used in order to examine whether data have a normal distribution, and a Student's t-test was applied in order to test if there is a statistically significant difference in children's motor abilities between the beginning and the end of the school term. For this purpose, we used Microsoft Office Excel 2010. At the end of the second school term, children in 9th grade have shown better results in all assessed variables, meaning they have increased motor ability levels after 4 months of applying specific exercises within the thematic plan of the physical education curriculum, which leads to the conclusion that physical education curriculum allows us to introduce effective tasks in increasing strength, explosive power and flexibility in 9th grade school children.

Keywords: *Physical Education, Curriculum, Motor Abilities, Children, Development*

Introduction

School physical education provides a context for regular and structured physical activity participation, and contributes to children's health and fitness, that is a common justification for its place in the school curriculum (Physical Education Association of the United Kingdom, 2004). In many countries, physical education classes are mandatory at both the primary and secondary levels, and for some sedentary children and adolescents, such classes may represent the only context in which they experience physical activity and motor challenges. Indeed, guidelines from national education ministries typically state that, through physical education, pupils shall experience motor learning and development by conducting a wide range of activities (e.g., swimming, team and individual sports, play and dance), indoors and outdoors (Australian National Curriculum in Physical Education, n.d.; England National Curriculum in Physical Education, n.d.; Singapore National Curriculum in Physical Education, n.d.; Loras, 2020).

Physical education lessons overarching goals are students: to take part in sport and physical activities; to gain sufficient knowledge and motor skills; and to get motivated to stay physically active outside school and throughout life. Thus, the emphasis of learning during physical education lessons focuses on: motor, cognitive, social, spiritual, cultural or moral development (Fairclough & Stratton, 2005). In order to achieve this, above mentioned aspects should be delivered within a curric-

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ulum which provides a diverse range of physical activity and exercise so that children will have the opportunity to improve. However, physical education teachers often adapt physical education curriculum and teaching approaches according to: class size, available space, organizational strategies and lesson content (Stratton, 1996).

Motor abilities and physical fitness level in school children, are a potent biomarker of motor development, effectiveness of the physical education curriculum, and health (Ortega, Ruiz, Castillo, & Sjöström, 2008). In order to assess motor abilities and physical fitness in school children, teachers use practical and easy-to-perform tests (Latorre-Román, García-Pinillos, & Mora-López, 2017). Thus, in the present study, it was used the test battery of Jovanovski (1998) to assess muscular strength, explosive leg power and flexibility. Muscular strength is defined as the ability to generate the maximal amount of force while performing a particular exercise (American Council on Exercise, 2014); explosive power as an ability to perform a maximum effort in a minimum amount of time (Singh, Kumar, & Ranga, 2017), while flexibility is typically characterized by the maximum range of motion in a joint or series of joints (McHugh, Kremenic, Fox, & Gleim, 1998).

More precisely, objective of this study is to evaluate the effectiveness of physical education curriculum in 9th grade school-children by assessing: abdominal muscle strength; lower back muscle strength; upper limbs muscle strength; lower limbs muscle strength; explosive leg power; and flexibility of the lower back and hamstring muscles (at the beginning, and at the end of the school term).

Methods

Participants

The present pilot-study is performed on a sample of 16 participants, pupils in 9th grade (14.59±0.33 years) in Elementary School Dimkata Angelov-Gaberot, in village Vatasha (municipality of Kavadarci, North Macedonia). The evaluation process took place during the academic year 2020/2021 at the same school with respect to all prevention and protection protocols due to COVID-19. The study was approved in advance by the principal of the Elementary School Dimkata Angelov-Gaberot, while parents of each pupil involved in the study, gave an individual approval.

Instruments

In order to realise the particular aim of the study, first it was performed measurement of some anthropometric characteristics (height, weight and BMI) in the children. They were measured barefoot and wearing light clothes, according to WHO manual (World Health Organization, 2007). Height was measured using a wall mounted stadiometer (SECA SE206). To measure weight a calibrated digital scale was used (TANITA TBF 300). BMI was calculated from height and weight as follows: Weight (kg)/Height(m)^2 (WHO, 2007).

Then, it was assessed muscular strength (abdominal, lower back, upper limbs and lower limbs), explosive leg power and flexibility (lower back and hamstring muscles) in pupils, by applying the test battery of Jovanovski (1998): (1) abdominal muscle strength test - abdominal crunches (in 1 min); (2) lower back muscle strength test - back extensions (in 1 min); (3) upper limbs muscle strength test – push ups (in 1 min); (4) lower limbs muscle strength test - squats (in 1 min); (5) lower limbs muscle strength test - standing long jump (in cm); and (6) flexibility of lower back and hamstring muscles test - sit and reach (in cm).

All the measurements and evaluation process took place twice: at the beginning of the second school term; and at the end of the second school term of the academic 2020/2021 year.

Intervention

Physical education curriculum in the second school term was used as an intervention to improve motor abilities in 9th graders. It is mainly consisted of exercises to increase: abdominal muscle strength; back muscle strength; upper limbs muscle strength; lower limbs muscle strength; explosive power; flexibility; balance; and motor coordination. It is described in more detailed way elsewhere (Bureau for development of Education, n.d). Specific exercises applied during physical education classes are: abdominal crunches; back extensions; push-ups; chin-ups; pull-ups; squats; plyometric jumps; and stretching exercises (Table 1). At the beginning of the school term, children did 3 sets, 10 repetitions in each (3x10) of the specific exercises planned for the class, with a 60-90s rest in between each set and 2 min rest between exercises. Then, in the following weeks, they progressively increased number of sets and repetitions in accordance with their own abilities. However, at the beginning of each class, before doing the main exercise part, children had 5-10 min to do the warm-up. It included: easy running (forward and sideways) accompanied with jumping; overall body exercises to mobilize joints; and specific warm-up related to the content of the main exercise part. At the end of each class children had 5-7 min to do the stretching, with the main focus on back and hamstring muscles. Children had physical education classes thrice per week, while the initial measurement took place at the end of January, and the final measurement took place after 4 months at the end of May of the academic 2020/2021.

Table 1. Physical exercises within the thematic plan of physical education curriculum and the specific exercises applied during classes

Physical Exercises within physical education curriculum	Specific Exercises applied during class
abdominal muscle strength	abdominal crunches
lower back muscle strength	back extensions
upper limbs muscle strength	a) push-ups b) chin-ups c) pull-ups
lower limbs muscle strength	a) squats b) squat position holds
explosive leg power	plyometric jumps
flexibility of lower back and hamstring muscles	a) static stretches b) dynamic stretches

Data analysis

Basic mathematical and appropriate statistical methods were used in order to calculate descriptive statistical parameters. Skewness and Kurtosis values, as well as Kolmogorov-Smirnov test, were used in order to examine whether data have a normal distribution. Student's t-test was applied in order to test if there is a statistically significant difference in children's motor abilities between the beginning and the end of the school term i.e. between the initial and final measurement. For that purpose we used Microsoft Office Excel 2010.

Results

According to the data presented in Table 2, results at the initial measurement of children in 9th grade have a normal distribution, with a normal asymmetry considered when values for Skewness are in a range between -1,00 to 1,00 (Zeqiri, Stojmanovska, & Georgiev, 2020), and Kurtosis values that are in an acceptable range of -3 to 3 as proposed by Kallner (2013).

Table 2. Descriptive statistical parameters of children in 9th grade (Initial Measurement)

	N	Min	Max	Mean	SD	Skewness	Kurtosis	K-S
Weight (kg)	16	41,00	90,00	57,69	14,26	0,81	-0,15	p > .20
Height (cm)	16	158,00	185,00	167,56	7,03	0,95	1,34	p > .20
BMI*	16	14,70	28,80	20,45	4,43	0,81	-0,44	p > .20
Abdominal crunches (rep)	16	20,00	42,00	30,63	6,89	0,32	-1,18	p > .20
Back extensions (rep)	16	10,00	35,00	22,75	6,81	-0,03	-0,55	p > .20
Push ups (rep)	16	3,00	17,00	10,44	3,83	-0,04	-0,55	p > .20
Squats (rep)	16	25,00	40,00	35,13	4,10	-0,99	1,19	p > .20
Standing long jump (cm)	16	105,00	240,00	168,44	36,41	0,28	0,28	p > .20
Sit and reach (cm)*	16	29,00	64,00	42,25	11,19	0,75	-0,60	p > .20

Note: N - Number of respondents; Min - Minimum value; Max - Maximum value; Mean - Arithmetic mean; S.D. - Standard deviation; Skewness - A measure of asymmetry; Kurtosis - A measure of flattening; K-S - Kolmogorov–Smirnov test; * - Variable with an opposite metric orientation

Table 3. Descriptive statistical parameters of children in 9th grade (Final Measurement)

	N	Min	Max	X	SD	Skewness	Kurtosis	K-S
Weight (kg)	16	41,00	88,00	57,44	13,77	0,73	-0,35	p > .20
Height (cm)	16	158,00	185,00	167,56	7,03	0,95	1,34	p > .20
BMI*	16	14,70	28,80	20,37	4,31	0,79	-0,41	p > .20
Abdominal crunches (rep)	16	19,00	47,00	32,50	8,79	0,05	-1,16	p > .20
Back extensions (rep)	16	14,00	40,00	26,38	7,64	0,24	-0,81	p > .20
Push ups (rep)	16	5,00	21,00	11,81	4,69	0,55	-0,81	p > .20
Squats (rep)	16	29,00	50,00	38,19	5,34	0,61	0,59	p > .20
Standing long jump (cm)	16	105,00	250,00	172,50	39,33	0,39	0,10	p > .20
Sit and reach (cm)*	16	29,00	64,00	41,38	11,04	0,83	-0,45	p > .20

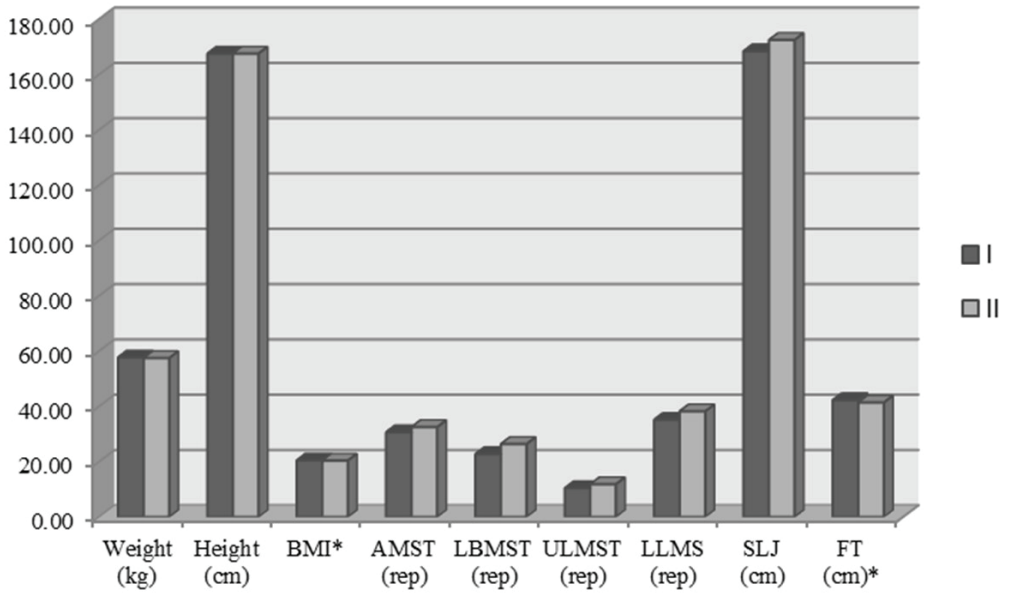
Based on data presented in Table 3, results at the final measurement of children in 9th grade have a normal distribution too, with a normal asymmetry considered when values for Skewness are in a range between -1,00 to 1,00 (Zeqiri et al., 2020), and Kurtosis values that are in an acceptable range of -3 to 3 as proposed by Kallner (2013).

Table 4. Arithmetic means at the initial and final measurement, t-test and p-value for children in 9th grade

	I	II	t – test	p level
Weight (kg)	57,69	57,44	1,07	0,300
Height (cm)	167,56	167,56	/	/
BMI*	20,45	20,37		
Abdominal crunches (rep)	30,63	32,50	-2,10	0,050
Back extensions (rep)	22,75	26,38	-6,93	0,000
Push ups (rep)	10,44	11,81	-3,08	0,010
Squats (rep)	35,13	38,19	-3,31	0,000
Standing long jump (cm)	168,44	172,50	-3,57	0,000
Sit and reach (cm)*	42,25	41,38	3,66	0,000

Note: * - Variable with an opposite metric orientation

According to what is presented in Table 4, we can conclude that there is a statistically significant difference in children at 9th grade, before the start of the second school term, and at the end of the second school term of the academic 2020/2021, in: abdominal muscle strength; lower back musle strength; upper limbs muscle strength; lower limbs muscle strength; explosive leg power; and flexibility of lower back and hamstring muscles. In addition, there is no statistically significant difference in the same children regarding weight (kg). The height (cm) remained unchanged during the period of 4 months. Children in 9th grade have shown better results in all assessed variables at the end of the second school term, meaning they have increased motor ability levels after 4 month of applying specific exercises within the thematic plan of the physical education curriculum, which leads to the constatation that the physical education curriculum allows us to introduce effective tasks in increasing strength, explosive power and flexibility in school children (Figure 1).



Note: AMST – abdominal muscle strength test; LBMST – lower back muscle strength test; ULMST – upper limbs muscle strength test; LLMS – lower limbs muscle strength test; SLJ - standing long jump; FT - flexibility test, * - variable with an opposite metric orientation

FIGURE 1. Comparison between initial (I) and final (II) measurement in children at 9th grade

Discussion

A major finding of the present study is that children in 9th grade significantly increased their muscular strength, explosive leg power and flexibility in response to an exercise program that is part of the physical education curriculum, and that was applied during the physical education lessons, thrice per week, within a 4 months duration, in the second school term of the academic 2020/2021.

Similarly, Faigenbaum, Zaichkowsky, Westcott, Micheli, & Fehlandt (1993) found a statistically significant increase in strength due to a training program consisted of exercises to improve strength following only 2 months of strength training, in children that were 8-12 years old. In addition Ramsay et al. (1990) also noted significant gains in strength following similar training intervention consisted of a program of structured strength exercise.

Current evidence indicates that children can increase muscle strength as a consequence of a programed exercises to improve strength, and this increase may be a result of increased neuromuscular activation and coordination, since according to Guy & Micheli (2001) the increase in strength in children is not a consequence of muscle hypertrophy as it is in adults.

Furthermore, in line with our results Fischetti, Vilardi, Cataldi, & Greco (2018) have also shown that plyometric exercises such as jumps, are effective in improving lower limbs power performance, and Coons, Gould, Kim, Farley, & Caputo (2017) demonstrated that one month of dynamic and static stretching added to a plyometric training program are enough to improve flexibility.

Thus, we may consider school as an ideal setting in which motor development tasks can be implemented. A public school-based physical education curriculum offers a good opportunity to improve motor abilities in children that are very important in everyday life (Zahner et al., 2006).

Conclusion

At the end of the second school term, children in 9th grade have shown better results in: abdominal muscle strength; lower back muscle strength; upper limbs muscle strength; lower limbs muscle strength; explosive leg power; and flexibility of lower back and hamstring muscles, meaning they have increased motor ability levels after 4 months of applying exercises within the thematic plan of the physical education curriculum, which leads to the constatation that the physical education curriculum may be effective in increasing strength, explosive power and flexibility in 9th grade school children. However, we must point out the small sample size included as the major limitation of this pilot-study. Children from one class may not be representative for the whole population. Thus, this pilot-study will serve as a direction for a future research.

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Conflict of Interest

The authors declare that there is no conflicts of interest.

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