



ORIGINAL SCIENTIFIC ARTICLE

THE SEVENTH AND EIGHTH GRADE PRIMARY SCHOOL STUDENTS' PHYSICAL FITNESS AND RESULTS ON THE GYMNASTICS POLYGON

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Accepted for Publication: August 14, 2023

Published: August 30, 2023

DOI: 10.17309/tmfv.2023.4.15

Abstract

The purpose of the study was to determine the connection between physical fitness and the results on the gymnastics polygon in the seventh and eighth grade elementary school students. Additionally, it was necessary to determine the differences in the observed variables in relation to the grade, separately for each gender.

Materials and methods. A total of 128 students from three elementary schools (64 male and 64 female students), 13 and 14 years old, participated in the testing. Five physical fitness tests were used (modified agility "T" test (MAT), Illinois agility run test, 10×5 shuttle run test, standing balance test and 2-minute step in place test), and a specially designed gymnastics polygon was used to assess the level of adoption of technical elements from artistic gymnastics.

Results. A statistically significant correlation was recorded between all observed parameters with different levels, from moderate to strong correlations, both in relation to the grade, as well as in relation to the gender of the students. It was also determined that in boys, there are differences in only one test (MAT) in favor of the eighth graders, while in girls, there was a difference in three tests (MAT; 10x5 shuttle test; 2-minute step in place test) in favor of the eighth graders.

Conclusions. So it can be concluded that there is a strong mutual connection between physical fitness and sports-specific skills, which are presented in this paper by means of the technical elements of artistic gymnastics.

Keywords: physical development, artistic gymnastics, physical education, male and female students.

Introduction

Sports activities form the basis of the physical education program. Physical education classes that include such activities affect the development of morphofunctional (Prontenko et al., 2020) and physical fitness (Ward et al., 2017). Sports content in the physical education program, in addition to improving physical fitness, also contributes to the development of fundamental motor and sport-specific skills and tactical knowledge (Milenković, 2022; Hastie, Martinez de Ojeda & Calderon, 2011; Wallhead & O'Sullivan, 2005), which makes physical education classes a spot where it is possible to master and improve a large number of such skills and knowledge in order to improve motor status of the students (Milenković, 2021). Sports-specific skills are trained and perfected through various sports activities in the form of team and individual sports. One of the sports activities is artistic gymnastics.

In artistic gymnastics, various technical elements are performed on different devices on which the exercisers master their body mass. Successful performance of these routines requires a high level of physical fitness (Kolimechkov, Petrov & Alexandrova, 2021). Due to its structure, physical requirements and physiological profile, artistic gymnastics belongs to the group of coordination-difficult aesthetic-technical disciplines (Boraczyński, Boraczyński, Boraczyńska & Michels, 2013). Artistic gymnastics, as a basic sport, is one of the most important contents of the physical education program in elementary school (Pajek, Čuk, Kovač & Jakše, 2010). Within this activity, which can be practiced from an early age, children are introduced to basic elements such as jumping, hanging, rotating, crawling, rolling, etc. Artistic gymnastics has had a central position in the physical education program for years and manages to keep it as one of the basic sports. It improves body management during the development of locomotor, non-locomotor and manipulative skills, promotes the development of coordination, flexibility, agility, muscle strength, endurance and bone strength, thus improving the body's health bulletin and a physically active

lifestyle (Werner, Williams & Hall, 2012, 5). The aims in the study of artistic gymnastics in the physical education program range from the contribution that gymnastics can make to the achievement of psychomotor competence at younger ages, through the use of this skill to understand the relationship between the structure and function of the body in the middle years of schooling, to the appreciation of not only the complex nature of movement in general, but also the context of artistic gymnastics in its widest sense in older school-aged children (Mauldon, 2014, 17).

Effective practice of sports content in physical education can also be performed through polygons, which represent a unique exercise with multiple tasks in order to perform motor activities without a break, with faster or slower continuous movement from one task to another (Rašidagić, Manić & Mahmutović, 2016). Polygons are very useful in the creative aspect of the organization of classes through very interesting and dynamic exercises/tasks that are at the same time very useful for the development of physical fitness and the improvement of sports education (Milenković, 2021). Polygons give results in the development of motor skills (Marinković, Pavlović, Korovljev, Dimitrić & Bogdanovski, 2016) and functional capacity (Bekić, Alić, Atiković & Emić, 2017). They can be used at different ages, such as high school (Milenković & Stanojević, 2013), older grades of elementary school (Milenković, 2022), but also to improve the motor skills of children in younger grades of elementary school (Pavlović, Marinković & Marković, 2018). Polygons are very effective in physical education with an important physical and mental impact on children (Popa, Contiu & Bădău, 2019).

Given the importance of the elements of physical development that are the subject of this paper, this research aims to determine the connection between physical fitness and the results on the gymnastics polygon in the seventh and eighth grade elementary school students. It is assumed that there is a statistically significant relationship between these elements of motor status, both in boys and girls. Additionally, the differences in the observed variables in relation to the grade should be determined, separately for each gender. The importance of this research is to identify which indicators of children's physical fitness have the greatest influence on the performance of gymnastic elements in the physical education program for elementary school students, in order to more effectively direct work towards their further development.

Materials and methods

Participants

128 students from three elementary schools, aged 13 to 14, participated in the testing, which was conducted at the beginning of the 2022-23 school year. The criteria for the inclusion of students in the testing included regular attendance of the physical education program. The sample was further divided into the 7th grade (32 male and 32 female) and the 8th grade (32 male and 32 female) students.

The consent for student testing was obtained from the school authorities, the children's parents, as well as the children themselves. The research was organized in accordance with the recommendations for clinical research given by the World Health Organization within the Helsinki Declaration (WHO, 2013) and approved by the Ethics

Committee of the Faculty of Sports, University Union – Nikola Tesla in Belgrade (code: 172/22).

Measuring instruments

Physical Fitness

To test physical fitness, a battery of five diagnostic tests was used (Wood, 2008), which previous research has found to be reliable and valid for assessing physical fitness: Modified agility «T» test – MAT (Sassi, et al., 2009); Illinois agility run test (Hachana et al., 2014; Kutlu, Yapici & Yilmaz, 2017); 10×5 Shuttle Test (Boddington, Lambert, St Clair Gibson & Noakes, 2001); Standing Balance Test (Geldhof et al., 2006); 2-Minute Step in Place Test (Haas, Sweeney, Pierre, Plusch & Whiteson, 2017)

Artistic Gymnastics Polygon

To assess the level of adoption of technical elements of artistic gymnastics, a specially designed polygon composed of those elements of artistic gymnastics that are studied in the older grades of elementary school (7th and 8th grades) was used.

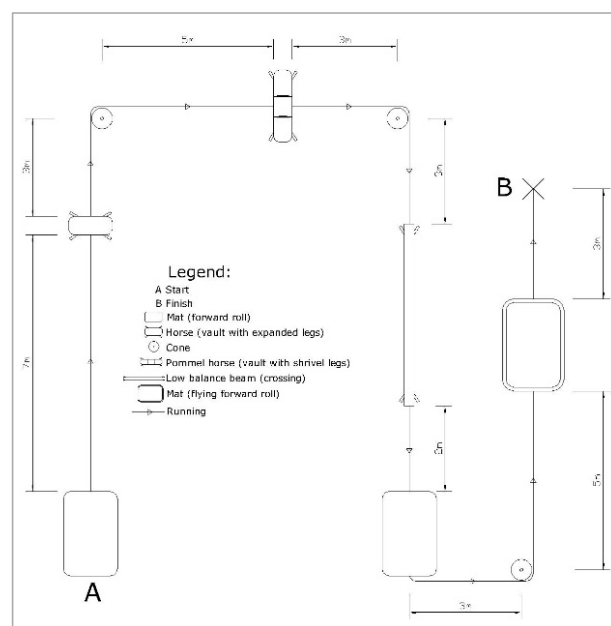


Fig. 1. Artistic Gymnastics Polygon

Description of the gymnastics polygon. Execution of the polygon starts from point A with a forward roll on the first mat. Afterwards a vault with expanded legs is performed over a horse, then the first cone is circled, followed by a vault with shrivel legs over a pommel horse. After going around the second cone, you cross over the low balance beam and perform another roll forward on the second mat. By going around the third cone, you get into a position for performing a flying forward roll on the third mat. The polygon and time measurement ends by running past point B. Either male or female student is obliged to fully complete the task before moving on to the next one (e.g. if he/she falls from a low balance beam he/she must climb to the same place from which he/she fell and continue moving along the balance beam).

Statistical analysis

Additionally to descriptive parameters (Mean±St.Dev), a correlation analysis was used to determine the relationship between physical fitness and the results at the gymnastics polygon (Pearson product-moment correlation coefficient). Pearson's correlation coefficient can be interpreted as an effect size and indicates the strength of the relationship between the two variables. According to Cohen (1988), a correlation coefficient of 0.10 or more is considered a weak or small correlation, 0.30 or more represents a moderate correlation, and 0.50 or more represents a strong or large correlation. The T test for independent samples was also used to determine differences in relation to the students' grade, separately for boys and girls. Statistical significance was established at the $p \leq 0.05$ level.

Results

The following chapter presents the research results (Tables 1 and 2), as well as their interpretation and analysis. Table 1 contains descriptive data of all variables of this research, presented in both total and by the gender. The

variables are the result obtained on the gymnastics polygon and the tests of physical fitness. (Modified agility "T" test, Illinois Agility Run Test, 10×5 Shuttle Test, Standing Balance Test and 2-Minute Step in Place Test).

If the difference between the grades is being analyzed, statistically more significant differences can be found in girls, than in boys. In the gymnastics polygon (AGP) and agility tests (MAT, ILL and 10×5), better results are represented by lower values. In the balance test (SBT) and endurance test (2-min), higher values are better results.

The eighth grade boys are significantly better than the seventh grade boys only on the MAT test ($t = 2.10$, $p = 0.040$). The eighth grade girls perform significantly better than the seventh grade girls on the MAT test ($t = 6.18$, $p < 0.001$), 10×5 Shuttle Test ($t = 2.50$, $p = 0.015$) and 2-Minute Step in Place Test ($t = -2.24$, $p = 0.028$).

The correlation between physical fitness and the results on the gymnastics polygon (AGP) can be found in Table 2. Statistical significance was recorded in all correlations for both boys and girls in both grades.

In the seventh grade, boys in most cases recorded strong correlations between physical fitness and the results

Table 1. Descriptives of 7th and 8th grade students (Mean±St.Dev.) and differences between the grades

	7 th grade		8 th grade	
	Boys (32)	Girls (32)	Boys (32)	Girls (32)
Height	167.31±7.62	161.78±6.31	173.34±7.19	165.47±4.16
Weight	54.53±9.78	47.56±4.6	59.59±9.24	55.13±5.62
BMI	19.42±2.7	18.15±1.09	19.75±2.22	20.14±2
MAT	8.29±1.25	9.32±0.96	7.7±0.98*	7.81±0.99*
ILL	20.55±2.34	23.13±2.29	19.46±2.46	22.41±2.23
10×5	14.93±1.26	16.46±1.5	15.56±2.74	15.58±1.32*
SBT	20.11±10.19	18.16±7.44	17.16±7.9	18.59±6.67
2-min	129.69±8.14	121.41±4.88	126.84±7.23	124.06±4.58*
AGP	21.65±1.77	23.20±3.02	21.31±1.80	22.48±2.23

Legend: * – significance of differences between 7th and 8th grade students $p \leq 0.05$; BMI – body mass index; MAT – modified agility T test; ILL – illinois agility run test; 10×5 – 10×5 shuttle test; SBT – standing balance test; 2-min – 2-minute step in place test; AGP – artistic gymnastics polygon.

Table 2. Pearson's correlation between physical fitness and the results on the gymnastics polygon

		Artistic Gymnastics Polygon (AGP)			
		7 th grade boys	7 th grade girls	8 th grade boys	8 th grade girls
MAT	Pearson	0.729	0.484	0.477	0.662
	Sig. (2-tailed)	<0.001*	0.005*	0.006*	<0.001*
ILL	Pearson	0.525	0.561	0.399	0.423
	Sig. (2-tailed)	0.002*	0.001*	0.024*	0.016*
10×5	Pearson	0.445	0.363	0.357	0.388
	Sig. (2-tailed)	0.011*	0.041*	0.045*	0.028*
SBT	Pearson	-0.582	-0.379	-0.607	-0.436
	Sig. (2-tailed)	<0.001*	0.033*	<0.001*	0.013*
2-min	Pearson	-0.384	-0.395	-0.414	-0.367
	Sig. (2-tailed)	0.030*	0.025*	0.019*	0.039*

on the gymnastics polygon (above .50): MAT ($r = 0.729$), ILL ($r = 0.525$) and SBT ($r = -0.582$), while in girls there are noticeably more moderate correlations (from 0.30 to 0.50): MAT ($r = 0.484$), 10×5 ($r = 0.363$), SBT ($r = -0.379$) and 2-min ($r = -0.395$).

When analyzing the eighth grade, most of the correlations in both boys and girls are at a moderate level, except for the SBT test in boys ($r = -0.607$) and MAT in girls ($r = 0.662$) where a strong correlation was recorded.

Discussion

This research was carried out with the aim of identifying the connection between physical fitness and the results on the gymnastics polygon in male and female students of the seventh and eighth grade of elementary schools. A statistically significant correlation was recorded between all observed parameters with different levels, from moderate to strong correlations, both in relation to the grade and in relation to the gender of the students. Differences in physical fitness and the results on the gymnastics polygon between the seventh and eighth grade students were also examined, separately for each gender. It was found that in boys there were differences in only one test (MAT $p = 0.040$) in favor of the eighth graders, while in girls there was a difference in three tests (MAT $p < 0.001$; 10×5 Shuttle Test $p = 0.015$; 2-Minute Step in Place Test $p = 0.028$) in favor of the eighth grade girls.

Artistic gymnastics is an essential part of physical education curricula all over the world, especially in the first years of schooling (Kovač, Sember & Pajek, 2020), but also in later school ages. Trajković, Madić, Sporiš, Aleksić-Veljković and Živčić-Marković (2016) point to the connection between the results in artistic gymnastics and the physical fitness of students and they believe that participation in gymnastics must be recommended as a positive basic activity for school-aged children from early childhood until adulthood, confirming that the teaching of gymnastics within the physical education program affects the increase in the physical fitness of students and therefore indicates a positive connection between the observed parameters. Annual school gymnastics training in combination with physical education improves the level of physical fitness in terms of speed, agility, flexibility, endurance and balance and thus promotes the development of physical fitness of young people (Granacher & Borde, 2017). Firmansyah, Rumini & Priyono (2022) share the same viewpoint and indicate that gymnastic exercises can affect the improvement of agility, coordination, balance and speed, as well as the overall motor development of both male and female students. Sukmawati, Septaliza, Fikri & Kesumawati (2022) also confirm the effectiveness of artistic gymnastics in improving physical fitness.

It is considered (Kirk, 2005) that due to the improvement of physical fitness and motor skills, students should be included in various sports activities, such as gymnastics, which contributes to higher quality physical education teaching, as well as greater physical activity of children in everyday life (Raudsepp & Päll, 2006; Logan, Webster, Getchell, Pfeiffer & Robinson, 2015; Jaakkola, Yli-Piipari, Huotari, Watt & Liukkonen, 2016). The researches clearly show the existence of positive transfer between different

motor and sport-specific skills (O'keeffe, Harrison & Smyth, 2007; Kokstejn & Musalek, 2019), which, on the other hand, significantly depend on the development of physical fitness (Hulteen, Morgan, Barnett, Stodden & Lubans, 2018; Ivashchenko, Berezhna & Cieśliska, 2020; Shevchenko, Khudoli & Potop, 2020).

The connection between the results in artistic gymnastics and physical fitness is also noted in elementary school children who practice gymnastics, because the results in the tests covering the area of speed (4x10m shuttle run test, 20m shuttle run test), explosive strength (standing long jump) and aerobic endurance tests (20m multistage fitness test) indicate a positive influence of the gymnastics program on the physical fitness and health status of the students (Kolimechikov, Petrov & Alexandrova, 2021). Similar results were obtained by Kiuchukov et al. (2019) who confirm that artistic gymnastics improves the components of physical fitness and has a positive effect on the physical development of children. In their research, both male and female gymnasts had better physical fitness in most parameters after the implementation of Alpha-Fit battery compared to their peers who do not go in for gymnastics.

The differences that exist between the children in the seventh and eighth grade (somewhat larger and more significant for girls in favor of the eighth grade) can be explained by attending a physical education program for a year longer with many teaching contents that can affect the better physical status and technical knowledge of the students. In this regard, the program contributed to a partial advantage in the physical preparedness and motor experience of the eighth-grade students when performing certain tests of physical fitness.

Conclusion

Within the physical education program, for the optimal physical development of children and the youth, diversity is needed; diversity which is reflected in the training, practice and improvement of various fundamental motor skills and sport-specific skills that arise from the former. On the other hand, the practice on the development of physical fitness that have a cause-and-effect relationship, both with fundamental motor skills and with sports-specific skills, also has its place in the program. All these components of physical development mutually influence each other and jointly contribute to the successful mastering of the elements of sports education as one of the thematic areas to which the contents of the physical education program are directed.

The aim of this research was to identify the connection between physical fitness and the results on the gymnastics polygon in the seventh and eighth grade elementary school students. Additionally, it was necessary to examine the differences in physical fitness and the results on the gymnastics polygon between the seventh and eighth grade students, separately for each gender. A significant correlation between the variables of physical fitness and the results on the gymnastic polygon is recorded in both boys and girls. In that regard, a strong mutual connection between physical fitness and sport-specific skills, which are presented in this paper through the technical elements of artistic gymnastics, is confirmed. The differences that exist in favor of male and female students of the eighth grade can also be explained by

the fact that older children were included in and treated with the contents of the physical education program for a longer period of time, which affected better technical training and physical preparation.

Attention should also be drawn to the use of the polygon as one of the organizational forms of work in physical education, which has proven to be an effective way of training, as confirmed by the aforementioned research. The application of the polygon provides great opportunities for the implementation of the content of the physical education program, both in an organizational and creative sense. Due to its interesting form of work, which is fun for students, the polygon seems very refreshing in the teaching process.

It can be said that the implementation of this research had certain limitations related to the relatively small sample of respondents that covered three schools. The inclusion of wider population and a larger number of respondents would have resulted in much more accurate and reliable results. Furthermore, in order to get a better insight, a larger number of physical performance parameters can be included. In any case, the research provides certain information that indicates the tendency of physical development of students and can serve for some new research that will include a much wider population with a more representative sample.

Conflict of interest

The author did not receive support from any organization for the submitted work. The author has no relevant financial or non-financial interests to disclose.

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ФІЗИЧНА ПІДГОТОВЛЕНІСТЬ І РЕЗУЛЬТАТИ НА ГІМНАСТИЧНОМУ ПОЛІГОНІ УЧНІВ 7-8 КЛАСІВ ПОЧАТКОВОЇ ШКОЛИ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 2 табл., 1 рис., 42 джерела.

Метою дослідження було встановлення зв'язку між фізичною підготовленістю та результатами на гімнастичному полігоні учнів 7-8 класів початкової школи. Крім того, необхідно було визначити відмінності в спостережуваних змінних залежно від класу, окремо для кожної статі.

Матеріали та методи. Загалом у тестуванні взяли участь 128 учнів трьох початкових шкіл (64 учні та 64 учениці) віком 13 та 14 років. Було використано п'ять тестів на фізичну підготовленість (модифікований Т-тест на спритність (MAT), Іллінойський тест на спритність, тест «човниковий біг 10х5», тест «збереження рівноваги стоячи» та тест «крок на місці протягом 2 хвилин»), а для оцінки рівня засвоєння технічних елементів спортивної гімнастики використовували спеціально спроектований гімнастичний полігон.

Результати. Була зареєстрована статистично значуща кореляція між усіма спостережуваними параметрами з різними рівнями, від помірної до сильної кореляції, як залежно від класу, так і залежно від статі школярів. Також встановлено, що у хлопців є відмінності лише в одному тесті (MAT) на користь восьмикласників, а у дівчат – у трьох тестах (MAT; тест «човниковий біг 10х5»; тест «крок на місці протягом 2 хвилин») на користь восьмикласниць.

Висновки. Отже, можна зробити висновок про наявність сильного взаємозв'язку між фізичною підготовленістю та специфічними спортивними навичками, які представлені в цій роботі у вигляді технічних елементів спортивної гімнастики.

Ключові слова: фізичний розвиток, спортивна гімнастика, фізичне виховання, учні та учениці.

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Cite this article as: Milenković, D. (2023). The Seventh and Eighth Grade Primary School Students' Physical Fitness and Results on the Gymnastics Polygon. *Physical Education Theory and Methodology*, 23(4), 600-606. <https://doi.org/10.17309/tmf.2023.4.15>

Received: 03.07.2023. Accepted: 14.08.2023. Published: 30.08.2023

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