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Original research paper

FITNESS PARAMETERS AND THE LEVEL OF NUTRITION IN GIRLS

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Marija Đorđević[1], Saša Pantelić[2], Anđela Đošić[2], Danijela Živković[2], Ivana Arsić[3]

[1]The Academy of Applied Preschool Teaching and Health Studies, Section Kruševac, Serbia
[2]Faculty of Sport and Physical Education, University of of Niš, Serbia
[3]Serbian School Sports Federation, Serbia

Abstract. *The aim of the study was to determine the differences in fitness parameters in ten-year-old girls with varying degrees of nutritional status. The research was conducted on a sample of 145 girls attending the fourth grade of elementary schools in the city of Niš, with average age of 10.12 (±0.72). Based on BMI, three sub-samples were formed (normal weight, overweight and obese subjects). Fitness parameters (explosive strength, coordination and speed) were determined by a battery of nine tests. Differences in fitness parameters were determined by MANOVA/ANOVA and LSD Post Hoc test. The results indicate that, in regards to BMI, there is a significant difference in fitness parameters in ten-year-old girls ($p<.01$). Normal weight subjects were significantly better than overweight and obese subjects in explosive leg strength, running and rolling, and running speed. Overweight subjects were significantly better in the frequent hand movement speed, compared to the normal weight subjects. The lowest results in almost all fitness parameters were recorded by the obese subjects. Increased BMI values in overweight and obese children adversely affect fitness, and this may have negative repercussions later in adulthood.*

Key words: *differences, explosive strength, coordination, speed*

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Corresponding author: Marija Đorđević
The Academy of Applied Preschool Teaching and Health Studies, Section Kruševac, Ćirila i Metodija 22, 37000 Kruševac, Serbia
Phone: +381 37 420 761 • E-mail: mdjordjevic@vaspks.edu.rs

1. INTRODUCTION

The nutritional status of children is one of the most important indicators of health, psychophysical capabilities and potential for normal and healthy growth and development (Lobstein, Baur, & Uauy, 2004). Any significant deviation from optimal weight in children increases the risk for the occurrence and development of many non-infectious diseases during their lifetime (Kelsey, Zaepfel, Bjornstad, & Nadeau, 2014; Meldrum, Morris, & Gambone, 2017; Lee & Yoon, 2018).

The attention of the scientific community is being focused on monitoring the physical status of children, pointing out the worrying prevalence of overweight and obese children. According to the data provided by the WHO (2018), more than 340 million children and adolescents aged between 5 and 19 are overweight and obese (According to Gudelj-Rakić et al., 2019). The World Obesity Federation (WOF) indicates that in 2020 as many as 158 million children worldwide aged between 5 and 19 are obese, while the obesity growth trend projected for 2030 will amount to 254 million obese children (Lobsten & Brinsden, 2019). According to the results provided by the WOF, the prevalence of obesity among children aged between 10 and 19 in Serbia in the year of 2016 was 10.4% for boys and 5.4% for girls. In Serbia, the latest official data provided by the Institute for Public Health "Dr. Milan Jovanović Batut" indicates that 3.4% of girls aged between 11 and 15 are underweight, 65.6% have normal weight, 16.9% are overweight and 6.6% are obese (Gudelj-Rakić et al. , 2019). Young children with excess adiposity are more susceptible to overweight or obesity in later childhood (Glavin et al., 2014) and at increased risk for adverse health consequences and obesity in adulthood (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). Also, the other studies have found that low levels of fitness and motor competence in children are strongly associated with the risk of subsequently becoming overweight or obese (Kim et al., 2005; Hruby et al., 2012; Rodrigues, Stodden, & Lopes, 2016).

Previous research, whether being transcersal (Lopes, Stodden, Bianchi, Maia, & Rodrigues, 2012; Morrison et al., 2012; Lopes L., Santos, Moreira, Pereira, & Lopes, P., 2015; Chowdhury, Wrotniak, & Ghosh, 2017; Luz et al., 2018; Lopes, Malina, Maia, & Rodrigues, 2018) or longitudinal studies (D'Hondt et al., 2013; D'Hondt et al., 2014; Cheng et al., 2016; Lima, Bugge, Pfeiffer, & 0Andersen, 2017; Lima, Bugge, Ersbøll, Stodden, & Andersen, 2019) indicate a negative correlation between the nutritional status and the level of fitness in children. Available data shows a negative relationship between the BMI and fundamental motor skills (Duncan, Bryant, & Stodden, 2016) and motor coordination (Lopes et al., 2012) in children. Studies have also shown that children with a higher level of motor coordination tend to have lower BMI values (Martins et al., 2010), whereas children identified as clumsy have a higher level of relative fatness (Hay, Hawes, & Faught, 2004). Negative correlations between the BMI and indicators of fitness have also been noted (He et al., 2011; Mcgavock, Torrance, Mcguire, Wozny, & Lewanczuk, 2009). Regular physical activity has a positive effect on the proper physical, psychological and mental development of children and adolescents. It is well known that physical activity aids in preserving and maintaining the integrity of bones, muscles and joints, helps regulate body weight, reduces the formation of excessive fat tissue, but also improves functional motor abilities (Miles, 2008; Janssen & LeBlanc, 2010; Anderson & Butcher 2006).

The aim of the research was to determine the differences in fitness parameters in ten-year-old girls with different nutritional status.

2. METHODS

2.1. Sample of participants

The research was conducted on a sample of 145 girls, who were fourth grade elementary school students from the city of Niš. The average age was 10.12 (± 0.72). All tests were conducted in schools during physical education classes. The research was conducted in accordance with the Declaration of Helsinki (WMA, 2013), and in order for a child to participate in the research, the consent of a parent or guardian was required.

After measuring body height and body weight and calculating BMI, three sub-samples were formed according to Cole, Bellizzi, Flegal, & Dietz (2000). The first sub-sample consisted of 106 normal weight girls (Age: 10.08 (± 0.43), BMI: 17.03 (± 1.87)), the second sub-sample consisted of 31 overweight girls (Age: 10.21 (± 0.56), BMI: 21.61 (± 1.21)) while 9 obese girls (Age: 10.06 (± 0.02), BMI: 26.54 (± 1.89)) made up the third sub-sample.

2.2. Measuring instruments

Fitness parameters were assessed with a battery of nine tests, which were used to determine explosive strength, coordination and speed. The plyometric jump (in cm) was used to assess the explosive leg strength (Nazarenko, 2000). The hyperextension-twist-throw Σ (in dm) was used to assess explosive arm strength (Kostić et al., 2009). The standing depth jump (in cm) was used to assess the explosive leg strength (Kurelić et al., 1975). The horizontal jump rope (in numbers) was used to assess leg coordination (Kurelić et al., 1975). The 20 sidesteps with a baton (in sec) was used to assess the coordination of arms and legs (Kurelić et al., 1975). The running and rolling (in sec) was used to assess spatial orientation (Kostić et al., 2009). The hand taping (in numbers) was used to assess frequent hand movement speed (Kurelić et al., 1975). The foot taping (in numbers) was used to assess frequent leg movement speed (Kurelić et al., 1975). The 5×10 m run (in sec) was used to assess speed (Kurelić et al., 1975).

2.3. Data processing

For all tested fitness parameters, basic descriptive parameters were calculated (Mean and Standard Deviation). Differences between the groups in fitness parameters were determined by using multivariate analysis of variance (MANOVA). Differences between the groups for each variable were determined by using univariate analysis of variance (ANOVA) and LSD Post Hoc test. Testing the differences was performed by using the F-test, and the level of significance was expressed as sig and was 0.05. The results were analyzed with the Statistical Package for the Social Science (SPSS) version 18.0.

3. RESULTS

Table 1 shows the basic parameters of descriptive statistics (mean values and standard deviations) of the fitness parameters of test subjects with different nutritional status.

Table 1 Basic descriptive statistical parameters (Mean±SD)

Fitness parameters	Normal (n=106)	Overweight (n=31)	Obese (n=8)
Plyometric jump [cm]	19.48 ± 6.34	16.48 ± 6.62	14.38 ± 4.03
Hyperextension-twist-throw Σ [dm]	76.54 ± 22.53	69.71 ± 15.84	70.99 ± 10.18
Standing depth jump [cm]	131.84 ± 22.85	127.68 ± 18.01	102.00 ± 17.25
Horizontal jump rope [number]	8.30 ± 4.94	6.52 ± 3.83	3.58 ± 4.50
20 sidesteps with a baton [sec]	19.07 ± 5.53	19.97 ± 7.31	20.94 ± 7.57
Running and rolling [sec]	18.05 ± 2.48	19.49 ± 1.99	21.09 ± 2.23
Hand taping [number]	33.58 ± 6.49	36.61 ± 7.02	33.63 ± 6.23
Foot taping [number]	17.97 ± 2.75	18.16 ± 1.70	17.13 ± 1.55

Legend: Mean – mean value; SD – standard deviation

Based on the obtained results (Table 1), it can be observed that the normal weight subjects achieved better results in almost all fitness parameters compared to the overweight and obese subjects, except for the frequent movement speed. Also, overweight subjects were better than the obese subjects in almost all tested fitness parameters, except for explosive arm strength.

Table 2 shows the differences between the groups in fitness parameters at the multivariate and univariate levels.

Table 2 MANOVA/ANOVA in fitness parameters

Fitness parameters	F	Sig.
Plyometric jump	4.56	.012*
Hyperextension-twist-throw	1.43	.242
Standing depth jump	7.17	.001**
Horizontal jump rope	2.82	.063
20 sidesteps with baton	0.55	.578
Running and rolling	9.30	.000**
Hand taping	2.57	.080
Foot taping	0.54	.583
5×10 m run	9.03	.000**
Wilk's = 0.702 F = 2.89 p = .001**		

Legend: Wilk's – Test Wilk's lambdas; F – Pao's F approximation;
p (Sig.) – significance level; statistical significance ** $p < .01$, * $p < .05$

The results of the multivariate analysis of variance indicate that the differences in fitness parameters among subjects with different nutritional status are statistically significant ($p < .01$). Differences at the univariate level are statistically significant in the tests designed for assessing explosive leg strength (plyometric jump (.012) and standing depth jump (.001)), coordination (running and rolling (.000)) and speed (5×10 m run (.000)).

Differences between the groups in individual fitness parameters are shown in Table 3 (LSD Post Hoc test).

Table 3 LSD Post Hoc test in morphological characteristics

			Mean Diff.	Sig.
Plyometric jump	normal	- overweight	2.99	.022*
	normal	- obese	5.10	.029*
	overweight	- obese	2.11	.400
Hyperextension-twist-throw	normal	- overweight	6.84	.110
	normal	- obese	5.55	.468
	overweight	- obese	-1.28	.877
Standing depth jump	normal	- overweight	4.16	.348
	normal	- obese	29.84	.000**
	overweight	- obese	25.68	.003**
Horizontal jump rope	normal	- overweight	1.79	.065
	normal	- obese	2.93	.092
	overweight	- obese	1.14	.542
20 sidesteps with a baton	normal	- overweight	-0.90	.468
	normal	- obese	-1.87	.402
	overweight	- obese	-0.97	.688
Running and rolling	normal	- overweight	-1.43	.004**
	normal	- obese	-3.04	.001**
	overweight	- obese	-1.60	.091
Hand tapping	normal	- overweight	-3.03	.026*
	normal	- obese	-0.04	.987
	overweight	- obese	2.99	.255
Foot tapping	normal	- overweight	-0.19	.712
	normal	- obese	0.85	.359
	overweight	- obese	1.04	.300
5×10m run	normal	- overweight	-0.74	.003**
	normal	- obese	-1.47	.001**
	overweight	- obese	-0.73	.128

Legend: Sig. – significance level; Mean Diff. – differences in mean values between the groups; statistical significance of differences ** $p < .01$, * $p < .05$

By analyzing the results (Table 3), it can be noted that in the plyometric jump, normal weight subjects were significantly better than the overweight (.022) and obese (.029). Normal (.000) and overweight (.003) subjects had significantly better results in standing depth jump compared to the obese subjects. In running and rolling, as well as in 5×10m run, normal weight subjects were significantly better than the overweight ((.004) and (.003), respectively) and obese ((.001) and (.001), respectively). A significant difference was recorded in the hand tapping test, where overweight test subjects performed better than normal weight subjects (.026). In other fitness parameters, no significant differences between the groups were recorded (hyperextension-twist-throw, horizontal jump rope, 20 sidesteps with a baton and foot tapping).

4. DISCUSSION

The obtained results (Table 2) indicate that there are significant differences in fitness parameters between girls with different nutritional status. It is concluded that overweight and obese girls have a lower level of certain fitness parameters compared to normal weight girls, which is in accordance with the previous research (Aphamis, Giannaki, Tsouloupas, Ioannou, & Hadjicharalambous, 2015; Koch et al., 2016; Pantelić, 2017; Živković, Ranđelović, Đrorđević, Pantelić, & Malobabić, 2018).

Normal weight subjects achieved better results compared to the overweight and obese subjects in all tests of explosive strength (arms and legs) and coordination, as well as in running speed. Thus obtained results were actually expected, considering that the excess body mass has a negative affect on tasks where the body mass is moved or projected through space, as in runs and jumps, or the lifting and supporting of the body off the ground (Malina, Bouchard, & Bar-Or, 2004; Moncef, Said, Olfa, & Dagbaji, 2012). When it comes to frequent hand movement, overweight and obese subjects had better results. Being overweight or obese is not a negative factor in the performance of these physical tasks because it does not require the movement or projection of body mass through space, and the movements are performed by individual segments of the body. Current research confirms that overweight and obese children often achieve better results in frequent movement (Pejčić, 2007; Leskošek, Strel, & Kovač, 2007; Ara, Moreno, Leiva, Gutin, & Casajús, 2007; Runhaar et al., 2010).

Movement structures in the motor tasks of running and rolling and 5×10m run are very similar, and involve moving and projecting body mass through space, and require frequent changes of direction in the shortest possible intervals of time. Explanation behind thus obtained results lies in the fact that excess body weight, due to greater development of subcutaneous fat tissue, represents a ballast mass that makes it difficult to perform these motor tasks (Đorđević et al., 2015; Đorđević et al., 2016).

In general, it is noted that obese girls had the worst results. The excess body mass might inhibit obese children from developing and exercising their motor skills, which contributes to declines in motor proficiency relative to the children with healthy weight (Castetbon & Andreyeva, 2012). These findings are important because poor motor skill development is associated with children's physical inactivity and poor fitness levels (Burgi et al., 2011; Wrotniak et al., 2006). Relative declines in children's motor proficiencies might also be associated with self-perceptions of poorer physical competence, which again might serve as a catalyst for inactivity and consequent weight gain (Spessato, Gabbard, Robinson, & Valentini, 2012).

5. CONCLUSION

The results of the conducted study indicate that there is a significant difference in the fitness parameters in ten-year-old girls related to their nutritional status. It is concluded that normal weight girls, compared to the overweight and obese, were significantly better in the motor tasks of explosive leg strength, running and rolling and running speed.

From all the above, the authors of this paper recommend the inclusion of overweight and obese children in organized forms of systematic physical exercise, in order to prevent obesity and increase the level of fitness among the population of this age.

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FITNES PARAMETRI I STEPEN UHRANJENOSTI DEVOJČICA

Cilj studije bio je da se utvrde razlike u fitnes parametrima kod desetogodišnjih devojčica različitog stepena uhranjenosti. Istraživanje je sprovedeno na uzorku od 145 devojčica četvrtog razreda osnovnih škola grada Niša, prosečne godine starosti 10.12 (± 0.72). Na osnovu BMI formirana su tri subuzorka (normalno uhranjene, prekomerno uhranjene i gojazne ispitanice). Fitnes parametri (eksplozivna snaga, koordinacija i brzina) utvrđene su baterijom od devet testova. Razlike u fitnes parametrima utvrđene su MANOVA/ANOVA-om i LSD Post Hoc testom. Rezultati studije ukazuju da u odnosu na stepen uhranjenosti postoji značajna razlika u fitnes parametrima kod desetogodišnjih devojčica ($p < .01$). Normalno uhranjene ispitanice bile su značajno bolje od prekomerno uhranjenih i gojaznih u eksplozivnoj snazi nogu, trčanju i valjanju i brzini trčanja. Prekomerno uhranjene ispitanice bile su značajno bolje u frekventnoj brzini pokreta ruku od normalno uhranjenih. Najlošije rezultate u gotovo svim fitnes parametrima zabeležile su gojazne ispitanice. Uvećane vrednosti BMI kod prekomerno uhranjene i gojazne dece utiču loše na fitnes, a to može imati negativne reperkusije kasnije u odraslom dobu.

Ključne reči: *razlike, eksplozivna snaga, koordinacija, brzina*