FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 14, N^{o} 1, 2016, pp. 1 - 11

Original research article

MORPHO-MOTORIC STATUS AND LEVEL OF NUTRITION IN NINE-YEAR-OLD GIRLS

UDC 676.014.8
796.012.1
613.2:796.071.2

Marija Đorđević[1], Radmila Kostić[2], Saša Pantelić[2], Slavoljub Uzunović[2], Zoran Milanović[2], Bojan Mitrović[3]

[1]Preschool Teacher Training College, Kruševac, Republic of Serbia
[2]Faculty of Sport and Physical Education, University of Niš, Republic of Serbia
[3]Department for Police Education and Training,
Ministry of Interior of the Republic Serbia, Belgrade, Republic of Serbia

Abstract. *The nutritional status of children is an important indicator of their physical and motor development, as well as one of the factors that affects their morpho-motoric status. The aim of this study was to determine differences in morphological characteristics and motor abilities in nine-year-old girls with varying degrees of nutritional status. The research was conducted on a sample of 89 third grade elementary school students in Niš, aged 9.01 ± 0.28. Based on the BMI, three sub-samples were formed (normal weight, overweight and obese participants). Morphological status was determined by measuring the parameters of longitudinal, transversal and circular dimensionality, body weight and subcutaneous fatty tissue. Motor abilities (explosive strength, coordination and speed) were determined by a battery of nine tests. Differences in morphological and motor variables were determined by using MANOVA/ANOVA and LSD Post Hoc test. The results indicate that, in regards to the BMI, there are significant differences in morpho-motoric status in nine-year-old girls. Higher values of morphological characteristics, but also a lower level of explosive strength, speed and coordination were recorded in overweight and obese participants.*

Key words: *nutritional status, morphological characteristic, motor abilities, differences, girls*

Received December 20, 2015 / Accepted March 31, 2016
Corresponding author: Marija Đorđević
Faculty of Sport and Physical Education, University of Niš, St.Čarnojevića 10a, 18000 Niš, Serbia
Phone: +381 18 510900 • E-mail: mdjordjevic@vspks.edu.rs

INTRODUCTION

The attention of the scientific community is being focused on the physical characteristics of children, pointing out a worrying prevalence of overweight and obese children. In children and adolescents obesity is defined as an increase in body weight above the referent values for a given age, sex, and height (Antić, 2009). The occurrence of obesity during childhood and adolescence increases the possibility of obesity in adulthood. It was found that obesity in girls in 30%, and among boys in 10% of cases occurs later in adulthood (Goran, 2001). Prevention of obesity in children of this age is of special importance, considering that the habits created in this particular period of life are usually retained later in adulthood (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Zametkin, Zoon, Klein, & Munson, 2004).

The nutritional status of children is one of the most important indicators of health, psychophysical capabilities and the potential for normal and healthy growth and development (Lobstein, Baur, & Uauy, 2004). Any significant deviation from optimal weight in children raises the risk for the emergence and development of many non-infectious diseases during their lifetime.

Current available literature indicates a negative correlation between childhood obesity and motor abilities in children of different ages (Biskanaki et al., 2004; D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2009; D'Hondt et al., 2013; Kostić et al., 2010; Pantelić, Kostić, Đurašković, Uzunović, & Ranđelović, 2012; Tokmakidis, Kasambalis, & Christodoulos, 2006). Overweight and obese children achieve lower results in motor tasks that require lifting and projecting one's body through space (Casajús, Leiva, Villarroya, Legaz, & Moreno, 2007; Leskošek, Strel, & Smith, 2007; Malina et al., 1995). High values of the body mass index in children correlate negatively with cardiorespiratory fitness and the level of physical activity (Ara, Moreno, Leiva, Gutin, & Casajús, 2007; Mota, Santos, Guerra, Riberio, & Duarte, 2002; Mota, Flores, Flores, Riberio, & Santos, 2006), which needs to be a key factor in children's healthy and balanced growth and development (Dencker & Anderson, 2008). Regular physical activity has a positive influence on the proper physical and mental development of children and adolescents (Hills, King, & Armstrong, 2007; Hills, Okely, & Baur, 2010). It is well known that physical activity contributes to proper construction and preservation of bones, muscles and joints, helps regulate body weight, reduces fatty tissue and also improves motor abilities (Biddle, Gorely, & Stensel, 2004; Strong et al., 2005).

Overweight and obesity in children lead to stagnation in motor development and creation of motor habits (Bala, 2007; Cawley & Spiess, 2008; Graf et al., 2004a, 2004b; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). A lower level of motor abilities in these children is associated with muscle insufficiency as a consequence of physical inactivity, which has an indirect impact on the emergence of a number of physical deformities (De Sá Pinto, Barros de Holanda, Radu, Villares & Lima, 2006; Jannini, Doria-Filho, Damiani, & Silva, 2011; O'Melley, Hussey, & Roche, 2012).

The aim of this study was to determine differences in morphological characteristics and motor abilities in nine-year-old girls of different nutritional status.

THE METHOD

Participants

The research was conducted on a sample of 89 third grade elementary school students from Niš, aged 9.01 (±0.28). All of the participants were healthy on the testing day and had written consents from their parents and the school principal. Measuring and testing took place in school facilities during a physical education class.

After measuring body height and body weight and calculating the BMI, three sub-samples were formed, according to children's BMI in accordance with the work of Cole, Bellizzi, Flegal, & Dietz (2000). The first sub-sample consisted of 58 normal weight participants with an average BMI of 16.68 (±1.71) and average age of 9.17 (±0.32). The second sub-sample consisted of 27 overweight participants with an average BMI of 21.00 (±1.26) and average age of 8.79 (±0.51). The third sub-sample consisted of 4 obese participants with an average BMI of 24.36 (±1.63) and average age of 9.09 (±0.02).

Measuring instruments

Morphological status is determined by measuring the parameters of: longitudinal Morphological status is determined by measuring the parameters of: longitudinal dimensionality (body height, arm length, leg length), transversal dimensionality (shoulder width, hip width, pelvic width), circular dimensionality and body weight (thorax volume, upper arm volume, thigh volume, calf volume) and subcutaneous fatty tissue (triceps skin folds, sub-scapular skin folds, abdominal skin folds, thigh skin folds, medial calf skin folds). The measuring technique for the morphological characteristics followed the guidelines of the methodology recommended by the International Biological Program (Weiner & Lourie, 1969).

Motor abilities were determined by using a battery of nine tests for the evaluation of explosive strength, speed and coordination. Metric characteristics of measuring instruments used for the assessment of explosive strength (plyometric jump, hyperextension-twist-throw, standing depth jump), coordination (horizontal jump rope, 20 sidesteps with a baton, running and rolling) and speed (hand taping, foot taping against a wall, 5×10 meter run) were described in the study carried out by Kostić et al. (2010).

Procedure

For all the measuring parameters, mean arithmetic values and standard deviations were calculated. Differences between the groups in morphological and motor variables were determined by using MANOVA/ANOVA and LSD Post Hoc test. The results were analyzed with the Statistical Package for the Social Science (SPSS) version 18.0.

RESULTS

Table 1 shows the arithmetic mean values and standard deviations of morphological and motor variables in normal weight, overweight and obese participants. Based on the results, it can be concluded that the highest values of all morphological characteristics were determined for the obese participants, followed by the overweight, while normal weight participants have the lowest results. In the area of motor abilities, it was noted that in most tests normal weight participants had better results than overweight and obese participants.

Table 1 Basic descriptive statistical parameters

	Morphological characteristics		
	Normal (n=58)	Overweight (n=27)	Obese (n=4)
Body hight [cm]	139.40 ± 5.84	40.05 ± 6.30	152.45 ± 7.38
Leg length [cm]	78.99 ± 4.50	78.46 ± 4.02	87.88 ± 4.39
Arm length [cm]	58.90 ± 3.66	59.16 ± 2.89	66.25± 4.19
Shoulder width [cm]	30.11 ± 1.59	31.35 ± 1.58	33.50 ± 2.86
Pelvic width [cm]	20.92 ± 1.43	23.34 ± 1.22	25.80 ± 2.17
Hip width [cm]	23.06 ± 1.71	24.85 ± 1.50	28.03 ± 1.23
Body weight [kg]	32.53 ± 4.68	41.34 ± 5.16	57.00 ± 9.66
Thorax volume [cm]	64.94 ± 5.25	73.11 ± 5.68	85.00 ± 5.73
Upper arm volume [cm]	19. 98 ± 2.06	22.96 ± 1.66	26.48 ± 2.39
Thigh volume [cm]	41.44 ± 4.63	45.71 ± 4.88	54.35 ± 2.40
Calf volume [cm]	28.32 ± 2.28	31.81± 1.79	34.85± 2.09
Triceps skin fold [mm]	12.71 ± 3.53	20.34 ± 5.13	23.55 ± 2.71
Sub-scapular skin fold [mm]	8.89 ± 3.54	18.77 ± 5.95	23.60 ± 4.63
Abdominal skin fold [mm]	11.99 ± 6.88	24.16 ± 7.65	26.60 ± 5.11
Thigh skin fold [mm]	16.85 ± 5.20	24.87 ± 5.73	27.55 ± 7.00
Medial calf skin fold [mm]	11.80 ± 4.33	16.16 ± 4.27	19.30 ± 4.70
	Motor abilities		
	Normal (n=58)	Overweight (n=27)	Obese (n=4)
Plyometric jump [cm]	19.01 ± 5.78	16.85 ± 6.02	12.25 ± 7.37
Hyperextension-twist-throw [dm]	69.88 ± 18.08	53.62 ± 17.33	80.25 ± 14.86
Standing depth jump [cm]	121.07 ± 21.25	111.93 ± 24.93	103.75 ± 11.09
Horizontal jump rope [number]	6.33 ± 5.07	4.48 ± 4.11	7.50 ± 3.11
20 sidesteps with a baton [sec]	23.47 ± 8.88	26.35 ± 11.80	20.31 ± 2.72
Running and rolling [sec]	18.18 ± 2.52	20.23 ± 2.60	19.55 ± 2.62
Hand taping [number]	32.84 ± 4.41	28.67 ± 4.20	32.75 ± 3.77
Foot taping [number]	16.81 ± 2.16	18.37 ± 3.85	17.50 ± 3.11
5×10 m run [sec]	17.21 ± 1.73	17.72 ± 1.34	17.50 ± 0.54

Legend: Mean – mean value; SD – standard deviation

The results of the multivarite and univariate analysis of variance are shown in Table 2. The results of the multivariate analysis of variance indicate that the differences in morphological characteristics and motor abilities of participants of different nutritional status are statistically significant (p <.01). Differences at the univariate level were statistically significant in all morphological characteristics, at the significance level of .01 (.000). Significant differences in motor abilities were recorded for the following tests: plyometric jump (.044), hyperextension-twist-throw (.000), running and rolling (.003) and hand tapping (.000).

Table 2 Multivariate and univariate analysis of variance in morphological characteristics and motor abilities between groups of different nutritional status

Morphological characteristics	F	Sig.	Motor abilities	F	Sig.
Body height	8.74	.000**	Plyometric jump	3.24	.044*
Arm length	8.46	.000**	Hyperextension-twist-throw	9.19	.000**
Leg length	8.39	.000**	Standing depth jump	2.37	.099
Shoulder width	11.50	.000**	Horizontal jump rope	1.66	.196
Pelvic width	43.80	.000**	20 sidesteps with baton	1.14	.323
Hip width	24.94	.000**	Running and rolling	6.12	.003**
Body weight	62.37	.000**	Hand taping	8.75	.000**
Thorax volume	41.03	.000**	Foot taping	2.84	.064
Upper arm volume	36.64	.000**	5×10 m run	1.33	.269
Thigh volume	19.59	.000**			
Calf volume	36.86	.000**			
Triceps SF	40.73	.000**			
Sub-scapular SF	58.34	.000**			
Abdominal SF	31.73	.000**			
Thigh SF	24.37	.000**			
Medial calf SF	13.17	.000**			
Wilk's = 0.145 F = 7.20 p = .000**			Wilk's = 0.541 F = 3.11 p = .000**		

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

Table 3 shows the differences in subsequent comparisons of morphological characteristics between the groups. It was noted that obese participants have significantly higher values of all morphological characteristic, compared to normal weight participants. In relation to the overweight, obese participants had significantly higher values of longitudinal, transversal and circular dimensionality, body mass and sub-scapular skin folds. Significantly higher values of transversal and circular dimensionality, body mass and subcutaneous fatty tissue were recorded for overweight, compared to the normal weight participants.

Table 3 LSD Post Hoc test in morphological characteristics

		Mean Diff.	Sig.
Body height	normal - overweight	-0.65	.646
	normal - obese	-13.05	.000**
	overweight - obese	-12.40	.000**
Leg length	normal - overweight	0.53	.605
	normal - obese	-8.89	.000**
	overweight - obese	-9.41	.000**
Arm length	normal - overweight	-0.26	.749
	normal - obese	-7.35	.000**
	overweight - obese	-7.09	.000**
Shoulder width	normal - overweight	-1.23	.002**
	normal - obese	-3.39	.000**
	overweight - obese	-2.15	.017*
Pelvic width	normal - overweight	-2.42	.000**
	normal - obese	-4.88	.000**
	overweight - obese	-2.46	.002**
Hip width	normal - overweight	-1.79	.000**
	normal - obese	-4.97	.000**
	overweight - obese	-3.18	.000**
Body weight	normal - overweight	-8.81	.000**
	normal - obese	-24.47	.000**
	overweight - obese	-15.66	.000**
Thorax volume	normal - overweight	-8.17	.000**
	normal - obese	-20.06	.000**
	overweight - obese	-11.89	.000**
Upper arm volume	normal - overweight	-2.98	.000**
	normal - obese	-6.49	.000**
	overweight - obese	-3.52	.001**
Thigh volume	normal - overweight	-4.27	.000**
	normal - obese	-12.91	.000**
	overweight - obese	-8.64	.001**
Calf volume	normal - overweight	-3.48	.000**
	normal - obese	-6.53	.000**
	overweight - obese	-3.04	.009**
Triceps skin fold	normal - overweight	-7.63	.000**
	normal - obese	-10.84	.000**
	overweight - obese	-3.21	.144
Sub-scapular skin fold	normal - overweight	-9.87	.000**
	normal - obese	-14.71	.000**
	overweight - obese	-4.83	.046*
Abdominal skin fold	normal - overweight	-12.17	.000**
	normal - obese	-14.61	.000**
	overweight - obese	-2.44	.522
Thigh skin fold	normal - overweight	-8.03	.000**
	normal - obese	-10.70	.000**
	overweight - obese	-2.68	.361
Medial calf skin fold	normal - overweight	-4.36	.000**
	normal - obese	-7.50	.001**
	overweight - obese	-3.14	.179

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

Differences in subsequent comparisons in motor abilities between the groups are shown in Table 4. Results in the area of motor abilities indicate that the normal weight participants are significantly better than the obese in explosive leg strength (plyometric jump, .030), while the overweight participants are significantly better in explosive arm strength (hyperextension-twist-throw, .000), coordination (running and rolling, .001) and frequent hand movement speed (hand tapping, .000). In regards to the frequent leg movement speed (foot tapping), the overweight participants had significantly higher results than the normal weight ones (.020), while regarding the explosive arm strength (hyperextension-twist-throw) they were significantly lower than in the obese participants (.006).

Table 4 LSD Post Hoc test in motor abilities

				Mean Diff.	Sig.
Plyometric jump	normal	-	overweight	2.16	.121
	normal	-	obese	6.76	.030*
	overweight	-	obese	4.60	.150
Hyperextension-twist-throw	normal	-	overweight	16.26	.000**
	normal	-	obese	-10.37	.262
	overweight	-	obese	-26.63	.006**
Standing depth jump	normal	-	overweight	9.14	.080
	normal	-	obese	17.32	.134
	overweight	-	obese	8.18	.493
Horizontal jump rope	normal	-	overweight	1.85	.098
	normal	-	obese	-1.17	.634
	overweight	-	obese	-3.02	.238
20 sidesteps with a baton	normal	-	overweight	-2.88	.207
	normal	-	obese	3.15	.532
	overweight	-	obese	6.03	.250
Running and rolling	normal	-	overweight	-2.05	.001**
	normal	-	obese	-1.37	.301
	overweight	-	obese	0.68	.620
Hand tapping	normal	-	overweight	4.18	.000**
	normal	-	obese	0.09	.966
	overweight	-	obese	-4.08	.082
Foot tapping	normal	-	overweight	-1.56	.020*
	normal	-	obese	-0.69	.637
	overweight	-	obese	0.87	.566
5×10m run	normal	-	overweight	-0.51	.108
	normal	-	obese	-0.29	.673
	overweight	-	obese	0.21	.767

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

DISCUSSION

Based on the obtained results, it was determined that differences in mean values between the groups show that normal weight participants were better in the plyometric jump, standing depth jump, running and rolling, 5×10 meter run and hand tapping, in relation to overweight and obese subjects. Such results are consistent with other studies

(Đorđević et al., 2015; Trutet, Pienaar, & Du Toit, 2012; Runhaar et al., 2010; Brunet, Chaput, & Tremblay, 2007; Suchomel, 2005; Ara et al., 2007; D'Hondt et al., 2013; Yusof, Aiman, Zawi, Hasan, & Radzi, 2013; Leskošek et al., 2007; Tokmakidis et al., 2006). The reason for these results lies in the fact that excessive body mass has a negative influence on motor tasks that involve jumping or have greater overall movement requirements. Overweight and obese children have a hard time performing motor tasks that involve projecting the body through space in short periods of time and also have stagnation in physical and motor development (Bala, 2007; Graf et al., 2004a, 2004b).

In the tests for evaluating the coordination of arms and legs (horizontal jump rope, 20 sidesteps with baton) approximately equal results were determined for the groups, with a reference that the obese participants had the best and the overweight ones had the worst results. Better results of obese participants on these tasks can be attributed to their significantly longer extremities (length of arms and legs), compared to normal and overweight participants (Bala, Jakšić, & Popović, 2009). Movement structures in these tasks do not involve large shifting and projecting the body through space, but for successful execution timing and synchronization of the arms and legs are very important.

Overweight participants had the worse results in almost all the motor abilities, which can be partially explained by differences in morphological characteristics, as well as in small number of obese participants. In fact, obese participants had significantly higher values in regards to the measures of longitudinal dimensionality of the skeleton but not the subcutaneous fatty tissue, compared to overweight participants. Higher values of longitudinal parameters allow longer strides when running, further jumping, longer throw etc. The small number of obese participants in the study (n = 4) affected the obtained results, so they can be accepted with great caution.

As expected, obese and overweight participants have significantly higher values of body mass, voluminosity and subcutaneous fatty tissue, compared to the normal weight ones, which is directly or indirectly in compliance with previous studies (Lazaar et al., 2007; Tokmakidis et al ., 2006; Deforche et al., 2003; Grund et al., 2000; Wells et al., 2006). Often, obese children are significantly taller than normal weight ones (Wells et al., 2006; Kain, Albala, Garcia, & Andrade, 1998), which may be reflection of their earlier maturation (Guo, Chumlea, Roche, & Siervogel 1998; Freedman et al., 2002). Wells et al. (2006) found that obese children have significant excess in fat mass and fat free mass, mostly detected in the arms, legs and trunk. Authors also suggest that the majority of excess mass is fat (73%), which is mostly located in the abdominal region. Webster, Hesp, & Garrow (1984) proposed a rule of thumb that 75% of excess weight is fat, and the remainder is fat free mass.

Generally speaking, overweight and obese girls achieved lower results in motor tasks whose movement structures include lifting and projecting body mass in space, but also frequent hand movement. On the other hand, overweight and obese participants had significantly higher values of morphological characteristics, in particular measures of transversal and circular dimensionality, body mass and subcutaneous fatty tissue, compared to the normal weight participants. Lower results in overweight and obese girls are caused by higher values of morphological characteristics, especially increased weight and fatty tissue. Study by Suchomel (2005) determined that children with low levels of motor abilities have significantly higher values of body mass, BMI and subcutaneous fatty tissue compared to the children with high levels of motor abilities.

CONCLUSION

The results of our study indicate that, in regards to the BMI, there are significant differences in the morpho-motoric status in nine-year-old girls. Higher values of morphological characteristics, but also a low level of explosive strength, speed and coordination, were recorded in overweight and obese participants.

From the abovementioned, the authors of this study recommend involvement of overweight and obese children in organized forms of exercise, in order to prevent obesity and also increase the level of motor abilities in the school population.

Acknowledgement: *In this study we used results obtained in doctorate dissertation by Đorđević, M. (2015). Trend of changes in morpho-motoric status of girls of varying degrees of nutritional status. Unpublished doctoral dissertation, Nis: Faculty of Sport and Physical Education, which originated from the project* Anthropological characteristics of children in south-east Serbia – condition, changes and trends, *implemented by the Faculty of Sport and Physical Education, University of Nis.*

REFERENCES

Antić, A.P. (2009). Arterijska hipertenzija gojazne dece i adolescenata [Hypertension in Obese Children and Adolescents]. *Srpski Arhiv za Celokupno Lekarstvo*, 137, 91-97.

Ara, I., Moreno, A.L., Leiva, T.M., Gutin, B., & Casajús, A.J. (2007). Adiposity, physical activity, and physical fitness among children from Aragón, Spain. *Obesity*, 15(8), 1918-1924.

Bala, G. (2007). Morfološke karateristike predškolske dece [Morphological characteristics of preschool children]. U G. Bala (Ur), *Antropološke karakteristike i sposobnosti predškolske dece [Anthropological characteristics and abilities of preschool children]* (str. 33-66). Novi Sad: Fakultet sporta i fizičkog vaspitanja.

Bala, G., Jakšić, D., & Popović, B. (2009). Trend relacija morfoloških karakteristika i motoričkih sposobnosti predškolske dece [Trend of Relations of Morphological Characteristics and Motor Abilities of Preschool Children]. U G. Bala (Ur), *Relacije antropoloških karakteristika i sposobnosti predškolske dece [Relationships Between Anthroplogical Characteristics and Abilities of preschool Children]* (str. 61-112). Novi Sad: Fakultet sporta i fizičkog vaspitanja.

Biddle, S., Gorely, T., & Stensel, D. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of sports sciences*, 22(8), 679-701.

Biskanaki, F., Panagiotou, K.A., Papadopoulou, S.K., Spiridou, N.G., Gallos, G.K., Gill, J., Zacharis, E.M., Tassoulas, E., & Fachantidou, A. (2004). The effect of sex and obesity on specific motor skills of Greek children aged 8 years old. *Pakistan Journal of Medical Research*, 43(3), 99-103.

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: the 'Québec en Forme' Project. *International Journal of Obesity*, 31, 637-643.

Casajús, A. J., Leiva, T. M., Villaroya, A., Legaz, A., & Moreno, L. A. (2007). Physical Performance and School Physical Education in Overweight Spanish Children. *Annals of Nutrition & Metabolism*, 51(3), 288-296.

Cawley, J., & Spiess, C. K. (2008). Obesity and skill attainment in early childhood. *Economics & Human Biology*, 6(3), 388-397.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition forchild overweight and obesity worldwide: international survey. *British Medical Journal*, 320, 1240-1243.

De Sá Pinto, A. L., De Barros Holanda, P. M., Radu, A. S., Villares, S. M., & Lima, F. R. (2006). Musculoskeletal findings in obese children. *Journal of Pediatrics and Child Health*, 42(6), 341-344.

Deforche, B., Lefevre, J., De Bourdeaudhuij, I., Hills, P. A., Duquet, W., & Bouckaert, J. (2003). Physical fitness and physical activity in obese and nonobese Flemish youth. *Obesity research*, 11(3), 434-441.

Dencker, M., & Anderson, L. B. (2008). Health-related aspects of objectively measured daily physical activity in children. *Clinical Physiology and Functional Imaging*, 28(3), 133-144.

D'Hondt, E., Deforche, B., De Bourdeaudhuij, I., & Lenoir, M. (2009). Relationship between motor skill and body mass index in 5- to 10-year-old children. *Adapted Physical Activity Quarterly*, 26, 21-37.

D'Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I., Vaeyens, R., Philippaerts, R., & Lenoir, M. (2013). A longitudinal analysis of gross motor coordination in overweigh and obese children versus normal-weight peers. *International Journal of Obesity*, 37, 61-67.

Đorđević, M., Kostić, R., Pantelić, S., Uzunović, S., Milanović, Z., & Živković, D. (2015). Motor abilities of eight-year-old girls of different nutritional status. In S. Pantelić (Ed.), *3th International Scientific Conference in Physical Education, Sport and Recreation „FIS COMMUNICATIONS 2015"*. (pp. 236-242), Niš: Faculty of Sport and Physical Education, Serbia.

Freedman, D., S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2002). Relation of age at menarche to race, time period, and anthropometric dimensions: the Bogalusa Heart Study. *Pediatrics*, 110(4), 1-7.

Goran, M. I. (2001). Metabolic precursors and effects of obesity in children: a decade of progress, 1990–1999. *American Journal of Clinical Nutrition*, 73(2), 158-171.

Graf, C., Koch, B., Dordel, S., Schindler-Marlow, S., Icks, A., Schüller, A., Bjarnason-Wehrens, B., Tokarski, W., & Predel, H. G. (2004). Physical activity, leisure habits and obesity in first-grade children. *European Journal of Cardiovascular Prevention and Rehabilitation*, 11(4), 284-290.

Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H. G., & Dordel, S. (2004). Correlation between BMI, leisure habits and motor abilities in childhood (CHILT project). *International Journal of Obesity and Related Metabolic Disorders*, 28(1), 22-26.

Grund, A., Dilba, B., Forberger, K., Krause, H., Siewers, M., Rieckert, H., & Muller, M., J. (2000). Relationships between physical activity, physical fitness, muscle strength and nutritional state in 5- to 11-year-old children. *European journal of applied physiology*, 82, 425-438.

Guo, S. S., Chumlea, W. C., Roche, A. F., & Siervogel, R. M. (1998). Age- and maturity-related changes in body composition during adolescence into adulthood: the fels longitudinal study. *International Symposium on In Vivo Body Comparison Studies*, 49(5-6), 581-585.

Guo, S. S., Roche, F. A., Chumlea, C. W., Gardner, D. J., & Siervoge, M. R. (1994). The predictive value of childhood body mass index velues for overweight at age of 35 years. *The American Journal of Clinical Nutrition*, 59, 810-819.

Hills, A. P., King, N. A., & Armstrong, T. P. (2007). The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: implications for overweight and obesity. *Sports Medicine*, 37(6), 533-546.

Hills, A. P., Okely, A. D., & Baur, L. A. (2010). Addressing childhood obesity through increased physical activity. *Nature Reviews Endocrinology*, 6, 543-549.

Jannini, S. N., Doria-Filho, U., Damiani, D., & Silva, C. A. (2011). Musculoskeletal pain in obese adolescents. *Jornal de Pediatria*, 87(4), 329-335.

Kain, J., Albala, C., Garcia, F., & Andrade, M. (1998). Obesity in Chilean preschool children: anthropometric evolution and socioeconomic determinants. *Revista medica de Chile*, 126, 271-278.

Kostić, R., Đurašković, R., Pantelić, S., Uzunović, S., Veselinović, N., & Mladenović-Ćirić, I. (2010). A Comparison of the Explosive Strength. Coordination and Speed of seven-year old boys. *European Psychomotricity Journal*, 3(1), 23-30.

Lazaar, N., Aucouturier, J., Ratel, S., Rance, M., Mayer, M., & Duché, P. (2007). Effect of physical activity intervention on body composition in young children: influence of body mass index status and gender. *Acta Paediatrica*, 96(6), 1315-1320.

Leskošek, B., Strel. J., & Kovač, M. (2007). Differences in physical fitness between normal-weight, overweight and obese children and adolescents. *Kinesiologia Slovenica*, 13(1), 21-30.

Lobstein, T., Baur, L., & Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obesity Review*, 5, S4-S85.

Malina, R. M., Beunen, G. P., Claessens, A. L., Lefevre, J., Eynde, V. B., Renson, R., Vanreusel, B., & Simons, J. (1995). Fatness and physical fitness of girls 7 to 17 years. *Obesity Research*, 3(3), 221-231.

Mota, J., Flores, L., Flores, L., Riberio, J. C., & Santos, M. (2006). Relationship of single measures of cardioresiratory fitnes and obesity in young schoolchildren. *American Journal of Humen Biology*, 18(3), 335-341.

Mota, J., Santos, P., Guerra, S., Riberio, J. C., & Duarte, J. A. (2002). Differences of daily physical activity levels of children according to body mass index. *Pediatric Exercise Science*, 14(4), 442-453.

O'Melley, G., Hussey, J., & Roche, E. (2012). A pilot study to profile the lower limb musculoskeletal health in children with obesity. *Pediatric Physical Therapy*, 24(3), 292-298.

Pantelić, S., Kostić, R., Đurašković, R., Uzunović, S., & Ranđelović, N. (2012). Motoričke sposobnosti učenica prvog razreda osnovnih škola različitog stepena uhranjenosti. *Nastava i vaspitanje*, 61(4), 741-753.

Runhaar, J., Collard, D. C. M., Singh, A. S., Kemper, H. C. G., van Mechelen, W., & Chinapaw, M. (2010). Motor fitness in Dutch youth: Differences over a 26-year period (1980-2006). *Journal of Science and Medicine in Sport*, 13(2), 323-328.

Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Mustin, A., Nixon, P. A., Pivarnik, J. M., Rowland, T., Trost, S., & Trudeau, F. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics*, 146(6), 732-737.

Suchomel, A. (2005). Somathic parameters of children with low and high levels of motor peformance. *Kinesiology*, 37(2), 195-203.

Tokmakidis, S. P., Kasambalis, A., & Christodoulos, A. D. (2006). Fitness levels of Greek primary schoolchildren in relationship to overweight and obesity. *European Journal of Pediatrics*, 165(12), 867-874.

Truter, L., Pienaar, A. E., & Du Toit, D. (2012). The relationship of overweight and obesity to the motor performance of children living in South Africa. *South African Family Practice*, 54(5), 429-435.

Webster, J., Hesp, R., & Garrow, J. (1984). The composition of excess weight in obese women estimated by body density, total body water and total body potassium. *Hum Nutr Clin Nutr*, 38(4), 299-306.

Weiner, J. S., & Lourie, J. A. (1969). *Human Biology*. Oxford and Edinburgh: Published for the International Biological Programme by Blackwell Scientific Publications.

Wells, J. C. K., Fewtrell, M. S., Williams, J. E., Haroun, D., Lawson, M. S., & Cole, T. J. (2006). Body composition in normal weight, overweight and obese children: matched case-control analyses of total and regional tissue masses, and body composition trends in relation to relative weight. *International Journal of Obesity*, 30, 1506-1513.

Wrotniak, B., Epstein, L. H., Dorn, J. M., Jones, K. E., & Kondilis, V. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics*, 118(6), 1758-1765.

Yusof, S., Aiman, S., Zawi, M. K., Hasan, H., & Radzi, A. A. (2013). Body composition index predict children's motor skills proficiency. *International Journal of Medical, Pharmaceutical Sciense and Engineering*, 7(7), 153-158.

Zametkin, A. J., Zoon, K. C., Klein, H. W., & Munson, S. (2004). Psychiatric aspects of child and adolescents obesity: a review of the past 10 years. *Journal of the American Academy of Children & Adolescent Psychiatry*, 43(2), 134-150.

MORFO-MOTORIČKI STATUS I STEPEN UHRANJENOSTI KOD DEVETOGODIŠNJIH DEVOJČICA

Stepen uhranjenosti dece jedan je od važnih pokazatelja njihovog telesnog i motornog razvoja i jedan je od faktora koji utiče na morfo-motorički status. Cilj studije bio je da se utvrde razlike u morfološkim karakteristikama i motoričkim sposobnostima devojčica starih 9 godina različitog stepena uhranjenosti. Istraživanje je sprovedeno na uzorku od 89 devojčica trećeg razreda osnovnih škola grada Niša, prosečne godine starosti 9.01 ± 0.28. Na osnovu BMI formirana su tri subuzorka (normalno uhranjene, prekomerno uhranjene i gojazne ispitanice). Morfološki status utvrđen je merenjem parametara longitudinalne, transverzalne i cirkularne dimenzionalnosti, mase tele i potkožnog masnog tkiva. Motoričke sposobnosti (eksplozivna snaga, koordinacija i brzina) procenjene su baterijom od devet testova. Razlike u morfološkim i motoričkim varijablama utvrđene su MANOVA/ANOVA-om i LSD Post Hoc testom. Rezultati studije ukazuju da, u odnosu na stepen uhranjenosti, postoji značajna razlika u morfo-motoričkom statusu kod devetogodišnjih devojčica. Veće vrednosti morfoloških karakteristika, ali i niži nivo eksplozivne snage, brzine i koordinacije zabeleženi su u grupi prekomerno uhranjenih i gojaznih ispitanica.

Ključne reči: *uhranjenost, morfološke karakteristike, motoričke sposobnosti, razlike, devojčice.*.