RELATIONS BETWEEN OBESITY INDICATORS AND AEROBIC CAPACITY OF PUPILS

Mateja Kunješić, Marko Badrić, Ivan Prskalo
Faculty of Teacher Education University of Zagreb, Republic of Croatia

Original scientific paper

Abstract
The aim of research was to determine the association between of obesity indicators and aerobic capacity of primary school pupils. The study included 333 pupils (178 boys and 155 girls) aged 7-11 years from two primary schools in Zagreb. To determine the association between functional capacity and body composition, four variables of anthropometry and one variable for assessing functional abilities were used. A statistically significant association between aerobic capacity and indicators of obesity was determined by Pearson's correlation coefficient at a significance level of p <0.05. Results indicate a significant negative correlation between functional abilities and body mass index (BMI) in boys (-, 18) and girls (-, 23). The results of correlation between body fat percentage (% BF) and functional capacity (FC) indicate a statistically significant association in boys (-, 25) and girls (-, 38). In the upper arm volume a statistically significant negative correlation with functional abilities in boys is proven (-, 16), while the results in girls show a negative correlation but not statistically significant. Also, the results show that in girls there is no statistically significant relationship between functional abilities and upper arm volume while in boys relationship is statistically significant (-, 16). Based on the obtained results it can be concluded that increased body fat percentage (BF%) has effect on physical performance. Increased body mass index (BMI) reduces the results of functional abilities in boys and girls. Volume of the body is negatively correlated with aerobic capacity. The level of aerobic capacity increases by reducing the fat content. It also reduces chances of various diseases appearance and improves overall physical fitness of primary school pupils.

Key words: *body mass index, primary school students, obesity, functional abilities*

INTRODUCTION

The prevalence of obesity in children has increased dramatically throughout the world, especially in the last twenty years (Wang, Monteiro, Popkin, 2002; Hedley, Ogden, Johnson, Caroll, Curtin, Flegal,, 2004). It is estimated that the range of overweight and obese children in developed countries is from 12% to 30%, while in undeveloped countries is from 2% to 12% (Lobstein, Baur, Uauy, 2004). It is alarming that the excessively heavy and obese children often have weight problems in adulthood (Reilly, Methven, McDowell, Hacking, Alexander, Stewart i ostali, 2003; Whitlock, Williams, Gold, Smith, Shipman, 2005; Singh, Mulder, Twisk, van Mechelen, Chinapaw, 2008) which entails many health problems and the cost to society. It is enough worrying fact that every third child aged 2 – 19 is overweight or obese (Ogden, Carroll, Kit, Flegal, 2012).

Obesity is undoubtedly multifactorial in origin, but the acquired influences probably exceed the genetic factors in its causation (Grundy, 1998). There are many risk factors for obesity in children, but parents obesity, socioeconomic status, birth weight, physical activity and nutrition are considered to be the most important (Agras, Hammer, McNicholas, Kramer, 2004).The association of overweight with a number of health problems (type 2 diabetes, high cholesterol, hypertension, etc.), including functional abilities, is confirmed in many studies.Results of some studies showed that overweight subjects were worse in cardiorespiratory tests than thinner subjects, and there were low to moderate high inverse correlation between cardiorespiratory fitness and thickness (Winsley, Armstrong, Midlebrooke, Ramos-Ibanez, Williams, 2006; Ara, Moreno, Leiva, Gutin, Casajus, 2007). Davidson, Mackenzie-Rife, Witmans, Montgomery, Ball, Egbogah, Eves (2013) in their study proved that the increase in body weight in children and adolescents is associated with a general reduction in lung volume, an increase in respiratory symptoms and decreased functional status. Some studies have not confirmed the association between body mass index and lung problems (Schachter, Peat, Salome, 2003; Bibi, Shoseyov, Feigenbaum, Genis, Friger, Peled, Sharff, 2004) while other studies have reported an association (Gilliland, Berhane, Islam , McConnell, Gauderman, Gilliland, Avola, Peters, 2003; Yang, Lee, Park, Shin, Kim, Park, 2006; Scholtens, Wijga, Seidell, Brunekreef, de Jongste, Gehring, Postma, Kerkhof, Smith, 2009). Mota, Flores, Flores, Ribeiro, Santos (2006) in their study demonstrated that elevated BMI is significantly associated with poorer cardiorespiratory fitness in girls but not in boys, regardless of elevated BMI. On the other hand, He, Wong, Du, Jiang Yu, Qiu Gao, Liu, Wu

(2011) have established a link between overweight and / or obesity and cardiorespiratory fitness in boys, while in girls correlation was not statistically significant.

Given the opposition of previous studies, the aim of the research is to determine the correlation between the indicators of obesity and functional capacity of primary school pupils.

METHODS

The sample of examinees consisted of 333 students of which 178 were boys with an average age 9.42 ± 1.27 years and 155 were girls with an average age 9.21 ± 1.15 years. The subjects were pupils from two primary schools in Zagreb, Ivan Goran Kovačić and Davorin Trstenjak. The measurement was conducted in the second month of the school year 2013 / 2014 in the morning. All pupils were healthy and for their participation in the study parental consent, according to the Code of Ethics of research with children, were obtained. The sample of variables consisted of anthropometric measures of body height, body weight, skin fold of the upper arm, back skinfold, upper arm and forearm volume. All measurements were performed according to the International Biological Program (IBP).

Body height was measured with the help of anthropometer and body weight with the help of digital scales. Skin folds were measured with the help of Harpendens's caliper, while the volumes were measured with the help of the centimeter tape. Functional skills are checked with 3 minutes run test - F3, which is used to assess the level of functional ability in primary education in the Republic of Croatia (Findak, Metikoš, Mraković, Neljak, 1996).

We estimated body fat percentage from the sum of sub-scapular (subsc) and triceps (tric) SFT (mm) according to the Slaughter equations (Slaughter , Lohman, Boileau, Horswill, Stillman, van Loan, et al. 1988). The amounts of body fatness and of fat-free mass were also calculated (in kg). Body mass index was obtained by the formula BMI (kg/m2 = weight (kg) / (height (m) 2).

Classification of subjects according to the percentage of body fat is made according to McCarthy and co-workers (McCarthy, Cole, Fry, Jebb, Prentice, 2006) with defined percentile curves specific to children with respect to age and gender and the division of the normal body weight (2-85 percentile), overweight fat (85-95 percentile) and obesity (over 95 percentile).

Statistical analysis

Data processing was performed with the program STATISTICA (data analysis software system), version 7.1. For all the studied variables basic descriptive parameters (arithmetic mean (AS), standard deviation (SD), minimum (MIN) and maximum (MAX) result, and Skewness and Kurtosis) were calculated. The significance of differences between the descriptive parameters of the subsamples defined by gender was calculated by t-test. Relations between functional capacity and body mass index, percentage of fat and volumes were determined by Pearson's correlation coefficient. Statistical significance was tested at a significance level of $p < 0.05$.

RESULTS

The research results i.e. results of anthropometric measures and functional abilities of pupils of 1st- 4thgrade of primary school are presented in the following tables.

Table 1. Results of descriptive parameters of anthropometric measures and functional abilities of boys in primary education

	Boys n=178					
	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Height-cm	137,59	9,28	113,20	173,50	0,28	0,64
Weight-kg	34,90	9,21	20,50	83,30	1,42	3,79
Body fat (%)	21,61	8,55	8,54	48,58	0,83	0,13
Upper arm volume	20,53	2,83	16,20	31,00	1,05	1,16
Forearm volume	19,02	2,15	15,00	28,00	0,72	0,92
Sub-scapular skinfold	9,65	5,96	1,00	30,33	1,59	2,05
Triceps skinfold	14,07	5,81	5,00	29,67	0,61	-0,54
BMI	18,20	2,92	13,83	28,65	1,32	1,95
Runing 3'	556,91	76,78	290,00	800,00	-0,28	0,80

Results in Table 1 show the descriptive parameters of boys from 1st-4thgrade mean age 9.42 ± 1.27 years. It is evident that the boys have average height 137.59 ± 9.28 and weight 34.90 ± 9.21 which classifies them among the children of normal body height and body weight in accordance with their age according to the reference values at the level of the Croatia (Jureša, Kujundžić Tiljak, Musil, 2011). Results of body fat percentage amounts 21,62%, which boys of total sample classified in normal weight subject according to reference values (McCarthy and associates, 2006). Body mass index values are on the level of the reference values for Croatia (Jureša and associates, 2011).

Table 2. Results of descriptive parameters of anthropometric measures and functional abilities of girls in primary education

	Girls n=155					
	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Height-cm	135,81	9,17	113,60	161,90	0,21	0,26
Weight-kg	32,99	7,45	18,40	54,50	0,53	-0,15
Body fat (%)	21,26	6,70	10,56	41,91	1,09	1,42
Upper arm volume	20,23	2,36	15,30	26,00	0,39	-0,29
Forearm volume	18,56	1,80	15,00	23,00	0,14	-0,44
Sub-scapular skinfold	9,62	5,41	4,00	32,00	1,92	3,82
Triceps skinfold	14,51	5,26	6,00	35,00	1,28	2,43
BMI	17,69	2,50	13,66	24,36	0,72	-0,13
Runing 3'	519,14	73,39	266,00	710,00	-0,16	0,42

Results in Table 2 show the descriptive parameters of the girls from 1st- 4th grade mean age 9.21 ± 1.15 years. It is evident that the girls have average height 135.81 ± 9.17 and weight 32.99 ±7.45 which classifies them as children of normal body height and body weight in accordance with their age according to the reference values at the level of the Croatian (Jureša et al. , 2011). Results of body fat percentage amounts 21,26 %, which girls of total sample classified in normal weight subject according to reference values (McCarthy and associates, 2006). Body mass index values are on the level of the reference values for Croatia (Jureša and associates, 2011).

Table 3. Results of t-test of anthropometric measures and functional abilities between girls and boys in primary education

	Boys n=178 Mean±SD	Girls n=155 Mean±SD	p-level
Height-cm	137,59±9,28	135,81±9,17	0,0896
Weight-kg	34,90±9,21	32,99±7,45	0,0353
Body fat (%)	21,61±8,55	21,26±6,70	0,6790
Upper arm volume	20,53±2,83	20,23±2,36	0,2892
Forearm volume	19,02±2,15	18,56±1,80	0,0370
Sub-scapular skinfold	9,65±5,96	9,62±5,41	0,9618
Triceps skinfold	14,07±5,81	14,51±5,26	0,4656
BMI	18,20±2,92	17,69±2,50	0,0867
Runing 3 minutes-m	556,91±76,78	519,14±73,39	0,0000

Analysis of the t-test for independent samples showed statistical significance between girls and boys in body weight ($p = 0.0353$) at a significance level of $p < 0.05$. Boys were significantly heavier than girls for almost two kilograms. Also statistical significance occurs in the variable volume of the forearm ($p = 0.0370$) which shows that boys have significantly higher values than girls. Results in the test run for 3 minutes determine statistical significance where boys (556.91 m) have more value than girls (519.14 m). Results of t-test for other variables have not found gender differences. Values of body fat percentage were similar in girls and boys.

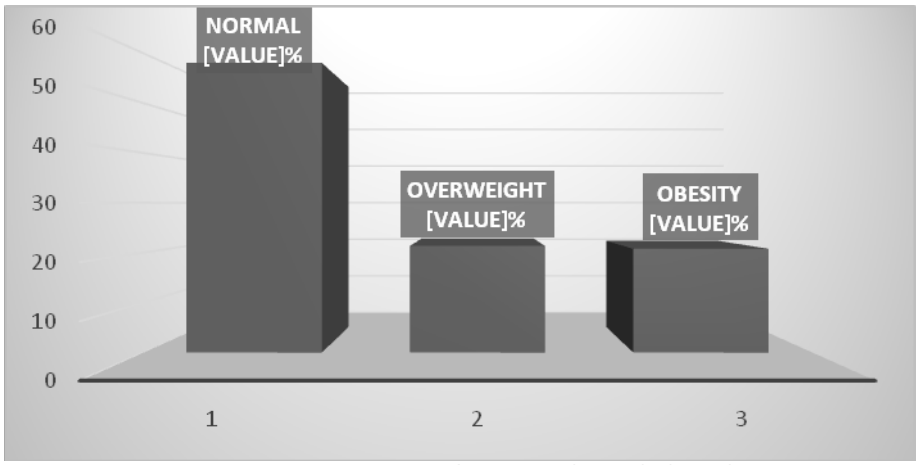


Figure 1. Percentage of overweight and obese boys

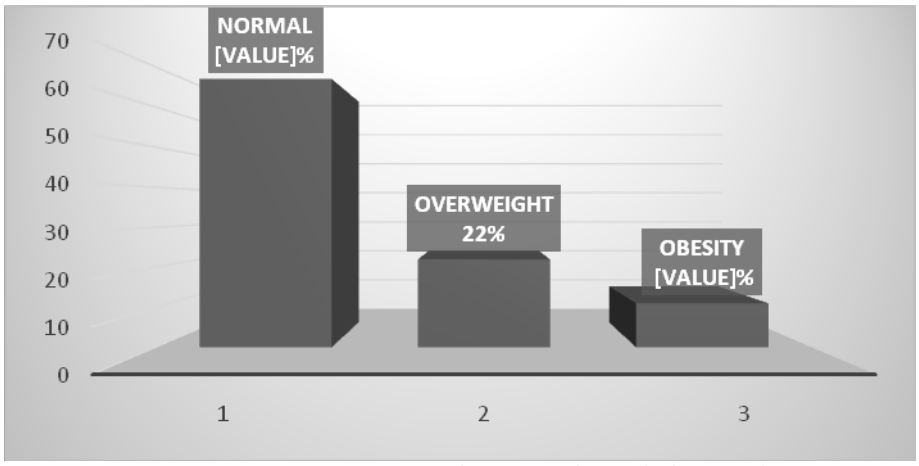
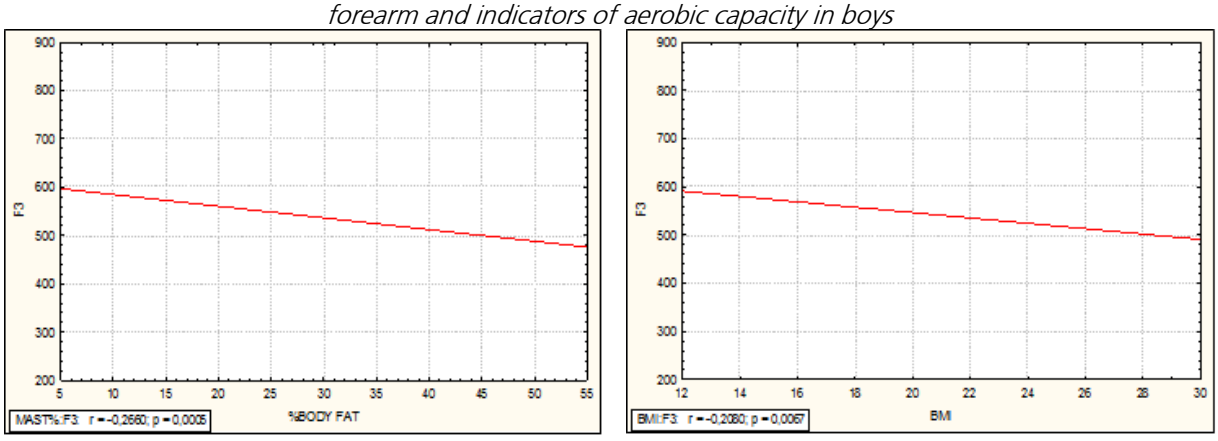
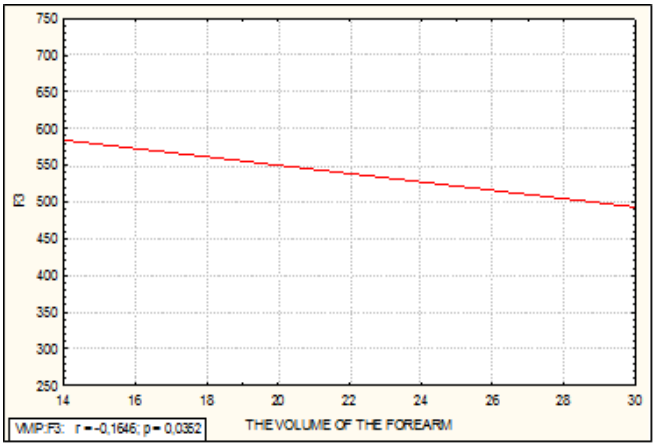


Figure 2. Percentage of overweight and obese girl

Looking at Figure 1 and Figure 2 it can be seen that of the total sample of boys, 21% belongs to a group of obese and 21% in a group of overweight. For girls, the results show that 67% have the normal percentage of fat in the body, while the 22% are overweight and 11% obese.

Figure 3. *Relations between the percentage of body fat, body mass index, the volume of the forearm and indicators of aerobic capacity in boys*





Based on the results shown in Figure 3 it can be seen that the correlation between aerobic capacity and percentage of body fat shows a significant negative correlation (r = -0.27; p = 0.00). A statistically significant negative correlation appears in relation to aerobic capacity and body mass index (r = -0.21; p = 0.01). Slightly lower inverse correlation, but still statistically significant, is between aerobic capacity and the volume of the forearm (r = -0.16; p = 0.04).

Figure 4. *Relations between the percentage of body fat, body mass index, the volume of the forearm and indicators of aerobic capacity in girls*

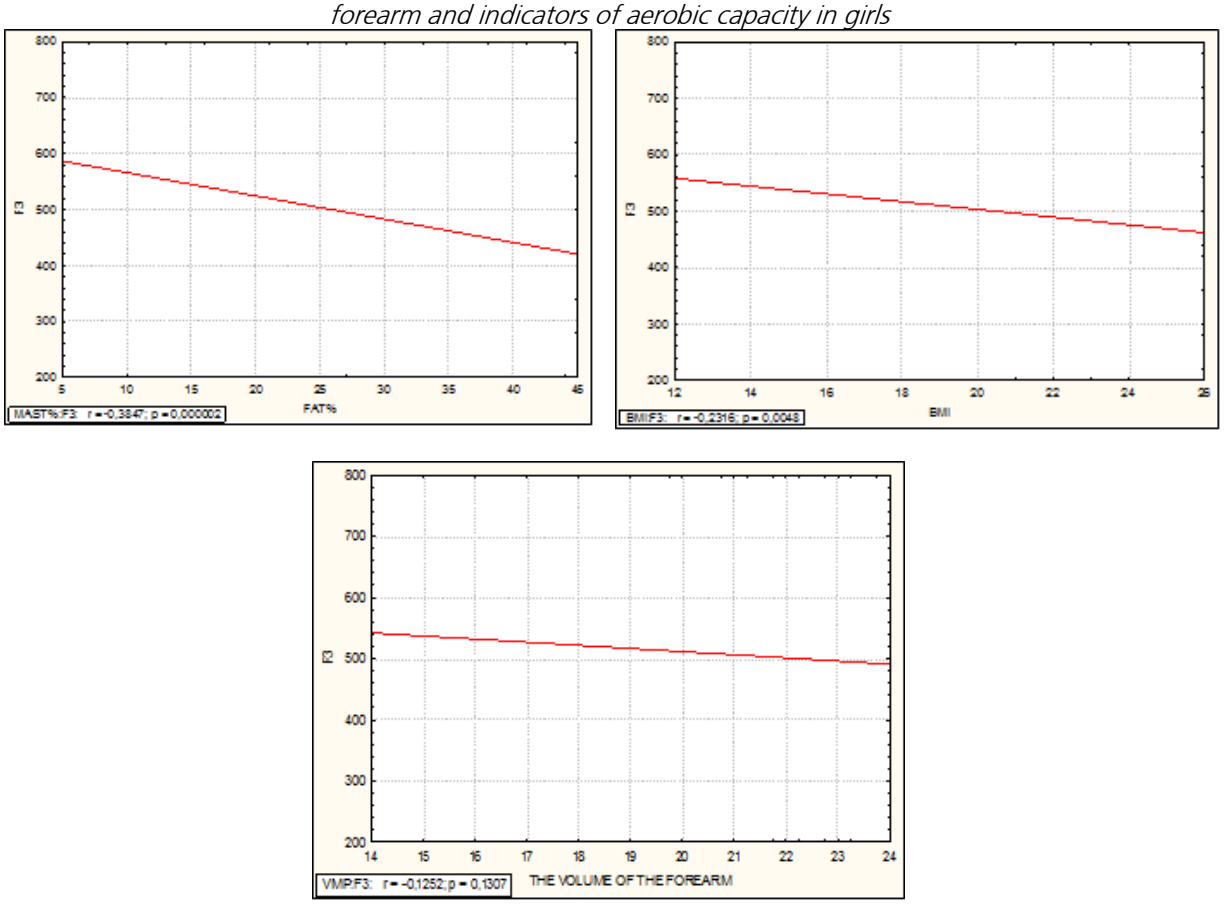


Figure 4 show the results of Pearson correlation coefficient for a sample of girls. The present results show that the correlation between aerobic capacity and percentage of body fat shows a high significant negative correlation (r = -0.38; p = 0.00).A statistically significant negative correlation appears in relation to aerobic capacity and body mass index (r = 0.23;

p = 0.00). Results of Pearson correlation coefficient shows negative correlation between aerobic capacity and the volume of the forearm, but not high enough to confirm statistically significant correlation (r = -0.13; p = 0.13).

DISCUSSION

Children with higher body mass index (BMI) score weaker results in tests for assessing physical fitness because overweight is limiting factor of development, both in strength and in physical performance (Andersen et al., 2007). Higher values of aerobic capacity in childhood and adolescence are strongly associated with the current level of health, but also with high prediction in the future (Ruiz et al., 2007, Ortega et al., 2011).Based on the research goal, significant association between indicators of obesity in the body and aerobic capacity in primary school pupils can be confirmed.

The results show that boys are slightly taller and heavier than girls, while the results for the percentage of body fat are equal in both genders. Most of the authors in their research has received the results in which girls had a higher percentage of fat than boys (abut, Abu-Nada, channels, 2009; Wang, Wang, Liu, Ma, 2013; Nwizu, Njokanma, Okoromah, David, 2014). Classification of subjects according to the nutritional status shows that 42% of boys are overweight and obese, while 33% of girls are overweight and obese. In relation to research (Findak et al., 1996), explored boys have slightly higher average scoresin test running for three minutes, while girls achieved slightly lower values. In relation to the results (Katic et al., 2004) in our study, boys and girls have achieved better results in this test for assessing aerobic fitness.Research (Dencker et al., 2006) shows that boys have better aerobic capacity than girls, while Kovač and colleagues (2013) found that girls scored better in tests for assessing aerobic fitness than boys.

Pearson's correlation coefficient showed significant negative correlation between aerobic capacity and % BF in boys, while in girls established a moderate negative correlation. Lee and Arslanian (2007) and Ekelund et al, (2001) were given slightly higher results of negative correlation with respect to the results of our research, while Ostojic et al (2011) found a very high negative correlation between % BF and aerobic capacity (r = -0.76). Lower, but still significant, negative correlation between aerobic capacity and BMI was found in both genders and it was confirmed in other researches (Katic et al., 2004, Lee and Arslanian, 2007, Andreas et al., 2010, Tambalis et al., 2013). Similar results in their research were obtained by other authors, which have proven negative effect of thickness on an aerobic capacity (Winsley, Armstrong, Midlebrooke, Ramos-Ibanez, Williams, 2006; Ara, Moreno Leiva, Gutin, Casajús, 2007).A recent survey of Héroux et al (2013) showed that in the Canadian and Kenyan pupils a significant negative correlation is low, while in Mexican children relatively high significant correlation was identified. The lack of significant correlation was found in the study of Ostojic et al (2011).

Our research also confirmed significant correlation between the extent of the forearm as a measure of body volume and aerobic capacity in boys, while in girls insignificant negative correlation were determined. In study Katic et al. (2004) similar values were obtained.

Since the boys achieved better results in the test run for 3 minutes (F3), they have a better level of aerobic fitness. The boys, although they have a slightly higher percentage of fat, have a better level of functional abilities of girls, and it can be concluded that this study has not proven impact of body composition on the level of functional ability. As far as the boys, similar results in their study were given by Mota, Flores, Flores, Ribeiro, Santos (2006) and Kim, Must, Fitzmaurice, Gillman, Chomitz, Kramer, McGowan, Peterson (2005). An interesting finding in their study was obtained by Jensen, Gibson, Collins and Wood (2014), namely that the respiratory function can affect lean mass, but not fat mass of the body, in the case of children with asthma. The sample size in this study should also be taken into consideration, which certainly affected the final results.

The limiting factor of this study is the lack of quality indicators for assessing the aerobic capacity. In some future field research with pupils of primary education can be used and some other tests, such as 20-m shuttle run test by which it is possible to obtain more precise information on the values of VO2max.For future research, it is necessary to take into account the assessment of overall physical activity of pupils because on the basis of this indicator it is possible to get a fuller reasons for the obtained results of aerobic capacity. Results of this study can not be generalized to the entire population because the study was conducted in an urban area, but the obtained findings can be used in future research in this area.

The findings of this study suggest that a high percentage of pupils are overweight. Aerobic capacity is inversely associated with obesity indicators, which means that students with high

levels of aerobic capacity have a lower percentage of body fat. Based on the results of research more attention should be given to the preparation of intervention programs to increase the overall level of aerobic capacity in primary school pupils. Also, it is important for Physical Education curriculum design to emphasize the need for planning more kinesiology content aimed at raising the overall aerobic fitness.

REFERENCES

1. Agras, W.S., Hammer, L.D., McNicholas, F., Kramer, H.C. (2004). Risk factors for childhood overweight: a prospective study form birth to 9.5 years. *J Pediatr,*145, 20-25
2. Andersen, L. B., Froberg, K., Kristensen, P. L., & Moller, N. C. (2007). Physical activity andphysical fitness in relation to cardiovascular disease in children. In W. D. Brettschneider & R. Naul (Eds.), *Obesity in Europe: young people's physical activity and sedentary lifestyles* (pp. 57–100). Frankfurt am Main: Peter Lang.
3. Andreasi, V., Michelin, E., Rinaldi, A.E.M. & Burini, R.C. (2010). Physical fitness and associations with anthropometric measurements in 7-15 year-old school children. *Journal de Pediatria,* 86(6), 497-502.
4. Ara, I., Moreno, L.A., Leiva, M.T., Gutin, B., Casajus, A. (2007). Adiposity, physical activity, and physical fitness among children from Aragon, Spain. *Obesity,*15, 1918-1924
5. Bibi H, Shoseyov D, Feigenbaum D, Genis M, Friger M, Peled R, Sharff S. (2004). The relationship between asthma and obesity in children: is it real or a case of over diagnosis? *J Asthma,*41, 403–410
6. Davidson, W. J., Mackenzie-Rife, K. A., Witmans, M. B., Montgomery, M. D., Ball, G. D., Egbogah, S., Eves, N. D. (2013). Obesity negatively impacts lung function in children and adolescents. *Pediatr Pulmonol,*49 (10),1003-1010
7. Dencker, M., Thorsson, O., Karlsson, M. K., Linden, C., Wollmer, P., & Anderson, L. B. (2007). Gender Differences and Determinants of Aerobic Fitness in Children Aged 8 - 11 Years. *European Journal of Applied Physiology*, 99, 19-26. http://dx.doi.org/10.1007/s00421-007-0406-y
8. Ekelund, U., Poortvliet, E., Nilsson, A., Yngve, A., Michael, A., & Sjöström, M. (2001). Physical activity in relation to aerobic fitness and body fat in 14- to 15-year-old boys and girls.*European Journal of Applied Physiology*, 85, 195–201.
9. Findak, V., Metikoš, D., Mraković, M., Neljak, B. (1996) *Primjenjena kineziologija u školstvu – Norme*. Hrvatski pedagoški-književni zbor. Zagreb. Fakultet za fizičku kulturu Sveučilišta u Zagrebu
10. Gilliland, F.D., Berhane, K., Islam, T., McConnell, R., Gauderman, W.J., Gilliland, S.S., Avol, E., Peters, J.M. (2003). Obesity and the Risk of Newly Diagnosed Asthma in School-age Children.*American Journal of Epidemiology,*158(5), 406-414. 10.1093/aje/kwg175
11. Grundy, S. (1998). Multifactoral causation of obesity: implications for prevention. *Am J Clin Nutr*, 67(suppl), 563S–572S
12. He, Q., Wong, T., Du, L., Jiang, Z., Yu, T.I., Qiu, H., Gao, Y., Liu, W., Wu, J. (2011). Physical activity, cardiorespiratory fitness, and obesity among Chinese children.*Preventive Medicine,*52(2), 109-113
13. Hedley, A.A., Ogden, C.J., Johnson, C.L., Caroll, M.D., Curtin, L.R., Flegal, K.M. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *JAMA,*291, 2847-2850
14. Héroux, M., Onywera, V., Tremblay, M.S., Adamo, K.B., Lopez Taylor, J., Jáuregui Ulloa, E., Janssen, I. (2013) The relation between aerobic fitness, muscular fitness, and obesity in children from three countries at different stages of the Physical Activity Transition. *ISRN Obes,* 13, 1-21.
15. Jang AS, Lee JH, Park SW, Shin MY, Kim DJ, Park CS (2006). Severe airway hyperresponsiveness in school-aged boys with a high body mass index. *Korean J Intern Med,*21,10–14
16. Jensen, M.E., Gibson,P.G., Collins, C.E., Wood, L.G. (2014). Lean mass, not fat mass, is associated with lung function in male and female children with asthma. Pediatr Res, 75(1-1), 93-98. DOI: 10.1038/pr.2013.181.
17. Jureša, V., Kujundžić Tiljak, M., Musil, V. (2011). *Hrvatske referentne vrijednosti antropometrijskih mjera školske djece i mladih tjelesna visina, tjelesna masa, indeks tjelesne mase, opseg struka, opseg bokova.* Zagreb: Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja „Andrija Štampar"
18. Katić, R., Pejcić, A., Babin, J. (2004). Integration of aerobic power into the morphological-motor system in children aged 7-11 years. *Coll Antropol,*28, 357-66.
19. Kim, J., Must, A., Fitzmaurice, G.M., Gillman, M.W., Chomitz,V., Kramer, E., McGowan, R., Peterson, K.E. (2005). Relationship of physical fitness to prevalence and incidence of overweight among schoolchildren. *Obes Res,* 13, 1246-1254

20. Kovač, M., Strel, J., Jurak, G., Leskošek, B., Dremelj, S., Kovač, P., Mišigoj-Duraković, M., Sorić, M., Starc, G. (2013) Physical Activity, Physical Fitness Levels, Daily Energy Intake and Some Eating Habits of 11-Year-Old Children. *Croatian Journal of Education*, 15 (S1), 127-139.
21. Lee, S.J., Arslanian, S.A. (2007) Cardiorespiratory fitness and abdominal adiposity in youth. *European Journal of Clinical Nutrition*, 61, 561–565
22. Lobstein, T., Baur, L., Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obes Rev*, 5(Suppl.1), 4–85.
23. McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM.(2006). Body fat reference curves for children. *Int J Obes*, 30, 598-602
24. Mota, J., Flores, L., Flores, L., Ribeiro, J.C., Santos, M.P. (2006). Relationship of single measures of cardiorespiratory fitness and obesity in young schoolchildren. *American Journal of Human Biology,*18 (3), 335-341
25. Nwizu, S.E., Njokanma, O.F., Okoromah, C.A.N., David, A.N. (2014). Age and gender-related fat mass index and fat- free mass index patterns among adolescents in Surulere LGA, Lagos. *Niger J Paed,* 41 (2), 120-124
26. Ogden, C.L., Carroll, M.D., Kit, B.K., Flegal, K.M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *Journal of the American Medical Association,* 307 (5), 483–490
27. Ortega, F.B., Artero, E.G., Ruiz, J.R., Espana-Romero, V., Jimenez-Pavon, D., Vicente-Rodriguez, G. et al. (2011) Physical fitness levels among European adolescents: the HELENA study. *Br J Sports Med*, 45, 20–29.
28. Ostojic, S.M., Stojanovic, M.D., Stojanovic, V., Maric, J., & Njaradi, N. (2011). Correlation between fitness and fatness in 6-14-year-oldSerbian school children. *Journal of Health, Population and Nutrition*, 29, 53-60.
29. Reilly, J.J., Methven, E., McDowell, Z.C., Hacking, B., Alexander, D., Stewart, L. i ostali (2003). Health consequences of obesity. *Arch Dis Child,* 88, 748-752
30. Ruiz, J.R., Ortega, F.B., Loit, H.M., Veidebaum, T., & Sjöström, M. (2007). Body fat is associated with blood pressure in school-aged girls with low cardiorespiratory fitness: the European Youth Heart Study. *Journal of Hypertension*, 25, 2027-2034.
31. Schachter, L.M., Peat, J.K., Salome, C.M. (2003). Asthma and atopy in overweight children. *Thorax,* 58,1031–1035
32. Scholtens, S., Wijga, A.H., Seidell, J.C., Brunekreef, B., de Jongste, J.C., Gehring, U., Postma, D.S., Kerkhof, M., Smit, H.A. (2009). Overweight and changes in weight status during childhood in relation to asthma symptoms at 8 years of age. *J Allergy Clin Immunol,* 123,1312–1318
33. Singh, A.S., Mulder, C., Twisk, J.W., van Mechelen, W., Chinapaw, M.J. (2008). Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Res,* 9,474-488
34. Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, van Loan MD, et al. (1988). Skin fold equations for estimation of body fatness in children and youth. *Hum Biol*, 60,709–23
35. Tambalis, K.D., Panagiotakos, D.B., Arnaoutis, G., Sidossis, L.S. (2013). Endurance, explosive power, and muscle strength in relation to body mass index and physical fitness in greek children aged 7-10 years. *Pediatr Exerc Sci.Aug*, 25(3),394-406.
36. Wang, J.J., Wang, H.J., Liu, J.S., Ma, J. (2013). The association between body mass index, waist circumference with body fat percent, and abdominal fat rate in overweight and obese pupils. *Zhonghua Yu Fang Yi Xue Za Zhi,* 47(7), 603-607
37. Wang, Y., Monteiro, C., Popkin, B.M. (2002). Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am J Clin Nutr,* 75, 971–977
38. Whitlock, E.P., Williams, S.B., Gold, R., Smith, P.R., Shipman, S.A. (2005). Screening and interventions for childhood overweight: a summary of evidence for the US Preventive Services Task Force. *Pediatrics,* 116(1), e125-e143. DOI: 10.1542/peds.2005-0242
39. Winsley, J.R., Armstrong, N., Midlebrooke, R.A., Ramos-Ibanez, N., Williams, C.A. (2006). Aerobic fitness and visceral adiposity tissue in children. *Acta Paediat*, 95,1435-1438
40. Zabut, B.M., Abu-Nada, O.S., Kanao, B.J. (2009). Prediction of Percent Body Fat and Energy Requirements of Preparatory School Children in the Gaza Strip. *The Islamic University Journal*, 17 (1), 41-61

Correspondence to:
Dr.Marko Badrić
Faculty of Teacher Education University of Zagreb
address: Savska cesta 77, 10000 Zagreb, Croatia
phone: +385915164548,
e-mail: marko.badric@gmail.com

Received: 05. May 2015
Accepted: 03. June 2015