Nutritional Status of 19-Year-Old Adolescents in Urban Areas of Vojvodina - The Republic of Serbia

Rada Rakić, Tatjana Pavlica

University of Novi Sad, Serbia

Address correspondence to: Rada Rakić, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia. Ph.: +381643385944; Fax: 021450-620; E-mail: rada.rakic@dbe.uns.ac.rs

Abstract

Objectives. Continuous evaluation of nutritional status in children and adolescents is very important. The aim of this study was to assess the nutritional status of 19-year-olds in Vojvodina.
Material and methods. Cross-sectional anthropometric study was carried out in the period from 2001 to 2004 in urban areas of Vojvodina-North Serbia. The investigated group consisted of 229 males and 239 females aged 19 years. Body height, body weight, mid-upper arm circumference, triceps skinfold and scapula skinfold were measured and, upper arm area, the upper arm muscle area, the upper arm fat area and the arm fat index were calculated. The nutritional status was assessed according to percentile values (NHANES I). The evaluation of muscle and fat status of upper arm was done according to Z-score reference values for age.
Results. Results showed that boys had significantly higher average values of all measures except triceps skinfolds, subskapular skinfold, fat mass and the arm fat index. The highest percentage of 19-year-old males and females had normal values of body mass index and nutritional parameters of the upper arm.
Conclusions. The obtained results point to the necessity for conducting permanent investigations of development and nutritional status in the future.

Keywords: nutritional status; male; female; Vojvodina.

Introduction

Nutritional status reflects the nutritional condition of an individual. The body composition and nutritional condition can be unbalanced by inadequate diet, i.e. increased or reduced intake of certain nutrients. The first critical period for obesity is the early childhood, while the adolescence ~~age~~ is the second critical period for obesity problems.

The prevalence of children and adolescents' obesity has been increasing worldwide (Popkin and Gordon-Larsen, 2004; Dehghan, Akhtar-Danesh and Merchant, 2005). In the USA, the prevalence of obesity in 2 to 19 year-old children and adolescents was 16.9% for the period 2009-2010 (Ogden et al. 2012). The obesity incidence among adolescents in the transition to adulthood has been noticeably high (Gordon-Larsen et al. 2004). An increasing number of overweight and obese adolescents has been recorded worldwide (Georgiadis and Nassis, 2007; Emandi et al. 2013). Higher prevalence of overweight and obesity in children and adolescents has also been reported in Serbia. In the period 1995-2002, in Backa (Vojvodina), obesity was detected in 6,9% of boys and 6.7% of girls (Pavlović and Lobstein, 2004). According to the Serbian Institute for Public Health (2008), almost a fifth of children and teenagers from 7 to 19 years of age (18%) are either

overweight (11.6%) or obese (6.4%). In the year 2000, the recorded values were 8.2% and 4.4%, respectively. In the town of Jagodina (Central Serbia), for example, the prevalence of overweight is 10.80%, and obesity is present in 5.60% of cases (Pavlica et al. 2012).

The aim of the present study was to assess the nutritional status of 19-year-old adolescents in Vojvodina.

Material and methods

A transversal anthropometric survey was conducted in the period 2001-2004. It included 229 males and 239 females, all of them at the age of 19. The decimal age, obtained on the basis of the measurement date and the birth date, was calculated for all of the subjects. The measurements included the height, weight, mid upper arm circumference (MUAC), triceps skinfold thickness (Ts) and scapular skinfold thickness (Sc). The Body mass index was also obtained (BMI, weight/height^2). The parameters for nutritional status of arm were obtained by Frisancho formula (1981):

Total Upper Arm Area (TUA) = $C^2 / (4 \times \pi)$,

Upper Arm Muscle Area (UMA) = $[C - (Ts \times \pi)]^2 / (4 \times \pi)$,

Upper Arm Fat Area (UFA) = Total Upper Arm Area - Upper Arm Muscle Area and Arm Fat Index (AFI) = (Upper Arm Fat Area / Total Upper Arm Area) x 100

(C = MUAC; Ts = triceps skinfold thickness)

The upper arm muscle and fat area status was assessed by Z-scores applying the reference values for age and gender (Frisancho, 1990).

The obtained values for arm anthropometric traits and nutritional parameters were compared to the gender specific standards given in categories. Category I includes the values lower than Z<-1,650 (< P_5 percentile) representing short stature, low weight, small arm muscle and fat area and arm fat index; category II includes below average values -1,645<Z<-1,040 (P_{5-15} percentile); category III covers average values -1,036<Z<+1,030 (P_{50} percentile); category IV includes the values above average +1,036<Z<+1,640 (P_{85-95} percentile); category V Z>+ 1,640 (P≥95 percentile) includes high values referring to the age and sex.

The muscle status is assessed by the percentile values and Z score for both height and upper arm fat area, while the fat status is based on the sum of triceps and scapular skinfold thickness, upper arm fat area and arm fat index.

Statistical analysis of the data:

All variables are given as the means ± standard deviation. Differences in sexes were determined by Student´s t test and Mann-Whitney U test depending on the normal value distribution set by Kolmogorov-Smirnov test. The percentile values – 5th, 15th, 50th, 85th and 95th – were obtained for all variables.

Concerning univariate statistical analyses, the chi-square test was used to evaluate proportions. IBM SPSS Statistics 20 was applied. All results were considered significant at $p < 0.05$.

Results

Males show significantly higher ($p < 0.001$) height, weight, upper arm circumference, body mass index, total upper arm area and muscle area. Females, on the other hand, have significantly higher triceps and scapular skinfold thickness, upper arm fat area and arm fat index. In males, the median values are higher in comparison to the average values of height and upper arm circumference, while in females the values are greater concerning the arm fat index (Table 1).

Table 1. Percentile values of anthropometric and nutritional parameteres in 19-year-old boys and girls

	X	SD	5	15	50	85	95
Males (N = 229)							
Height (cm)***	180.50	7.05	168.65	173.10	180.60	188.05	192.35
Weight (kg)***	77.42	12.06	59.50	65.75	76.00	88.25	100.00
MUAC (cm)***	28.92	3.11	23.50	25.50	29.00	32.25	34.25
Ts (mm)	11.19	5.38	5.30	6.30	9.80	17.00	22.27
Sc(mm)	9.83	3.45	6.33	7.20	9.07	11.87	16.93
BMI (kg/m^2)***	23.74	3.34	19.17	20.53	23.31	26.60	30.19
TUA (cm^2)***	67.34	14.55	43.97	51.77	66.96	82.81	93.40
UMA (cm^2)***	51.86	10.06	36.54	42.17	50.03	63.02	69.97
UFA (cm^2)	15.48	8.39	6.56	8.32	12.90	24.15	33.45
AFI (%)	22.17	8.27	12.13	14.07	20.02	31.91	38.38
Females (N = 239)							
Height (cm)	166.46	6.57	156.00	160.00	166.30	173.80	177.80
Weight (kg)	60.96	8.29	49.00	53.00	60.00	69.00	76.00
MUAC (cm)	25.43	2.24	22.00	23.00	25.00	28.00	29.50
Ts (mm)†††	16.68	4.82	9.40	11.60	16.40	21.80	25.13
Sc(mm)†††	10.75	3.36	6.73	7.80	10.00	13.73	16.87
BMI (kg/m^2)	21.98	2.52	18.40	19.39	21.78	24.37	26.40
TUA (cm^2)	51.90	9.26	38.54	42.12	49.76	62.42	69.29
UMA (cm^2)	32.70	5.53	23.79	27.24	32.30	38.29	42.56
UFA (cm^2)†††	19.20	6.34	9.82	12.52	18.79	26.07	29.89
AFI (%)†††	36.42	7.84	23.69	27.79	36.67	44.99	49.16

*** $p < 0.001$ Significantly higher values in males in relation to females
††† $p < 0.001$ Significantly higher values in females in relation to males

Table 2. The percentage of Z –score categories for anthropometric and nutritional parameters in 19-year-old boy and girls

Categories	I	II	III	IV	V
Males					
Height (cm)	4.80	10.04	69.87	9.61	5.68
Weight (kg)	2.62	11.79	73.80	6.11	5.68
MUAC (cm)	5.24	10.48	69.43	10.04	4.80
Ts (mm)	0.00	7.42	75.98	7.86	8.73
Sc(mm)	0.00	3.49	87.34	3.06	6.11
BMI (kg/m^2)	1.75	11.35	76.86	3.49	6.55
TUA (cm^2)	3.49	12.23	69.43	8.30	6.55

UMA (cm^2)	2.18	11.35	70.31	10.04	6.11
UFA (cm^2)	0.00	6.11	79.04	6.99	7.86
AFI (%)	0.00	12.66	69.00	10.04	8.30
Females					
Height (cm)	4.18	9.62	70.29	10.04	5.86
Weight (kg)	3.35	8.79	73.64	7.53	6.69
MUAC (cm)	2.51	14.64	67.78	10.04	5.02
Ts (mm)	2.09	13.39	69.04	9.62	5.86
Sc(mm)	0.00	10.04	77.41	5.44	7.11
BMI (kg/m^2)	2.51	12.55	72.38	6.28	6.28
TUA (cm^2)	1.67	15.48	67.78	10.04	5.02
UMA (cm^2)	4.18	9.21	72.38	7.95	6.28
UFA (cm^2)	1.67	13.81	69.04	10.46	5.02
AFI (%)	4.60	11.30	68.20	11.72	4.18

With reference to the obtained BMI values, the largest number of males (76.86%) and females (72.38%) are normally nourished. There is a greater number of underweight males (13.10%) and females (15.06%), the categories I and II, in comparison to the number of the obese (10.04% of males and 12.56% of females), the categories IV and V. Considering the total sample, BMI values indicate that 25.38% of the subjects are undernourished (23.14% males and 27.62% females). The arm nutritional parameters suggest that the greatest number of males and females have normal values set for their age (from 15^{th} to 85^{th} percentile). Below 15^{th} percentile, there is greater percentage of TUA (17.15%), UFA (15.48%) and AFI (15.90%) recorded in females than it is the case with TUA (15.72%), UFA (6.11%) and AFI (12.66%) values found in males. Above 85th percentile, greater percentages of UMA (16.15%) and AFI (18.34%) are recorded in males than it is the case with females (14.23% and 15.90%, respectively). Girls show higher percentage of UFA (15.48%) and TUA (15.06%) when compared to males (14.85%) (Table 2).

Table 3. Muscle and fat status in 19-year-old boys and girls

	I	II	III	IV	V
Males					
Muscle status	1 (0.44)	5 (2.18)	115 (50.22)	5 (2.18)	2 (0.88)
Fat status	0 (0.00)	8 (3.49)	150 (65.50)	3 (1.31)	10 (4.37)
Females					
Muscle status	3 (1.26)	3 (1.26)	120 (50.21)	4 (1.67)	1 (0.42)
Fat status	2 (0.84)	17 (7.11)	131 (54.81)	4 (1.67)	3 (1.26)

Normal values of muscle and fat status (Table 3) are recorded in more than 50% of the sample. Males show higher muscle and fat status (3.06% and 5.68%, respectively) above 85th percentile in comparison to females. Higher percentage of fat status below 15th percentile is recorded in girls (7.95%) when compared to boys (3.49%). Considering the muscle status below 15th percentile, there are similar values recorded in boys (2.62%) and girls (2.52%).

Discussions

The study of nutritional status of 19-year-old adolescents from urban areas in Vojvodina points out that the majority of subjects have standard values for their age concerning the studied anthropometric traits and nutritional parameters.

The average height in boys is 180.50 cm, while in girls it is 166.46 cm. As for the weight, the average values are 77.42 kg and 60.96 kg, for boys and girls, respectively. The males are found to be 14.04 cm taller and 16.46 kg heavier than females. The difference is justified by the influence of hormones. In comparison with girls and the effect of estrogen on them, testosteron affects boys in later years of age and influences their bone formation causing gretar height and weight (Wells, 2007). In the last few decades, children have generally been reported to be taller, and in some countries considerably heavier (Lobstein, Baur and Uauy, 2004).

In comparison with American adolescents in the period 2007-2010 (Fryar, Gu and Ogden, 2012), 19-year-old boys and girls from Vojvodina have greter height, smaller weight, lower BMI, smaller upper arm circumference and lower values of triceps and scapular skinfold thickness. As for American 19-year-old adolescents, the reference values for height are 177.8 cm and 163.3 cm, for boys and girls, respectively. In present study the subjects are approximately 3 cm taller in comarison with the above values. Discrepancy is also observed in the weight results, as both girls and boys have lower weight – on average, girls appear to be 7 kg lighter and boys 2 kg in relation to the reference values. This points to the necessity of establishing national criteris for assessing the growth, development and nutritional status of children and adolescents.

The average BMI values (23.74 in boys and 21.98 in girls) appear to be slightly higher than those obtained in the town of Jagodina – Central Serbia (Pavlica et al., 2012), with the average BMI being 23.37 in boys and 21.20 in girls. The same refers to the results obtained in Western Romania (Emandi et al., 2012), where the recorded BMI was 22.8 in males and 20.8 in girls.

As for 50^{th} percentile BMI values, the obtained results are 23.3 and 21.78 kg/m^2 in boys and girls, respectively. The results are higher than those obtained for American adolescents in 1991 (21.88 kg/m^2males, 20.80 kg/m^2 females) (Must, Dallal and Dietz, 1991), but lower in comparison with the results obtained later, i.e. in the period 2007-2010 (24.0 kg/m^2 in males and females) (Fryar, Gu and Ogden, 2012). The results indicate an increase in BMI values, not only in Serbia, but in other countries worldwide.

The overweight prevalence is lower in males (3.49%) than in females (6.28%), while the number of obese boys and girls is identical (6.55% of boys and 6.28% of girls). The study indicates that 19-year-old adolescents do not have underweight or overweight problems, which is not the case with other studies reported worldwide (Gür et al., 2006; Kelishadi et al., 2005; Cole et al., 2000). Although the prevalence of underweight and overweight subjects in the present study is not high, it should not be neglected as it might cause risk factors in older age.

The upper arm circumference is known as a reliable parameter for nutritional status assessment (Dasgupta et al. 2010). UMA and UFA are basic indexes for assessing body composition. UFA and AFI are indicators of fat status and as the obtained values are significantly higher in females, this points to the sexual dimorphism.

The muscular status shows normal values in 50 % of the subjects. The fat status, however, has normal values in 65.5% of males, while in females it is lower – 54.81%. Lower fat status is recorded in 3.5% of males and 8% of females, while higher values are detected in 5.68% of males and 2.93% of females. The reason for this may be tha fact that girls pay more attention to their physical appearance and tend to go on diet.

Conclusions

In spite of being transversal and including only one age, the present study offers a better insight into the growth and nutritional status of 19-year-old adolescents. Bearing in mind that childhood and adolescence obesity may cause diabetes mellitus type 2 and cardiovascular diseases later in life, the best prevention is identification of obesity problems in childhood and adolescence period. Although the overweight and obesity prevalence is not very high, it should not be neglected. The results of the study stress the importance of introducing periodical check ups of nutritional status, promotion of healthy diet, reduction of sedentary lifestyle and more physical activities.

On the basis of the obtained results, it can be concluded that in the largest number of 19-year-old adolescents anthropometric and nutritional parameters are within the standard values set for the age and sex.

Bibliography

1. Cole, T.J., Bellizzi, M.C., Flegal, K.M. and Dietz, W.H., 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal*, 320. pp. 1240-3.
2. Dasgupta, A., Butt, A., Kanti Saha, T., Basu, G., Chattopadhyay, A. and Mukherjee, A., 2010. Assessment of Malnutrition Among Adolescents: Can BMI be Replaced by MUAC, *Indian Journal of Community Medicine*, 35(2), pp.276–9.
3. Dehghan, M., Akhtar-Danesh, N., and Merchant, A.T., 2005. Childhood obesity, prevalence and prevention. *Nutrition Journal*, 4, pp. 24.
4. Emandi, A.C., Puiu, M., Gafencu, M., and Pienar, C., 2013. Overweight and obesity in school age children in Western Romania. *Revista Medico-Chirurică A Societăţii de Medici şi Naturalişti din Iaşi*, 117(1), pp. 36-45.
5. Emandi, A.C., Puiu, M., Gafencu, M., and Pienar, C., 2012. Growth references for school aged children in Western Romania. *Acta Endocrinologica*, 8(1), pp.133-152.
6. Frisancho, A.R., 1981. New norms of upper limb fat and muscle areas for assessment of nutritional status. *American Journal of Clinical Nutrition*, 34, pp. 2540-5.
7. Frisancho, A.R., 1990. *Anthropometric Standards for the Assessment of Growth and Nutritional Status*. Ann Arbor: the University of Michigan Press.
8. Fryar, C.D., Gu, Q., and Ogden, C.L., 2012. Anthropometric Reference Data for Children and Adults: United States, 2007-2010. National Center for Health Statistics. *Vital and Health Statistics*, 11(252), pp. 1-48.
9. Georgiadis, G., and Nassis, G.P., 2007. Prevalence of overweight and obesity in a national representative sample of Greek children and adolescents. *European Journal of Clinical Nutrition*, 61, pp.1072-74.
10. Gordon-Larsen, P., Adair, L.S., Nelson, M.C. and Popkin, B.M., 2004. Five–year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health**.** *American Journal of Clinical Nutrition*, 80, pp.569-75.
11. Gür, E., Can, G., Akkus, S., Ercan, G., Arvas, A., Güzelöz, I., and Cifcili, S., 2006. Is undernutrition a problem among Turkish school children?: Which factors have an influence on it? *Journal of Tropical Pediatrics*, 52 (6), pp.421-6.

12. Kelishadi, R., Hashemipour, M., Sadeghi, M., Roohafza, H.R., Tavasoli, A.A., Khosravi, A. et al. 2005. The impact of familial factors on obesity in Iranian children and adolescents. *Journal of Pediatrics Neonatal*, 2 (2), pp.16-23.
13. Lobstein, T., Baur, L., and Uauy, R., 2004. Obesity in children and young people: a Crisis in public health. *Obesity Reviews*, 5 (1), pp.4-85.
14. Must, A., Dallal, G.E. and Dietz, W.H., 1991. Reference data for obesity: 85th and 95th percentiles of body mass index (Wt/ht^2) –a correction. *American Journal of Clinical Nutrition*, 54, p.773.
15. Ogden, C.L., Caeoll, M.D., Kit, B.K. and 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), pp. 483-90.
16. Pavlica, T., Rakić, R., Djuricanin, A., Korovljev, D., and Srdić, B., 2012. Growth and Nutritional Status of Children and Adolescents from 7 to 19 Years of Age in the Town of Jagodina (Central Serbia). *HelthMED*, 6 (1), pp. 284-93.
17. Pavlović, M., and Lobstein, T., 2004. Assessment and monitoring of nutritional status of children and adolescents in North Backa region, Serbia. In: M.A. Caroli, R.K. Chandra, and M.L. Frelut (eds.) *Childhood Obesity From Basic Sciences to Public Health*. Napoli Giuseppe de Nicola, Editore. pp.109-114.
18. Popkin, B.M. and Gordon-Larsen, P., 2004. The nutrition transition: worldwide obesity dynamics and their determinants. *International journal of obesity and related metabolic disorders*, 28 (3), pp. 2-9.
19. Wells, J.C., 2007. Sexual dimorphism of body composition. *Best Practice & Research Clinical Endocrinology & Metabolism*, 21, pp. 415-30.
20. ***Serbian Institute for Public Health "Dr Milan Jovanović Batut". 2008. The Health Condition of Serbian population – an analytic study 1997-2007. [Online] Belgrade. pp.45-51. Available from: http://www.batut.org.rs/download/publikacije/Zdravlje stanovnika 1997-2007.pdf [Accessed 29 September 2013].