Coll. Antropol. **37** (2013) Suppl. 2: 131–138
Original scientific paper

Are the Physically Active Adolescents Belonging to the »At Risk of Overweight« BMI Category Really Fat?

Matea Zajc Petranović, Željka Tomas, Tatjana Škarić-Jurić, Jasna Miličić and Nina Smolej Narančić

Institute for Anthropological Research, Zagreb, Croatia

A B S T R A C T

The adolescence is recognized as one of the critical periods for the development of obesity. Children and adolescents who practice sports regularly have higher muscle mass and lower percentage of body fat than their peers who are physically less active. Since body mass index (BMI) is a widely used indicator of overweight/obesity in spite of the fact that it directly measures excess in weight but not in fat, it often misclassifies athletic populations, both children and adults. The specific aim of this study was to evaluate whether BMI adequately assesses fatness in adolescents, especially physically active ones. The analysis was performed on anthropometric data from two surveys (1997 and 2009/2010) of Zagreb secondary school adolescents, 1315 girls and 1034 boys, aged 15–19 years. The group defined as »physically active« consisted of adolescents who practice organized sports (36.2% girls, 44.6% boys), while the »physically inactive« group was made of their peers who practice sport only as a part of physical education in schools. The standardized values, calculated within each sex by survey, were used for comparison of adolescents with different levels of physical activity. Physically active adolescents of both sexes had lower sum of skinfolds mean Z-values ($p_{girls}<0.05$, $p_{boys}<0.001$); additionally, boys had higher Z-values for body weight ($p<0.05$) and triceps/subscapular ratio (indicating peripheral distribution of body fat) ($p<0.05$) than their less active peers. In order to evaluate whether BMI was adequate indicator for body composition during adolescence, we estimated the concordance of above-median category defined by BMI and the other body fat indicators. The largest discrepancy was found for sum of skinfolds in both sexes and was more pronounced in physically active adolescents. This finding was further confirmed in more extreme BMI category (85^{th} – 95^{th} percentile) which indicated that adolescents categorized as »at risk of overweight« were predominantly characterized by larger lean body mass and not by increased fatness.

***Key words**: body mass index, skinfolds, body composition, percentiles, overweight, physical activity, adolescence, Croatia*

Introduction

The recommendation for amount of physical activity necessary to obtain health benefits in children and adolescents is at least 60 minutes of moderate or high-intensity activity daily[1,2]. However, the number of children and adolescents who practice sports has been noted to be too low, particularly in developed and developing countries[3]. At the same time, the number of obese/overweight children and adolescents is rapidly increasing[4–6]. These findings are especially alarming in the light of a proven link of excessive body mass in childhood and adolescence with obesity in adult age[7,8]. In the long run obesity increases the risk of numerous comorbidities, including cardiovascular and metabolic diseases[9].

The reports on epidemics of obesity are mostly based on the body mass index (BMI) values. However, in spite of its wide usage as a surrogate measure of body fatness, BMI measures only deficiency or excess in weight but not in fat[10]. As BMI does not distinguish between excess fat and muscle or bone mass, it is possible that muscular individuals, especially males, may have a high BMI due to increased muscle mass while at the same time slen-

Received for publication April 08, 2013

der-framed individuals, mostly females, in spite of significant amount of excess fat may appear false negative for obesity[11]. Hence, BMI itself is unlikely to be a valid measure of adiposity or body composition in athletic populations, although some researchers reported that it is possible to adjust it to better reflect adiposity using linear regression equations[12].

Body composition of athletes is most frequently estimated using measures of the skinfolds' thicknesses and body circumferences which can differentiate excess body fat from lean body mass in children and adolescents[13]. For instance, significantly lower triceps and subscapular thickness was found in 7–8-year-old rhythmic gymnasts compared with controls although their mean height, weight and BMI did not differ[14]. These results indicate higher percentage of body fat in controls which was confirmed by X-ray-determined body composition: controls had elevated body fat mass and higher percentage of body fat. Similar results were obtained in the study of 33,986 adolescent athletes aged 11–19 yrs: skinfold testing provided more accurate information on body composition than BMI[15]. Moreover, skinfold thickness in adolescence was reported as a better predictor of body fatness in adulthood than BMI[16].

It would be expected that not only athletes but also youth who regularly practice sports at moderate intensity have higher muscle mass and lower percentage of body fat than their peers who are physically less active. The aims of this study of secondary school adolescents were: a) to compare the distribution of our sample according to the referent WHO and CDC BMI standard cut-off points, b) to determine informativness of BMI as opposed to other most often used anthropometric indices, including skinfolds and waist circumference, in assessing excess fat and body composition in relation to physical activity, and c) to evaluate the concordance of BMI classification with classification according to other body composition indicators within the subsample of adolescents whose BMIs were above median (>50th percentile of referent CDC and WHO values). The physical activity was investigated through organized regular non-professional engagement in sports self-reported by participants. The analysis was conducted on two cohorts (1997 and 2009/2010), giving us an additional insight into secular changes.

Subjects and Methods

Two surveys of secondary school adolescents from Zagreb, Croatia were carried out in 1997 and in 2009/2010 by a team of trained experts from the Institute for Anthropological Research. Surveys were conducted with different foci and therefore the numbers of examinees differ. The aim of 1997 survey was to develop referent values for the indices of physical status, and the 2010 survey was focused on anthropometric assessment of nutritional status as well as secular trend in growth and development for the Croatian youth population. All the adolescents from several randomly selected state and private secondary schools were invited to participate; the response rate varied from 68% in 1997 survey to 43% in 2010 survey. From database that contains the results of these extensive surveys, we extracted all 15–19-year-old adolescents: there were 2349 adolescents, 1315 girls and 1034 boys. 27 girls were excluded due to refusing to participate in weight measuring (1.15% of total sample and 2.05% of total female sample) and, in addition, 7 professional athletes, two girls and 5 boys, were excluded from further analyses (0.3% of total sample). The professional athletes were excluded because our study aimed at assessing general adolescent population data.

If the participants were legally adults (18+ years) they signed informed consent, but if they were under-aged their parents had to allow children's participation in this study as well. The Ministry of Science, Education and Sports of the Republic of Croatia approved the study protocol as well as the Ethics Committee of the Institute for Anthropological Research.

The first, 1997 survey, included 887 girls and 624 boys (the 15–19-year-olds from sample analyzed in [17,18]), and the second, 2009/2010 survey, included 399 girls and 405 boys (described in [19,20]). The study protocols consisted of an interview designed corresponding to the interest of the particular survey and a short anthropometry. Only a subset of these data is presented here. Adolescents who reported organized regular non-professional engagement in sports activity were in further analysis considered physically active, while those who practice sports less frequently or not at all, apart from the physical education in schools, were considered as physically inactive.

Short anthropometry was undertaken following standard IBP recommendations[21], using standard equipment. For these anthropometric measurements, subjects wore light athletic clothing and no shoes. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer. Body weight was measured to the nearest 0.1 kg with a portable scale. Triceps (upper arm) and subscapular skinfolds' thicknesses and waist circumference were measured three times for each adolescent, but not consecutively; they were measured one after the other, and then the same measurements were repeated twice. Mean values of three measurements were used in further analysis.

Body Mass Index (BMI) was calculated as weight in kilograms divided by squared height in meters (kg/m^2). The subjects were divided into six age- and sex-specific standard BMI categories (<5th percentile, 5th – 15th percentile, 15th – 50th percentile, 50th – 85th percentile, 85th – 95th percentile, >95th percentile) defined by CDC and WHO reference databases organized by Frisancho[22]. The triceps/subscapular ratio (T/S) was used as an index of fat distribution.

Mean values and Z-standardized values of the analyzed parameters were compared between surveys using t-test. The differences between sexes and/or between groups of different level of physical activity were tested using χ^2-test. The analyses were performed by SPSS Statistics 13.0 statistical package for Windows (SPSS Inc.,

TABLE 1
GENERAL AND ANTHROPOMETRIC CHARACTERISTICS OF ADOLESCENTS FROM TWO SURVEYS CONDUCTED IN 1997 AND 2009/2010

Cohort	Adolescent boys			Adolescent girls		
	1997	2009/2010	p*	1997	2009/2010	p*
Sample size (N)	624	405		887	399	
Age (yrs)	16.74±1.18	16.81±1.22	ns	16.69±1.20	16.71±1.23	ns
Weight (kg)	68.31±10.16	73.29±13.02	<0.001	57.54±7.67	59.82±10.34	<0.001
Height (cm)	178.98±6.93	178.91±7.31	ns	166.71±6.02	165.70±5.79	<0.05
BMI (kg/m^2)	21.29±2.67	22.87±3.68	<0.001	20.70±2.51	21.76±3.39	<0.001
Waist circumference (mm)	788.10±75.13	792.50±111.19	ns	729.89±64.11	742.61±84.65	<0.01
Skinfold thickness (0.1 mm)						
Tricipital	92.37±40.25	113.25±51.47	<0.001	139.66±35.87	156.97±53.86	<0.001
Subscapular	83.63±32.67	114.65±49.75	<0.001	98.42±33.16	138.01±59.70	<0.001
Sum of skinfolds	176.00±69.05	227.90±91.06	<0.001	238.08±61.90	295.11±102.52	<0.001
Tric/Subscap ratio	1.11±0.29	1.04±0.43	<0.01	1.48±0.36	1.20±0.36	<0.001
	N (%)		p*	N (%)		p*
Practicing sports	272 (43.7)	187 (46.2)	ns	317 (35.7)	148 (7.1)	ns

* The values of the variables age, weight, height, BMI, WC and skinfolds are presented as X±SD
** The quantitative differences between cohorts were tested using t-test and qualitative using χ^2-test.

Chicago, IL, USA), with statistical significance set at $p<0.05$. The differences in proportions of adolescents practicing and not practicing sports and categorized into BMI and other indicators' categories were tested using the difference in proportions test for two independent samples[23].

Results

The characteristics of the study population are shown in Table 1 by survey and sex. In 2009/2010 mean weight and BMI were higher in both sexes (all p values were <0.001) and height in girls was lower ($p<0.05$) while height in boys it did not change. Tricipital (upper arm) and subscapular skinfolds were also higher in both sexes (all p values were <0.001) and their ratio was lower but less significantly in boys ($p<0.01$) than in girls ($p<0.001$).

The prevalence of subjects within CDC and WHO BMI age-per-sex categories differed significantly between surveys for both sexes (Figure 1). According to CDC referent values, in 2009/2010 *vs*. 1997 survey there was almost twice as much at risk of overweight (14.3% *vs*. 7.9%) and almost thrice as much overweight adolescent boys (8.9% *vs*. 2.4%) ($p<0.001$). Similar results were obtained for girls: in 2009/2010 there was almost thrice as much at risk of overweight and overweight girls in comparison with 1997 results ($p<0.001$). Results were very similar for both sexes when WHO age-per-sex BMI cut-offs were applied (both $p<0.001$).

Since the prevalence of adolescent boys practicing sports did not change significantly over time (43.7% in 1997 *vs*. 46.2% in 2009/2010), nor did the prevalence of girls (35.7% in 1997 *vs*. 37.1% in 2009/2010) (Table 1), we decided to combine the adolescents from both surveys and to compare their indicators of body composition between those who practiced sports regularly and those who were less physically active. Considering that there were significant differences between surveys in four out of five selected indicators (weight, BMI, sum of skinfolds and triceps/subscapular ratio differed, while waist circumference did not differ significantly) (Table 1), the calculation of Z-values was performed for each survey sample separately before data were pooled. Adolescents of both sexes who regularly practiced sports had lower mean Z standardized sum of two skinfolds than their companions who did not practice any sports ($p_{girls}<0.05$, $p_{boys}<0.001$) (Table 2). In addition, physically active adolescent boys had higher Z values of weight ($p<0.05$) and triceps/subscapular ratio ($p<0.05$) than their inactive peers.

We further explored whether adolescents whose BMIs were above median value had above median values of other investigated body fat indicators as well (Table 3). The above median BMI subsample was defined using both WHO and CDC references. The concordance between BMI and weight classifications was expectedly 91.9 to 100% for both sexes. Similar results were obtained for waist circumference in adolescent boys but the discrepancy was found in girls. The proportion of congruently classified physically active girls (74.3% for WHO and 73.4% for CDC) was significantly lower ($p<0.05$) in comparison with less active ones (80.9% for WHO and 78.2% for CDC). Sum of skinfolds showed the lowest concordance with BMI classification, from 10.0 to 41.0%. Proportion of physically active adolescents of both sexes who were correctly categorized was significantly lower in comparison with less active peers ($p<0.001$).

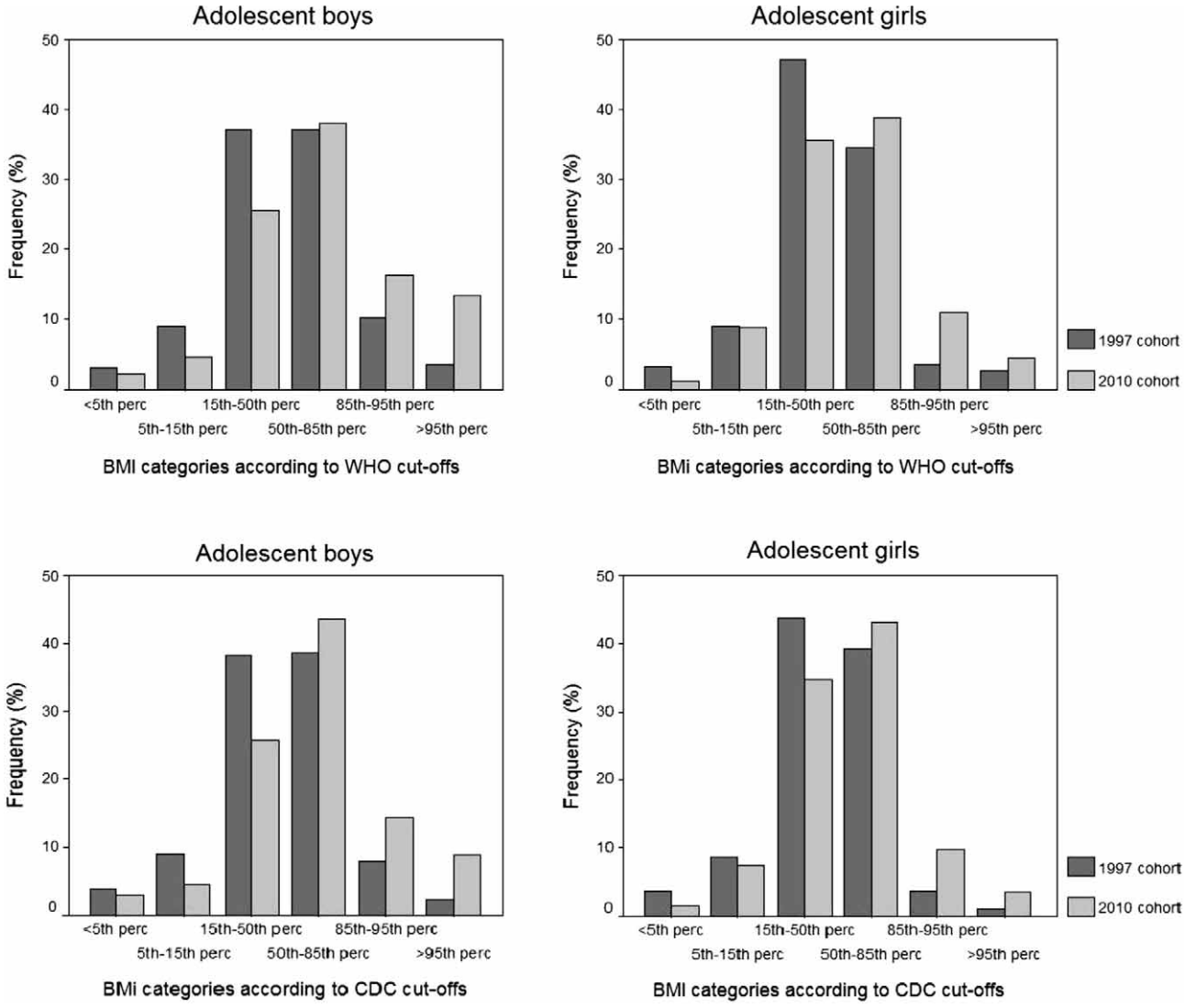

Fig. 1. Secular trend in age-for-sex specific BMI categories defined by WHO and CDC cut-offs.

TABLE 2
THE COMPARISON OF Z-STANDARDIZED VALUES OF BODY COMPOSITION INDICATORS BETWEEN PHYSICALLY ACTIVE AND INACTIVE ADOLESCENTS (X±SD)

Z-standardized indicators of body composition*	Adolescent boys			Adolescent girls		
	Practicing organized sports (N=459)	Not practicing organized sports (N=569)	p**	Practicing organized sports (N=465)	Not practicing organized sports (N=821)	p**
Z-weight	0.080±0.89	–0.068±1.07	<0.05	0.052±0.90	–0.029±1.05	ns
Z-BMI	0.032±0.86	–0.032±1.09	ns	0.031±0.87	–0.018±1.07	ns
Z-waist circumference	0.013±0.88	–0.015±1.09	ns	–0.032±0.89	0.018±1.06	ns
Z-sum of skinfolds	–0.123±0.87	0.095±1.08	<0.001	–0.076±0.91	0.043±1.04	<0.05
Z-index of fat distribution	0.072±1.09	–0.056±0.91	<0.05	0.072±0.99	–0.030±1.00	ns

* Before pooling the data, values of the analyzed parameters were standardized separately for each survey.
** The differences between groups were tested using t-test.

TABLE 3
THE CONCORDANCE IN CLASSIFICATION OF ADOLESCENTS BELONGING TO THE ABOVE-MEDIAN CATEGORY* BETWEEN BMI AND OTHER INDICATORS OF BODY COMPOSITION

	Numbers and proportions of adolescents whose both BMI and other indicator of body composition were above median N (%)					
	According to WHO references					
	Adolescent boys			Adolescent girls		
Indicators of body composition	Practice organized sports	Do not practice organized sports	p**	Practice organized sports	Do not practice organized sports	p**
Weight	287 (99.7)	298 (100.0)	ns	214 (94.7)	328 (93.4)	ns
Waist circumference	271 (93.4)	283 (94.7)	ns	168 (74.3)	284 (80.9)	p<0.05
Sum of skinfolds	29 (10.0)	69 (23.1)	<0.001	64 (28.3)	144 (41.0)	<0.001
	According to CDC references					
	Adolescent boys			Adolescent girls		
Indicators of body composition	Practice organized sports	Do not practice organized sports	p**	Practice organized sports	Do not practice organized sports	p**
Weight	276 (99.6)	294 (100.0)	ns	227 (93.0)	341 (91.9)	ns
Waist circumference	262 (93.9)	280 (95.0)	ns	179 (73.4)	290 (78.2)	ns
Sum of skinfolds	29 (10.4)	69 (23.5)	<0.001	65 (26.6)	146 (39.3)	<0.001

* The sample comprises only the adolescents whose individual BMI, weight, waist circumference and sum of skinfolds values were above the median according to international references. ** The differences between physically active and inactive groups were tested using the difference in proportions test.

Additionally, we paid special attention on body composition indicators in adolescents in »at risk of overweight« BMI category (85th – 95th percentile) defined by WHO and CDC cut-offs. The girls from this category who regularly practiced sports had lower waist circumference than physically inactive girls. Analysis of the same category in boys revealed that boys involved in sports had lower sum of skinfolds when compared with boys who were not physically active (Figure 2). Thus, these results further confirm those obtained for above-median BMI category presented in Table 3. The results of the analysis of same indicators in the upper extreme BMI category (>95th percentile) were not significant although suggested the same trend of differences between physically active and less active adolescents (data not presented).

Discussion

Body composition in athletes has extensively been studied and abundance of data confirm differences in comparison with general population. Higher BMI in elite athletes generally reflects higher proportion of lean body mass and not fat[24,25]. Physically active adolescents who were not professional athletes were not studied in such an extent in this regard. This study was aimed at assessing impact of moderate physical activity on body composition which was determined with several anthropometric indicators and BMI. Additional goal was to evaluate appropriateness of BMI usage to adequately assess fatness in physically active adolescents in comparison to inactive ones. Furthermore, as the analysis was conducted on two cohorts, we got an insight into secular changes taking place in Croatia over 13 years.

When comparing it with 1997 survey, in 2009/2010 we observe secular trend towards higher values for weight, BMI and skinfold thickness, as well as higher prevalence of »at risk of overweight« and »overweight« according to both WHO and CDC cut-offs. Especially interesting were sex differences in classification within BMI categories. In 1997, 10.3% (CDC) – 13.8% (WHO) adolescent boys fit into the »risk of overweigh/obesity« BMI category (over 85th percentile) while in 2010 as much as 23.2% (CDC) – 29.6% (WHO) boys were in this category. The similar shift towards the upper extreme values was also detected in girls but at a lesser degree. In 1997, 4.8% (CDC) – 6.2% (WHO) of them were in over 85th percentile category compared to 2010 when there were 13.3% (CDC) – 15.5% (WHO) girls. We can see that in 1997 the proportions of adolescents of both sexes fell below those expected according to over 85th percentile BMI categories of referent populations, whereas in 2010, the BMI in girls approached and in boys exceeded these proportions. Also, in contrast to 1997, the majority of adolescents of both sexes falling within the »normal« BMI range, i.e. 15th to 85th percentile were in 2010 mostly grouped in the upper »normal« category, the one defined by 50th to 85th percentile.

Similar trends of increase in the prevalence of »at risk of overweight« were detected worldwide and it is proposed that this changes could be attributed to the rapid

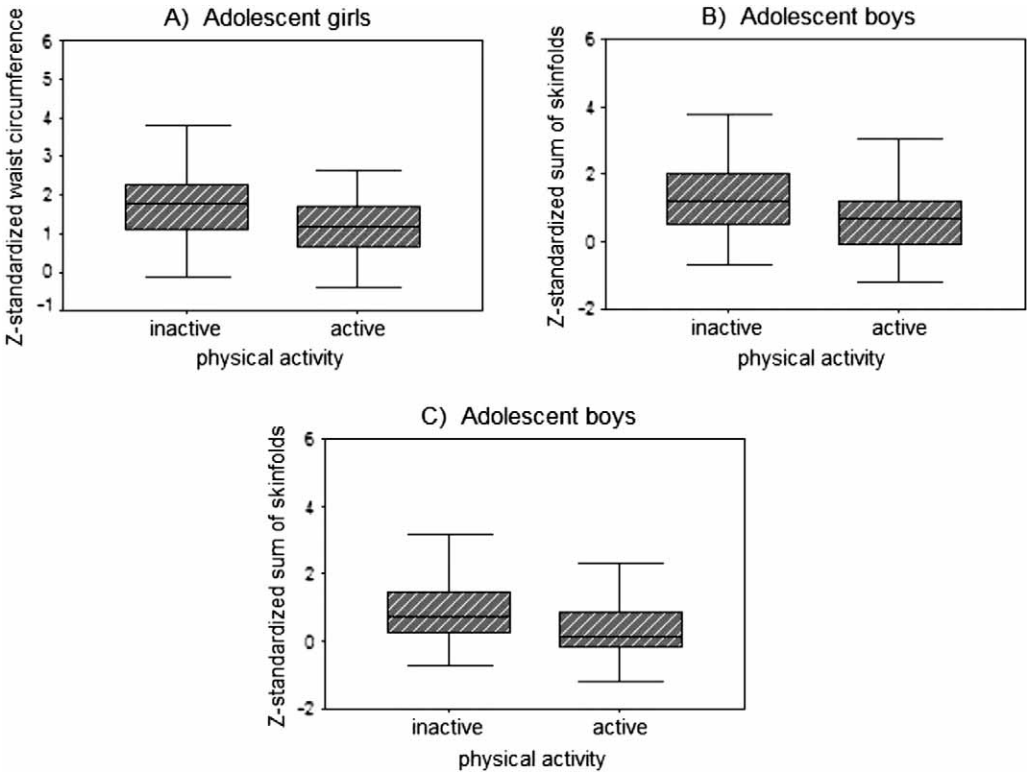

Fig. 2. The comparison of body composition indicators in the BMI age-for-sex specific 85th – 95th percentile category. The indicators' values were standardized for each sex and survey separately and compared between groups of different levels of physical activity. Only statistically significant results are presented here: A) Waist circumference means between physically active (N=23) and inactive (N=50) adolescent girls in BMI 85th–95th percentile CDC category (p<0.05), B) Sum of skinfolds means between physically active (N=58) and inactive (N=72) adolescent boys in BMI 85th–95th percentile WHO category (p<0.05), C) Sum of skinfolds means between physically active (N=47) and inactive (N=60) adolescent boys in BMI 85th–95th percentile CDC category (p<0.01).

globalisation and urbanisation[26]. Most striking consequence of globalisation on children's health is brought through the rise in screen-based activities, accompanied with the inactivity, and through the changes in diet, as cheap calorie-dense foods, fats, and oils are made widely available across the world[27,28]. Inappropriate nutritional and lifestyle habits, in addition to high prevalence of »at risk of overweight«, were confirmed in schoolchildren aged 7–15 from all regions of Croatia[29].

The suggested growth of »at risk of overweight/overweight« prevalence from 1997 to 2009/2010, more pronounced in boys than in girls, is opposed to the fact that more boys than girls were involved in organized sports activities in both surveys. Since skinfolds' thicknesses were found to give more accurate assessment of body composition than BMI[15], or in addition to BMI substantially improve the estimation of body fatness in healthy 5 to 18-years-olds[8], we tested the sum of skinfolds and other indicators of body composition between adolescents with different levels of physical activity. Standardized and pooled data from both surveys were compared, and physically active boys were found to be significantly heavier and had significantly higher triceps/subscapular skinfold index, suggesting less abdominal and more peripheral subcutaneous fat. The participation of male adolescents in regular physical activity was already found to have the potential to prevent preferential storage of subcutaneous fat in the trunk area[30].

Lower sum of skinfolds was the only indicator which in both sexes differentiated physically active from inactive persons while, for instance, BMI did not. The sum of skinfolds was also found to be important for discriminating adolescent boys falling within »at risk of overweight« category. Thus, we may conclude that physically active boys falling to 85th – 95th percentile category was indeed not fat and their higher weight was most likely due to their increased lean body mass. Very low concordance of the above-median categories of BMI and sum of skinfolds, even lower in physically active adolescents, indicates inappropriateness of WHO and CDC standard referent values for our adolescent population. It is very interesting to note that similar findings were already reported for the Croatian adult population: the study conducted in several Dalmatian islands found that the overweight segment of the population (BMI >85th CDC percentile) had less fat deposited both peripherally and centrally than the United States population[31]. It was proposed that their overweightness largely reflected muscularity and skeletal robustness rather than excess body fatness and concluded that the U.S. upper percentiles of BMI were

imprecise indicators of excess body fatness in Croatian population.

However, one should have in mind that, due to relatively low response rate which reflects voluntary base of participation, our results may be somewhat biased. We have to point out that the low response rate in majority of cases reflects the problem of timely obtaining the parental written consent and not unwillingness of adolescents themselvess to take part in the study.

Conclusions

The benefits of physical activity on physical, motoric and cognitive development were confirmed by studies of the young athletes[32,33]. Our results indicate that even moderate but regular physical activity has marked impact on body composition with prospects for future health benefit in active individuals. Since sum of skinfolds was found to better distinguish individuals with excess body fat from those with more muscle mass in both sexes, we confirmed that use of BMI as a single indicator of overweight and/or obesity is not appropriate, especially in physically active adolescent population.

Acknowledgements

This study was supported by the Ministry of Science, Education and Sports of the Republic of Croatia (projects: 196-1962766-2747; 196-1962766-2736). We thank to the study participants, their parents and to the administration and employees of schools included in this surveys. We appreciate efforts of our colleagues and friends, Miroslav Živičnjak, PhD, and Andrea Veček, MD, PhD, for organizing field research, collecting the data and building the electronic database.

REFERENCES

1. LIVINGSTONE MBE, ROBSON PJ, WALLACE JMW, MCKINLEY MC, Proc Nutr Soc, 62 (2003) 681. — 2. LIPNOWSKI S, LEBLANC CM, CANADIAN PAEDIATRIC SOCIETY, HEALTHY ACTIVE LIVING AND SPORTS MEDICINE COMMITTEE, Paediatr Child Health, 17 (2012) 209. — 3. CURRIE C, ZANOTTI C, MORGAN A, CURRIE D, DE LOOZE M, ROBERTS C, SAMDAL O, SMITH O, BARNEKOW V (Eds) Social determinants of health and well-being among young people. Health Behaviour in School-aged Children (HBSC) study: international report from the 2009/2010 survey (Copenhagen, WHO Regional Office for Europe, 2012). — 4. TROIANO RP, FLEGAL KM, Pediatrics, 101 (1999) 497. — 5. CHINN S, RONA RJ, Brit Med J, 322 (2001) 24. — 6. LISSAU I, OVERPECK MD, RUAN WJ, DUE P, HOLSTEIN BE, HEDIGER ML, Arch Pediatr Adolesc Med, 158 (2004) 27. — 7. GUO SS, CHUMLEA WC, Am J Clin Nutr, 70 (1999) S145. — 8. FREEDMAN DS, KETTEL L, SERDULA MK, DIETZ WH, SRINIVASAN SR, BERENSON GS, Pediatrics, 115 (2005) 22. — 9. LAVIE CJ, MILANI RV, VENTURA HO, J Am Coll Cardiol, 53 (2009) 1925. DOI: 10.1016/j.jacc.2008.12.068. —10. ODE JJ, PIVARNIK JM, REEVES MJ, KNOUS JL, Med Sci Sports Exerc, 39 (2007) 403. DOI: 10.1249/01.mss.0000247008.19127.3e. — 11. NEVILL AM, STEWART AD, OLDS T, HOLDER R, Am J Phys Anthropol, 129 (2006) 151. DOI: 10.1002/ajpa.20262. — 12. NEVILL AM, WINTER EM, INGHAM S, WATTS A, METSIOS GS, STEWART AD, J Sports Sci, 28 (2010) 1009. DOI: 10.1080/02640414.2010.487071. — 13. SPEAR B, Sports Nutrition. In: STANG J, STORY (Eds) Guidelines for adolescent nutrition services. (Minneapolis, MN: Center for Leadership, Education and Training in Maternal and Child Nutrition, Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, 2005). — 14. PARM AL, SAAR M, PÄRNA K, JÜRIMÄE J, MAASALU K, NEISSAAR I, JÜRIMÄE T, Coll Antropol, 35 (2011) 739. — 15. ETCHISON WC, BLOODGOOD EA, MINTON CP, THOMPSON NJ, COLLINS MA, HUNTER SC, DAI H, Sports Health, 3 (2011) 249. DOI: 10.1177/1941738111404655. — 16. NOOYENS AC, KOPPES LL, VISSCHER TL, TWISK JW, KEMPER HC, SCHUIT AJ, VAN MECHELEN W, SEIDELL JC, Am J Clin Nutr, 85 (2007) 1533. — 17. ŽIVIČNJAK M, NARANČIĆ SN, SZIROVICZA L, FRANKE D, HRENOVIĆ J, BIŠOF V, Coll Antropol, 27 (2003) 321. — 18. ŽIVIČNJAK M, SMOLEJ NARANČIĆ N, SZIROVICZA L, FRANKE D, HRENOVIĆ J, BIŠOF V, TOMAS Ž, ŠKARIĆ-JURIĆ T, Coll Antropol, 32 (2008) 419. — 19. VEČEK N, VEČEK A, ZAJC PETRANOVIĆ M, TOMAS Ž, ARCH-VEČEK B, ŠKARIĆ-JURIĆ T, MILIČIĆ J, Eur J Obstet Gynecol Reprod Biol, 160 (2012) 51. DOI: 10.1016/j.ejogrb.2011.09.029. — 20. VEČEK A, TOMAS Ž, ZAJC PETRANOVIĆ M, VEČEK N, ŠKARIĆ-JURIĆ T, SMOLEJ NARANČIĆ N, ARCH-VEČEK B, MILIČIĆ J, Anthropologist, 14 (2012) 353. — 21. WEINER JS, LOURIE JA, Practical Human Biology (Academic Press inc Ltd, London, 1981). — 22. FRISANCHO AR, Anthropometric standards. An interactive nutritional reference of body size and body composi-tion for children and adults. (The University of Michigan Press, Ann Arbor, 2008). — 23. WASSARSTATS: WEBSITE FOR STATISTICAL COMPUTATION. Available from: URL: http://www.vassarstats.net. — 24. WILMORE JH, Med Sci Sports Exerc, 15 (1983) 21. — 25. STEWART AD, SUTTON L, Body Composition in Sport, Exercise and Health (Routledge, New York, 2012). — 26. BRODY J, Nutrition Bytes, 8 (2002) 1. — 27. SCHNEIDER D, Soc Sci Med, 15 (2000) 955. — 28. SOBAL J, Int J Epidemiol, 30 (2001) 1136. — 29. ANTONIĆ-DEGAČ K, KAIĆ-RAK A, MESAROŠ-KANJSKI E, PETROVIĆ Z, CAPAK K, Paediatr Croat, 48 (2004), 9. — 30. DIONNE I, ALMERAS N, BOUCHARD C, TREMBLAY A, Med Sci Sports Exerc, 32 (2000) 392. — 31. SMOLEJ NARANČIĆ N, ŽAGAR I, Coll Antropol, 24 (2000) 411. — 32. ERCEG N, ZAGORAC M, KATIĆ R, Coll Antropol, 32 (2008) 241. — 33. KATIĆ R, BALA G, Coll Antropol, 36 (2012) 69.

M. Zajc Petranović

Institute for Anthropological Research, Gajeva 32, 10 000 Zagreb, Croatia
e-mail: matea@inantro.hr

JESU LI TJELESNO AKTIVNI ADOLESCENTI ČIJI JE ITM UNUTAR KATEGORIJE »RIZIKA ZA PRETILOST« UISTINU DEBELI?

S A Ž E T A K

Adolescencija je jedno od kritičnih razdoblja za razvoj pretilosti. Djeca i adolescenti koji su redovito tjelesno aktivni imaju veću mišićnu masu i manji postotak tjelesne masti u odnosu na vršnjake koji su manje tjelesno aktivni. S obzirom da se indeks tjelesne mase (ITM) koristi kao indikator prekomjerne težine i/ili pretilosti unatoč činjenici da direktno mjeri suvišnu težinu, a ne suvišno masno tkivo, populacije sportaša, i djeca i odrasli, često se pogrešno klasificiraju. Specifičan cilj ove studije bio je utvrditi procjenjuje li ITM adekvatno debljinu kod adolescenata, posebno onih koji su tjelesno aktivni. Provedena je analiza antropometrijskih podataka prikupljenih u dva transverzalna istraživanja (1997. i 2009./2010.) učenika srednjih škola grada Zagreba, 1315 djevojaka i 1034 mladića dobi 15–19 godina. U skupinu »tjelesno aktivnih« uključeni su adolescenti koji prakticiraju organizirane oblike tjelesenih aktivnosti (36,2% djevojaka, 44,6% mladića), dok su skupinu »tjelesno neaktivnih« činili njihovi vršnjaci koji organizirano vježbaju samo u sklopu nastave tjelesnog odgoja u školama. Vrijednosti varijabli standardizirane su unutar svakog spola odvojeno za svako istraživanje te su uspoređene kod adolescenata različitog stupnja tjelesne aktivnosti. Kod tjelesno aktivnih adolescenata oba spola utvrđene su niže srednje Z-vrijednosti zbroja kožnih nabora ($p_{djevojke}<0,05$; $p_{mladići}<0,001$), s tim da su mladići imali i više Z-vrijednosti tjelesne težine ($p<0,05$) i omjera triceps/subskapularni kožni nabor (koji upućuje na perifernu distribuciju masti) ($p<0,05$) u odnosu na manje aktivne vršnjake. Kako bismo utvrdili je li ITM prikladan indikator sastava tijela u adolescenciji, provjerili smo jesu li kod ispitanika čije se vrijednosti ITM-a nalaze iznad medijana i vrijednosti ostalih indiktora debljine također iznad medijana. Najveće odstupanje utvrđeno je za zbroj kožnih nabora kod oba spola, koje je bilo naglašenije u tjelesno aktivnih adolescenata. Ovaj nalaz potvrđen je i u ekstremnijoj kategoriji ITM-a, onoj između 85. i 95. percentila, što ukazuje da je kod tjelesno aktivnih adolescenata – okarakteriziranih kao prekomjerno teških – utvrđena veća nemasna masa tijela, a ne veća debljina.