FAT MASS ASSESSMENT IN SCHOOL CHILDREN

[1]VOICHIŢA HURGOIU, [2]AIDA PUIA, [3]MARIA HANŢIG, [4]ŞT. ŢIGAN, [5]CARMEN MICU

[1,4,5]*"Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca,* [2]*"Dr. Puia Aida" Private Medical Surgery, Cluj-Napoca,* [3]*County Hospital, Sighetu Marmaţiei*

Abstract: *Background. The body weight excess reached a dramatic incidence in the world during the last years and it is expected to rise. The aim of the study was to assess the extension of adipose tissue mass in school children to detect the gender differences in their dynamics before puberty in order to predict obesity. Subjects and methods: 1,687 healthy school children, 879 girls and 808 boys, aged 5.10 – 11.7 years from urban areas in the north of Transylvania. The body weight and height; the tricipital, subscapular and abdominal skin fold thickness were measured. The fat mass percentage was calculated from the body mass index by Martarelli's equation. Results: the fat mass increased from 8.33±2.6 % to 11.89±5.4 % in girls and from 3.12±0.7 % to 4.1±2.3 in boys. The skin folds showed a more significant decrease at the age of 7 years in both genders and higher values were noted in the girls. Conclusions: the body fat mass in school children was higher in girls than in boys and it increased during the age of 6 – 12 years. The skin fold thickness was more evident at the age of 7 in both genders.*

Keywords: *adipose tissue, anthropometry, body mass index, skin folds, school children*

Rezumat: *Introducere: excesul masei corporale a atins o incidenţă dramatică în ultimii ani, în plan mondial, iar incidenţa lui este în creştere. Scopul lucrării: evaluarea masei ţesutului adipos la şcolari pentru a cunoaşte dinamica prepubertală a diferenţelor dintre sexe şi în predicţia obezităţii. Subiecţi şi metode: 1687 şcolari sănătoşi, 879 fete şi 808 băieţi, în vârstă de 5,10 – 11,7 ani din zona urbană a nordului Transilvaniei. S-a măsurat greutatea; înălţimea; pliul cutanat tricipital, subscapular şi abdominal. Proporţia masei grase s-a calculat în baza indicelui masei corporale conform ecuaţiei lui Martarelli. Rezultate: masa grasă a crescut de la 8,33±2,6 % la 11,89±5,4 % la fete şi de la 3,12±0,7 % la 4,1±2,3 % la băieţi. Grosimea pliurilor cutanate a fost superioară la fete şi a diminuat la ambele sexe, mai semnificativ la vârsta de 7ani. Concluzii: Masa grasă a şcolarilor a crescut la vârsta de 6 – 12 ani şi a fost superioară la fete, comparativ cu băieţii. Grosimea pliurilor cutanate a descrescut la ambele sexe, mai evident la 7ani.*

Cuvinte cheie: *ţesut adipos; antropometrie; indicele masei corporale; pliuri cutanate; şcolari*

INTRODUCTION

Obesity in children showed a marked increase in the world during the last decades, it becoming a public health problem (1,2). Obesity in childhood is associated with cardiovascular diseases, diabetes mellitus type 2 and metabolic syndrome in teenagers and adults (3,4). The risk of obesity is higher in children who presenting a rapid body weight increase during infancy (4). Obesity becomes manifest in the prepuberty when the distribution of the fat tissue (fat mass) shows gender differences. The child is considered obese when the body mass index (BMI) exceeds 19.5 kg/m^2.(5) Fat deposition in children is subject to the phenomenon of secular growth.(2,6)

The aim of the present study was to investigate the representation of the fat tissue in small school children during the last decade in order to detect the moment when the gender differences and the prepuberty changes occur.

MATERIALS AND METHODS

The study included 1,687 healthy children from urban areas, 879 girls and 808 boys, aged 5 years and 10 months – 11 years and 7 months, attending kindergartens and, classes I to IV of the schools from Cluj-Napoca in the period 2001-2002 and Sighetu Marmaţiei, Dragomireşti and Săliştea de Sus in Maramureş county in the period 2005-2006.

The study protocol included a questionnaire filled in by the parents, comprising the personal data, family and personal history and the economic-social situation of the family. After examining the health record a general clinical examination was performed, the children with family history of obesity, diabetes mellitus and metabolic syndrome not being included in the study.

The study was approved by the Ethics Committee of the University, also obtaining the informal consent of the teachers and of the parents, obtaining their signature on the form.

In each case the following measurements were made in duplicate: body weight by a classical balance, height with a stadiometer, BMI and the skin folds by means of a digital caliper 15 seconds after application, preserving the confidentiality and intimacy of the subjects in data handling and record keeping. The fat mass was assessed as percentage depending on age, rank and gender of the subjects based on Martarelli's equation (7) to which a parabolic extrapolation corresponding to the children's BMI was applied.

The results of the measurements were interpreted statistically by the ANOVA variance analysis and the Spearman relationship coefficient considering the significance threshold p≤0.05 and r>0.5.

RESULTS

The significant number of children included in the study came from organized families with parents in professional activity and adequate economic-social conditions. Most of them were rank I (67.8%) and II (25.6%). BMI was within the range 15.17 – 18.03 kg/m^2 in girls and 15.43 – 17.92 kg/m^2 in boys.

The fat mass increased (p=0.000) with the age of the children, in girls the mass being higher (p=0.000) than in boys over the whole follow up period. Relating the fat mass with the child's rank indicated an inverse relationship representation with the succession of the birth, with the preservation of the gender differences.

Table no. 1. School children fat mass

	Girls	Boys
	(879)	(808)
Total	9,070±3,25	3,251±1,24
Age (years)		
<6	8,332±2,66 21	3,119±0,74 17
6,1-7	8,066±2,58 78	2,886±0,80 71
7,1-8	8,049±2,24 198	2,936±0,84 214
8,1-9	8,422±2,23 176	3,093±0,82 165
9,1-10	9,337±2,94 183	3,308±0,95 146
10,1-11	10,465±4,12 188	3,752±1,76 154
>11	11,897±5,44 35	4,134±2,38 41
	p=0.0000	p=0.0000

The tricipital, subscapular and abdominal skin folds presented a decrease (p=0.000) in both gender, this being more obvious at the age of 7 years, in an unsignificant correlation with the proportion of the fat mass (r=0.214). The skin folds in girls exceeded (p=0.009) the skin folds in boys. Table II

The tricipital skin fold correlated with the subscapular skin fold (r=0.87) and the abdominal skin fold (r=0.90) demonstrating the homogeneous distribution of the reserve adipose tissue between 6 and 12 years. The ratio between the tricipital and subscapular skin folds decreased (p= 0.000) up the age of 9 years in a similar manner in both genders.

DISCUSSIONS

The results indicated the extension of the fat mass with age and a change of its distribution at the age of 7-9 years. The fat mass represents the subcutaneous and visceral adipose tissue. The brown fats situated interscapulary play a role in thermogenesis and decrease with age. The white adipose tissue is considered a multifunctional organ playing a role in the regulation of the energy balance, in the mechanic protection of the internal organs, in the synthesis and release of over 100 factors involved in a number of metabolic and physiologic processes as signals for other organs such as the muscle, adrenal cortex, nervous system. The adipocytes release cytokines: TNFα, IL-6, IL-8, angiotensinogen II, plasminogen activator-inhibitor-1 factor, adiponectins involved in the inflammatory processes, angiogenesis, regulation of the blood pressure, in hemostasis, glucose homeostasis and in the acute phase of the stress, which are responsible for the complications of obesity.(8,9)

Our results on the proportion of the fat mass were lower than in children aged 6-9 years of Brasilia (10) and the children aged 10-20 years in Italy investigated by bioelectrical impedance and of the girls aged 10-13 years in Finland (11) or Australia (1) whose fat mass was appreciated by dual-energy X-rays absorptiometry, the BMI not situating them as obese. In our opinion a comparison in the discussion of these results would be hazardous in the conditions of the geographic area, of the small number of cases and of the very different evaluation methods.

The correlation of the skin folds in the present study indicated a homogeneous distribution of the lipid reserves but the standard deviations plead for larger individual variations which hidden by the number of cases. A meta-analysis of the studies of the tricipital and subscapular skin folds over five decades carried out by Olds (2) indicated their involvement in the secular growth, a close correlation between the mean and median values, situating the tricipital/subscapular ratio as an index of the cardiovascular risk. The insignificant relationship between the fat mass and the skin folds investigated suggested their moderate validity in the assessment of the fat mass in small school children. The subcutaneous adipose tissue releases more slowly the lipids at the changes in the energy supply as compared with the intra abdominal/visceral adipose tissue.(12) The abdominal skin fold participates together with visceral fat to the definition of the abdominal circumference.(6) The increase of the fat mass concomitantly with the decrease of the thickness of the investigated skin folds suggested a prepubertal statural-ponderal leap at the age of 9 years.

The differences between girls and boys in the accumulation of the fat mass was reported in more studies.(3,12,13) This was attributed to the different distribution of the reserve fats, prevailingly in the subcutaneous tissue in girls, where the estrogen receptors are found and in the visceral tissue in boys, which is rich in testosterone receptors.(12,15) The sex hormones act in the regulation of the energy balance and in the fat mass distribution, signalling the hypothalamus in the release of leptin and of the adrenocortical hormones.

Table no. 2. Skin folds

	Skin folds (mm)						
	Tricipital		**Subscapular**		**Abdominal**		**Tricipital/Subscapular**
	Girls	**Boys**					
Total	3,475±5,18	3,107±4,63	2,798±3,67	2,495±3,13	2,939±4,32	2,664±3,95	
Age (years)							
<6	12,762±3,36	11,353±2,98	8,429±3,46	7,529±2,18	10,333±4,23	9,412±3,71	1,58±0,32
	(21)	(17)	(21)	(17)	(21)	(17)	(38)
6,1-7	11,428±4,86	9,979±4,71	8,026±3,85	6,692±3,09	9,189±4,43	7,880±4,47	1,45±0,38
	(78)	(71)	(78)	(71)	(78)	(71)	(149)
7,1-8	5,247±5,99	4,225±5,29	3,981±4,33	3,291±3,76	4,259±4,99	3,687±4,65	1,03±0,42
	(198)	(214)	(198)	(214)	(198)	(214)	(412)
8,1-9	2,946±4,84	2,553±4,17	2,514±3,68	2,224±3,07	2,572±4,20	2,204±3,49	0,89±0,36
	(176)	(165)	(176)	(165)	(176)	(165)	(341)
9,1-10	0,776±0,41	0,770±0,99	0,987±0,33	0,940±0,63	0,793±0,52	0,754±0,93	0,80±0,34
	(183)	(146)	(183)	(146)	(183)	(146)	(329)
10,1-11	0,847±0,43	0,834±0,63	1,081±0,37	1,003±0,43	0,903±0,59	0,812±0,59	0,81±0,41
	(188)	(154)	(188)	(154)	(188)	(154)	(342)
>11	1,057±0,93	1,041±0,82	1,190±0,46	1,206±0,60	0,879±0,66	1,004±0,81	0,91±1,09
	(35)	(41)	(35)	(41)	(35)	(41)	(76)
	p=0,0000	p=0,0000	p=0,0000	p=0,0000	p=0,0000	p=0,0000	p=0,0000

() number of cases

CONCLUSIONS

The fat mass in normal weight school children aged 6-12 years showed a progressive increase with age, in a negative relationship with the rank and it was higher in girls. The tricipital, subscapular and abdominal skin folds decrease with age in both genders within the context of the fat mass increase without reaching the values of obesity.

REFERENCES

1. Sakuragi S, Abhayaratna K, Gravenmaker KJ. et al. Influence of adiposity and physical activity on arterial stiffness in healthy children. Hypertension 2009;53:611-616.
2. Olds TS. One million skinfolds:secular trends in the fatness of young people 1951-2004. Eur J Clin Nutr 2009;63: timothy.olds@unisa.edu.au
3. Liem E, De Lucia Rolfe E, L'Abée C, Sauer P, Ong K, Stolk R. Measuring abdominal adiposity in 6 to 7-year-old children. Eur J Clin Nutr 2009;63:e.t.liem@bkk.umcg.nl.
4. Demerath E, Reed D, Choh A et al. Rapid postnatal weight gain and visceral adiposity in adulthood: the Fels longitudinal study. Obesity 2009;17:ewd@umn.edu.
5. Ebbeling C, Backstrand J, Rodriguez N. Screening indices for paediatric obesity. Nutr Res 1999;19:805-815.
6. Castro-Pinero J, Artero E, Espana-Romero V et al. Criterion-related validity of field-based fitness tests in youth: a systematic review. Br J Sport Med 2009;43:http://journals.bmj.com.
7. Martarelli D, Martarelli B, Pompei P. Body composition obtained from the body mass index. Eur J Nutr 2008;47:409-416.
8. Trayhurn P. The biology of obesity. Proceedings of the Nutrition Society 2005;64:31-38.
9. Hauner H. Secretory factors from human adipose tissue and their functional role. Proceedings of the Nutrition Society 2005;64:163-169.
10. Sant'Anna M, Tinoco A, Rosado L. et al. Body fat assessment by bioelectrical impedance and its correlation with different anatomical sites used in the measurement of waist circumference in children. J Pediatr (Rio J). 2009;85:61-66.
11. Cheng S, Völgyi E, Tylavsky F et al. Trait-specific tracking and determinants of body composition: a 7-year follow-up study of pubertal growth in girls. BMC Medicine 2009; http://www.biomedcentral.com.
12. Shi H, Clegg D. Sex differences in the regulation of body weight. Physiology & Behavior 2009;97:199-204.
13. Cartier A, Cộté M, Lemieux I et al. Sex differences in inflammatory markers: what is the contribution of visceral adiposity? Am J Clin Nutr 2009;89:1307-1314.
14. Mittendorfer B. Sexual dimorphism in human lipid metabolism. J Nutr 2005;135:681-686.