ORIGINAL ARTICLE

Nutritional Status Assesment in Overweight and Obese Children

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Background: Obesity represents the abnormal/excessive accumulation of fat in adipose tissue. Anthropometry takes a person's body measurements, especially for use on a comparison or classification basis to establish his/her nutritional status. Nutritional condition also includes clinical examination and laboratory findings. Our **aim** was to assess the nutritional status in a group of obese children versus normal-weight children.
Material and methods: Our prospective study, conducted between October 1, 2010 and April 15, 2011, included a study group with 20 obese children and a control-group with 35 healthy children; we performed antropometric measurements, we calculated some anthropometric indices and performed laboratory tests, abdominal ultrasound and real-tyme elastography; statistical analysis involved Graph PadPrisma and Graph Pad InStat Demo programme; Student's t test and correlation coefficient Pearson were used.
Results: Children weight and weight-for-age z-score significantly differed between the study-group and controls, at each age group, stature and height-for-age z-score was not significantly different. Medium upper-arm circumference (MUAC) had higher values than Body Mass Index, (BMI), while Tricipital Skin-fold (TSF) recorded the highest values, reflecting the fat deposits of obese children (in controls these indices were between -2SD and +2SD). The laboratory findings were generally within normal limits; total cholesterol values were higher in obese and triglycerides were incresed in a part of children in which they were determined. Liver elasticity was lower in obese than in the control-group.
Conclusion: Overweight alters the nutritional status, disturbs lipid metabolism and decreases the elasticity of the liver, highlighting the risks related to obesity and the importance of prevention and treatment of this disorder.

Keywords: nutritional status, overweight, obesity, child

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Introduction

Obesity is generally defined as the abnormal or excessive accumulation of fat in adipose tissue which can affect health [1]. It is the most common childhood nutritional disorder worldwide and is widely acknowledged as having become a global epidemic [2,3].

Nutritional status reflects the balance between input and needs, and the consequences of any disruptions, representing the foundation of nutritional support given to patients [4]. Child nutritional status assessment includes nutrition history, physical examination, anthropometry, the calculation of indices based on the measurement and comparison with reference standard growth curves, as well as laboratory findings [5,6].

One approach in the study of the nutritional status is the assessment based on anthropometric indicators, measurements of the body (physical), such as height or weight, perimeters, waist and hip circumferences, mean upper-arm circumference – MUAC, abdominal and tricipital skin folds and others (related to age and sex of the individual), with the advantage of being inexpensive and non-invasive [7].

Three of the indicators most commonly used for infants and small children are weight-for-height, height-for-age and weight-for-age, derived by comparison of basic indicators, with reference data for ”healthy” children. Measurements shall be understood both separately and through correlative indices, which are recommended by WHO as being more precise in assessing nutritional status (waist-hip index, Ponderal index, or Body Mass Index, BMI).

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By comparing measurements of similar individuals (in terms of age/sex), anthropometric indices are converted into reference data. There are three ways to express these comparisons: Z-score (standard deviation score), percentage of median and percentile [9].

Before 1994 the scientific literature on child overweight and obesity included a wide range of defining criteria and descriptive names; the differences in terminology were sometimes confusing [10]. At that time, the term ”obese” was avoided. In 2005, the Institute of Medicine (IOM) defined children with BMI at $\geq 95^{th}$ percentile for age and gender as obese rather than overweight. A recent expert committee recommended to replace the terms ”at risk of over-weight” and ”overweight” with the terms ”overweight” and ”obese,” respectively [11,12]. Individuals with a BMI at $\geq 85^{th}$ percentile but $<95^{th}$ percentile or 30 kg/m^2 (whichever is smaller) should be considered overweight, while children with a BMI of >30 kg/m^2 or $\geq 95^{th}$ percentile for age and gender should be considered obese [10].

Material and method

This paper presents the preliminary result of a study in progress, which started on October 1st 2010; data were collected until April 15, 2011. The study group included 20 overweight and obese children; we used for comparison the results of evaluation from a control group which included 35 normal weight children.

We performed antropometric measurements (weight, length/height, MUAC, TSF). Stature and body mass were measured according to standard procedures [5]. Stature was measured to the nearest 0.1 cm using a wall stadiometer, and body mass was measured to the nearest 0.1 kg

Table I. Characteristics of the studied pediatric patients

Characteristics	Group								p		
	Healthy children				Overweight/obese children						
Age	0–5 years	6–12 years	13–18 years	Total 35	0–5 years	6–12 years	13–18 years	Total 20			
Sex											
Boys	9	4	5	18	4	8	2	14			
Girls	13	3	1	17	2	3	1	6			
W (kg)	14.0±1.23	27.10±2.55	48.87±5.09		24.0±10.0	46.8±12.33	88.23±35.21		<0.0001	0.0008	0.0235
Length/height (cm)	91.52±3.94	129.71±5.99	162.17±7.15		98.16±22.31	138.54±15.36	162±10.81		0.1776	0.1692	0.9779
BMI (kg/m²)	na	14.72±3.54	18.7±2.18		na	23.96±2.36	32.7±9.41			<0.0001	0.0077
BMI (SD)	na	-0.16	-0.22		na	2.34	32.7±9.412.72				
MUAC		-0.44±1.11				4.16±1.76				<0.0001	
TSF		-0.26±1.25				4.16±1.47				<0.0001	
WAZ		0.1±0.79				3.0±0.52				<0.0001	
HAZ		0.61±1.18				0.63±1.17				0.9519	
BMIAZ		-0.29±1.24				3.08±0.95				<0.0001	
ALT		19.2±8.21				20.05±8.55				0.7174	
AST		24.3±12.01				27.93±9.27				0.2488	
SWV		1.17±0.19				1.61±0.52				<0.0001	

using a standard balance beam scale. The body mass index (BMI) was calculated using the equation: body mass in kg/stature in m^2. Mean arm circumference (MUAC) was measured midway between the upper arm and the olecranon, with upper limb flexed at 90°, calculating the average of three measurements. Tricipital skin-fold thickness (TSF) was measured between the thumb and index, by grasping a fold of approx 1 cm, then placed the instrument called caliper, and the average of three measurements was determined. Using program Growyh Analyser 3. Application. version 3.5 we expressed the results as standard deviations (SD) and we obtained some anthropometric indicis (BMI). WHO Anthro software (version 3.2.2, January 2011) was used in order to generate Height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and BMI-for-height (BMIAZ); weight-for-height (WHZ) z-scores.

Laboratory tests [6] were based on blood samples drawn in the morning, after at least an eight hour fasting period, obtained via venopuncture using sterilized and disposable materials; they were processed and the corresponding determinations were made at the laboratory in the County Emergency Clinical Hospital of Tîrgu Mureș. We have determined transaminases, glucose, cholesterol, triglycerides, bilirubin, alkaline phosphatase, lactate dehydrogenase. The evaluation also included an abdominal conventional ultrasound and an elastogram was performed using an ultrasound machine Siemens S 2000 with a latest generation tehnology and a special soft allowing evaluation of stiffness/elasticity of the tissues expressed by a numerical value called shear wave velocitz (SWV), the more higher as the tissue is less elastic.

Statistical analysis

Means and standard deviation (SD) were calculated for the statistical analysis. Student's t test was used to compare the mean results of the analyzed variables and the correlations between the media of the study variables between different groups were assessed on the basis of correlation coefficient Pearson (r). A p value below or equal to 0.05 was considered to be statistically significant for a 95% CI. The data were analyzed through Graph Pad Prisma and Graph Pad InStat Demo programme.

Results

The characteristics of our study population are presented in Table I, separate for controls and for the group of children with overweight or obesity. Considering that in children, unlike in adults, there are important differences at different ages, we divided them by age groups.

Children weight significantly differed between the study group and controls, at each age group, while stature (length in children below 80 cm, respectively, height for those over 80 cm) was not significantly different between the two groups. The same same situation was found in terms of weight-for-age z score (WAZ), that was significantly higher in the study group compared to controls, while height-for-age z score (HAZ) showed no significant differences.

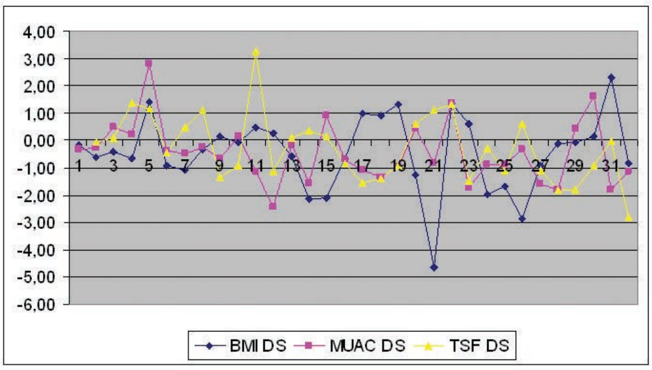

Fig. 1. BMI, MUAC and TSF in control group

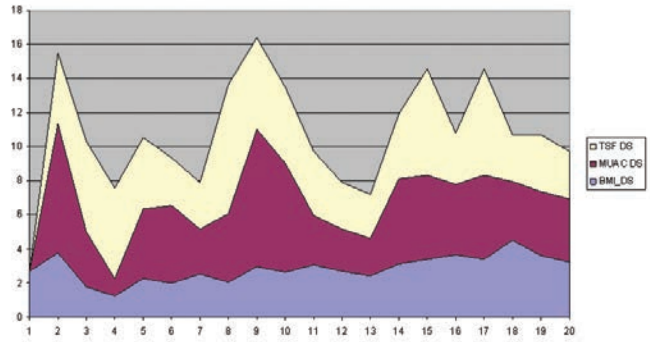

Fig. 2. BMI, MUAC and TSF in study group

BMI was expressed both in kg/m^2 and in SD, including in the group of overweight children cases with BMI over 85th percentile for age, considered as obese children with BMI over the 95th percentile for age. Logically, the difference between BMI for the study group and control group were highly statistically significant as well as BMI-for-age z score (BMIAZ).

Obesity is one of the easiest diagnoses to establish, but we have to objectify medical findings in relation to generally accepted common criteria; in some cases BMI has not exceeded 2 SD, but both the value of arm circumference, MUAC and TSF were very high. Figure 1 shows (normal) values of anthropometric measurements in healthy children.

Figure 2 shows values of anthropometric measurements in group of overweight an obese children, with BMI generally more than 2 SD, MUAC also increased and TSF to very high values, highlighting the fat deposits (with statistical significant difference, p<0.0001).

Figure 3 shows the MUAC and TSF in the study group (both parameters were greatly increased) versus the same indicators in the group of children with normal nutritional status.

Regarding laboratory parameters, we have not detected significant differences between the two groups for the values of transaminases (aspartate amino transferase, AST and alanine amino transferase, ALT, respectively); Cholesterol in study group was 168.4±34.01 mg/dl, but the determination was performed only in 60% of patients, 50% of them had values above the maximum allowed for children, as shown in Figure 4.

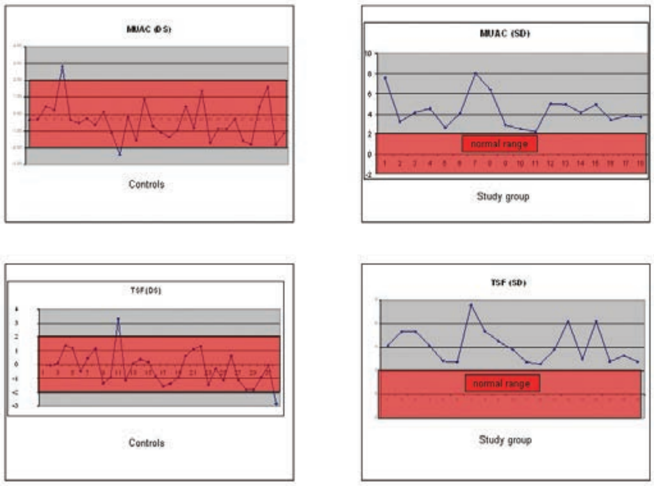

Fig. 3. MUAC and TSF in healthy children compared to study group

The remaining laboratory tests which have been performed were within normal limits (glucose, bilirubin, etc.); serum triglycerides were higher in 33.3% of children screened.

Conventional abdominal ultrasound examination showed in 35% of obese patients increased echogenity of the liver, in some cases a granular hepatic appearance and even posterior attenuation appearance, suggestive for steatosis. Ultrasound elastography performed by ARFI technique revealed higher rates than in the control group, shear wave velocity having a median of 1.61±0.52m/s, versus 1.17±0.19m/s in normal-weight children, difference which was highly statistically significant (p<0.0001), as it appears in Figure 5.

Discussions

BMI is a measure calculated as weight in kilograms divided by height in meters squared, formula proposed by Quetelet in 1869, which became common in clinical use since 1972, thanks to its use by Keys [5,7]. BMI can be used for age of 2 years up to adolescence, it is a significant predictor for the installation of obesity in adolescence or adulthood (not under the age of 2 years) [8]. We considered BMI to assess nutritional status only for children over 6 years of age, not for

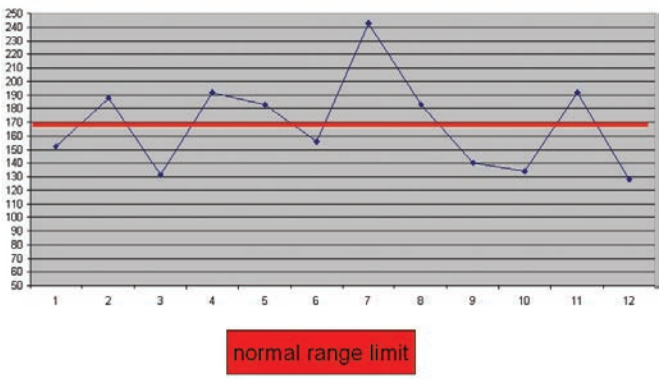

Fig. 4. Total cholesterol levels in overweight and obese children

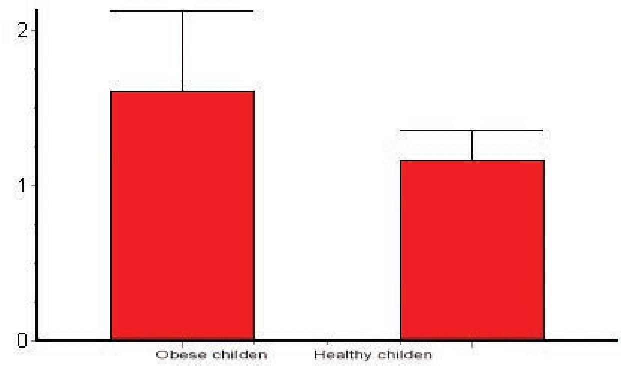

Fig. 5. Liver elasticity in obese children versus normal-weight group

infants and toddlers, because several reports support the use of BMI as a measure of adiposity in children and adolescents [13,14], although by measuring body fat using skin fold thickness, Zimmerman et al. confirmed a highly significant relationship between BMI and percentage body fat [15].

However, in clinical settings it is important to obtain the BMI and also apply other measurements which may help to identify major contributors to increased BMI, which is why we prefered to evaluate also HAZ and BMI-for-age z-scores, as well as MUAC and TSF, obtained using Growyh Analyser and WHO Anthro software [16,17]. TSF was statisticaly significant higher than MUAC, both of them being significantly higher than BMI (SD), with $p<0.0001$. We have not made too many references to WAZ, because reference data are not available beyond age 10 (it does not distinguish between height and body mass in an age period where children are experiencing the pubertal growth spurt and may appear as having excess weight when they are just tall) [17].

The maximum cholesterol value allowed for children was considered 170 mg/dl, according to Couch and Daniels [18]; only total cholesterol could be determined and only in 9 cases in the control group (values were within normal limits), so we were not able to prove that the values were statistical significantly higher in study group.

Conclusions

Overweight and obesity alter the nutritional status, disturb lipid metabolism and decrease the elasticity of the liver, highlighting the risks related to obesity and the importance of prevention and treatment of this disorder. Information on the nutritional status of children can be used to develop programmes aimed at improving food availability and dietary and physical activity habits starting at young ages, especially regarding obesity, knowing the possible complications, most of which having possibly permanent repercussions in adulthood.

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