ORIGINAL ARTICLE

First body fat percentiles for 607 children from Thessaloniki-Northern Greece

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Abstract

Background and Aim: The purpose of this study was to establish for the first time reference curves for body fat levels in a Greek pediatric population aged 7-15y.

Methods: Six hundred and seven (607) children randomly selected from 8 primary and secondary schools from Northern Greece. Percentage body fat was measured by bioelectrical impedance analysis and percentile curves were constructed using the LMS method. All children were measured twice in the morning and the mean number of the two measurements was considered as the percentage of body fat.

Results: The mean number of the percentage body fat for the age group (7-9) was 18.2 ± 5.1 and 18.4 ± 6.1 for boys and girls, respectively. In the second age group (10-12) the girls had higher mean fat levels than boys (22.6 ± 5.8 vs. 20.4 ± 6.2). This increase was continued also in the third age group (13-15) with the girls having higher mean body fat levels (24.2 ± 5.5 vs. 17 ± 5.9). The 85th and 95th percentiles represented the cut-off point for overweight and obesity and it was (26.3, 33.0 and 28.9%) and (34.0, 38.2 and 38.1) for boys for the three age groups (7-9, 10-12 and 13-15), respectively. On the other hand, the girls had higher 85th and 95th percentiles for the same age group (7-9, 10-12, 13-15y) and it was (34.5, 32.9 and 33.6%) and (39.0, 370 and 38.3%), respectively.

Conclusion: Body fat level, which is the component of overweight that leads to pathology, is a better representative over body mass index. These first percentile curves will be at great assistance helping the medical community to identify obesity in these children at early stages and to prevent development at pathological diseases early in their lives. Hippokratia 2010; 14 (3): 208-211

Key words: body fat percentiles, bioelectrical impedance analysis, obesity, children, body fat

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Childhood obesity is a growing public health problem in Greece[1,2]. Comorbidities associated with excess overweight such as hypertension, diabetes mellitus type 2 and dyslipidemia, have been found to be established at young ages[3]. Body Mass Index (BMI) is widely used to assess overweight (OW) and obesity (OB) in adults. BMI cut-off points have been also developed for children by International Obesity Task Force (IOTF)[4]. However, BMI does not distinguish between increased lean mass, bone and fat. Since the pathology associated with obesity is related very strongly with excess body fat, the ideal tool should assess adiposity[5]. Bioelectrical impedance analysis (BIA) is simple, convenient and inexpensive method for assessing adiposity. Recent papers have begun to use percentage of body fat (PBF) measured by BIA as the "gold standard" in pediatric obesity[6]. Studies for body fat curves have been reported in UK, Hong Kong and USA[7-9]. The aim of this study was to develop for the first time reference curves of PBF to be used for local children from Northern Greece.

Methods

Six hundred and seven children (324 boys-283 girls) aged 7-15y randomly selected from 8 primary and secondary schools from rural and urban areas of Thessaloniki, Northern Greece which is a city of about one million people. Randomizations took into consideration population distribution with regard to age and sex both for urban and rural habitants. This procedure was performed by using a computer assisted method (SPSS.v. 13). Demographic information, as well as medical and diet history of each child was collected by children's parents. All children categorized in three age groups (7-9, 10-12, and13-15y). All children were individually coded and the data was anonymised. The study was approved by the University's ethics committee.

A trained research team of three people contacted the schools to collect the anthropometric data. Weight was measured with light clothes, without shoes and without having eaten for 10-12 hours, with SECA 700 to the nearest 0.1 gm. Height was measured to the nearest 0.1 cm with SECA stadiometer. BMI was calculated as follows [weight (kg)/ height^2 (m)]. Waist Circumference (WC) was measured with a traditional tape to the nearest 0.1 cm midway between the lowest rib and the superior border of iliac crest. Children were categorized as OW or OB based on IOTFs' criteria[4].

Body fat was measured by Maltron BF-906 (Body fat

Table 1: Sample sizes, mean and standard deviations for weight, height, BMI, WC and body fat for 607 Greek children aged 7-15 years.

Sex	Age	Weight (kg)	Height (cm)	BMI	WC (cm)	% BF
Boys	7-9 (n=81)	30.7 ± 9	1.31 ± 0.07	17.4 ± 3.9	60.5 ± 14.6	18.2 ± 5.1
	10-12 (n=105)	49 ± 14.3	1.52 ± 0.11	20.7 ± 4.7	73.5 ± 12.4	20.4 ± 6.2
	13-15 (n=138)	60.2 ± 14.1	1.66 ± 0.09	21.5 ± 4.2	77.5 ± 10.4	17.6 ± 5.9
Girls	7-9 (n=65)	33.5 ± 11.4	1.31 ± 0.08	19.3 ± 5.7	64.2 ± 15	18.4 ± 6.1
	10-12 (n=83)	46.5 ± 12.8	1.49 ± 0.09	20.6 ± 4.7	69 ± 11	22.6± 5.8
	13-15 (n=135)	56.6 ± 14.4	1.62 ± 0.07	21.4 ± 5.1	74.4 ± 11.4	24.2 ± 5.5

BMI: body mass index, WC: waist circumference, BF: body fat

analyzer, Maltron Ltd, Essex, UK) twice and the mean number of the two measurements was considered as the PBF. This machine uses hand –to-foot electrodes and has been previously used by other colleagues[10]. The method depends on measuring the resistance (impedance) to an electrical current travelling through body tissues. Fat-free mass (FFM) contains high levels of water and electrolytes, and acts as a conductor of electrical currents, whereas fat mass is comparatively anhydrous and acts as a resistor to the flow of electrical current. BIA method has been found to correlate strongly (r=0.86) with other adiposity measurements in children[11]. In our study, the repeatability of Maltron was evaluated by 2 investigators at two different times in the morning in 34 children for two consecutive days.

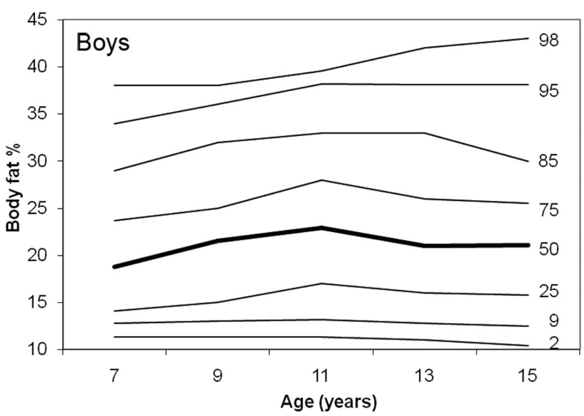

Figure 1: Smoothed percentile curves for %BF of boys.

Statistics

All statistical analyses were performed using the statistical package for the social sciences (SPSS, ver-

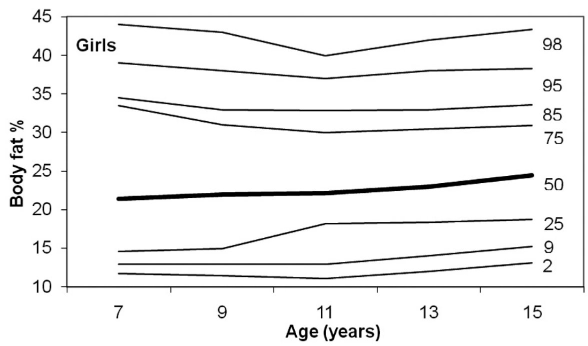

Figure 2: Smoothed percentile curves for %BF of girls.

Table 2: Body fat % percentile values by age-group.

		Percentiles								
Sex	**Age**	**2%**	**9%**	**25%**	**50%**	**75%**	**85%**	**91%**	**95%**	**98%**
Boys	7-9 (n=81)	11.3	12.8	14.1	18.8	23.7	26	30.8	34	40
	10-12 (n=105)	11.3	13.2	17	22.9	28	33	35.3	38.2	39.6
	13-15 (n=138)	10.4	12.5	15.8	21.1	25.5	28.9	32.9	38.1	45
Girls	7-9 (n=65)	11.7	12.9	14.6	21.4	33.5	34.5	37.8	39	47.1
	10-12 (n=83)	11.1	12.9	18.2	22.2	30	32.9	34.5	37	40
	13-15 (n=135)	13.1	15.2	18.7	24.5	30.9	33.6	35	38.3	43.4

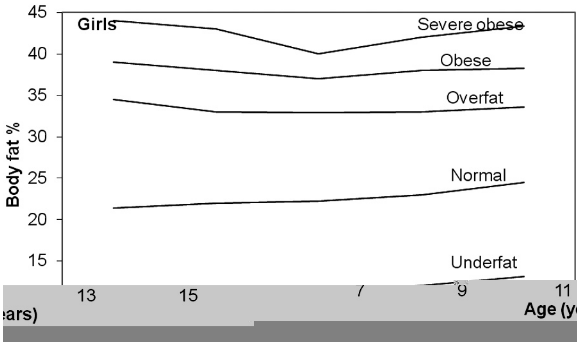

Figure 3: Cutoffs for underfat, normal, overfat, obese and severely obese Greek boys children.

sion 13.0; Chicago, IL, US). Percentile curves were constructed for PBF results and smoothed using the LMS method[12]. Eight percentile curves were calculated from the 2nd to the 98th, spaced two thirds of an s.d score apart. Then were selected the 2nd percentile to define the upper limit of under fat, and the 85th and 95th ones to define the lower limits of overfat and obese while the 98th one was used to define severe obesity. Relationships between the anthropometric measurements in the two sexes were assessed with Pearson's correlation coefficients. $P < 0.05$ was considered as statistically significant.

Results

Sex and age-specific mean weight, height, BMI, WC and PBF values are presented in Table 1.

In Figure 1 and 2 smoothed sex and age-group specific PBF percentiles are presented. The tabulated data is listed in Table 2.

Boys and girls have fairly similar PBF until 50th percentile for all three age groups (7-9, 10-12 and 13-15 y) with the girls having slightly higher number than boys. Above the 50th percentile the girls' PBF increases dramatically, compared to boys' PBF, especially in the age group of 7-9 and 13-15 y.

Figure 3 and 4 illustrates the new percentiles which define underfat, normal, overfat, obese and severe obese children. The repeatability of Maltron 906 is presented in table 4.

Discussion

We presented data and percentile curves for PBF for children 7-15 y from Northern Greece. The data collected may serve as reference standard of measuring adiposity for further research on PBF in such children. Also, this data can be used as a preventing tool of obesity in such a Greek pediatric population since pediatric obesity in Greece has been dramatically increased the last two decades[3]. Cardiovascular disease (CVD) is the leading cause of deaths in Greece[13] and obesity and CVD risk factors have been found to be established in young ages[3].

Our study showed that PBF was higher in girls compared to boys. Similar results have been reported also by other authors[7-9]. This difference is probably due to the fact that boys gain more muscle during puberty and less fat[14]. It is very complicated to compare our results with other body composition measurements in children from other studies[7-9,15,16] due to the fact that different sampling methods and BIA machines have been used or real biological differences may exist in when comparing the subjects.

Our 50th percentile PBF for the age group (7-9y) was lower for girls compared to those from the UK[8] and the USA[9], while for the boys it was higher compared to the UK[8] and lower to the USA[9], respectively. As far as the second age group (10-12y) is concerned, we reported a slightly lower PBF for both sexes compare to the UK[8] and a higher PBF to the USA[9], respectively. In the last age group (13-15y) our results showed that both sexes had higher PBF compared to other two above ethnicities[8,9].

The 95th centile data from our study is closely similar to the US data. For all three age groups both sexes were presented with a slightly increase in PBF compared with the US[9]. This small increased difference expanded dramatically for all age groups for both boys and girls when compared with the UK[8].

The new curves will help focus medical attention on excess adiposity that is associated with co- morbidities[17]. To further emphasize this distinction we propose that the five categories identified in the proposed clinical cutoff charts should be a) underfat, b) normal, c) overfat, d) obese, e) severe obese (Figure 2).

A limitation of our study was that we did not report each PBF for each age since the number of subjects was not adequate and also we did not take in account the stage tanner of each child. Another limitation is that the available bioelectrical impedance analysis (BIA) prediction equations are not necessarily applicable to overweight or obese children. The ability of BIA to predict fatness in the obese is difficult because they have a greater proportion of body mass and body water accounted for by the trunk, the hydration of fat-free mass is lower in the obese and the ratio of extracellular water to intracellular water is increased in the obese.

Nevertheless, it is very important to our country to have for the first time a new set of percentiles that we can

Figure 4: Cutoffs for underfat, normal, overfat, obese and severely obese Greek girls children.

Table 3: Repeatability of BF Maltron 906 in a cohort of children aged 7-15 years.

Repeatability	No of children	Mean difference (%) *	95% limits of agreement**
1st investigator	34	0.53	-2.41 to 3.17
2nd investigator	34	0.46	-2.53 to 3.22
*Mean difference in % body fat measured at two different times, in the morning, of two consecutive days.			
**The 95% limits of agreement correspond to the mean ± 2 SD.			

use to measure adiposity in a pediatric population from Northern Greece.

Conclusion

These PBF percentile data would help medical and other health advisors to identify and prevent pediatric obesity in these children decreasing the risk of health problems later in their lives. However, more clinical correlation studies are needed before reliable advice can be offered concerning the PBF that is meaningful in relation to CVD.

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