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ORIGINAL ARTICLE

Defining overweight and obesity among Greek children living in Thessaloniki: International versus local reference standards

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Abstract

Background: Body Mass Index (BMI) offers a simple and reasonable measure of obesity that, with the use of the appropriate reference, can help in the early detection of children with weight problems. Our aim was to compare the two most commonly used international BMI references and the national Greek BMI reference in identifying Greek children being overweight and obese.

Methods: A group of 1557 children (820 girls and 737 boys, mean age: 11.42 ± 3.51 years) were studied. Weight and height was measured using standard methods, and BMI was calculated. Overweight and obesity were determined using the International Obesity Task Force (IOTF) standards, the Centers for Disease Control and Prevention (CDC) BMI-for-age curves and the most recent Greek BMI-for-age curves.

Results: Results showed that the IOTF's cut-off limits identifies a significantly higher prevalence of overweight (22.4%) compared with both the CDC's (11.8%, p=0.03) and the Greek's (7.4%, p=0.002) cut-off limits. However, the prevalence of obesity was generally increased when it was determined using the CDC's cut-off limits (13.9%) compared to the prevalence calculated with both the IOTF's (6.5%, p=0.05) and the Greek's (6.9%, n.s.) cut off limits.

Conclusions: The use of the national Greek reference standards for BMI underestimates the true prevalence of overweight and obesity. On the contrary, both the IOTF and the CDC standards, although independently, detect an increased number of overweight and obese children and thus they should be adopted in the clinical practice for an earlier identification and a timelier intervention. Hippokratia 2011; 15 (2): 141-146

Key words: children, obesity, overweight, BMI, Greek

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During the last decades, obesity has emerged as a major health problem with dramatically increasing prevalence that affects all socioeconomic groups in both developed and developing countries spreading around the world as a global epidemic[1] World Health Organization (WHO) estimates that in 2005, 1.6 billion adults were overweight; whereas at least 400 million of these were obese[2]. Simultaneously, the number of children who fall into the overweight and obese category is climbing at an alarming high rate. Approximately 22 million children under the age of 5[3] and 155 million children at school age are considered obese worldwide [4]. By 2010, it is predicted that one in seven children in Americas and one in every ten children in the Eastern Mediterranean and European regions will be classified as obese, whereas nearly 40% of the children in these areas will be overweight [5]. Greece currently holds one of the highest rates in childhood overweight and obesity worldwide with a prevalence that reaches 33%(6) and that apparently is leveling off during the last four years (7). Similarly reports from Thessaloniki, North Greece indicate an increased prevalence of childhood overweight and obesity that has been stable during the last decade (8, 9).

Childhood obesity is the dominant predictor of obesity and related morbidity during adulthood[10, 11]. Additionally, children and especially adolescents with obesity face stigmatization and discrimination in many areas of their lives[12], therefore they are more prone to psychosocial problems[13]. Early and accurate identification of the obese child is an essential prerequisite for prevention and successful intervention. Both the International Obesity Task Force (IOTF)[14] and the Centers for Disease Control and Prevention (CDC)[15] recommend that Body Mass Index (BMI) offers a reasonable measure of obesity and should be used in both clinical practice and epidemiological research. However, no globally accepted definition of obesity on the basis of BMI for children and adolescents currently exists. The IOTF has provided international sex and age-specific cutoff points for BMI by analyzing data from 6 countries and by projecting the percentile curves through the adult cutoff points at the age of 18 years[16]. CDC uses as cutoff points the 85th and the 95th percentiles on sex-specific BMI for age reference curves[17]. Discrepancies in terminology also exist as in the United States the terms *at risk of overweight* and *overweight* are adopted instead of *overweight* and *obese*, respectively.

The aim of this study was to determine the weight status of children, aged 4 to 18 years, living in Thessaloniki, North Greece and compare the percentages of overweight and obesity as determined by different national and international reference standards.

Materials and Methods

This study was part of another investigation assessing bone status with the use of quantitative ultrasonography and providing normative reference curves for speed of sound parameter in healthy Greek paediatric population[18]. Subjects were recruited from randomly selected schools that covered all socio-economic areas of the city of Thessaloniki in a uniform manner. Written informed consents from parents or legal guardians and verbal consents from the participants were obtained. The study protocol was in accordance with the revised version of the Helsinki declaration regarding research involving human subjects and was approved by the Greek Ministry of National Education and Religious Affairs.

One thousand, five hundred and fifty-seven children (820 girls and 737 boys) with a mean decimal age of 11.42 ± 3.51 years (range: 3.78 – 18.33 years) were finally included in this study. Anthropometric measurements were obtained in a private place at the school setting with the participants wearing light clothing and no shoes. Height was measured with the use of a, regularly calibrated, wall-mounted ruler (minimetre) and expressed in centimeters (cm) rounded to the nearest 0.5. Weight was measured on a portable electronic scale and expressed in kilograms (kg) to the nearest 0.5. BMI was calculated as the ratio weight / (height)^2 (kg/m^2, Quetelet index).

Overweight and obesity was determined according to the following methodologies:

A. The International Obesity Task Force (IOTF) curves developed by Cole et al[16] as an effort to produce international reference standards by compiling data from 6 heterogenous countries (Brazil, Great Britain, Hong Kong, the Nederlands, Singapore and the United States). In this approach the 85th and the 95th percentiles of the sex-specific BMI for age curves were projecting through the adult BMI cutoff points for overweight (25 kg/m^2) and obesity (30kg/m^2) at the age of 18 years.

B. The Centers for Disease Control and Prevention (CDC) BMI for age curves [17] which collectively gathered data from five national health examination surveys performed from 1963 to 1994 in the United States. Overweight was determined by a BMI greater that the 85th percentile but lower or equal to the 95th percentile in relation to sex and age. Obesity was defined by a BMI greater than the 95th percentile on the same basis.

C. The most recent Greek BMI for age curves developed by Chiotis et al, analyzing data from children who live in Athens area between years 2000 and 2001 [19]. Overweight and obesity were determined with the use of the 85th and 95th percentiles respectively, as described above.

For statistical analysis and graphical demonstration Microsoft Office Excel® 2003 software program and Statistical Package for Social Sciences-SPSS® for Windows ver.14.0 were employed. Chi-square test was used to assess the significance between differences in the prevalence of overweight and obesity as determined by the different cut off limits. A p value less than 0.05 was considered as statistically significant. Kappa statistic was used to evaluate concordance between different cut off limits in diagnosing overweight and obesity. Interpretation of kappa coefficient (k) consists of: $k > 0.8$ denotes almost perfect agreement; $0.6 < k \leq 0.8$ denotes full agreement; $0.4 < k \leq 0.6$ denotes moderate agreement; $0.2 < k \leq 0.4$ denotes low agreement and $k \leq 0.2$ denotes very low agreement[20].

Results

Scatter plots showing the distribution of BMI values in boys and girls plotted against the cut off limits of overweight and obesity as determined by the IOTF, the CDC and the Greek reference data are showing in Figure 1 and 2 respectively.

The prevalence of overweight as determined by the IOTF cut off limits was significantly increased compared to the prevalence calculated with both the CDC cut off limits (for boys p=0.02; for girls p=0.03 and in total p=0.03) and the Greek reference data (for boys

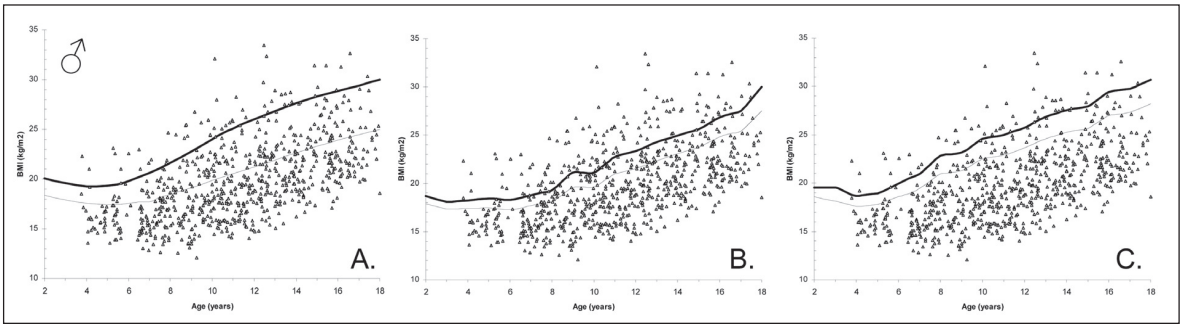

Figure 1: Diagrams showing BMI values of the boys plotted against the IOTF cut-off curves for defining overweight (grey line) and obesity (black line) (A), the 85th percentile (grey line) and the 95th percentile (black line) of the CDC BMI charts for boys (B) and the 85th percentile (grey line) and the 95th percentile (black line) of the respective Greek charts (C).

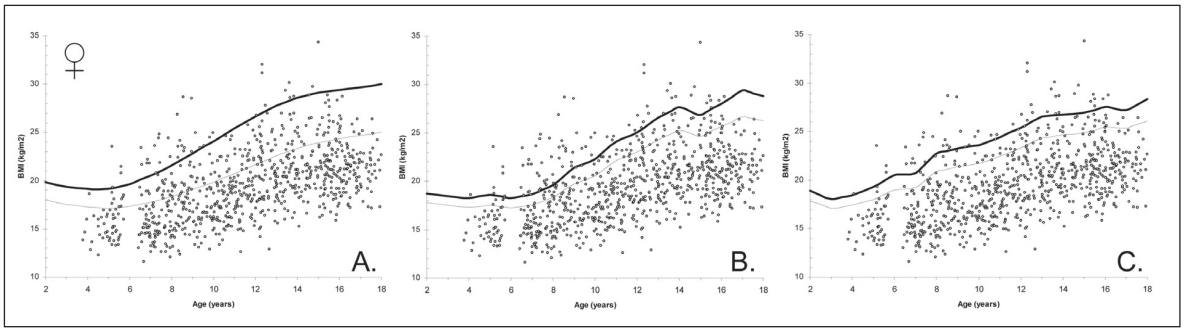

Figure 2: Diagrams showing BMI values of the girls plotted against the IOTF cut-off curves for defining overweight (grey line) and obesity (black line) (A), the 85th percentile (grey line) and the 95th percentile (black line) of the CDC BMI charts for girls (B) and the 85th percentile (grey line) and the 95th percentile (black line) of the respective Greek charts (C).

p<0.001, for girls p=0.006 and in total, p=0.002). On the other hand, the prevalence of obesity was generally increased when it was calculated using the CDC cut off limits and this was statistically significant when compared to the prevalence calculated with both the IOTF limits (p=0.03) and the Greek reference data in boys (p=0.02) and with the prevalence calculated with the IOTF cut off limits in total (p=0.05). Percentages of overweight and obesity calculated with the different cut off limits and significant differences among them are presented in Figure 3.

IOTF cut off limits and CDC cut off limits showed full agreement in identifying overweight and obese children in both gender and in total (k=0.703 for boys, k=0.712 for girls and k=0.710 for total, p<0.001). On the contrary, when cut off limits from the Greek reference curves were used, only moderate agreements to the IOTF (k=0.472 for boys, k=0.589 for girls and k=0.528 for total, p<0.001) and the CDC cut off limits (k=0.400 for boys, k=0.660 for girls and k=0.520 for total, p<0.001) were found in determining overweight and obesity Cross-tabulation of IOTF, CDC and Greek reference cut off limits to identify overweight and obese children are presented in Table 1.

Percentages of overweight and obesity as defined by IOTF, CDC and Greek standards and classified in 3 age groups: 4-6 years, 6-12 years and 12-18 years are presented in Table 2. The percentages of overweight boys as defined by the IOTF standards were significantly increased in age groups 6-12 years and 12-18 years compared to age group 4-6 years (p=0.02 and p=0.001, respectively). On the contrary, the percentage of obese boys aged 12-18 years as determined by the IOTF standards was statistically decreased compared to the percentages of obesity in the age group 4-6 years (p=0.02). With regards to the girls, a significantly decrease in the percentage of obesity was recorded when the CDC reference curves were employed in the age group 12-18 years compared to the age group 6-12 years.

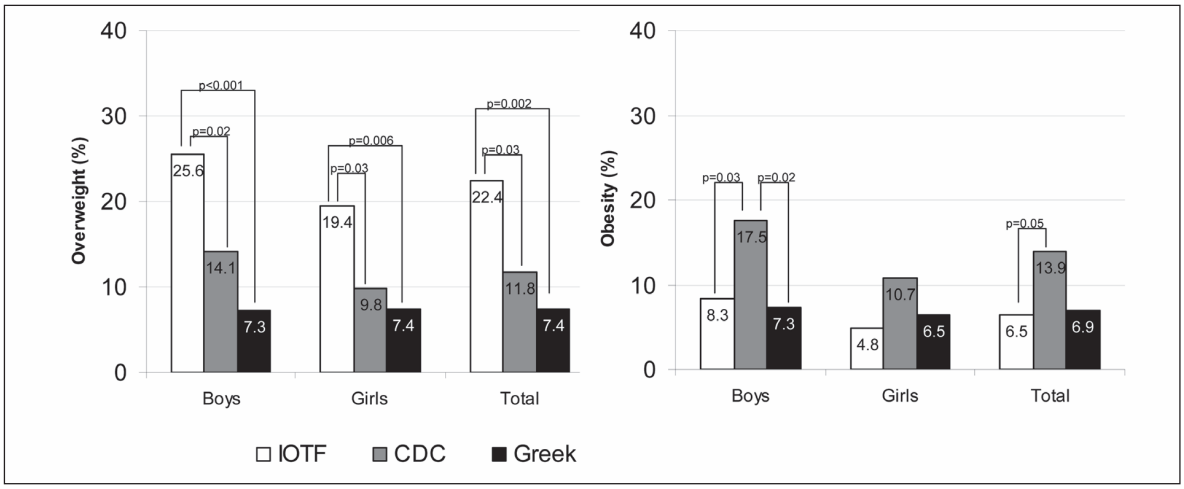

Figure 3: The prevalence of overweight was significantly increased when it was calculated with the use of the IOTF cut off limits compared to the prevalence calculated with both the CDC cut off limits and the Greek reference data in boys, in girls and in total. The prevalence of obesity was increased when it was calculated with the use of the CDC cut off limits when compared to the prevalence calculated with both the IOTF limits and the Greek reference data in boys and with the prevalence calculated with the IOTF cut off limits in total.

Table 1: Paired crosstabulation of IOTF, CDC and Greek reference cut off limits to identify overweight and obese children in the total studied population.

		CDC			
		Normal	**Overweight**	**Obese**	**Total**
IOTF	**Normal**	**1092**	16	1	**1109**
	Overweight	64	**168**	116	**348**
	Obese	0	0	**100**	**100**
	Total	**1156**	**184**	**217**	**1557**
		Greek			
		Normal	**Overweight**	**Obese**	**Total**
IOTF	**Normal**	**1107**	2	0	**1109**
	Overweight	224	**98**	26	**348**
	Obese	4	15	**81**	**100**
	Total	**1335**	**115**	**107**	**1557**
		Greek			
		Normal	**Overweight**	**Obese**	**Total**
CDC	**Normal**	**1152**	4	0	**1156**
	Overweight	140	**42**	2	**184**
	Obese	43	69	**105**	**217**
	Total	**1335**	**115**	**107**	**1557**

Discussion

Body Mass Index (BMI), calculated from basic, auxological indices such as weight and height, represents a simple and accurate indicator for monitoring children's body weight status[14]. However, a relatively recent survey from 188 countries[21], evaluating child growth monitoring practices, showed that the most commonly used auxological indicator, worldwide, is weight-for-age (97% of the countries), whereas, weight-for-length/height is used only in the 23% of them with BMI being used even more rarely. Moreover, a valuable interpretation of BMI measurements requires an appropriate set of reference values across to which they will be contrasted. A number of international and local reference standards on various auxological parameters have been developed worldwide. In this study, we aimed to compare the two most commonly used international references and the national Greek references for interpreting BMI to identify overweight and obese children.

Our results revealed that the estimated prevalence of both overweight and obesity varied widely between the three methods used, in both genders. When using the IOTF cut-off points[16], a significantly higher number of children were classified as overweight compared to both the CDC's[17] and the Greek's cut-off points[19]. On the other hand, the CDC's criteria categorized more children, especially boys, as being obese compared to the two other methods. However, the paradox was that when using the CDC's criteria more children, in both genders and in total, were identified as being obese than being overweight. Higher prevalence of both overweight and obesity identified with the CDC's criteria have been documented by other comparative studies performed on children of various nationalities[22-25], and in one recently published Greek study[26]. Thus, it has been suggested that CDC criteria favors compared to the IOTF ones in terms of an earlier identification of individuals with weight problems. This conclusion is not supported by the results of our study, as we shown that both CDC and IOTF cut-off points identify high total prevalence of overweight and obese children, thus they can both serve as valuable tools for early detection and preventive intervention for obesity, at an early stage.

In 2004, Lissau et al showed that Greece has one of the highest prevalence of BMI at or above the 85th and the 95th percentiles in adolescents, equivalent to that of the United States[27]. The results of our study are in line with this report as 22.4% and 6.5% of the total paediatric population were classified as overweight and obese, respectively, based on the IOTF criteria. Similarly, the most recently published report from 700 Greek children, aged 10-12 years and living in Athens, recorded a total of 8.6% and 9% of obese boys and girls respectively, whereas the percentages of overweight boys and girls were 33.9% and 22.1%, respectively[28]. Significantly lower percentages of overweight boys and girls (17.48% and 13.05%, respectively) and obese girls (3.73%) but not obese boys (10.4%) were reported in the large study from the Athenian area which was held in 2001 and supplied with data the latest national reference curves[19]. From that same year, a study in our area showed equivalent to our

Table 2: Percentages of overweight and obesity as defined by IOTF, CDC and Greek reference standards categorized in three age groups: 4-6 years, 6-12 years and 12-18 years ([a] statistically significant compared to the age group 4-6 years of the same sex and definition, [b] statistically significant compared to age group 6-12 years of the same sex and definition).

		Boys			**Girls**			**Total**		
		4-6	**6-12**	**12-18**	**4-6**	**6-12**	**12-18**	**4-6**	**6-12**	**12-18**
IOTF	**Overweight**	12.5	23.4[a]	30.7[a]	16.7	20.9	18.3	14.5	22.1	23.8
	Obese	10.7	8.7	3.1[a]	7.4	6.4	2.8	9.1	7.6	4.8
CDC	**Overweight**	10.7	13.6	15.3	9.3	10.5	9.2	10	12	11.9
	Obese	16.1	19.6	15.3	11.1	15.5	6.1[b]	13.6	17.5	10.2
Greek	**Overweight**	7.1	7.1	7.7	9.3	7	8.4	5.5	7	8.1
	Obese	8.9	6.8	7.7	3.7	6.4	6.1	9.1	6.6	6.8

percentages of overweight (22.4%) and obesity (4.1 %) among schoolchildren [29]. Thus, it seems that, at least in the area of Thessaloniki, the increased secular trend of body weight observed during the second half of the 20th century, as a result of the improvement of the socio-economic conditions, the changes in the dietary habits and the increase of the sedentary activities[30], tends to flatten over the past decade. This conclusion is also supported by other studies that have been recently published[9,26].

What is important is to emphasize that the use of Greek National references provides conservative estimates of both overweight and obesity among Greek children. This can be attributed to the "descriptive" basis of the Greek reference standards and to the increasing trends of obesity and overweight observed in the Greek paediatric population during the last decades. In this way, a recently updated reference database that includes descriptive samples of populations undergoing increasing trends of overweight and obesity, redefines these conditions as "normal" and resets the prevalence of overweight and obesity to 15% and 5%, respectively[31]. Recognizing the implication that this effect has on the accuracy of measuring overweight and obesity, UK decided to "freeze" the British 1990 BMI reference and to introduce future reference revisions only after wide ranging consultation[32]. Additionally, in the recently published WHO international growth reference for infants and young children until the age of 5 years[33], a "prescriptive" approach was adopted as it was designed to provide data describing how children should grow rather than imprinting their actual growth.

In conclusion, our study shows that the use of the national Greek reference standards for BMI underestimates the true prevalence of overweight and obese Greek children. On the contrary, both IOTF and CDC criteria, although independently, detect an increased number of children being overweight and obese, providing an earlier identification and timelier intervention on children with weight problems. These international cut-off limits should be adopted in clinical practice from Greek paediatricians until a more appropriate, "prescriptive" reference exists.

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