ORIGINAL ARTICLE

Obesity and Insulin Resistance Status: The Impact of Using Different International Growth Standards in Romanian Children

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Introduction: Worldwide, childhood obesity is on the rise. A lot of debate exists within the scientific community regarding the best way to define overweight and obesity in different populations. Currently, three sets of growth references are in use internationally: the 2007 World Health Organization (WHO) growth standards, the International Obesity Task Force (IOTF) reference, and the 2000 Center for Disease Control and Prevention (CDC) growth charts. We examined the impact of using these international growth references on diagnosing obesity in a group of overweight and obese Romanian children. Afterwards, we evaluated the relationship between diagnosed obesity and insulin resistance status.
Material and method: We studied retrospectively the observation charts of children who had their insulin levels tested in our hospital's laboratory between January 1st 2008 and December 31st 2009. The study population consisted of 76 children. We analyzed: age, gender, body mass index (BMI), the homeostatic model assessment: insulin resistance (HOMA-IR). We divided the children into two categories according to their HOMA-IR values. We used each of the standards and grouped the study population into two BMI groups: overweight and obese. We used One-Way ANOVA to evaluate the differences between the three definitions.
Results: We found significant differences between the WHO and the IOTF and CDC references. The WHO standards identified the least overweight children with insulin resistance.
Conclusions: Our study shows that using WHO growth standards may be the proper method to diagnose obese children. A large populational study is needed to establish the proper growth references for our population.

Keywords: WHO, IOTF, CDC growth standards, obesity, insulin resistance, children

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Introduction

The World Health Organization (WHO) reported in 2010 an astounding number of 42 million overweight children under the age of five worldwide [1]. At the moment, body mass index (BMI) for age, gender and race is considered the best anthropometric tool for assessing weight status in children [2]. Ideally, specific growth references for each population should exist, but in Romania they are missing. During the past years, efforts have been made to create internationally available growth standards [3,4]. Currently, three sets of growth references are in use internationally: (1) the 2007 WHO growth standards; (2) the International Obesity Task Force (IOTF) reference; (3) the 2000 Center for Disease Control and Prevention (CDC) growth charts [3–6]. A lot of debate exists within the scientific community regarding the best way to define overweight and obesity in each population [7–16]. We examined the impact of using these three international growth references on diagnosing obesity in a group of overweight and obese Romanian children. Furthermore, we evaluated the relationship between diagnosed obesity and insulin resistance status for each of the growth standards.

Material and method

We studied retrospectively the observation charts of children who had their insulin levels tested in our hospital's laboratory between January 1st, 2008 and December 31st, 2009. Further data was registered if the BMI was above the 25 cut-off point for age and gender, as defined by the IOTF. Exclusion criteria were the known presence of diabetes, diseases associated with insulin resistance, the use of medication that alters blood pressure, glucose or lipid metabolism and incomplete data. The study population consisted of 76 children.

Our analysis included the following variables: age, gender, weight, height, baseline glucose, baseline insulin. We calculated the BMI (weight in kilograms divided by the square height in meters) and the homeostatic model assessment: insulin resistance (HOMA-IR, fasting glucose in millimoles per liter multiplied by baseline insulin in microunits per milliliter, divided by 22.5).

We considered that HOMA-IR values above 2.5 defined insulin resistance. We divided the children into two categories according to their HOMA-IR values: children with insulin resistance (IR+) and children without insulin resistance (IR–).

Initially, we used the IOTF definition (gender-age-specific BMI cut-offs that correspond to BMIs of 25 for overweight and 30 for obesity at age 18) and grouped the study population into two BMI groups: overweight and obese. Afterwards, we did the same using the WHO growth standards (BMI 85th and 97th percentiles to classify overweight and obesity, respectively) and the CDC growth

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Table I. Descriptive characteristics of the study population[1]

Variable		Study Population (n=76)
Gender	no (%)	
Female		34 (44.7)
Male		42 (55.3)
Age (years)	mean±SD	11.8 (3.38)
Height (m)	mean±SD	1.52 (0.15)
Weight (kg)	mean±SD	70.53 (23.20)
BMI (kg/m^2)	mean±SD	29.68 (5.71)
Baseline glucose (mmol/l)	mean±SD	4.65 (0.50)
Baseline insulin (µui/l)	mean±SD	14.80 (11.69)
HOMA-IR	mean±SD	3.14 (2.75)
Insulin resistance	no (%)	
IR+		40 (52.6)
IR–		36 (47.4)

[1]SD denotes standard deviation, BMI body mass index, HOMA homeostatic model assessment: insulin resistance, IR+ denotes children with insulin resistance, IR– denotes children without insulin resistance. To convert the values for glucose to milligrams per deciliter, multiply by 18; to convert the values for insulin to picomoles per liter, multiply by 6.

charts (BMI 85th and 95th percentiles to classify overweight and obesity, respectively).

Plasma glucose levels were measured with COBAS INTEGRA-400 (Roche Diagnostics). Plasma insulin levels were measured with DPC-IMMULITE-ONE (Siemens Medical Solutions).

The data are expressed as means ± standard deviation or as frequencies. We used One-Way ANOVA (with a confidence interval of 95 percent) to evaluate the differences between the 3 growth standards when applied to our study population. We performed Post Hoc Multiple Comparisons for unequal variances (Tamhane's) to evaluate growth standards two by two. All analyses were performed with the use of SPSS Statistics software (version 17, IBM Company).

Results

Descriptive characteristics of the study population are shown in Table I. We found significant differences between the three international growth references when applied to our study population, as shown in Table II. We found significant differences between WHO and IOTF and between WHO and CDC growth standards. We did not found significant differences between IOTF and CDC standards (Table III). There was only one child with insulin resistance who was considered overweight by WHO standards. There were 39 (53.42%) children with insulin resistance that were considered obese by WHO standards (Table IV).

Table II. Overweight and obese groups according to IOTF, WHO and CDC growth standards[2]

BMI group		Growth standard			p value[3]
		IOTF	WHO	CDC	
Overweight	no (%)	15 (19.74)	3 (3.95)	12 (15.79)	
Obese	no (%)	61 (80.26)	73 (96.05)	64 (84.21)	
Total		76	76	76	

[2]IOTF denotes International Obesity Task Force, WHO World Health Organization, CDC Center for Diseases Control, BMI body mass index
[3]ANOVA p value when comparing the 3 international growth standards

Table III. Tamhane's Post Hoc Multiple Comparisons for One-Way ANOVA when comparing the IOTF, WHO and CDC growth standards[4]

Growth standard		p value[5]
IOTF	WHO	0.00
	CDC	0.89
WHO	IOTF	0.89
	CDC	0.04
CDC	IOTF	0.89
	WHO	0.04

[4]IOTF denotes International Obesity Task Force, WHO World Health Organization, CDC Center for Diseases Control
[5]p value when comparing growth standards 2 by 2

Discussions

Using WHO growth standards seems to be the best method to diagnose obese children in our study population.

The WHO references were significantly different from IOTF and CDC standards, while the last two were similar in classifying overweight and obese children. The WHO definition classified the most children as obese and the least as overweight, while IOTF standards may underestimate obesity. Our findings seem to follow the same global trend, although we had a small sample in comparison with international populational studies: IOTF definition underestimates obesity in Caucasians [7,11–13], Asians [7,14], Latin Americans [8,9]. For example, 57% of obese Asian girls would be classified as "non-obese" according to IOTF standards. In a sample of Swiss children, the IOTF criteria failed to identify 40–50% obese children. In Brazilian children obesity prevalence using WHO standards was 11% compared to the 5% prevalence when using the IOTF definition.

Although we found no significant differences in the way CDC and IOTF criteria classify overweight and obesity, the frequency of obese children classified with CDC standards was slightly higher that of IOTF defined obese children. Larger studies, also in different types of populations, found that CDC estimated obesity had a higher

Table IV. Insulin resistance categories across overweight and obese groups when using the IOTF, WHO and CDC growth standards[6]

BMI group	Insulin resistance category		Growth standard		
			IOTF	WHO	CDC
Overweight	IR+	no (%)	9 (60)	1 (33.33)	6 (50)
	IR–	no (%)	6 (40)	2 (66.67)	6 (50)
	Total		15	3	12
Obese	IR+	no (%)	31 (50.82)	39 (53.42)	34 (53.13)
	IR–	no (%)	30 (49.18)	34 (46.58)	30 (46.87)
	Total		61	73	64
Total			76	76	76

[6]IOTF denotes International Obesity Task Force, WHO World Health Organization, CDC Center for Diseases Control, BMI body mass index, IR+ denotes children with insulin resistance, IR– children without insulin resistance

prevalence when compared with IOTF [8, 10–15]. For example, in Canadian children obesity prevalence when using CDC standards was 28% versus 26% when using IOTF criteria.

To strengthen our findings, we verified the insulin resistance status when applying the three different growth references. The WHO standards identified the least overweight children with insulin resistance and also the most obese children with insulin resistance. When using the IOTF criteria, we identified the most overweight children with insulin resistance and the least obese children with insulin resistance. Several studies have shown that there is a good correlation between the BMI and IR [17–21], although additional anthropometric measurements, like waist circumference, have been proposed to better link body fat with metabolic anomalies [5,22].

In our practice, we face the lack of motivation from children and parents, when preventing and treating childhood obesity. Some may feel that a definition which overestimates obesity is harmful [23]. We strongly believe that it is better to promote a healthy lifestyle to a larger number of children, than to classify a population that clearly is at risk as normal weighted. This is why we feel that, in the absence of national growth references, WHO growth standards may prove useful in establishing weight status in our children.

Limitations of the present study are the small sample, the absence of normal and underweight children and the limited number of preschool children from our study population.

Conclusions

Our study shows that using WHO growth standards may be the proper method to diagnose obese children. A large populational study is needed to establish the proper growth references for our population.

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