Body Mass Index as a Marker of Dyslipidemia in Children

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Summary

Background: Obesity is very frequently associated with conditions such as dyslipidemia e diabetes.

Objective: To verify the diagnostic value of the cut-off points proposed by the International Obesity Task Force (IOTF) and Conde & Monteiro (C&M) for the screening and identification of dyslipidemia in children between 10 and 12 years of age.

Metods: The Body Mass Index (BMI) of 374 children of the school network of the city of Santa Maria-RS was ascertained. The children were selected in a stratified manner from a population of 4,083 children. Lipid levels (reference standard) were determined by means of analysis of total cholesterol (TC), LDL-C, HDL-C and triglycerides (TG). The cut-off points of the IOTF and C&M were used to classify the BMI. Descriptive statistics and analysis of sensitivity and specificity were employed.

Results: There was a statistical difference in excess weight prevalence between both proposals (24.7% and 28.6% for IOTF and C&M, respectively). A variation was observed in sensitivity (33% - 83%) and specificity (62% - 80%) between the cut-off points as to the detection of dyslipidemia. The percentage of false negatives was lower than the percentage of false positives.

Conclusion: The proposals may be used to screen elevated TC and LDL-C in male individuals. Either the IOTF or the C&M classification may be used to identify subjects without dyslipidemia, as these proposals presented high specificity. (Arq Bras Cardiol 2009;93(1):20-24)

Key words: Body mass index; students; sensitivity and specificity, dyslipidemia.

Introduction

Obesity has great impact on cardiovascular diseases because it is very frequently associated with conditions such as dyslipidemia, arterial hypertension, insulin resistance and diabetes[1,2]. Excess weight in children has been rising to epidemic levels and seems to be the phenomenon that presents the greatest influence on negative changes in the lipid profile (elevated levels of total cholesterol – TC, triglycerides – TG, low density cholesterol – LDL-C and low levels of high density cholesterol – HDL-C) in children and adolescents[3,4].

Epidemiologic studies have traditionally assessed excess weight[5] by means of the body mass index (BMI)[6,7]. BMI curves for children and adolescents have been proposed by the International Obesity Task Force (IOTF), and were modeled based on a population aggregate from different countries, including Brazil[8]. Based on these curves, the identification of children and adolescents at risk for overweight and obesity would have as cut-off points BMIs of 25 and 30 kg/m² respectively, both adapted for each age group and gender.

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Conde & Monteiro[9] (C&M) have recently established BMI values for Brazilian children e adolescents. The data was extracted from the National Survey on Nutrition and Health of 1989 which was designed to verify the population's health and nutritional conditions. Just like IOTF, C&M used the critical values of 25 and 30 kg/m² for overweight and obesity respectively in adulthood.

The concern about establishing the sensitivity and specificity of BMI relative to dyslipidemia is justified because in theory BMI cut-off points should identify the moment when the risk to health increases as obesity begins[8]. Knowledge of these reference values is particularly useful to detect the risk of developing diseases, both relative to nutritional surveillance and population-based studies of diagnosis[10], with the advantage that it does not require invasive measures.

Therefore this study was designed to verify if the cut-off points proposed by IOTF and C&M can be used to screen and identify dyslipidemia in children aged between 10 and 12 years.

Methods

We assessed 374 subjects who were randomly selected, and stratified by age, gender (208 girls and 166 boys) and school network (public or private) of the municipality of Santa Maria – RS, born in 1994 (11.25±0.28 years). Sample

collections were carried out between August and December 2005.

The study was approved by the Research Ethics Committee of the Federal University of Santa Maria (UFSM) (CAAE 0018.0.243.000-05). The free and informed consent term (TCLE) was signed by the children's parents or guardian.

The blood collection was carried out using a technique of the Clinical Analysis Laboratory of UFSM between 7:30 and 10 a.m. Four milliliters of blood were collected by venous puncture with vacuum tubes after 12 hours fast and placed in dry tubes for biochemical tests. The tests were conducted using the enzymatic colorimetric dosing method (TC, HDL-C and TG), using Hitachi's 917 Automatic Analyzer (Boehringer Mannhein). LDL-C was calculated using the following formula: $[(TCl - HDL-C)-(TG/5)]$.

Body mass (BM) and height (H) measurements were taken by one single evaluator[k]. A scale, of the Plena brand, with a resolution of 100 g and a metal stadiometer, of the Cardiomed brand, with a resolution of 1 cm were used.

Based on BM and H scores, the BMI was calculated as follows: BMI (kg/m^{-2}) = BM (kg) / H^2 (m).

To analyze sensitivity and specificity the IOTF and C&M cut-off points were adopted (tab.1). These values correspond to the BMI reference values of 25 and 30 kg/m^2, adapted for age and gender, to identify overweight and obesity, respectively[8,9]. Blood analyses of TC, HDL-C, LDL-C and TG[l] were considered as the reference standards for the detection of dyslipidemia.

Because the IOTF and C&M use different nomenclatures for overweight, the term excess weight will be used in this study to refer to "overweight+obesity".

In order to categorize IOTF's proposal, children from 10 to 10.25 years were considered as being 10 years old; 10.26 to 10.75 years as 10.5 years old; 10.76 to 11.25 years as 11 years old; 11.26 to 11.75 years as 11.5 years old and 11.76 to 12 years as 12 years old. As for C&M, in which classification is done in months, we adopted the same criterion: 10 to 10.25 years as 120.5 months; 10.26 to 10.75 years as 126.5 months; 10.76 to 11.25 years as 132.5 months; 11.26 to 11.75 years as 138.5 months and 11.76 to 12 years as 144.5 months.

In order to classify lipid levels, the reference values suggested by the 3rd Brazilian Guidelines on Dyslipidemia[12] for children and adolescents (2 to 19 years of age) were considered. The desirable values are: TC <170 mg/dl, HDL -C >35 mg/dl, LDL -C <110 mg/dl and TG <130 mg/dl; borderline values (classified as normal in this study) for TC between 170 and 199 mg/dl; LDL-C between 110 and 129 mg/dl; elevated values for TC > 200 mg/dl; LDL-C > 130 mg/l; and TG > 130 mg/dl.

To analyze the sensitivity and specificity of indicators of excess fat (BMI) relative to altered lipid levels, cases of false positive, false negative, true negative and true positive have been considered (fig.1).

The data were submitted to the Kolgomorov-Smirnov test to test normality. Descriptive statistics (mean, standard deviation, minimum and maximum values) and data frequency were used. Possible differences between the genders were assessed using the "t" test for independent samples in view of the normality of data. The chi-square test was used to verify possible differences between the prevalences of excess weight. BMI cut-off points in the screening for lipid alterations were proposed using the ROC (*Receiver Operating Characteristic*) curve analysis. A confidence interval of 95% was considered. The analyses were conducted in the SPSS Version 10.0 statistics package.

Results

The study assessed 374 children, of which 208 were girls (56%) and 166 were boys (44%). Table 2 provides the descriptive characteristics of the sample including mean, standard deviation, minimum and maximum values of the variables analyzed and the prevalence of lipid alterations.

Upon analyzing the prevalences of overweight and obesity relative to these authors, we verified that, according to IOTF, 14.7% and 5.1% of the subjects assessed were overweight or obese, respectively. These percentages differed statistically (p<0.05) from C&M's proposal, in which 21.4% of the subjects presented overweight and 7.2% presented obesity. A greater occurrence of excess weight was found when the C&M cut-off points (28.6%) were compared with the IOTF (19.8%) cut-off points. No case of low weight was observed in either one of the classifications.

BMI sensitivity and specificity were tested relative to scores of lipid levels as presented in table 3. A wide range of variation was observed for sensitivity (27% to 93%) and specificity (62% to 80%) percentages.

Table 1 - *Cut-off points* (kg/m²) suggested by IOTF[10] and C&M[11] according to age group and gender

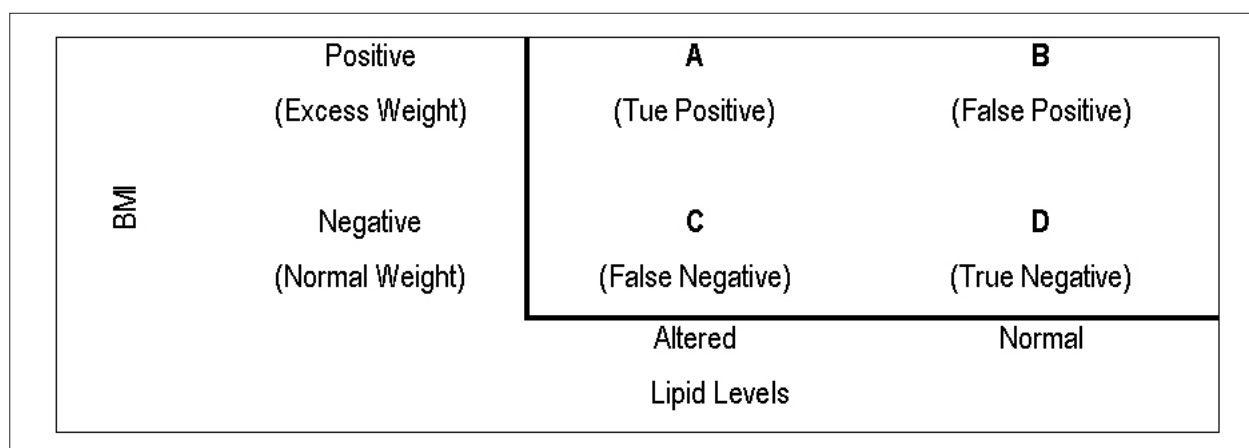|	Overweight males		Overweight females		Obesity males		Obesity females	
	IOTF	C&M	IOTF	C&M	IOTF	C&M	IOTF	C&M
10 years	19.84	19.09	19.86	18.63	24.0	24.67	24.11	22.32
10.5 years	20.20	19.38	20.29	19.04	24.57	25.14	24.77	22.91
11 years	20.55	19.68	20.74	19.51	25.10	25.58	25.42	23.54
11.5 years	20.89	20.00	21.20	20.01	25.58	25.99	26.05	24.21
12 years	21.22	20.32	21.68	20.55	26.02	26.36	26.67	24.89

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Figure 1 - *Model for sensitivity and specificity analyses of BMI anthropometric indicators relative to lipid levels, where: sensitivity (%)= A/(A+C)x100 and specificity (%)=D(/B+D)x100*[13].

Table 2 – **Descriptive data of the lipid profile of children in Santa Maria, RS, 2005**

Variable	Gender	Mean ± sd	Minimum	Maximum	%
Age (years)	F	11.24±0.27	10.25	11.83	-
	M	11.26±0.30	10.5	11.83	-
BMI (kg/m²)	F	18.54±3.08	13.77	32.08	-
	M	19.01±3.58	13.68	33.99	-
TC (mg/dl)	F	154.43±26.13	89.00	223.00	5.8
	M	151.70±24.85	95.00	219.00	3.6
HDL-C (mg/dl)	F	49.25±10.87	27.00	102.00	6.8
	M	50.18±10.01	20.00	79.00	4.2
LDL-C (mg/dl)	F	88.01±22.83	37.80	155.60	5.3
	M	87.31±21.06	39.8	151.2	3.6
TG (mg/dl)	F	85.93±43.26*	30.00	352.00	10.1
	M	71.05±33.43*	27.00	243.00	7.2

Where: *Significant statistical difference (p<0.05), "t" test for independent samples; sd - standard deviation; % - prevalence of alterations.

According to the ROC curve, the ideal cut-off points (best association between sensitivity and specificity) to identify lipid alterations for females and males respectively in the age group at hand are: TC (16.7 and 19.3 kg/m²); HDL-C (19.9 and 14.0 kg/m²); LDL-C (18.7 and 19.3 kg/m²); and TG (19.3 and 19.3 kg/m²). For females, the cut-off points suggested for LDL-C and TC are substantially lower than those proposed for HDL-C and TG, as well as than the normal values of IOTF and C&M. In males, there was greater variability, especially for HDL-C which is lower than other serum indicators.

Discussion

The consequences of elevated cholesterol in addition to other risk factors constitute a public health problem worldwide. From a clinical point of view, early surveillance and detection of risk factors associated with dyslipidemia are key factors for preventive actions especially those relative to excess weight in children. Excess weight in children can be controlled by helping children achieve and maintain adequate weight for height, gender and age through primary care actions[6].

This study used the IOTF and C&M proposals to assess the nutritional condition of children. Among the classifications there was a statistically significant difference (p<0.05) between the prevalences of overweight and obesity . According to IOTF, 14.7% and 5.1% of the subjects were classified as overweight and obese respectively; according to C&M these prevalences increase to 21.4% and 7.2%.

The prevalence of excess weight found in this study (19.8% and 28.6% according to IOTF and C&M respectively) endorses studies involving children and adolescents that were conducted in São Paulo[n] (29.55% - 11 to 17 years) and in Pelotas[o] – RS (26.3% – 10 to 19 years). These prevalences are greater than those found in Rio de Janeiro[p] (4 to 18

Table 3 – **Sensitivity, specificity, false positive (FP) and false negative (FN) of BMI values proposed by IOTF e C&M concerning lipid levels of children aged between 10 and 12 years**

		Sensitivity %)		Specificity (%)		False negative (%)		False Positive (%)	
		IOTF	C&M	IOTF	C&M	IOTF	C&M	IOTF	C&M
TC	F	33	42	77	73	3.85	0.36	21.15	25.48
	M	67	83	63	72	1.2	0.60	35.54	26.51
HDL-C	F	43	57	78	74	3.85	2.88	20.19	24.04
	M	50	50	62	71	1.81	1.81	36.14	27.71
LDL-C	F	27	36	77	73	2.85	3.36	21.63	25.96
	M	83	93	64	72	0.60	0.60	34.94	26.51
TG	F	43	62	80	76	5.77	3.85	18.75	21.63
	M	56	56	63	72	2.41	2.41	34.94	26.51

years) and Brasília[7] (6 to 10 years) (11.72% and 11.05% respectively). However, the studies conducted in São Paulo and Rio de Janeiro used different protocols as compared with those used in this study; Pelotas and Brasília used the IOTF classification.

Varied sensitivity (33% to 83%) and specificity (62% to 80%) was observed in both proposals analyzed (tab.3). The C&M classification presented sensitivity values above those of IOTF's for both genders, demonstrating that the C&M proposal presents greater discrimination power to identify ill subjects (with dyslipidemia).

As for specificity, the IOTF classification presented greater diagnostic value for females while C&M worked better for males as to the detection of non-ill subjects.

FN values were low for IOTF and C&M, thus allowing for the verification that there is incidence of dyslipidemic subjects (ill) who are considered eutrophic. There was a high number of FP, thus suggesting a trend towards the occurrence of dyslipidemia in non-ill subjects. The possibility of classifying subjects as ill when they are actually not so (FP) is a limitation of both the IOTF and C&M proposals. However, this wouldn't present a great problem, since healthy children could participate, together with ill ones in preventive educational programs.

This study verified the diagnostic value of the cut-off points proposed by IOTF and C&M as to the identification of dyslipidemia in children aged between 10 and 12 years. Early diagnosis is important since cardiovascular risk factors are characteristics that tend to persist until adulthood[17]. Screening tests should be of low cost, easy to apply, non-invasive and with high sensitivity (to minimize the number of false negatives). Diagnostic tests, however, should present higher specificity[18].

In this study, according to the IOTF classification, when used as a screening method for TC and LDL-C in males, only one child out of 100 was wrongly classified (FN). As a dyslipidemia diagnostic method in females, it classified 20 children as ill when they are actually not ill (FP). C&M, in turn, classified just two individuals wrongly relative to TC

and LDL-C for males and four female children relative to altered TG (screening power - FN).

In view of the above, and following recommendations proposed by Tomkins[19], the values recommended by C&M are recommended to implement planning and monitoring nationwide since the cut-off points are based on a Brazilian set of data and proved to be more sensitive and specific than the IOTF proposal as regards the detection of dyslipidemia.

There are still gaps in the literature relative to studies involving obesity, cardiovascular diseases and dyslipidemia in younger populations, especially as concerns screening and diagnostic methods. This study is a preliminary one as concerns the use of BMI as a dyslipidemia marker in children; however, the number of studies focusing on this will certainly increase because metabolic alterations and the consequences of obesity, which used to be evident only in adults, are increasingly seen in childhood and adolescence[20]. The detection of dyslipidemia in this age group is essential since the cholesterol level in children is a predictor of the cholesterol level in adults[21].

This study also verified that both proposals can be used to screen elevated TC and LDL-C in males, since these proposals presented high sensitivity (67% to 97%) and low percentage of FN (0.6% to 1.2%), thus indicating that only one out of 100 children may be classified as non-ill when they are actually dyslipidemic. As concerns females, only C&M proved to have a good screening power, and this only for elevated TG.

In the diagnosis of subjects without dyslipidemia, both the IOTF and the C&M classification can be used since both present high specificity.

Acknowlegements

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