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Comparison of the anthropometric and biochemical variables between children and their parents

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SUMMARY. The objective of this study was to compare the anthropometry, body composition and biochemical profile between eutrophic and obese children, as well as to relate the children's nutritional state and body composition to those of their respective parents. A control-case study was carried out with 50 eutrophic and 50 obese children paired according to gender, age, socioeconomic condition, and selected from the nutritional evaluation of 2 074 children aged 6 to 8 years, attending public and private urban schools in Viçosa, Minas Gerais, Brazil. The measurements evaluated were weight, height, circumferences (waist and hip) and thickness skinfolds (triceps and subscapular). The serum levels of glucose, total-cholesterol, HDL, LDL, triglycerides and hemoglobin in the children were evaluated. The obese children presented a larger body size and higher percentage for total body fat as well as its accumulation in the central region, and higher serum levels for triglycerides ($p < 0.05$). For all biochemical parameters, except for hemoglobin and HDL, there occurred a positive correlation with the located fat in the central region as well as with the total body fat in children ($p < 0.05$). The obese mothers showing high percentage of body fat and its accumulation in the central region rather tend to have children with these characteristics ($p < 0,05$). The highest number of the close relatives who are obese and present dyslipidemia is highlighted in the obese children ($p < 0.05$). This study evidences the differences concerning to the distribution of the body fat and lipid profile among eutrophic and obese children, as well as the strong influence of the maternal obesity upon child's obesity.
Key words: Nutritional status, body composition, child, parents, hyperlipidemias, obesity.

RESUMEN. Comparación de las variables antropométricas y bioquímicas entre niños y sus padres. El objetivo de este estudio fue comparar la antropometría, composición corporal y el perfil bioquímico entre niños eutróficos y obesos y, además relacionar el estado nutricional y la composición corporal de los niños con los de sus respectivos padres. Se realizó un estudio caso control con 50 niños eutróficos y 50 obesos, pareadas de acuerdo con el sexo, de la edad y condiciones socioeconómicas, y seleccionados a partir de una evaluación nutricional de 2074 niños entre los 6 a 8 años, matriculados en escuelas urbanas públicas y privadas de la ciudad de Viçosa, Minas Gerais, Brasil. Las medidas evaluadas fueron el peso, estatura, circunferencias (cintura y cadera) y pliegues cutáneos (tricipital y subescapular). Los niveles de glucosa, colesterol total, HDL, LDL, triglicéridos y hemoglobina también fueron evaluados. Los niños obesos presentaron mayor tamaño corporal (IMC) y porcentaje de grasa total, así como predominio de grasa en la región central, y valores superiores de triglicéridos ($p < 0.05$). Para todos los parámetros bioquímicos, excepto la hemoglobina y el HDL, hubo correlación positiva con la grasa localizada en la región central y grasa corporal total en los niños (< 0.05). Las madres obesas que presentaron elevado porcentaje de grasa corporal y acúmulo de grasa en la región central tienden a tener hijos con estas mismas características ($p < 0.05$). Un mayor número de familiares obesos y con dislipidemias fue observado en los niños obesos ($p < 0.05$). Este estudio evidencia diferencias en cuanto a la distribución de la grasa corporal y perfil lipídico entre niños eutróficos y obesos, así como la fuerte influencia de la obesidad materna sobre la obesidad en los niños.
Palabras clave: Estado nutricional, composición corporal, niños, padres, hiperlipidemias, obesidad.

INTRODUCTION

Obesity is considered as an emerging problem of public health in Brazil and worldwide. It is one of the main nutritional problem occurring in children, since it can lead to serious negative consequences for the physical and mental health. In addition, it is considered as predictor for obesity in the adult life, besides causing a risk situation which can lead to increased mortality as a cause associated to the atherosclerotic disease, hypertension, and metabolic alterations. The association between obesity and dyslipidemia observed in adults has been also documented in children and teenagers (1). According to Freedman et al. (2), when the overweight school children were compared with their respective thinner pairs, they presented 2.4 to 7.1 times higher probability to have an elevated total cholesterol, LDL-cholesterol, triglycerides and blood pressure as well as 12.6 times higher probability to have hyperinsulinemia. It is worth to emphasize that the visceral fatty tissue is exclusively related to risk factors, such as the altered insulin and lipid profile in children, which can contribute to the development of the insulin resistance syndrome at precocious ages, which comprises several risk factors for the emergence of cardiovascular diseases in the adult life (3).

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The childhood obesity is considerably present in the industrialized countries, whereas the parents' obesity is one of the stronger risk factors. This fact is explained by the genetic factor, as well as by the environmental family influences (4). Scaglioni et al. (5) verified that the parents' overweight was the highest risk factor for childhood obesity, as being the overweight prevalence in 5 years-old children significantly higher in those with overweight parents than in the ones whose parents did not present overweight (37.3% vs 8.3% respectively, $p < 0.001$). Reis et al. (6) observed that child-parent association was strong for obesity and abdominal adiposity. Parents of obese children were at 6 times higher odds of being obese than parents of non obese children. Similarly, parents of children who had abnormally large waist circumferences were themselves at 6 times higher odds of having abdominal adiposity. According to the authors, because children access primary care is more frequently than adults, children can potentially serve as the index case to identify families at increased risk of obesity.

In this context, this study was carried out to compare the anthropometry, body composition and biochemical profile among eutrophic and obese children, as well as to relate the children's nutritional state and body composition to those of their respective parents.

METHODS

According to the General Education Office in Minas Gerais State (MG), Viçosa county, Brazil, totalizes 26 urban schools (19 public and 7 private) attending children at the age range from 6 to 8 years . All school children aged 6 to 8 years (n = 2 074) who were enrolled in the respective schools which spontaneously accepted to participate in the study, were weighed and measured. Only one public school had no participation in this study because it was not authorized by the school direction. The body mass index (BMI) was calculated from the weight and height measures conducted in appropriate places at the respective schools. From the percentiles corresponding to this index and according to the age and gender, the children's nutritional state were defined according to the anthropometrical reference provided by the Center for Disease Control and Prevention (7). The cutting points used for the classification of obesity (≥ percentile 95) was based on the classification proposed by Must et al. (8). However, only the obese children showing BMI/age equal or superior to the percentile 96 were included in the sample, because the increased specificity of cutting point reduces the possibility to obtaining false-positive children in the sample.

This is a case-control study, in which the obese children were selected from the anthropometrical evaluation conducted in schools. These children were paired with the eutrophic at the proportion 1:1, according to gender, age and classroom, as well as school and socioeconomic condition. Only the obese children showing BMI/age equal or superior to the percentile 96 were included in the sample. The criterion for selecting the eutrophic ones ($5 \le$ BMI /age < 85) was based on the random choice of children with the same gender, age and classroom of the obese ones. From the total children (2,074) under evaluation, 58 (2.8%) were classified as obese (≥ percentile 96). Eight obese children were lost (6.9%), consequently, their eutrophic pairs (n = 8) were not evaluated. The lost of 8 obesity children occurred because the mothers informed that the children were already receiving nutritional assistance for another professional and there would not be need of the participation in the study (2); the mothers informed unavailability of time to participate in the study (4) and alteration of the children's nutritional status of obesity for overweight between the moment of the selection of the sample and the beginning of the collection of data (n=2). Thus, the sample consisted of 50 obese and 50 eutrophic children.

From the selection of the obese and eutrophic children groups by the BMI/age, their parents were invited by telephone to participate in the study and scheduled a personal encounter for evaluation. In this encounter, the consent term was presented and explained, and a written authorization for children's participation was solicited to their parents. Those parents and children who spontaneously accepted to participate in this study attended for the data collection in the Nutritional Evaluation Laboratory pertaining to the Nutrition and Health Department, Federal University of Viçosa.

For ethical reasons, in spite of the fact that the study was intended for obese and eutrophic children, mothers whose children presented low weight and overweight were informed about their children's nutritional status and directed to the public health service where they received nutritional assistance. Besides, after collecting all necessary information for the accomplishment of the study by research participants, all children and their parents were given specific nutritional orientation aiming at the improvement of both feeding habit and lifestyle, according to their nutritional state and body composition previously diagnosed.

The whole anthropometric evaluation was only conducted by one of the authors of this study, to avoid possible biases in checking the measures. In the evaluation of the nutritional status of the children and their parents, the weight was obtained with a portable, digital and electronic scale with 150 kg capacity and 50g division. The height was verified with 2m-extension stadiometer divided into centimeters and subdivided into millimeters. The techniques proposed by Jelliffe (9) were used in checking both measures.

For estimating the adiposity in the central region, the waist circumference of the children and that of their parents were evaluated, by checking with non-elastic measuring tape that was applied horizontally midway between the lowest rib margin and the iliac crest. The children's hip circumference was measured at the point yielding the maximum circumference over the buttock. The waist/hip relationship was obtained by division between the waist circumference and hip circumference values.

Both triceps and subscapular skinfold thicknesses were verified on the right side of the children's body by using the equipment Lange Skinfold Caliper. Each measurement was verified three non-consecutive times, and the results were calculated by the mean of those two closer values. The children's percentage body fat was estimated by equations derived from a multicomponent model proposed by Slaughter et al. (10). This equation was based on the values of the triceps and subscapular skinfold thicknesses adjusted to gender, maturation level, and ethnicity. Since all children were at age range from 6 to 8 years, the maturation level considered for classification of the percentage body fat was the pre-pubescent one. Concerning to ethnicity, the percentage body fat for those light-brunet and dark-brunet children was estimated by equations preconized for white and black races, respectively, being that predictive equations specifically for white and black people. When the body fat values were above 20% for boys and 25% for girls, the excessive adiposity was diagnosed (11). The subscapular / triceps skinfold relationship was obtained by division between the subescapular thickness skinfold and triceps thickness skinfold.

After fasting for 12 hours, the blood samples of the children were taken in only one laboratory pertaining to Viçosa county. Disposable materials were used to evaluate the concentration of both glucose and serum lipoproteins, such as total cholesterol, triglycerides, HDL-cholesterol (High Density Lipoproteins) and LDL-cholesterol (Low Density Lipoproteins). For hemoglobin analysis, the blood was collected by digital puncture, and dosage was performed by the colorimeter method through a portable hemoglobinometer. Those children showing a hemoglobin below 12 g/dL were considered as anemic ones (12). The reference values for the lipid and glucose profiles were based on recommendation of the American Academy of Pediatrics (13) and American Diabetes Association (14), respectively.

By BMI calculation, the parents' nutritional status was classified according to the WHO (15): low weight (BMI < 18.5), euthrophy ($18.5 \leq$ BMI < 25.0), overweight ($25.0 \leq$ BMI <30.0) and obesity (BMI ≥ 30.0). The waist circumference values obtained for parents were compared to the cut off points established by WHO (15) as risk of metabolic complications associated to obesity: women ($\geq$ 80 cm) and men ($\geq$ 94 cm).

When evaluating the parents' body composition, the bipedal electric bioimpedance was used to estimate the percentage total body fat, according to the classification proposed by Lohmann (16). Evaluation of the parents' body composition was performed from 6:30 to 8:00h in the morning, and those parents were fasting. The non-ingestion of alcoholic beverages for at least 48 hours before testing was also requested (17).

Mothers or the child's responsible were interrogated about the presence of chronic-degenerative diseases in the child's close relatives [mother, father, grandmothers and grandfathers, uncles and aunts (both maternal and paternal)], such as obesity, dyslipidemia, diabetes, hypertension, cancer and cardiovascular diseases (18-20).

The database and statistical analyses were accomplished, by using the softwares Epi Info version 6.04 and Sigma-Stat. The Kolmogorov-Smirnov normality test was used to verify the normal distribution of the variables. The association of the variables with children's obesity was analyzed by the qui-square test among paired samples. In addition, odds ratio and confident interval of 95% were calculated for each factor presenting statistical differences. According to the distribution of the variables in the normal curve, the paired t-test and the Wilcoxon test were used to compare the averages or medians among the paired groups, respectively, as well as the Pearson and Spearman correlation tests. The probability below 5% was considered as statistical significance level.

This study was approved by the Ethics Committee of Federal University of Viçosa.

RESULTS

Table 1 shows the anthropometry and body composition in eutrophic and obese children. Superior values was observed for weight, height, BMI, waist and hip circumferences, triceps and subscapular skinfold thicknesses as well as the skinfold sum in the obese group ($p<0.001$). Aiming at the evaluation of the body fat distribution, either the waist/hip relationship and the subscapular/triceps skinfold thicknesses (SS/TS) relationship were analyzed, where statistically significant differences were found for this last index, and the obese children's group showed the highest values ($p<0.001$). When evaluating the body composition, it was verified that the obese children showed higher values for percentage body fat ($p<0.001$). It is important to emphasize that 98% obese children showed a higher percentage for total body fat for age and sex, whereas the value was 2% in the eutrophic group.

Except for hemoglobin and HDL-cholesterol, all biochemical parameters showed a positive and statistically significant correlation with either the fat located at the central region and total body fat, that were represented by the values of the subscapular skinfold thickness, skinfold sum and percentage body fat. Only this last one showed no correlation with the LDL-cholesterol levels, in spite of the proximity to the statistical significance found ($p = 0.056$) (Table 2). It is important to emphasize that only glucose and triglyceride levels showed significant positive correlation with the waist circumference (Table 2).

TABLE 1
Antropometry and body composition according children's nutritional state

Characteristics	n	Children Obese (n=50) X̄+ SD	Me	Control (n=50) X̄+ SD	Me	p
Weight (kg)	100	40.6 + 6.2	39.6	25.7 + 3.7	25.6	< 0.001*
Height (cm)	100	132.0 + 7.3	31.9	127.4 + 6.0	127.5	< 0.001*
BMI (kg/m²)	100	23.2 + 2.3	22.6	15.8 + 1.2	15.9	< 0.001‡
Waist circunference (cm)	100	70.5 + 5.6	70.8	55.1 + 3.5	54.8	< 0.001*
Hip circunference (cm)	100	81.2 + 5.5	81.2	64.6 + 4.7	64.7	< 0.001*
Waist/hip relationship	100	0.87 + 0.05	0.9	0.85 + 0.05	0.8	0.104‡
Triceps skinfold (mm)	100	20.1 + 3.2	20.0	9.7 + 2.8	9.2	< 0.001*
Subscapular skinfold (mm)	100	18.5 + 5.8	18.5	6.5 + 1.8	6.0	< 0.001*
Skinfold Sum	100	38.6 + 8.1	38.5	16.2 + 4.2	15.0	< 0.001*
TS/SS relationship	100	0.9 + 0.2	0.9	0.7 + 0.1	0.7	< 0.001‡
Percentage body fat	100	31.5 + 5.0	31.0	15.4 + 3.8	14.6	< 0.001‡

Average + Standard Deviation (X̄ + SD) Median (Me)
BMI = Body Mass Index; TS = Triceps Skinfold; SS = Subscapular Skinfold
The p values is taken from the corresponding paired t-test* (variables with normal distribution) or Wilcoxon test‡ (variables without normal distribution); and the significant p-values ($p < 0.05$) are given in bold type.

Higher glucose and triglyceride levels were found in the obese group, and the difference was statistically significant ($p = 0.019$; $p = 0.004$; respectively) (Table 3). For other biochemical parameters such as hemoglobin, total-cholesterol, HDL and LDL, no statistically significant differences were found between those two groups ($p = 0.88$; $p = 0.10$; $p = 0.07$; $p = 0.10$, respectively) (Table 3).

Table 4 shows the significantly higher values for BMI, percentage body fat, and waist circumference in the obese children's mothers, with respect to those of the eutrophic ones ($p = 0.006$; $p = 0.015$; $p = 0.017$, respectively). Regarding the variables of the father, no statistically significant differences were found between both groups ($p = 0.64$; $p = 0.52$; $p = 0.23$, respectively).

TABLE 2
Correlations between children's anthropometry and body composition with biochemical parameters

Variables	Hemoglobin (n = 100) r	p	Glucose (n=100) r	p	Triglyceride (n=100) r	p	Cholesterol-total (n=100) r	p	HDL–cholesterol (n=100) r	p	LDL–cholesterol (n=100) r	p
WC	- 0.050	0.619*	0.315	0.001‡	0.241	0.015‡	0.122	0.227*	- 0.145	0.150 ‡	0.116	0.250*
HC	- 0.028	0.782*	0.290	0.003‡	0.189	0.059‡	0.127	0.208*	- 0.128	0.205 ‡	0.134	0.184*
WC/HC	- 0.059	0.557*	0.098	0.332‡	0.195	0.051‡	0.001	0.990*	- 0.085	0.397 ‡	- 0.034	0.735*
TS	0.041	0.684*	0.246	0.013‡	0.276	0.005‡	0.185	0.065*	- 0.125	0.217 ‡	0.179	0.075*
SS	- 0.047	0.639*	0.285	0.004‡	0.282	0.004‡	0.232	0.020*	- 0.101	0.316 ‡	0.208	0.037*
Skinf Sum	- 0.007	0.944*	0.288	0.003‡	0.297	0.002‡	0.218	0.029*	- 0.116	0.252 ‡	0.202	0.044*
SS/TS	- 0.113	0.264*	0.170	0.090‡	0.192	0.055‡	0.169	0.093*	- 0.043	0.671 ‡	0.134	0.183*
%BF	0.017	0.863*	0.298	0.002‡	0.281	0.004‡	0.212	0.034*	- 0.095	0.343 ‡	0.191	0.056*

Biochemical parameters

WC (waist circumference), HC (hip circumference), WC/HC (waist circumference/ hip circumference index), TS (triceps skinfold), SS (subscapular skinfold), Skinf Sum (skinfold sum), SS/TS (subscapular skinfold / triceps skinfold index), %BF (body fat)
The p values is taken from the corresponding Pearson correlation* (at least one or two variables with normal distribution) or Spearman correlation‡ (two variables without normal distribution); and the significant p-values ($p < 0.05$) are given in bold type.

TABLE 3
Children's bioquemical profile according nutritional status

Characteristics	n	Children Obese (n=50) X̄+ SD	Me	Control (n=50) X̄+ SD	Me	p
Hemoglobin (g/dL)	100	13.1 + 1.1	12.9	13.2 + 1.3	13.0	0.881*
Glucose (mg/dL)	100	83.4 + 7.8	81.4	79.8 + 8.3	78.4	0,019‡
Total-cholesterol (mg/dL)	100	160.2 + 27.9	158.5	152.4 + 20.5	154.9	0.105*
HDL-cholesterol (mg/dL)	100	39.5 + 8.1	39.0	42.3 + 9.4	42.1	0.078*
LDL-cholesterol (mg/dL)	100	103.3 + 22.2	102.8	97.2 + 16.1	99.0	0.103*
Triglyceride (mg/dL)	100	86.8 + 43.7	77.5	63.7 + 23.7	60.0	0.004‡

Average + Standard Deviation (X̄+ SD)
Median (Me)
The p values is taken from the corresponding paired t-test* (variables with normal distribution) or Wilcoxon test‡ (variables without normal distribution); and the significant p-values ($p < 0.05$) are given in bold type.

Besides, a positive and statistically significant correlation was found between all anthropometric and body composition measures of the child, except for the waist/hip relationship, with those of their mothers', that is, the overweight mothers with excessive body fat and accumulation of body fat in the central region have children with these characteristics. Such a fact is confirmed by positive and significant correlations, as follows: between the BMI, waist and hip circumferences, triceps and subscapular skinfold thicknesses, sum and skinfold relationship, and percentage body fat of the children with the BMI, percentage body fat and waist circumference of their mothers. However, no correlation was found for fathers (Table 5).

TABLE 4
Average or median distribution of maternal and paternal BMI, percentage body fat and waist circumference according children's nutritional status

Characteristics	n	Children Obese (n=49) X̄+ SD	Me	Control (n=48) X̄+ SD	Me	p
Mother						
BMI	97	28.8 + 5.8	28.0	25.7 + 4.8	24.7	0.006‡
Percentage body fat	97	40.0 + 6.1	40.0	36.8 + 6.4	35.7	0.015‡
Waist circumference	97	83.2 + 10.1	83.0	78.3 + 9.9	78.7	0.017*
		Obese (n= 40)		Control (n=44)		
Father		+ SD	Me	+ SD	Me	
BMI	84	26.8 + 4.9	26.1	26.1 + 3.9	25.7	0.641‡
Percentage body fat	84	24.5 + 8.5	23.7	23.2 + 7.7	22.5	0.521‡
Waist circunference	84	89.8 + 13.1	87.3	86.9 + 9.4	86.0	0.230*

Average + Standard Deviation (X̄+ SD)
Median (Me)
BMI = Body Mass Index
The p values is taken from the corresponding paired t-test* (variables with normal distribution) or Wilcoxon test‡ (variables without normal distribution); and the significant p-values ($p < 0.05$) are given in bold type.

TABLE 5
Correlations between children's anthropometric measures and percentage body fat with those their parents

Children	Maternal variables (n=97)	r	p	Paternal variables (n=84)	r	p
Body mass index	BMI	0.386	< 0.001‡	BMI	0.060	0.586‡
	% BF	0.358	< 0.001‡	% BF	0.060	0.581‡
	WC	0.320	0.001‡	WC	0.077	0.488*
Waist circunference	BMI	0.365	< 0.001‡	BMI	0.036	0.738‡
	% BF	0.356	< 0.001‡	% BF	0.036	0.742‡
	WC	0.325	0.001*	WC	0.079	0.478*
Hip circunference	BMI	0.327	0.001‡	BMI	0.055	0.619‡
	% BF	0.330	0.001‡	% BF	0.048	0.663‡
	WC	0.292	0.003*	WC	0.087	0.431*
Waist/hip relationship	BMI	0.171	0.093‡	BMI	- 0.084	0.446‡
	% BF	0.172	0.091‡	% BF	- 0.067	0.539‡
	WC	0.173	0.090*	WC	- 0.007	0.948*
Triceps skinfold	BMI	0.367	< 0.001‡	BMI	0.072	0.512‡
	% BF	0.342	< 0.001‡	% BF	0.076	0.486‡
	WC	0.320	0.001*	WC	0.121	0.274*
Subscapular skinfold	BMI	0.370	< 0.001‡	BMI	0.014	0.899‡
	% BF	0.367	< 0.001‡	% BF	0.022	0.840‡
	WC	0.333	< 0.001*	WC	0.006	0.955*
Skinfold sum	BMI	0.378	< 0.001‡	BMI	0.042	0.702‡
	% BF	0.371	< 0.001‡	% BF	0.043	0.693‡
	WC	0.339	< 0.001*	WC	0.058	0.597*
SS/TS relationship	BMI	0.220	0.030‡	BMI	0.042	0.702‡
	% BF	0.250	0.013‡	% BF	0.043	0.693‡
	WC	0.228	0.020‡	WC	0.058	0.597‡
Percentage body fat	BMI	0.368	< 0.001‡	BMI	0.040	0.717‡
	% BF	0.361	< 0.001‡	% BF	0.047	0.665‡
	WC	0.326	0.001*	WC	0.079	0.475*

SS/TS = Subscapular Skinfold/Triceps Skinfold
BMI = Body Mass Index; %BF = Percentage Body Fat; WC = Waist Circunference
The p values is taken from the corresponding Pearson correlation* (at least one or two variables with normal distribution) or Spearman correlation‡ (two variables without normal distribution); and the significant p-values ($p < 0.05$) are given in bold type.

According to the data obtained from this study, it is important to emphasize that the child's chance to present obesity was six times higher when the mother had a high percentage body fat, comparative to the eutrophic pairs whose mothers did not show high percentage body fat (OR = 6.0; IC = 1.27 – 38.68; p = 0.01) (data not shown in table).

This study investigated the presence of close relatives (grandfathers, grandmothers, mother, father, uncles and aunts) with positive obesity history, dyslipidemia, diabetes, hypertension, cardiovascular disease and cancer. For obesity, it was observed that 78 and 54% of the obese and eutrophic children respectively presented one or more close relatives with positive obesity history, and this difference was statistically significant (p = 0.01). The obesity presence in two or more close relatives of the obese and eutrophic children group were 44 and 14%, respectively, being the difference also statistically significant (p = 0.001) (data not shown in table).

Regarding to dyslipidemia, it was verified 82% of the obese children to present one or more close relatives with history for positive dyslipidemia, whereas a value of 62% was found for the eutrophic ones, being an statistically significant difference (p = 0.04). The same result was found for the dyslipidemia presence in two or more close relatives in both obese and eutrophic children's group (54% vs 28%, respectively; p = 0.02) (data not shown in table).

For the presence of diabetes, arterial hypertension, cardiovascular diseases and cancer in the close relatives, no significant differences between obese children and the eutrophic ones were found (data not shown in table).

A low positive correlation, but significant, was observed between the child's BMI and the number of close relatives with positive history for obesity (r = 0.278; p = 0.005). For other family chronic diseases, no correlation with the child's BMI were found for dyslipidemia (r = 0.18; p = 0.07), diabetes (r = 0.17; p = 0.08), hypertension (r = 0.13; p = 0.18), cardiovascular diseases (r = 0.04; p = 0.68) and cancer (r = 0.12; p = 0.20) – data not shown in table.

According to the data obtained from this study, a child's probability to present obesity was four times higher when there were one or more close relatives with obesity in relation to those eutrophic pairs who had no obese close relatives (OR = 4.00; IC = 1.25 – 14.10; p = 0.01), and this chance was increased for the presence of two or more close obese relatives (OR = 4.75; IC = 1.52 – 16.45; p = 0.001). The same result was found for the dyslipidemia. A child's probability to present obesity was three times higher when there were one or more close relatives with dyslipidemia, in relation to those eutrophic pairs who had no close relatives with this characteristic (OR = 3.0; IC = 1.02 – 9.41; p = 0.04), and this chance was also increased for the presence of two or more close relatives with dyslipidemia (OR = 2.85; IC = 1.14 – 7.41; p = 0.02) (data not shown in table).

DISCUSSION

The highest height values found in the obese children were also observed in other studies, such as that accomplished by Hui et al. (21), who found 6- and 7-years old obese children from Hong Kong to present significantly higher height than the eutrophic ones at the same age group. Gulliford et al. (22) also verified the obese children to be considerably taller than their non-obese pairs. According to Garn & Clarck (23), the obese children tend to be taller, as presenting advanced bone age and precocious maturation than non-obese ones.

This study emphasizes the body differences between eutrophic and obese children, where the last ones presented higher values for all anthropometric and body composition parameters, therefore emphasizing the highest body size and higher fat percent, and it is important to emphasize the prevalence of body fat in this group's central region. In addition, obese children tend to present undesirable biochemical profiles just because the probably inadequate feeding habit and shortage of physical activities. So, the total body fat is increased besides being able to accumulate in the central region, as favoring the emergence of the dyslipidemia. This fact can be confirmed by the discoveries from this study, since all biochemical parameters under study, except hemoglobin and HDL-cholesterol, showed a positive and significant correlation with either fat located in the central region and the total body fat represented by the values of the subscapular thicknesses skinfold, cutaneous skinfold sums and percent body fat.

The relationship between the children's dyslipidemia and abdominal adiposity happens due to the abdominal fatty tissue presenting higher lipolytic rates in relation to other subcutaneous tissues (24). The lipolysis leads to the production of high rates of free fatty acids in the portal circulation and liver (25). The high exposure of the hepatic tissue to free fatty acids leads to the increase in the lipid hepatic synthesis, consequently to dyslipidemia (26). It is possible the fatty acids of the abdominal adipose tissue to be the strongest predictor of the children's serum lipid levels. The dyslipidemia together with abdominal adiposity is characterized by the plasmatic increase of triglycerides, LDL-cholesterol, VLDL-cholesterol, and Apo B, as well as reduction in HDL-cholesterol levels (24). Besides, the increased release of the fatty acids in the liver can increase the hepatic glyconeogenesis, so leading to the hyperinsulinemia and resistance to insulin (27).

Higher glucose and triglyceride levels were found in the obese group, and the difference was statistically significant. Spite of the differences found in glucose concentration between both groups, all blood values did not surpass those recommended by the American Diabetes Association (14). However, the difference found for triglyceride levels evidences a higher percentage of obese children with levels above that recommended by American Academy of Pediatrics (13) with respect to the eutrophic ones (34% vs. 10%, respectively). Similar results were found by Botton et al. (28) and Asato et al. (29), who studied the obese and eutrophic children and observed statistically significant difference between those two groups for triglyceride levels, which was higher in the obese ones.

It is worth to emphasize that although no statistical differences were found for the average values of hemoglobin, total-cholesterol, HDL and LDL between both groups, a higher percent of the obese children showed increased levels of the total cholesterol, LDL and reduced HDL in relation to the eutrophic ones, according to recommendation of the American Academy of Pediatrics (13). However a higher percent of the obese children showed increased levels of the total cholesterol (8% vs. 2%), LDL (14% vs. 2%) and reduced HDL (54% vs. 46%) in relation to the eutrophic ones, according to recommendation of the American Academy of Pediatrics (13). This fact might be presenting the possible initial inadequacy of the lipid profile in childhood, mainly in obese children. Concerning to hemoglobin, was verified that 14% eutrophic and 12.2% obese children were anemic. Almost all anemic children were from public schools (91.7%). It is important to emphasize the possible influence of the socioeconomic level in the prevalence of anemia, since low purchasing power families might have not enough financial condition to acquire heme-iron-source foods, such as meat.

It is known that parents' obesity is a strong predictor for obesity in the children, as a function of both genetic and environmental influence, as inadequate feeding habits and lifestyles developed within family. Such an influence can be still higher between mother and son, because most of the time she is more responsible for the direct child care, so she can interfere into feeding and lifestyle of her children. This close relationship between the mother's nutritional state and the child' was confirmed by the results from this study, because besides the highest values for BMI, body fat percentage, and waist circumference in the obese children's mother group in relation to the eutrophic ones, there were found correlation among all anthropometrical and body composition measures of the mothers with their children, except for the waist/hip relationship of the last ones. This discovery reinforces the idea that the maternal influence on their children's nutritional state tends to be superior to the paternal', just because the mother's proximity with the child's education, as she can interfere into decision about what the child can eat during leisure moments, which tend to be similar to the maternal lifestyle.

It is not pertinent to disregard the maternal genetic influence, possibly existing between the maternal obesity and children's obesity. According to Maffeis (4), the stronger risk factor for childhood obesity is still the parents' obesity, by occurring as a result from either the genetic map and environmental influences, as well as the same family environment between them. However, the influence of the parents' nutritional state on their children's obesity, that is partly due to genetic components, it is also strongly determined by the family's food intake. It is important to emphasize that the mother's feeding habit tends to be adopted by the child, because the mothers are usually more involved into preparation and choice of the foods (30). Similar resulted were observed by Nguyen et al. (18) who verified the children's feeding to be more similar to the mother' than to father'. Studies had observed that maternal overweight (BMI > 25 kg/m^2) and obesity (BMI > 30 kg/m^2) was a risk factor for obesity in children, whereas paternal BMI showed no association (30-32). Authors had verified that both parents' overweight (BMI > 25 kg/m^2) and obesity (BMI > 30 kg/m^2) were significantly associated to the obesity in 6 and 7-years old children, and it should be emphasized that the strength of association between maternal obesity and the child's overweight was almost double the paternal obesity (21,33).

The success of the obesity treatment in childhood includes self-monitoring, change in feeding behavior and mainly the parents' decreased overweight, what will probably contribute to the positive modification in the child' feeding and lifestyle (34). According to Mossberg (35), the possibility an obese child to continue presenting obesity will intensively depend on the obesity level in the family members, especially the mother'. Kain et al. (36), analyzed the combined influence of the anthropometric and socioeconomic variables upon childhood obesity, and observed the maternal obesity to be the factor showing higher correlation with this nutritional disturbance, a fact implicating that the actions to preventing the childhood obesity must involve the mother in the sense she adopts healthy life habits, therefore being able to transmit them to their children.

Concerning to the presence of chronic-degenerative diseases in close relatives, the results emphasize the influence of the close relatives who are obese and present dyslipidemia on the children's obesity, which occurs exactly because these children pertain to families with probably inadequate lifestyles, such as undesirable feeding habits and sedentariness, besides genetic influence. The modification of the parents' lifestyle is important for the treatment of the childhood obesity, mainly when the child presents genetic tendency. In addition, it is worth to emphasize that the parents' example can extend to other members of the family, therefore favoring the positive modification of the child's lifestyle and its permanence throughout the life, since many children have a tendency to accompanying their parents, who they usually see as model.

The family lifestyle, also including the feeding habits, influences the development of the children's feeding preferences, so affecting their body weight. The feeding patterns of those individuals with excessive adiposity may be explained, at least partly, by the family's similar preferences for some foods. The parent's lipid intake and body fat are usually associated to their children's fat intake and adiposity (18). Shamir et al. (19) verified those children from which the relatives presented dyslipidemia showed significantly higher values for total-cholesterol, LDL, apo-B and triglycerides, compared with the control group.

The family obesity history is an independent risk factor for the increased weight in children (37). Youssef et al. (20), followed-up either the children whose relatives' history were positive for cardiovascular diseases until their adult phase and children without family history. Those authors observed that the first children presented higher values for BMI, subscapular and triceps cutaneous skinfolds since the childhood to adult phase, and manifested hyperinsulinemia when reached the adult phase. These observations evidence the important implication for working the healthiest lifestyle with the family.

Davison & Birch (38) emphasized the family centralization in the etiology of the infantile excessive weight, as well as the need for the parents' support during the treatment of obesity in childhood. According to those authors, the risk factors tend to occur within the family, since parents with excessive weight tend to practice low physical activities and to consume higher percent of the total energy value under fat form. The same may happen in relation to the habits of the family members presenting chronic-degenerative diseases. It is worth to emphasize that the children's lifestyle can be affected by their close relatives living together in the same environment.

A limitation of our study is that adiposity was assessed with anthropometric measurements, which are less accurate than those of dual-energy X-ray absortiometry (DXA). However, waist circumference is considered as an appropriate marker of abdominal obesity in children (39) and the equations based on skinfold thickness as a good indicator of overall adiposity (10). Furthermore, it is possible that the reduction of the sample size of fathers has limited the statistical significance among the variables. An advantage of this study was the whole anthropometric evaluation was only conducted by one of the authors of this study, to avoid possible biases in checking the measures.

This study allows to conclude that there are body differences between the eutrophic and obese children, as evidencing a higher percent fat in the obese children, which predominates in their central region, besides presenting higher serum values for triglycerides. It is important to emphasize the relationship between the excessive body fat and its central distribution with the increased lipid profile. Besides, mother's obesity is a factor associated to childhood obesity because the obese mothers with high percent body fat and its accumulation in the central region present children aged 6 to 8 years with these characteristics. Though, no differences and/or correlation were found for the fathers' parameters. The influence from the obese and dislipidemic close relatives upon children's obesity is important to be considered.

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