

Adiposity and metabolic profile of schoolchildren in the urban areas of Ouro Preto, Minas Gerais

Adiposidade e perfil metabólico em crianças de escolas da zona urbana de Ouro Preto – MG

André Everton de Freitas¹, Joel Alves Lamounier², Danusa Dias Soares³,
Thiago Henrique de Oliveira⁴, Débora Romualdo Lacerda⁵, Joyce Batista Andrade⁶,
Flávia Komatsuzaki⁷, Vanessa Gontijo de Freitas⁸, Leida Maria Botion⁹, Flávio Diniz Capanema¹⁰

DOI: 10.5935/2238-3182.20130002

ABSTRACT

Obesity, defined as an excess in body fat, is a multifactorial disease involving both genetic and environmental risk factors. Early diagnosis and interventions during critical periods of development of obesity – childhood and adolescence – have been recommended, aiming at preventing unfavorable outcomes at a later age. This cross-sectional study sought to characterize the lipid profile, glucose, adiponectin, leptin and ghrelin in schoolchildren between six and nine years of age with overweight and obesity in the city of Ouro Preto (MG). The data was analyzed with the Shapiro Wilk normality test, groups comparisons were made with either a parametric (T test) or a nonparametric (Mann Whitney) test, adopting confidence intervals of 95% and a significance level of ≤ 0.05 . The average age of the school population was 7.8 ± 1.1 years, with a prevalence of 8.9% of overweight and 3% of obesity. Hypercholesterolemia was found in 5.5%, HDL was abnormal in 98.7%, LDL levels were borderline in 32.4% and altered glucose levels were present in 46.6% of the children. In stratified analysis by gender, higher values of leptin in girls ($p = 0.032$) and ghrelin in boys ($p = 0.033$) were found, with no difference for the other variables. The results show that overweight/obesity among schoolchildren should be considered a significant health problem in this population, highlighting the importance of implementing early intervention programs. Uncovering the precursors of childhood obesity could lead to interventions so as to prevent or mitigate its consequences in youth and adulthood.

Key words: Overweight; Obesity/prevention & control; Child Health; Child Nutrition Disorders.

RESUMO

A obesidade, doença multifatorial definida como excesso de gordura corporal, apresenta concomitância entre fatores de risco genéticos e ambientais. O diagnóstico precoce e as intervenções no período crítico do desenvolvimento da obesidade – infância e adolescência – têm sido recomendados, buscando-se evitar desfechos desfavoráveis na idade adulta. Este estudo transversal teve como objetivo caracterizar perfil lipídico, glicemia, adiponectina, leptina e grelina de escolares entre seis e nove anos, portadores de sobrepeso e obesidade, do município de Ouro Preto-MG. Os dados foram analisados a partir do teste de normalidade Shapiro Wilk; e nas comparações entre os grupos foi aplicado o teste paramétrico (Teste t) ou não paramétrico (Teste Mann Whitney), adotando-se intervalo de confiança de 95% e nível de significância para valores $\leq 0,05$. A idade média da população escolar foi de $7,8 \pm 1,1$ anos, com prevalência de 8,9% de sobrepeso e 3% de obesidade. Foram identificados hipercolesterolemia em 5,5%, HDL alterado em 98,7%, taxa limítrofe de LDL em 32,4% e glicemia alterada em 46,6% das crianças. Na análise estratificada quanto ao gênero, foram observados valores mais altos para leptina

¹ Physical Therapist. Professor at the Pontifícia Universidade Católica de Minas Gerais – PUC Minas. Belo Horizonte, MG – Brazil.

² Physician. Professor of Pediatrics at the Universidade Federal de São João Del Rei, Campus Centro-Oeste. Divinópolis, MG – Brazil. Post-graduate Program in Child and Adolescent Health at the School of Medicine, UFMG. Belo Horizonte, MG – Brazil.

³ Physical educator. Professor of Exercise Physiology at the Physical Education School, UFMG. Laboratory of Physiology of Exercise at the EEEFTO, UFMG. Belo Horizonte, MG – Brazil.

⁴ Physical Therapist. Post-graduate Program in Child and Adolescent Health at the School of Medicine, UFMG. Belo Horizonte, MG – Brazil.

⁵ Physical educator. Laboratory of Exercise Physiology at the EEEFTO, UFMG. Belo Horizonte, MG – Brazil.

⁶ Nutritionist. Post-graduate Program in Child and Adolescent Health at the School of Medicine, UFMG. Belo Horizonte, MG – Brazil.

⁷ Statistician. Assistant Professor at the School of Engineering, UFMG. Belo Horizonte, MG – Brazil.

⁸ Psychologist. Professor of the Faculdade Pitagoras. Divinópolis, MG – Brazil. Post-graduate Program in Social Psychology, PUC Minas. Belo Horizonte, MG – Brazil.

⁹ Pharmacist. Associate Professor. Laboratory of Metabolism at the ICB/UFMG. Belo Horizonte, MG – Brazil.

¹⁰ Physician. Adjunct Professor and Coordinator of the Center for Children and Adolescent Health at the Faculdade de Saúde e Ecologia Humana – FASEH. Vespasiano, MG – Brazil. Education and Research Manager at the Fundação Hospitalar do Estado de Minas Gerais – FHEMIG. Belo Horizonte, MG – Brazil.

Submitted: 10/02/2012
Approved: 11/15/2012

Institution:
Fundação Hospitalar de Minas Gerais – FHEMIG
Belo Horizonte, MG – Brazil

Corresponding Author:
Flávio Diniz Capanema
E-mail: flavio.capanema@fhemig.mg.gov.br

em meninas ($p=0,032$) e grelina nos meninos ($p=0,033$), não havendo diferença para as demais variáveis. Os resultados demonstram ser o excesso de peso entre escolares problema de saúde relevante no município, ressaltando-se a importância de implementação de programa de intervenção precoce por parte dos gestores. Elucidar os precursores da obesidade na infância pode levar a intervenções capazes de atenuar ou impedir suas consequências na juventude e fase adulta.

Palavras-chave: Sobrepeso; Obesidade/prevenção & controle; Saúde da Criança; Transtornos da Nutrição Infantil.

INTRODUCTION

Obesity is a chronic disease defined as excess body fat, for which there are concomitant genetic and environmental risk factors.^{1,3} Its etiology is not easily identifiable, and is characterized as multifactorial. It is believed that external factors are more relevant in the incidence of obesity than genetic ones.^{4,6}

Prevalence of obesity in childhood and adolescence has been growing steadily and tends to persist in adult life; around 50% of children who are obese at six months of age and 80% at age five will remain obese in their adult lives.⁷ Estimates show that in 2025 Brazil will be the fifth country in the world with obesity issues in its population.⁵

The literature highlights ages close to six years as the most critical periods for the development of body fat accumulation and for the occurrence of obesity, according to a distribution by sex and age, with a high risk for girls.⁸

Considered one of the most stigmatized conditions and with low social acceptance in childhood, obese children and adolescents have worse quality of life when compared with healthy individuals of the same age.⁹ Obese children are characterized for showing increased aggressiveness, appetite, interest in sexuality, anxiety, tendency to depression, worse interpersonal relations, marked affective imbalance, and poor tolerance to frustrations.¹⁰

Changes in body constitution over time may bring direct consequences in bodily functions, leading to increased prevalence of several conditions associated with obesity, including diabetes *mellitus*, dyslipidemia, cardiovascular and respiratory problems, psychological and orthopedic disorders, and high blood pressure.^{11,12}

Preventing obesity requires special attention so that it is diagnosed during childhood and in the pre-school period, given that it is in this age range that a

substantial increase in the prevalence of obesity is observed.¹³ Early diagnosis and interventions in this critical period of obesity development (childhood and adolescence) have been recommended to avoid unfavorable outcomes in adult life.¹⁴

Bearing in mind that during childhood the process of growth and development is the period when food habits are formed, knowing the nutritional status of this age group is justified so that effective dietary guidance, promotion of healthy habits, and physical activity can be implemented whenever necessary. In this context, this study aims to characterize adiposity, lipid profile, glycemia, adipocytokines (adiponectin and leptin) and ghrelin in children aged six to nine years enrolled in public schools in the city of Ouro Preto – MG.

CASE STUDIES AND METHODS

Study Design

This is a cross-sectional study with children aged six to nine years in seven public schools in the urban areas of the city of Ouro Preto, Minas Gerais, enrolled both in morning and afternoon shifts, from introductory to school phase IV.

Study population and sampling

From the initial 1,019 school children eligible for the study, we sought to identify those who were overweight and obese. After nutritional evaluation, 119 children were diagnosed as overweight or obese, with a total of 79 children included in this study after parents and/or guardians gave their written consent. Blood sample was collected to determine lipid profile, glycemia, adiponectin, leptin and ghrelin. The study was approved by the Ethics and Research Committee of the Universidade Federal de Minas Gerais.

Data Collection

Data collection was made based on assessment of anthropometric parameters (body mass index, body fat percentage, skin folds, and waist/hip ratio) and blood tests (lipid profile, adiponectin, leptin, ghrelin, and glycemia).

All evaluations required for the study took place in the morning. A protocol was created for data collection so as to standardize the procedures. All researchers were selected and trained on procedures prior to starting collection.

Body mass index (BMI) was used to characterize adiposity and was calculated as the ratio between total body weight in kilograms and height in meters squared (Quetelet index).¹⁵ The cutoff points recommended in 2007 by the World Health Organization (WHO) were used.¹⁶

To measure height, we adopted the Alturaexata vertical stadiometer with one-centimeter intervals up to 2.13 meters and an accuracy of 0.1 cm, equipped with a plastic visor and square angle attached to one end. To measure weight in kilograms as well as body fat percentage, we used a TANITA brand, model BF599 electronic digital scale, with a maximum capacity of 180 kg and 50g divisions, according to norms defined by Jelliffe.¹⁷

To measure triceps (TSF) and calf (CSF) skin folds we used the *Lange Skinfold Caliper*, with a range of 0-60 mm and accuracy of ± 1 mm, constant pressure of ~ 10 g/mm², unchanged after opening, according to the techniques recommended by Heyward *et al.*¹⁸ The equation proposed by Slaughter *et al.*¹⁹ was used to assess body fat percentage. All measurements were performed by a trained examiner, on the subject's non-dominant arm and with alternate repetitions at least three times in the same place. The representative value considered was the arithmetic mean of measurements for each region. Waist and hip circumferences were measured using a 2m-long flexible and inelastic tape, with centimeter and millimeter intervals. We avoided squeezing any soft parts and adopted the cutoff points described by Taylor *et al.*²⁰ Waist-hip ratio was obtained dividing the waist by the hip circumference.

Biochemical variables were obtained through blood samples taken in the morning (between 7:00 and 09:00). A total of 6 mL of blood per sample was collected from each child in the school environment, centrifuged and stored at 20°C. All children were instructed to observe a 12h fast. Analyses were performed using the *enzyme-linked immunoabsorbent assay* (ELISA) (*Linco Research*) method for adiponectin, leptin, and ghrelin concentrations.²¹⁻²³ For serum triglyceride analysis (TG), total cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL), and glycemia the colorimetric method (labtest®) was adopted. LDL was calculated based on the equation proposed by Friedewald *et al.*²⁴ Lipid

profile was determined according to the cutoff points proposed for childhood and adolescence on the I Guideline for Prevention of Atherosclerosis in Childhood and Adolescence.²⁵

Data Analysis

The data collected were organized in an Excel spreadsheet and then exported to the *software* used for statistic analyses (EpiInfo version 6.2 and SPSS version 14.0).

Study data were analyzed by listing the frequency of characteristics of the several categorical variables and by obtaining the central tendency measures (means) and dispersion measures (standard deviation). Based on the data's probability distribution after the Shapiro Wilk normality test, comparisons of means or medians were made between groups (male and female) with either a parametric (T test) or a nonparametric (Mann Whitney) test, when distribution was considered normal and non-normal, respectively. A 5% (≤ 0.05) level was considered statistically significant.

RESULTS

The prevalence of overweight and obesity in a population of 1,019 schoolchildren aged six to nine years enrolled in seven public schools in the urban area of Ouro Preto was of 8.9% ($n = 89$) and 3% ($n = 30$), respectively, to total of 119 children (Figure 1). We registered a percentage of 82.3% ($n=839$) eutrophic and 5.9% ($n=60$) underweight children. In order to analyze the chosen variables, all children considered overweight and obese were invited to participate in the study and the sample consisted of 79 children whose parents signed the consent form.

Table 1 shows the means and standard deviations in the study group ($n=79$), with reference to the mean age of 7.8 ± 1.1 years, mean weight of 37.84 ± 8.77 kgf and mean BMI of 21.10 ± 2.85 kg/m². For the leptin, adiponectin, and ghrelin variables, the mean values were 21.16 ± 16.17 ng/mL; 27.59 ± 11.99 , and 408.29 ± 203.36 pg/mL. Regarding lipid profile, the results were: 126.91 ± 29.79 mg/dL for total cholesterol, 19.86 ± 13.27 mg/dL for HDL, 91.18 ± 27.83 mg/dL for LDL, and 84.79 ± 47.31 mg/dL for triglyceride. We found a mean glycemia value of 86.32 ± 17.10 mg/dL.

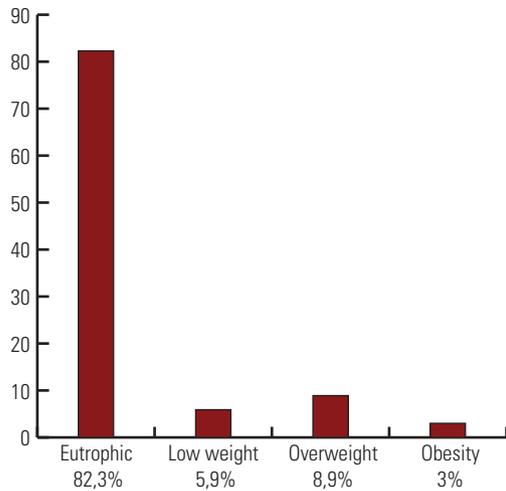


Figure 1 - Nutritional status of school children aged six to nine years in public schools in Ouro Preto, MG.

In stratified analysis of study variables by sex, there was a significant difference (at a confidence interval of 95%) between females and males for leptin ($p = 0.032$) and ghrelin ($p = 0.033$) levels. No differences were found between these groups for other variables (Table 1).

Table 2 shows the prevalence of alterations in lipid profile and glycemia for schoolchildren aged six to nine years. The prevalence of hypercholesterolemia

was 5.5%, HDL was altered in 98.7%, borderline LDL in 32.4% and altered glycemia in 46.6% of children.

Table 2 - Classification of lipid and glucose profiles of students in public schools in the city of Ouro Preto – MG

Variables	Desirable		Borderline		High		Total
	n	%	n	%	n	%	
TC (mg/dL)	58	79,5	11	15,1	4	5,5	73
HDL (mg/dL)	1	1,3			71	98,7	72
LDL (mg/dL)	46	64,8	23	32,4	2	2,8	71
TG (mg/dL)	50	68,5	13	17,8	10	13,7	73
Glycemia (mg/dL)	39	53,4	-	-	34	46,6	73

TC = total cholesterol; HDL= high density lipoprotein; LDL= low density lipoprotein; TG= triglycerides.

DISCUSSION

Data in this study revealed a prevalence of 8.9% of overweight and of 3% of obesity among schoolchildren aged six to nine years in seven public schools in the city of Ouro Preto, totaling 11.6%. Comparing these prevalences of overweight and obesity with results from other studies is a complex issue because they use different age groups, cutoff points for diagnosis, a variety of methods to determine nutritional status, as well as other aspects.

Table 1 - Description of quantitative variables of overweight and obese students aged six to nine years in public schools in Ouro Preto, MG

Variables	Group			Female			Male			p
	n	Mean	±SD	n	Mean	±SD	n	Mean	±SD	
Age (years)	79	7,8	1,10	39	7,72	1,19	40	7,90	1,01	0,405 ²
Weight (kg)	79	37,84	8,77	39	37,71	9,96	40	37,98	8,69	0,822 ²
Height (cm)	79	133,39	8,03	39	132,79	7,70	40	133,98	8,39	0,512 ¹
%BF	79	30,77	6,18	39	32,04	5,15	40	29,54	6,88	0,072 ¹
BMI (kg/m ²)	79	21,10	2,85	39	21,13	3,17	40	21,07	2,53	0,724 ²
SF (%BF)	79	33,70	6,78	39	34,20	6,00	40	33,22	7,50	0,523 ¹
WHR	79	89,30	6,36	39	89,10	7,20	40	89,50	5,49	0,787 ¹
Leptin (ng/mL)	61	21,16	16,17	28	25,81	16,69	33	17,36	14,92	0,032 ²
Adiponectin	61	27,59	11,99	28	27,27	13,65	33	27,87	10,93	0,853 ¹
Ghrelin (pg/mL)	62	408,29	203,36	27	353,12	157,26	34	449,30	222,16	0,033 ¹
TC (mg/dL)	73	126,91	29,79	36	127,57	32,46	37	126,32	27,34	0,859 ¹
HDL (mg/dL)	72	19,86	13,27	35	21,15	18,16	37	18,75	5,70	0,554 ²
LDL (mg/dL)	71	91,18	27,83	34	88,96	29,42	37	91,19	23,45	0,519 ²
TG (mg/dL)	73	84,79	47,31	36	86,51	54,30	37	83,18	40,00	0,974 ²
Glycemia (mg/dL)	73	86,32	17,10	36	88,54	16,28	37	83,77	17,82	0,596 ²

¹ Independent samples test (Test t); ² Mann Whitney Test ; IC=95%.

% BF = percentage of body fat; BMI = body mass index; skinfold = PC; WHR = waist/hip ratio; TC = total cholesterol; HDL = high density lipoprotein; LDL = low density lipoprotein; TG = triglycerides; SD = standard deviation.

The prevalence of overweight and obesity in children in Brazil grows at a brisk pace while malnutrition decreases in children and adults. The projections made by studies in the last three decades indicate the clearly epidemic behavior of this problem and demonstrate a process of nutritional transition in the country.²⁶

Studies show a prevalence of overweight and obesity of 18% in public schools in Fortaleza,⁷ of 16.5% overweight and 14.7% obesity in the region of Palheiros – SP,²⁸ 10.4% overweight and 10.4% obesity among schoolchildren from 1st-4th grade in municipal public schools in Rio de Janeiro,²⁹ 15.4% overweight and 6% obese in a sample of 4,964 children aged six to ten years in public and private schools in the state of Santa Catarina,³⁰ and a prevalence of 13.1 and 9% of overweight and obesity, respectively, in a study of 2,651 preschool children from public and private schools in Recife – PE.³¹

International studies also show high prevalence rates for overweight and obesity in this age group, with data demonstrating that obesity and overweight in children have high prevalence rates that have increased over the past two decades in various parts of the world. These findings confirm the status of overweight and obesity as a global epidemic and make it the target of public health concern because of possible associations with other diseases in adulthood, as well as high rates of morbidity and mortality.³²⁻³⁶

Despite showing differences in prevalence rates for overweight and obesity between male and female children, this study did not detect significant differences between the variables assessed with the exception of leptin, with a higher value in girls (25.81 ± 16.9 ng/mL), and ghrelin, higher for boys (449.30 ± 222.16 pg/mL). The mean value of 28.6 ± 15.1 ng/dL for leptin was found in a study with 34 obese children aged seven to 11 years, higher than our results.³⁷ In a research with 30 boys and 17 girls, ages nine and ten years, the mean values for adiponectin were 7.6 ng/dL for boys and 8.3 ng/dL for girls, while for leptin values were found at 10.6 ng/dL for boys and 13.0 ng/dL for girls.³⁸ Conversely, lower values of leptin were found in the study by Hamidi *et al.*³⁹ with obese children aged seven to 12 years (8.25 ng/dL for boys and 11.0 ng/dL for girls). Whatmore *et al.*,⁴⁰ when assessing eutrophic children and adolescents, found a concentration of 162 pg/mL (60-493 pg/mL) for ghrelin and no difference between sexes.

In this study we found a low prevalence of hypercholesterolemia (5.5%), a high prevalence of altered HDL (98.7%), a borderline rate of LDL in 32.4% and

altered glycemia in 46.6% among the overweight and obese students. The literature shows that, in addition to the association of overweight and obesity with cardiovascular diseases, hypertension, metabolic syndrome, osteoarthritis, sleep apnea and some forms of cancer,^{41,42} excessive weight gain in children weight have a considerable influence in negative changes in the lipid profile (high TC, TG, LDL and low HDL levels) of children and adolescents.^{43,44}

A research performed with children and adolescents found that overweight individuals were 1.6 to 9.1 times more likely to develop risk factors for cardiovascular diseases such as systemic hypertension, elevated total cholesterol, LDL, triglycerides, and glucose levels, as well as reduced HDL levels, when compared with eutrophic participants.⁴⁵ Gerber and Zielinky,⁴⁶ in a study performed in Southern Brazil with children and adolescents, recorded a prevalence of dyslipidemia between 24 and 33%, lower than values found in the present study. In a research made in Florianópolis – SC with 1,053 individuals aged seven to 18 years the mean levels found for total cholesterol, HDL, triglycerides and LDL were 162 ± 28, 53 ± 10, 93 ± 47 and 89 ± 24 mg/dL, respectively.⁴⁷ A study with 52 obese children aged seven to 10 years of age reported values of 87.2 ± 5.6 mg/dL for boys and 86.5 ± 5.1 mg/dL for girls and HDL of 53.2 ± 6.3 mg/dL for boys and 49.2 ± 7.4 mg/dL for girls.⁴⁸

The consequences of high cholesterol, added to other risk factors, constitute a public health problem. Clinically speaking, surveillance and early detection of risk factors associated with dyslipidemia are key preventive actions. In the case of excess weight in children particularly, control in primary healthcare and prevention actions are feasible for reaching and maintaining adequate weight for height, gender, and age.

Several studies suggest that socioeconomic characteristics and family, personal, and environmental factors are to be considered relevant in childhood obesity.⁴⁹⁻⁵² According to Duncan *et al.*,⁵³ many healthy habits are initiated and maintained in the family context, and the family (parents and siblings) may be considered as one of the main social factors able to influence the social behavior of children and adolescents. Thus, identifying those aspects could contribute to a better understanding of the factors leading to overweight and obesity, as well as help in planning prevention and treatment strategies.

CONCLUSION

Data in this study revealed a combined prevalence of overweight and obesity of 11.6% as well as the consequences for the children's health, evidenced by alterations on hormonal levels, lipid profile and glycemia. In-depth research on these variables becomes suitable for determining political and social changes that may interfere in the causes and in the treatment of childhood obesity. Schools can be important allies in combating the epidemics of childhood obesity and its comorbidities because they can promote and sponsor ideas, form new values, habits and act as common locale for social communication with families.

The results evidenced that this is a public health problem that affects both sexes and emphasized the importance of early intervention to prevent overweight and obesity in children. Elucidating the precursors of childhood obesity can lead to effective interventions to prevent its development or to mitigate its consequences in youth and adulthood.

ACKNOWLEDGEMENTS

The authors thank the students and families that took in this study, the entire project team, the Postgraduate Centre at the Medical School, and the financial support of the IAEA (*International Atomic Energy Agency*) ARCAL RLA 6/059, as well as FAPEMIG PP-SUS 3282 / 06, CNPq MCT/CNPq 479616/2006-0 FIP-PUC 2008/2515-S1 and the Universidade de Ouro Preto through the School of Nutrition and the Pharmacy Laboratory (LAPAC), the Municipality of Ouro Preto - Department of Education, the Universidade Federal de Minas Gerais - Laboratory of Exercise Physiology - CENESP, Metabolism Laboratory - ICB and the Faculdade de Saúde e Ecologia Humana - FASEH/MG.

REFERENCES

- Guillaume M. Defining obesity in childhood: current practice. *Am J Clin Nutr.* 1999; 70(Suppl):126S-30.
- Blair SN, Ho RTON, Leon AS, Lee IM, Drink Water BL, Dishman RK *et al.* Physical activity, nutrition, and chronic disease. *Med Sci Sports Exerc.* 1996; 28:335-49.
- Egger G, Bolton A, O'Neill M, Freeman D. Effectiveness of an abdominal obesity reduction programme in men: the Gu t Buster 'waist loss' programme. *Int J Obes Relat Metab Disord.* 1996; 20:227-31.
- Damaso A. Etiologia da obesidade. Rio de Janeiro: Medsi; 2003.
- Bouchard C. Atividade física e obesidade. São Paulo: Manole; 2000.
- Nobrega FJ. Distúrbios da nutrição. Rio de Janeiro: Revinter; 1998.
- Hanley AJG, Harris SB, Gittelsohn J, Wolever TMS, Saksvig B, Zinmam B. Overweight among children and adolescents in a Native Canadian Community: prevalence and associated factors. *Am J Clin Nutr.* 2000; 71:693-700.
- Associação Brasileira para o estudo da obesidade e da Síndrome metabólica-Abeso. Consenso Latino-Americano em Obesidade. 1998. [Citation in 2012, Sept. 09]. Available in <http://www.abeso.org.br/pdf/consenso.pdf>.
- Schwimmer JB, Burwinkle TM, Varni JW. Health-related quality of life of severely obese children and adolescents. *J Am Med Assoc.* 2003; 289(14):1813-9.
- Lamounier JA, Chagas AJ, Vieira EC. Obesity. In: Leão E, Correa E, Mota JAC, Viana BV. *Pediatria ambulatorial.* Belo Horizonte: Coppedmed; 2005. 1034 p.
- Reilly JJ. Assessment of body composition in infants and children. *Nutrition.* 1998; 14(5):821-5.
- Semiz SO, Sabir N, Semiz E. Body fat distribution childhood obesity: association with metabolic risk factors. *Indian Pediatr.* 2008; 45(6):457-62.
- Kain JB, Lera LM, Rojas JP, Uauy RD. Obesidad em preescolares de La Región Metropolitana de Chile. *Rev Méd Chile.* 2007; 135(1):63-70.
- Triches RM, Giugliani ERJ. Obesidade, práticas alimentares e conhecimentos de nutrição em escolares. *Rev Saúde Pública.* 2005; 39(4):541-7.
- Garrow JS, Webster J. Quetelet's index (W/H²): as a measure of fatness. *Int J Obesity* 1985; 9:147-53.
- De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull WHO.* 2007; 85:660-7.
- Jelliffe DB. Evaluación del estado de nutrición de la comunidad com especial referencia a las encuestas en las regiones en desarrollo. Geneva: OMS; 1968.
- Heyward VH, Stolarczyk LM. Avaliação da composição corporal. São Paulo: Manole; 2000. 243 p.
- Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, Loan MDV *et al.* Influence of maturation on relationship of skinfold to body density: a cross-sectional study. *Hum Biol.* 1988; 56(4):681-9.
- Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and conicity index as screening tools for high trunk fat mass, as measured by dual-energy by dual-energy X-ray absorptiometry, in children aged 3-19 y. *The Am J Clin Nutr.* 2000; 72(2):490-5.
- Ferguson MA, White LJ, McCoy S, Kim HW, Petty T, Wilsey J. Plasma adiponectin response to acute exercise in health subjects. *Eur J Appl Physiol.* 2003; 91:324-9.
- Koistinen HA, Tominen JA, Ebeling P, Heiman ML, Stephens TW, Koivisto VA. The effect of exercise on leptin concentration in health men and type 1 diabetic patients. *Med Sci Sports Exerc.* 1998; 30:805-10.

23. Foster-Schubert K, McTiernan A, Frayo S, Schwartz RS, Rajan KB, Yasui Y *et al*. Human plasma ghrelin levels increase during a one-year exercise program. *J Clin Endocrinol Metabol*. 2005; 90(2):820-5.
24. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem*. 1972; 18(6):499-502.
25. Sociedade Brasileira de Cardiologia. I Diretriz de Prevenção da Aterosclerose na infância e adolescência. *Arq Bras Cardiol*. 2005; 85(VI):1-36.
26. Batista Filho M, Rissin A.A transição nutricional no Brasil: tendências regionais e temporais. *Cad Saúde Pública*. 2003; 19:181-91.
27. Campos LA, Leite AJM, Almeida PC. Prevalência de sobrepeso e obesidade em adolescentes escolares do município de Fortaleza, Brasil. *Rev Bras Saúde Matern Infant*. 2007; 7:183-90.
28. Fagundes ALN, Ribeiro DC, Naspitz L, Garbelini LEB, Vieira JKP; Silva AP *et al*. Prevalência de sobrepeso e obesidade em escolares da região de Parelheiros do município de São Paulo. *Rev Paulista Pediatr*. 2008; 26(3):212-7.
29. Castro IRR, Engstrom EM, Anjos LA, Azevedo AM, Silva CS. Perfil nutricional dos alunos da rede municipal de educação da cidade do Rio de Janeiro. *Anais do Simpósio: Obesidade e anemia carencial na adolescência*. Salvador, BA: Instituto Danone; 2000. p.231-2.
30. Ricardo GD, Caldeira GV, Corso ACT. Prevalência de sobrepeso e obesidade e indicadores de adiposidade central em escolares de Santa Catarina, Brasil. *Rev Bras Epidemiol*. 2009; 12(3):424-35.
31. Granville-Garcia AF, Menezes VA, Lira PIC, Serqueira LA, Ferreira JMS, Cavalcanti AL. Prevalência de sobrepeso e obesidade em pré-escolares de escolas públicas e privadas em Recife, Pernambuco, Brasil. *Cad Saúde Coletiva*. 2009; 17(4):989-1000.
32. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Body mass index, waist circumference, and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. *Pediatrics*. 2004 Aug; 114(2):e198-205.
33. Ribeiro RCQ, Lotufo PA, Lamounier JA, Oliveira RG, Soares JF, Botter DA. Fatores adicionais de risco cardiovascular associado ao excesso de peso em crianças e adolescentes. O estudo do coração de Belo Horizonte. *Arq Bras Cardiol*. 2006; 86(6):406-16.
34. Jolliffe CJ, Janssen IJ. Vascular risks and management of obesity in children and adolescents. *Vasc Health Risk Managem*. 2006; 2(2):171-87.
35. Rolland-Cachera MF, Castetbon K, Arnault N, Bellisle F, Romano MC, Lehighue Y *et al*. Body mass index in 7-9-year-old French children: frequency of obesity, overweight and thinness. *Int J Obes Relat Metab Disord*. 2002; 26:1610-6.
36. Martorell R, Khan KL, Hughes ML, Grummer-Strawn LM. Overweight and obesity in preschool children from developing countries. *Int J Obes Relat Metab Disord*. 2000; 24:959-67.
37. Gutin B, Ramsey L, Barbeau P, Cannady W, Ferguson M, Litaker M *et al*. Plasma leptin concentrations in obese children: changes during 4-mo periods with and without physical training. *Am J Clin Nutr*. 1999; 69: 388-94.
38. Nishimura R, Sano H, Matsudaira T, Miyashita Y, Morimoto A, Shirasawa T, *et al*. Childhood obesity and its relation to serum adiponectin and leptin: A report from a population-based study. *Diabetes Res Clin Pract*. 2007 May; 76(2):245-50.
39. Hamidi A, Fakhrazadeh H, Moayyeri A, Heshmat R, Ebrahimpour P, Larijani B. Metabolic syndrome and leptin concentrations in obese children. *Indian J Pediatr*. 2006 Jul; 73(7):593-6.
40. Whatmore AJ, Hall CM, Jones J, Westwood M, Clayton PE. Ghrelin concentrations in healthy children and Adolescents. *Clin Endocrinol*. 2003; 59:649-54.
41. Klein S, Burke LE, Bray GA, Blair S, Allison DB, Pi-Sunyer X *et al*. Clinical implications of obesity with specific focus on cardiovascular disease: a statement for professionals from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism; endorsed by the American College of Cardiology Foundation. *Circulation*. 2004; 110:2952-67.
42. National Heart Lung and Blood Institute. The Practical Guide: identification, evaluation, and treatment of overweight and obesity in adults. Washington, DC: National Institutes of Health; 2000.
43. Manios Y, Kolotourou M, Moschonis G, Sur H, Keskin Y, Kocaoglu B *et al*. Macronutrient intake, physical activity, serum lipids and increased body weight in primary schoolchildren in Istanbul. *Pediatr Int*. 2005; 47(2):159-66.
44. Ballesteros MN, Cabrera RM, Saucedo MS, Aggarwal D, Shachter NS, Fernandez ML. High intake of saturated fat and early occurrence of specific biomarkers may explain the prevalence of chronic disease in northern Mexico. *J Nutr*. 2005; 135(1):70-3.
45. Katzmarzyk PT, Tremblay A, Pérusse L, Després JP, Bouchard C. The utility of the international child and adolescent overweight guidelines for predicting coronary heart disease risk factors. *J Clin Epidemiol*. 2003; 56:456-62.
46. Gerber ZRS, Zielinsky P. Fatores de risco de aterosclerose na infância: um estudo epidemiológico. *Arq Bras Cardiol*. 1997; 69:231-6.
47. Giuliano ICB, Coutinho MSSA, Freitas SFT, Pires MMS, Zunino JN, Ribeiro RQC. Lípidos séricos em crianças e adolescentes de Florianópolis, SC: Estudo Floripa Saudável 2040. *Arq Bras Cardiol*. 2005; 85(2):85-91.
48. Ferreira AP, Oliveira CER, França NM. Metabolic syndrome and risk factors for cardiovascular disease in obese children: the relationship with insulin resistance (HOMA-IR). *J Pediatr*. 2007; 83(1):21-6.
49. Wang Y, Monteiro C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am J Clin Nutr*. 2002; 75(6):971-7.
50. Dietz WH. Policy and environmental changes related to the prevention and treatment of childhood and adolescent obesity. In: Chen C, Dietz WH, editors. *Obesity in Childhood and Adolescence*. Philadelphia: Lippincott Williams e Wilkins; 2002; p.273-86.
51. Ramos de Marins VM, Almeida RM, Pereira RA, De Azevedo Barros MB. The relationship between parental nutritional status and overweight children/adolescents in Rio de Janeiro, Brazil. *Public Health*. 2004; 118:43-9.
52. Anderson PM, Kristin FB, Phillip BL. Economic perspectives on childhood obesity. Chicago Federal Reserve Bank, *Economic Perspectives* 2003; 27(3):30-48.
53. Duncan SC, Duncan TE, Strycker LA. Sources and types of social support in youth physical activity. *Health Psychol*. 2005; 24:3-10.