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Bariatric surgery: is it reasonable before the age of 16?

Cirurgia bariátrica: é razoável antes dos 16 anos de idade?

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A B S T R A C T

Objective: *to assess the severity of obesity in children and adolescents through the presence of comorbidities and the potential indication of bariatric surgery.* **Methods**: *we conducted a cross-sectional study with clinical and laboratory data of the first consultation of patients at the childhood obesity clinic at a tertiary hospital from 2005 to 2013. We divided the patients into groups with or without potential indication for surgery, and recorded age, gender, birth weight, age of obesity onset, BMI Z score, presence of acanthosis nigricans, blood pressure, total cholesterol and fractions, triglycerides, blood glucose and fasting insulin, HOMA1-IR, CRP and ESR. The group with potential indication for surgery included: BMI > 40 or between 35-40 with comorbidities (Triglycerides >130mg/dl, glucose levels >100mg/dl, HOMA1-IR >3.16, Total Cholesterol >200mg/dl, LDL >130mg/dl and HDL <45mg/dl), regardless of age, epiphysis consolidation and previous treatment.* **Results**: *of the 296 patients included in the study, 282 (95.3%) were younger than 16 years. The most frequent change was the HDL (63.2%), followed by HOMA1-IR (37.5%). Of the group of 66 patients with potential indication for surgery (22.3%), only ten (15.1%) had more than 16 years. Acanthosis nigricans, the average HOMA1-IR, insulin, CRP, ESR, age, BMI Z score and systolic and diastolic blood pressure were significant in the group with potential surgical indication.* **Conclusion**: *bariatric surgery might be indicated by BMI and comorbidities in children and adolescents under 16 years.*

Keywords: *Pediatric obesity. Child. Adolescent. Bariatric surgery.*

INTRODUCTION

In the last 50 years, there have been changes in the profile of health problems in children and adolescents and, in this context, obesity has emerged as a pandemic disease of high prevalence and morbidity[1]. After nearly three decades of alarming increase in its prevalence in the world, the latest studies in developed countries show a trend of stabilization, but with worsening severity[2-4]. In some developing communities, where we observe the coexistence of growth delay and obesity, it is believed that this population is changing from malnutrition to excess weight, without going through eutrophy[5]. In Brazil, after the measures of social inclusion, there was decrease in the levels of poverty and malnutrition. On the other hand, new challenges emerged, as the increase of overweight, currently three times greater than malnutrition[6]. The latest data show increased prevalence in all age groups, a little lower in children under five years, and in both genders[6,7].

Despite numerous efforts, the difficulty in combating obesity is evident, due to it highly complex etiology and pathophysiology. When present in children and adolescents, it causes a negative impact on the secular increase in life expectancy[8], as well as commitment in the psychological domain[9,10], becomes persistent in adulthood[11] and predisposes to the occurrence of premature death from endogenous causes (insulin resistance and hypertension)[12].

In view of this, various forms of treatment have been studied, the main and initial one being the recommendations for change in lifestyle, including decreased caloric intake, increased energy expenditure and psychological evaluation with emphasis on individual, family, school and community. However, in practice the long-term results are not very encouraging[10,13,14]. Drug treatment, little used and contraindicated in children, also does not show good results[10,15]. Due to the increased severity of cases and the positive results obtained with bariatric surgery in adults, both in relation to weight loss as the correction of comorbidities, indications in adolescents, initially restricted to the most serious patients with complete pubertal development, is becoming most studied[11,13].

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However, it is important to note that the surgical option is an aggressive and controversial treatment in this age group, mainly due to the physical, psychological and metabolic changes[16,17].

Given these considerations, this study aims to assess the severity of obesity in children and adolescents referred to the outpatient clinic of a tertiary hospital, through the presence of comorbidities and the potential for bariatric surgery indication.

METHODS

This is a cross-sectional study based on data from the first patient consultation at the Referenced Multidisciplinary Clinic for Obesity in Children and Adolescents of the Clinics Hospital of the Campinas State University (UNICAMP), from 2005 to 2013. After exclusion of patients with a genetic syndrome, renal, hepatic or endocrine disease, continuous use of psychoactive drugs and/or oral corticosteroids and physical disabilities that prevented the realization of anthropometry, we included 333 patients. We recorded the following data from the first consultation: date of birth, obesity onset age, birth weight, weight and height, body mass index (BMI), BMI Z score[18], presence of acanthosis *nigricans*, blood pressure (BP), systolic and diastolic.

We also evaluated the first laboratory tests: total cholesterol and fractions (LDL and HDL), triglycerides, fasting glucose, insulin, C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR). These tests were performed by the UNICAMP Clinics Hospital central laboratory. We calculated the HOMA1-IR index by the following formula[19]: fasting insulin (mU/l) x fasting glucose (mmol/l) / 22.5.

In 2013, The Brazilian Ministry of Health published a decree allowing bariatric surgery from the age of 16 up, using as criteria, in addition to BMI, the presence of comorbidities, clinical treatment failure (for at least two years) and the consolidation of growth epiphyses [20]. In this study, the classification of patients with potential indication for bariatric surgery was based on BMI values of the International Pediatric Endosurgery Group (IPEG)[21] and on the American standards[18], which are the same for adults determined by the Brazilian Ministry of Health [20]. Therefore, we divided patients into BMI <35, BMI between 35-40 and BMI >40. We included in the group with potential surgical indication (G2) patients with BMI >40 or BMI between 35-40 with comorbidities. We considered the following as comorbidities: triglycerides >130mg/dl, total cholesterol >200mg/dl, LDL cholesterol >130mg/dl, HDL cholesterol <45mg/dl, blood glucose >100mg/dl and HOMA1-IR >3.16.

After splitting into groups without (G1) or with (G2) potential surgical indication, we performed the analysis of variables, both clinical (age, gender, birth weight, obesity onset age, BMI Z score, presence of acanthosis *nigricans* and BP) and laboratorial (total cholesterol and its fractions, triglycerides, blood glucose and fasting insulin, HOMA1-IR, CRP and ESR).

For the evaluation of non-numeric variables, we used the chi-square test, and for numeric variables, the Student's t test, since all were normally distributed (Kolmogorov-Smirnov). The data were stored and organized in the computer program SPSS 16.0. We considered α <0.05.

The work was approved by the Ethics in Research Committee (CEP) of the Faculty of Medical Sciences (FCM) of Unicamp, № 376,289, on August 27, 2013.

RESULTS

The distribution of frequency, mean and standard deviation of clinical and laboratory variables are shown in Table 1. There was difference in the frequency due to lack of information in the medical records. Of the 333 patients, we excluded 37 (11.1%) due to lack of at least one result of laboratory tests. Of the 296 remaining, 152 (51.4%) were male, 282 (95.3%) were under 16 and 47 (15.9%) had normal laboratory tests. Of those with normal laboratory tests, 45 (95.7%) had a BMI <35, two (4.3%), BMI 35-40, and none, BMI >40 (Table 2).

The distribution of comorbidities according to the BMI is shown in Table 2. The most frequent alteration was HDL cholesterol <45mg/dl in 187 (63.2%) individuals, followed by HOMA1-IR >3.16 in 111 (37.5%). We detected the presence of two comorbidities in 90 (30.4%) patients, and the presence

Table 1. Distribution of frequency, mean and standard deviation (SD) of the studied clinical and laboratory variables.

Variables	N (%)	Mean (SD)
Age (years)	333 (100)	10.53 (3.53)
Birth weight (g)	235 (70.6)	3.38 (0.63)
Age (years)	262 (78.7)	4.10 (3.09)
BMI Z score	329 (98.8)	2.49 (0.59)
Diastolic BP (mmHg)	318 (95.5)	73.63 (11.72)
Systolic BP (mmHg)	318 (95.5)	115.11 (16.23)
Blood glucose (mg/dl)	289 (86.8)	83.20 (7.16)
Insulin (μ IU/ml)	264 (79.3)	16.55 (12.08)
HOMA1-GO	254 (76.3)	3.45 (2.76)
Total cholesterol (mg/dl)	292 (87.7)	163.07 (33.70)
LDL cholesterol (mg/dl)	284 (85.3)	99.14 (31.71)
HDL cholesterol (mg/dl)	287 (86.2)	43.28 (9.95)
Triglycerides (mg/dl)	292 (87.7)	112.14 (56.53)
CRP (mg/dl)	131 (39.3)	0.65 (1.51)
ESR (mm/h)	115 (34.5)	20.04 (15.29)

of three comorbidities in 55 (18.6%). Only the HOMA1-IR showed statistical difference between normal and abnormal values and BMI.

Of those with normal laboratory tests, 45 (95.7) had a BMI <35, two, BMI 35-40, and none, BMI >40 (Table 3). Of the total, 66 (22.3%), at the first visit, already had potential indication for bariatric surgery (BMI between 35 and 40 with one or more abnormal laboratory tests or BMI >40 – group with potential surgical indication), yet only ten (15.1%) of these had more than 16 years (Table 3).

The comparison of clinical and laboratory data between the group without indications for bariatric surgery (G1) and the group with potential indication (G2) is shown in Table 4. In clinical analysis, we found that the average age (p=0.006), the BMI Z score (p=0.005) and the systolic and diastolic BP measurements (p=0.000) were significant in the group with potential surgical indication, as well as the presence of acanthosis nigricans (p=0.006). Among the laboratory variables, the mean HOMA1-IR (p=0.000), insulin (p=.000), CRP (p=0.012) and ESR (p=0.013) were also significantly higher in this group. The other variables did not differ.

DISCUSSION

This study revealed the severity of the patients coming to primary care in this specialized clinic due to the large number of comorbidities. It also showed that about a quarter of these patients, regardless of age, presence of epiphyseal consolidation or prior treatment, prerequisites determined by the health ministry, had potential indication for bariatric surgery. Of these, only ten (15.1%) were in the age range recommended by the Brazilian Ministry of Health, over 16 years. However, it is important to note that BMI increases with age since four to five years old, which may underestimate the actual number of patients with potential surgical indication in this study. Teens that have a BMI greater than or equal to 35 over 12 years of age are approximately in the 99th percentile or above, a percentile that is associated with increased metabolic risk. For this reason, the BMI of 35 is used as the minimum cutting value for the indication of bariatric surgery[18,21]. Another alarming fact showing the seriousness of these patients is that most (61.8%) individuals who were not included in the group with potential indication for bariatric surgery due to BMI <35 already had one or more abnormal laboratory tests at the first outpatient visit.

Table 2. Distribution of the 249 patients with one or more altered laboratory tests according to the body mass index (BMI).

Laboratory Exams		BMI			p
		< 35	35-40	> 40	
		N (%)	N (%)	N (%)	
CT	Normal	194 (86.2)	37 (92.5)	21 (77.8)	0.228
	Altered	31 (13.8)	3 (7.5)	6 (22.2)	
LDL	Normal	185 (84.9)	34 (87.2)	22 (81.5)	0.817
	Altered	33 (15.1)	5 (12.8)	5 (18.5)	
HDL	Normal	82 (37.1)	9 (23.1)	9 (33.3)	0.234
	Altered	139 (62.9)	30 (76.9)	18 (66.7)	
TGL	Normal	161 (86.2)	27 (92.5)	18 (77.8)	0.785
	Altered	64 (28.4)	13 (32.5)	9 (33.3)	
Homa 1-GO	Normal	129 (66.5)	9 (27.3)	5 (18.5)	0.000
	Altered	65 (33.5)	24 (72.7)	22 (81.5)	
2 alterations	No	118 (64.7)	22 (59.5)	19 (65.6)	0.898
	Yes	65 (35.3)	15 (40.5)	10 (34.4)	
3 or + alterations	No	147 (80.3)	27 (73.0)	20 (69.0)	0.264
	Yes	36 (19.7)	10 (27.0)	9 (31.0)	

Reference values for changed: CT = total cholesterol >200 mg/dl; LDL = LDL cholesterol >130mg/dl; HDL = HDL cholesterol <45 mg/dl; TGL = Triglycerides >130mg/dl; HOMA1-GO >3.16.

In line with the literature, we found that patients with higher BMI had a higher number of comorbidities. This points to the severity of the condition, because, as discussed by Salawi *et al*., in 2014[22], in a Canadian study, comorbidities in children evolve faster and more severely than in adults. Still, the same study found that obese patients who come to the health facility seeking treatment already have clinical and laboratory severity criteria since the first approach by the medical team, which includes the presence of many comorbidities. The same could be observed in this study, in which many patients referred to the basic sectors of the health system have reached the specialized clinic for obesity in children and adolescents with several comorbidities.

The mostly observed comorbidities in the group with potential surgical indication were increased systolic and/or diastolic blood pressure, insulin resistance and dyslipidemia (primarily increased triglycerides). Regarding acanthosis *nigricans*, its significant presence in the group with surgical potential corroborates its importance in the clinical diagnosis of insulin resistance in obese children and adolescents, also evidenced by abnormal laboratory values of insulin and HOMA1-IR. As for the significant number of patients with altered ESR and PCR, this datum suggests the association of obesity with inflammatory disease, which strengthens the hypothesis of its involvement in diseases such as asthma and cancer, for example[23,24].

In the current context of obesity in children and adolescents, the initial therapy for all patients should include changes in measures of lifestyle, with multidisciplinary team for at least two years[10,13,15]. So far, though, long-term studies have found failure to reduce BMI, especially in older children and with higher BMI[10,15,25]. Drug treatment also does not show good results and few drugs are released. Bariatric surgery, even being an aggressive and controversial procedure, has been increasingly performed in younger patients[13,16,25].

Table 3. Distribution of the 296 children and adolescents according to the presence of comorbidities and minimum age (16 years) for potential indication of Bariatric Surgery according to BMI.

BMI	Without Comorbidities			With Comorbidities		
	<16a	>16a	Total	<16a	>16a	Total
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
<35	43 (14.5)	2 (0.7)	45 (15.2)	181 (61.1)	2 (0.7)	183 (61.8)
35-40	2 (0.7)	0	2 (0.7)	35 (11.8)	2 (0.7)	37 (12.5)
>40	0	0	0	21 (7.1)	8 (2.7)	29 (9.8)

Bariatric surgery began to be carried out in adults in 1960, and two decades ago also in adolescents[26]. To date, three surgical techniques have been widely studied, with different results and complications: adjustable vertical band, sleeve gastrectomy, and Roux-en-Y gastric bypass. According to the technique, the decrease in weight after surgery can vary between 58 and 73% of adolescents, with a greater chance of the patient reaching a BMI within normal values the lower the baseline BMI. Regarding comorbidities, long-term studies in this age group are still few, but early studies suggest improvements in psychological and cardiovascular risk. Mortality due to the surgical risk is low, as well as the lower length of stay and the risk of cholelithiasis and "dumping". Among surgical complications, nutritional deficiencies of vitamins and minerals and the loss of bone mass in younger age groups should be well studied, even as supplementation should be long-term and observed less adherence to treatment from[16,25-27]. As for the loss of bone mass, this may be more relevant in adolescence, since the peak bone mineral density occurs at 20 years of age[25,28].

Beyond these considerations, studies indicating who would be the ideal patient to undergo bariatric surgery are still scarce, especially in children and adolescents. Among the difficulties, there is the need for a careful assessment of the mental health of patients prior to surgery in an attempt to identify those with disorders like depression, anxiety, drug abuse, compulsory feeding and provocation of vomiting. However, no one knows for sure if these changes are related or not to obesity. Thus, it becomes difficult to determine whether bariatric surgery would bring advantages and disadvantages in this regard. Therefore, it is essential that the initial treatment include a family approach, both for the procedure indication and for the discussion about the possible results and subsequent follow-up[25,27].

Finally, for surgery indication, besides considering the child's BMI and age, studies reinforce the importance of assessment of pubertal development (Tanner stages IV to V), skeletal maturity (at least 95%), previous treatment with changes in lifestyle habits (importance of diet and physical activity), psychological development (mature decision), social and family support and understanding of nutritional supplementation[13,21,25]. Therefore, it is important to note that the treatment of obesity in adolescents with bariatric surgery is complex. One must take factors into consideration, such as prior assessment of the patient by a multidisciplinary team, choosing the best age, surgical technique to be employed, diagnosis and monitoring of comorbidities, understanding of long-term follow-up by the patient and the family and informed consent, as it is a procedure that causes various biological and psychosocial effects[13,25,29].

Brazilian studies on bariatric surgery in this age group are few. Velhote, in 2007[30], studied the evolution after one year of eight teenagers from ten to 19 years with a BMI >40, operated by adaptive gastro-entero-omentectomy technique with intestinal reserve (GARI). Ferraz *et al*., in 2015[31], studied 20 patients with a mean age of 18.1 years, who underwent Roux-en-Y gastric bypass after a multidisciplinary clinical follow-up. In both studies, they observed large weight loss, reduction of comorbidities, low rates of complications and no deaths.

This study has some limitations due to being a cross-sectional chart review. In addition, there are few studies in the literature for comparison, which limited

Table 4. Comparison of clinical and laboratory variables between groups without (G1) and with (G2) potential surgical indication.

Variables	Groups	N	Mean	SD	p
Gender	G1	F = 110 M = 120			0.597
	G2	F = 34 M = 32			
Age (years)	G1	230	9.79	3.38	0.000
	G2	66	13.09	2.93	
Birth weight (g)	G1	161	3380.55	660.45	0.582
	G2	48	3438.75	578.11	
Age (years)	G1	181	3.91	2.91	0.109
	G2	53	4.66	3.25	
BMI Z score	G1	226	2.44	0.64	0.005
	G2	66	2.68	0.33	
Acanthosis *Nigricans*	G1	A = 46 P = 91			0.006
	G2	A = 6 P = 41			
Diastolic BP (mmHg)	G1	218	71.62	10.09	0.000
	G2	66	80.86	12.85	
Systolic BP (mmHg)	G1	218	111.17	14.02	0.000
	G2	66	128.08	16.82	
Blood glucose (mg/dl)	G1	223	71.62	7.21	0.439
	G2	66	83.80	7.01	
Insulin (µ IU/ml)	G1	197	14.35	11.43	0.000
	G2	58	23.79	11.64	
HOMA1-GO	G1	196	3.01	2.69	0.000
	G2	58	4.93	2.51	
Total cholesterol (mg/dl)	G1	227	163.59	33.03	0.624
	G2	65	161.26	36.15	
LDL cholesterol (mg/dl)	G1	219	99.51	30.47	0.723
	G2	65	97.92	35.81	
HDL cholesterol (mg/dl)	G1	222	43.60	10.52	0.303
	G2	65	42.15	7.69	
Triglycerides (mg/dl)	G1	227	109.37	55.65	0.118
	G2	65	121.80	58.96	
CRP (mg/dl)	G1	100	0.48	0.89	0.012
	G2	26	1.33	2.84	
ESR (mm/h)	G1	94	18.38	13.70	0.013
	G2	21	27.48	19.73	

G1 = without surgical potential, G2 = with surgical potential, F = female, M = male, A = absent, P = present, SD = Standard Deviation.

the results' analysis of. However should note that the project was carried out with data from the first visit to the Obesity Multidisciplinary Reference Clinic, which meant that the study sample was invariably composed of more serious patients than those seen in the primary care network, and this severity was evaluated through the potential indication of bariatric surgery.

The study revealed that a significant percentage of children and adolescents already has very high BMI, associated with high prevalence of comorbidities and consequent potential indication of bariatric surgery, regardless of age, which makes us think about the best way of monitoring and management of this population.

R E S U M O

Objetivo: avaliar a gravidade da obesidade em crianças e adolescentes pela presença de comorbidades e pela potencial indicação de cirurgia bariátrica. **Métodos:** estudo transversal com dados clínicos e laboratoriais da primeira consulta de pacientes do ambulatório de obesidade infantil em um hospital terciário no período de 2005 a 2013. Os pacientes foram divididos em grupos com ou sem potencial indicação cirúrgica, e associados com idade, sexo, peso de nascimento, idade de início da obesidade, escore z de IMC, presença de acantose *nigricans,* pressão arterial, colesterol total e frações, triglicérides, glicemia e insulina de jejum, HOMA1-IR, PCR e VHS. O grupo com potencial indicação cirúrgica incluiu: IMC >40 ou IMC entre 35-40 com comorbidades (Triglicérides >130mg/dl, Glicemia >100mg/dl, HOMA1-IR >3,16, Colesterol total >200mg/dl, LDL >130mg/dl e HDL <45mg/dl), independente da idade, consolidação das epífises e tratamento prévio. **Resultados:** de 296 pacientes incluídos no estudo, 282 (95,3%) tinham menos de 16 anos. A alteração mais frequente foi a do HDL (63,2%), seguido do HOMA1-IR (37,5%). Do grupo de 66 pacientes com potencial indicação cirúrgica (22,3%), apenas dez (15,1%) tinham mais de 16 anos. Acantose *nigricans*, as médias de HOMA1-IR, insulina, PCR, VHS, idade, escore z de IMC e pressões sistólica e diastólica foram significantes no grupo com potencial indicação cirúrgica. **Conclusão:** os resultados sugerem que a cirurgia bariátrica, poderia estar indicada pelo IMC e presença de comorbidades, em crianças e adolescentes com menos de 16 anos.

DESCRITORES: Obesidade Pediátrica. Criança. Adolescente. Cirurgia Bariátrica.

REFERENCES

1. Sabin MA, Kao KT, Juonala M, Baur LA, Wake M. Viewpoint article: childhood obesity--looking back over 50 years to begin to look forward. J Pediatr Child Health. 2015;51(1):82-6.
2. Olds T, Maher C, Zumin S, Péneau S, Lioret S, Castetbon K, et al. Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. Int J Pediatr Obes. 2011;6(5-6):342-60.
3. Ogden C, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA. 2014;311(8):806-14.
4. Skinner AC, Skelton JA. Prevalence and trends in obesity and severe obesity among children in the United States. JAMA Pediatr. 2014;168(6):561-6.
5. Lobstein T, Jackson-Leach R, Moodie ML, Hall KD, Gortmaker SL, Swinburn BA, et al. Child and adolescent obesity: part of a bigger picture. Lancet. 2015;385(9986):2510-20.
6. Conde WL, Monteiro CA. Nutrition transition and double burden of undernutrition and excess of weight in Brazil. Am J Clin Nutr. 2014;100(6):1617S-22S.
7. IBGE. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares. Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil [Internet]. Rio de Janeiro: IBGE; 2008-2009. [cited 2010 set 1]. Available from: http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pof/2008_2009/default.shtm.
8. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, et al. A potential decline in life expectancy in the United States in the 21st century. New Engl J Med. 2005;352(11):1138-45.
9. Sinha A, Kling S. A review of adolescent obesity: prevalence, etiology, and treatment. Obes Surg. 2009;19(1):113-20.
10. Daniels SR, Arnett DK, Eckel RH, Gidding SS, Hayman LL, Kumanyika S, et al. Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. Circulation. 2005;111(15):1999-2012.
11. Inge TH, Jenkins TM, Zeller M, Dolan L, Daniels SR, Garcia VF, et al. Baseline BMI is a strong predictor of nadir BMI after adolescent gastric bypass. J Pediatr. 2010;156(1):103-8.
12. Franks PW, Hanson RL, Knowler WC, Sievers ML, Bennett PH, Looker HC. Childhood obesity, other cardiovascular risk factors, and premature death. New Engl J Med. 2010;362(6):485-93.

13. Pratt JS, Lenders CM, Dionne EA, Hoppin AG, Hsu GL, Inge TH, et al. Best practice updates for pediatric/adolescent weight loss surgery. Obesity. 2009;17(05):901-10.
14. Han JC, Lawlor DA, Kimm SY. Childhood Obesity. Lancet. 2010; 375(9727):1737-48.
15. Reinehr T. Lifestyle intervention in childhood obesity: changes and challenges. Nat Rev Endocrinol. 2013;9(10):607-14.
16. Vilallonga R, Yeste D, Lecube A, Fort JM. [Bariatric surgery in adolescents]. Cir Esp. 2012;90(10):619-25. Spanish.
17. Godoy-Matos AF, Guedes EP, Souza LL, Martins MF. Management of obesity in adolescents: state of art. Arq Bras Endocrinol Metab. 2009; 53(2):252-61.
18. Centers for Disease Control and Prevention. Childhood obesity facts [Internet]. Atlanta (GA): National Center for Chronic Disease Prevention and Health Promotion (US); 2010 [updated 2014 Aug 27; cited 2015 Jan 14]. Available from: http://www.cdc.gov/HealthyYouth/obesity
19. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia. 1985;28(7):412-9.
20. Brasil. Ministério da Saúde. Portaria nº 424, de 19 março de 2013. Redefine as diretrizes para a organização da prevenção e do tratamento do sobrepeso e obesidade como linha de cuidado prioritária da Rede de Atenção à Saúde das Pessoas com Doenças Crônicas [Internet]. Brasília (DF): Ministério da Saúde; 2013 Mar 19 [cited 2015 Jan 15]. Available from: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2013/prt0424_19_03_2013.html
21. International Pediatric Endosurgery Group (IPEG). IPEG guidelines for surgical treatment of extremely obese adolescents. J Laparoendosc Adv Surg Tech A. 2009;Suppl 1:xiv-xvi.
22. Salawi HA, Ambler KA, Padwal RS, Mager DR, Chan CB, Ball GDC. Characterizing Severe Obesity in Children and Youth Referred for Weight Management. BMC Pediatrics. 2014;14:154.
23. Camilo DF, Ribeiro JD, Toro ADC, Baracat ECE, Barros Filho AA. Obesidade e asma: associação ou coincidência? J Pediatr. (Rio J). 2010;86(1):6-14.
24. Lashinger LM, Ford NA, Hursting SD. Interacting inflammatory and growth factor signals underlie the obesity-cancer link. J Nutr. 2014;144(2):109-13.
25. Hsia DS, Fallon SC, Brandt ML. Adolescent bariatric surgery. Arch Pediatr Adolesc Med. 2012;166(8):757-66.
26. Stefater MA, Jenkins T, Inge TH. Bariatric surgery for adolescents. Pediatric Diabetes. 2013;14(1):1-12.
27. Davies DA, Hamilton J, Dettmer E, Birken C, Jeffery A, Hagen J, et al. Adolescent bariatric surgery: the Canadian perspective. Semin Pediatr Surg. 2014;23(1):31-6.
28. Kelly TL, Wilson KE, Heymsfield SB. Dual energy X-Ray absorptiometry body composition reference values from NHANES. PLoS One. 2009;4(9):e7038.
29. Kelly AS, Barlow SE, Rao G, Inge TH, Hayman LL, Steinberger J, et al. Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. Circulation. 2013;128(15):1689-712.
30. Velhote MCP. Tratamento cirúrgico da obesidade na adolescência: resultados iniciais [dissertação]. São Paulo: Faculdade de Medicina da Universidade de São Paulo; 2007.
31. Ferraz AAB, Siqueira LT, Noronha CG, Holanda DBR, Araújo Júnior JGC, Muniz MC. Tratamento cirúrgico da obesidade severa em adolescentes: resultados tardios. Arq Bras Cir Dig. 2015;28(Supl 1):7-10.

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