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RESEARCH PAPER

Lifestyle factors and socioeconomic variables associated with abdominal obesity in Brazilian adolescents

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***Background and aims*: Lifestyle variables have a key role in the development of abdominal obesity (AO). The objective of this study was to identify lifestyle factors and socioeconomic variables associated with AO in adolescents.**
***Methods and results*: This study carried out a school-based survey in the Brazilian city of Maringá in Paraná. The representative sample was of 991 adolescents (54.5% girls) from both public and private high schools selected through multi-stage random sampling. AO was classified according to waist circumference value. The independent variables studied were: gender, age, socioeconomic level, parental and household characteristics, smoking, alcohol use, physical inactivity, sedentary behaviour and nutrition-related habits. Poisson regression was used with robust variance adjustment to analyse the associations. The analysis was stratified by sexes. The prevalence of AO was 32.7% (girls = 36.3%, boys = 28.4%). In girls, excessive intake of fried foods was inversely associated with AO and excessive consumption of soda was positively associated. In boys, the results demonstrated a negative association with excessive consumption of sweets and soda.**
***Conclusion*: It is concluded that the prevalence of AO among adolescents was higher in both sexes. AO is associated with different eating habits in females and males and these relationships are mediated by familial contexts.**

Keywords: Adolescents, obesity assessment, waist circumference, cross-sectional study, low- and middle-income countries

INTRODUCTION

The paediatric obesity epidemic has grown significantly over the last three decades (Lobstein et al. 2004). According to the National Center for Health Statistics (NCHS) reported by Ogden et al. (2012), one in five American children are overweight. In Brazil, the increase in prevalence of overweight children has risen over 200% in the last three decades and it is estimated that ~ 18% of the boys and 15% of the girls who are overweight will be obese (Wang et al. 2002). This increase is a problem for the healthcare system, given that being overweight is directly associated with an increased risk for metabolic complications (Ferreira et al. 2007; de Moraes et al. 2009). The aetiology of obesity springs from the presence and/or grouping of behavioural and biological risk factors inherent to the individual and community in which this individual is integrated (socio-economic, environmental, cultural and urban conditions) (Egger and Swinburn 1997).

In epidemiological studies, anthropometry has been considered an efficient method for diagnosis of obesity (Mercer et al. 2004; Nagy et al. 2008). The body mass index (BMI) has been used frequently in studies as an indicator of general obesity and recommended by an expert committee on paediatric obesity. On the other hand, waist circumference (WC) has been used as an indicator of abdominal obesity (AO), with high sensitivity and specificity (Karelis et al. 2004). This indicator has been presenting more accurate positive associations with cardiovascular risk factors and is more accurate than the BMI (Després and Lemieux 2006; de Almeida et al. 2007).

Abdominal obesity is a component of metabolic syndrome according to the criterion of the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III) (2001). Nevertheless, the prevalence of AO and the analysis of the association of this outcome with modifiable risk behaviour are scarce in developing countries. It is therefore essential to try to identify and analyse which

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variables are most significant in the development of this condition in this population.

Thus, the aims of this study were: (i) to investigate the current prevalence of AO in a sample of adolescents living in Maringá, Brazil; and (ii) to identify the lifestyle behaviours associated with an increased risk of abdominal obesity in young Brazilians.

METHODS

This school-based survey was carried out in the city of Maringá, which has 326 000 inhabitants and is located in the northwest region of the state of Paraná, in the southern reaches of Brazil. The city's Human Development Index is high (HDI = 0.84; while the overall HDI value for Brazil is 0.79) (UN 2007). After having received a formal request and information on this study's importance, objectives and methodology, the board of each selected school granted consent for this study to be conducted.

This study was approved by the Ethics Committee on Research Involving Human Participants of the University Center of Maringá and was authorized by the Ethics Committee on Research Projects of the University of São Paulo's *Hospital das Clínicas* in accordance with Brazilian laws. All students from selected groups who were present on the day of data collection were considered eligible to participate in the study after their parents or guardians had given written consent in addition to the students' verbal consent.

Sample size

The complete methodology of this study has been described in an earlier study (Moraes et al. 2011). Briefly, the study population included adolescents from 14–18 years of age, of both sexes, enrolled in public or private high schools in 2007. In the sample process, population and schools (public and private) were used for each stratum and data were obtained from the State Department of Education of Paraná and the Union of Private Schools of Maringá, PR (Secretaria de Estado Educação do Paraná 2007).

The sample was obtained via a classroom selection process divided into two stages: by school categories (primary sampling unit) and by classrooms. Schools were classified into two categories: public ($n = 26$) and private ($n = 12$). In the first stage, in which eight public and four private schools were selected, schools were randomly selected with respect to the proportional probability of population in each high school stratum. In the second stage, classrooms were selected by simple random sampling; their number was proportional to the population of students in each grade (10^{th}–12^{th} grade). Exclusion criteria were: adolescents with orthopaedic problems that prevented anthropometric assessments; no parental consent; or adolescent pregnancy.

Variables

Data were collected by a team of four interviewers. This research was conducted by A.C. de Moraes, in a 40-hour training session to standardize the questionnaires and anthropometric assessments.

Outcome

Abdominal obesity was the outcome of this study. To classify this, WC was measured using a metal tape measure (nearest centimetre) at the mid-point between the iliac crest and last rib (de Onis et al. 2004). The values considered acceptable for intra-observer and inter-observer variability were 1.0% and 1.5%, respectively, according to the WHO guideline (de Onis et al. 2004). The diagnosis of AO (non-obese and obese) was based on cut-off points developed for adolescents by Taylor et al. (2000), because there has been no standardization of cut-off points for this outcome or locale (Brazil) and, according to a review conducted by this group (de Moraes et al. 2011), these cut-off points are used and an appropriate statistical method showed that sensitivity and specificity for determining the cut-off point.

Independent variables

The independent variables investigated were: gender, age, socioeconomic status [Brazil Criterion of Economic Classification (ABEP 2006), which divides families into five groups, where 'A' is the highest income bracket]. In this analysis the levels were dichotomized into high (A + B + C) and low (D + E) and mother's employment (yes or no), adolescent's formal employment (yes or no), living with parents [yes or no (including with grandparents, alone, hostel, husband and/or wife)] and lifestyle behaviours. The lifestyle behaviour measurements were: *tobacco smoking* (smokers were defined as those who had ever smoked at least one cigarette per day for at least 1 month (Malcon et al. 2003)), *regular alcohol use* (drinkers were defined as those who habitually consumed at least one drink per week for at least 1 month (Strauch et al. 2009)), *insufficient physical activity* (minutes/day, physical activity data collected by questionnaire for adolescents (Arvidsson et al. 2005), defined as < 60 minutes/day of moderate to vigorous-intensity physical activity (Strong et al. 2005)), *sedentary behaviour* (hours per day spent in front of the television/computer/games) and *nutrition-related habits* (NRH) (World Health Organization 2004). The questionnaire was translated and modified for Brazilian dietary habits (Government 2007), after being submitted to a reliability study of Brazilian adolescent students (Romanzini et al. 2008). For example, the question 'How often do you usually eat fruit in a normal week?' assessed fruit consumption. No specific amount was recorded, therefore only data collected were used to assess the frequency of weekly consumption of each food group: fruit, vegetables, sweet food (cakes, biscuits and sweets), fried food and soda (in reference to a normal week). The consumption of food groups was classified according to recommendations by the Brazilian Ministry of Health (Brazilian Ministry of Health 2007).

Statistical analyses

Data were entered twice in an Epi-Info database with automatic checks for consistency and range. Data cleaning

Table I. Characteristics of the sample in prevalence (%) or mean according to sex among adolescents in Maringá/PR, Brazil (2007).

Variables	Female ($n = 540$)		Male ($n = 451$)		p-value
	mean	%	mean	%	male vs female
Age (years)	16.2		16.4		0.030[b]
Socioeconomic status[a]					0.043[d]
A (richest)		13.7		14.6	
B		50.0		55.7	
C		28.5		25.7	
D + E (poorest)		7.8		4.0	
Public school		71.1		63.6	0.012[e]
Living with parents		89.8		91.8	0.285[b]
Mother employment		69.7		62.4	0.016[e]
Adolescent employment		13.5		26.8	<0.001[e]
Weekly consumption frequency					
Vegetables (≤4 days/week)		59.6		68.7	0.003[e]
Fruit (≤4 days/week)		58.2		68.3	<0.001[e]
Sweet food (>4 days/week)		74.8		67.6	0.013[e]
Fried food (>4 days/week)		62.2		67.6	0.083[e]
Soda (>4 days/week)		68.3		72.1	0.211[e]
Alcohol consumption		29.4		26.8	0.495[e]
Tobacco smoking		5.2		6.4	0.402[e]
Physical activity level (minutes/day)	353.8		436.3		0.001[c]
Insufficient physical activity (<60 minutes/day)		57.9		56.0	0.461[e]
Sedentary behaviour (hours/day)	7.1		6.0		<0.001[c]
Waist circumference (cm)	77.3		78		<0.001[b]
Abdominal obesity		36.3		28.4	0.008[e]

[a] Brazilian economic classification criteria according to the Brazil Criterion of Economic Classification; [b] Unpaired t-test; [c] Mann-Whitney test; [d] Chi-square test for linear trend; [e] Chi-square test with Yates correction.

and analyses were carried out using Stata 11.0 software (STATA Corp., College Station, TX). Initially, to compare the dependent and independent variables between the sexes, for continuous variables we used the unpaired t-test and Mann-Whitney test and for categorical variables we used the chi-square test for linear trend and the chi-square test with Yates correction. Then we analysed the proportion of obese adolescents according to each independent variable. Adjusted analyses were calculated using the Poisson regression with robust variance adjustment, which is recommended for high prevalence outcomes (Coutinho et al. 2008), with a confidence interval of 95% (CI95%) calculated for the prevalence ratio (PR). The adjusted analysis was stratified by gender and performed according to a hierarchical framework previously separated into three levels: (1) age and socioeconomic status; (2) living with parents and employment; and (3) lifestyle behaviours. In this model, the variables were controlled for those of the same or higher levels (Victora et al. 1997). For a variable to be retained in the model, the significance level was set at $p < 0.20$. The *Wald* test for heterogeneity was used to check the significance level (5% alpha) of dichotomous variables and the linear trend was used for ordinal categorical variables. All analyses were adjusted for the clustered nature of the sample using the Stata 'svy' set of commands.

RESULTS

The number of adolescents selected from public and private schools was 774 and 492, respectively. The loss of potential subjects, including those who refused to participate, was anticipated in the research planning and fell within the projected parameters for sample size. The total loss was 275, 92 of whom were absent on the day of data collection (76.1% from public schools, $n = 70$) and 183 of whom either did not deliver the consent form or refused to participate in the research (82% from private schools, $n = 150$). Thus, the final sample consisted of 991 high school students, (67.7% students from public schools, $n = 671$).

Characteristics of the sample by gender are presented in Table I. For socio-demographic variables, significant differences were found between the sexes in average age, the prevalence of adolescents studying in public schools and that of adolescents who had jobs. For lifestyle factors, females presented a lower prevalence of inadequate eating of fruit and vegetables and a higher frequency of consuming sweets, as well as a higher number of hours spent in front of the television/videogame/computer screen and a lower level of physical activity than male adolescents.

Abdominal obesity was more prevalent among female adolescents. Based on these differences, analyses of associations between outcomes and independent variables were separated by gender.

Table II shows the prevalence of abdominal obesity and adjusted PR and respective 95% CI by independent variables for females. Sociodemographic variables associated with abdominal obesity were: age, employment of mothers and female adolescents. Lifestyle factors: only high consumption of sodas presented a positive association, while high consumption of sweets was negatively associated with AO.

Table III shows the prevalence of abdominal obesity and adjusted PR and respective 95% CI by independent variables for males. Adolescents who were employed were more likely to have abdominal obesity than their non-employed peers.

Table II. Prevalence (%) of abdominal obesity, adjusted prevalence ratio (PR) and their respective 95% confidence intervals (95% CI) according to the independent variables for females ($n = 540$), Maringá/PR, Brazil (2007).

		Abdominal obesity			
Level[a]	Variables	%	p-value	Adjusted PR (95% CI)	p-value[b]
1	*Age (years)*		0.038[d]		0.098
	14	52.0		1.00	
	15	41.0		0.78 (0.57–1.09)	
	16	28.1		0.51 (0.36–0.72)	
	17 and 18	37.9		0.80 (0.57–1.12)	
2	*Socioeconomic status*[c]		0.105[d]		0.132
	A (richest)	25.7		1.11 (0.72–1.71)	
	B	35.6		0.91 (0.59–1.41)	
	C	42.2		0.69 (0.40–1.19)	
	D + E (poorest)	38.1		1.00	
	Living with parents		0.336[e]		0.154
	Yes	36.7		1.00	
	No	32.7		0.77 (0.54–1.10)	
	Mother employment		0.003[e]		*0.001*
	No	45.1		1.00	
	Yes	32.5		*0.68 (0.55–0.85)*	
	Adolescent employment		0.005[e]		*0.001*
	No	34.1		1.00	
	Yes	50.7		*1.50 (1.18–1.88)*	
3	*Tobacco smoking*		0.560[e]		0.575
	No	36.3		1.00	
	Yes	35.7		1.15 (0.70–1.90)	
	Alcohol consumption		0.109[e]		0.084
	No	38.2		1.00	
	Yes	32.4		0.81 (0.63–1.03)	
	Insufficient physical activity (<60 minutes/day)		0.351[e]		0.788
	No	37.4		1.00	
	Yes	35.5		1.03 (0.81–1.31)	
	Sedentary behaviour (≥4 h/day)		0.424[e]		0.734
	No	37.8		1.00	
	Yes	36		0.94 (0.68–1.31)	
	Vegetables consumption (≤4 days/week)		0.316		0.509
	No	39.0		1.00	
	Yes	34.5		0.92 (0.73–1.17)	
3	*Fruit consumption (≤4 days/week)*		0.588		0.497
	No	35.0		1.00	
	Yes	37.3		1.08 (0.85–1.38)	
	Sweet food consumption (>4 days/week)		<0.001		*< 0.001*
	No	51.5		1.00	
	Yes	31.2		*0.57 (0.45–0.71)*	
	Fried food consumption (>4 days/week)		0.518		0.799
	No	38.2		1.00	
	Yes	35.1		0.97 (0.76–1.23)	
	Soda consumption (>4 days/week)		0.444		*0.029*
	No	33.9		1.00	
	Yes	37.4		*1.32 (1.02–1.70)*	
	Total	36.3			

Significant associations are in italics; [a] The effect of each variable on the outcome is adjusted for other variables in the same level or above in the hierarchical model; [b] Variables with $p = 0.2$ were excluded from the model; [c] Brazilian economic classification criteria according to the Brazil Criterion of Economic Classification; [d] Chi-square test for linear trend; [e] Chi-square test with Yates correction.

Only the high consumption of sweets was associated with the outcome and this was a negative association.

DISCUSSION

The prevalence of abdominal obesity and association of lifestyle and socioeconomic factors with this outcome were explored in this study. We found a high prevalence of abdominal obesity among adolescents and found also that nutrition-related habits and family context are associated with this outcome.

In epidemiological studies, anthropometry has been an effective method for diagnosing the nutritional status of children, adolescents and adults (Neovius et al. 2005; Moreira et al. 2008). In recent years there has been an increase in the number of studies on the prevalence of abdominal obesity which can be put down to the fact that abdominal obesity is part of two criteria used to diagnose metabolic syndrome NCEP-ATP III (2001) and the *International Diabetes Federation* (IDF) (Jolliffe and Janssen 2007), as well as new anthropometric has been proposed to assess the AO, such as waist circumference divided by height (Mokha et al. 2010).

Table III. Prevalence (%) of abdominal obesity, adjusted prevalence ratio (PR) and their respective 95% confidence intervals (95% CI) according to the independent variables for males ($n = 451$). Maringá/PR, Brazil (2007).

		Abdominal obesity			
Level[a]	Variables	%	*p*-value	Adjusted PR (95% CI)	*p*-value[b]
1	*Age (years)*		0.290[d]		0.274
	14	35.4		1.00	
	15	27.9		0.77 (0.46–1.28)	
	16	30.8		0.85 (0.51–1.39)	
	17–18	24.7		0.68 (0.40–1.15)	
2	*Socioeconomic status*[c]		0.357[d]		0.347
	A (richest)	27.8		0.92 (0.41–2.04)	
	B	25		1.06 (0.50–2.28)	
	C	29.1		1.17 (0.52–2.65)	
	D + E (poorest)	31.8		1.00	
	Living with parents		0.509[e]		0.825
	Yes	28.5		1.00	
	No	27		0.95 (0.54–1.66)	
	Mother employment		0.241[e]		0.406
	No	30.6		1.00	
	Yes	27.1		0.88 (0.65–1.19)	
	Adolescent employment		0.020[e]		*0.053*
	No	31.1		1.00	
	Yes	20.8		*0.68 (0.47–1.00)*	
3	*Tobacco smoking*		0.388[e]		0.605
	No	28.7		1.00	
	Yes	24.1		0.83 (0.42–1.64)	
	Alcohol consumption		0.197[e]		0.183
	No	27		1.00	
	Yes	31.4		1.23 (0.91–1.68)	
	Insufficient physical activity (<60minutes/day)		0.160[e]		0.075
	No	31		1.00	
	Yes	26.3		0.77 (0.58–1.02)	
	Sedentary behaviour (≥4 h/day)		0.135[e]		0.079
	No	23.9		1.00	
	Yes	29.9		1.40 (0.96–2.05)	
	Vegetables consumption (≤4 days/week)		0.156		0.543
	No	35.2		1.00	
	Yes	64.8		1.10 (0.80–1.52)	
	Fruit consumption (≤4 days/week)		0.322		0.201
	No	29.7		1.00	
	Yes	70.3		1.23 (0.89–1.70)	
	Sweet food consumption (>4 days/week)		0.013		*0.025*
	No	40.6		1.00	
	Yes	59.4		*0.71 (0.53–0.96)*	
	Fried food consumption (>4 days/week)		0.404		0.511
	No	33.6		1.00	
	Yes	66.4		1.11 (0.81–1.51)	
	Soda consumption (>4 days/week)		0.037		0.095
	No	34.4		1.00	
	Yes	65.6		0.77 (0.59–1.04)	
	Total	28.4			

Significant associations are in italics; [a] The effect of each variable on the outcome is adjusted for other variables in the same level or above in the hierarchical model; [b] Variables with $p = 0.2$ were excluded from the model; [c] Brazilian economic classification criteria according to the Brazil Criterion of Economic Classification; [d] Chi-square test for linear trend; [e] Chi-square test with Yates correction.

In our sample, we found that the prevalence of AO using this indicator was 27.0% for girls and 18.2% in boys ($p = 0.001$), lower values than those presented by AO verified by waist circumference. However, we used waist circumference as an indicator because it is the anthropometric variable indicated by the NCEP-ATP II and IDF, as well as being directly related to other cardiovascular risk factors such as dyslipidemia (Freedman et al. 1999; Ramírez-López et al.), diabetes mellitus type 2 (Gabbay et al. 2003; Petersen et al. 2007) and insulin resistance (Kotlyarevska et al. 2011).

Regarding the sampling characteristics (representative population-based sample), the finding of a high prevalence of AO corroborate the data available in the literature, if differences in the criteria used are taken into consideration (Daratha and Bindler 2009; Fernandes et al. 2011). When prevalence was analysed by gender, female adolescents presented a greater prevalence of AO. This greater prevalence of AO in females may be partly explained because females have a higher percentage of body fat than males (Lee et al. 2008), regardless of pubertal stage (Taylor et al. 2000, 2010). However, in a recent review we found that there is no consensus in the literature (de Moraes et al. 2010), where in some studies female adolescents present a higher proportion of AO than male adolescents (Gigante et al. 2008), while in others male adolescents have a greater prevalence (Tzotzas et al. 2008).

The prevalence of abdominal obesity was even higher than overweight (girls = 11.1%, boys = 12.2%) and obesity (girls = 3.3%, boys = 8.6%) diagnosed by BMI in both sexes. One possible explanation is that BMI has low sensitivity to identify adiposity and may fail to identify adolescents with excess body fat (Okorodudu et al. 2010), despite being widely used in epidemiological research.

For lifestyle factors, female adolescents had a lower prevalence of inadequate consumption of healthy foods, fruit and vegetables. These results can be explained by the fact that they are more knowledgeable about nutrition (Pirouznia 2001) and also go on diets more frequently in order to slim down and, thus, consume more fruit and vegetables (Yannakoulia et al. 2004). On the other hand, male adolescents show higher levels of physical activity than females and spend less time in front of the television and computer. These results may be partly explained by the fact that boys have more social and family support than girls when it comes to performing physical activities (Goncalves et al. 2007). For public health managers these results demonstrate the importance of establishing education policy about the importance of adopting healthy behaviours in adolescence.

Among female adolescents, those with abdominal obesity consumed more soda, a risk factor for the development of AO (Snethen et al. 2006) in that the beverage contains high energy density derived mainly from simple carbohydrates, rapidly raising blood glucose levels (Mahmood et al. 2008), without producing satiety (leptin levels) (Barquera et al. 2008).

Among male adolescents, the obese were less likely to consume sweets excessively. However, it should be remembered that the cross-sectional design of the study and susceptibility of causality can reverse this association (Duquia et al. 2008) and the association may be explained because adolescents with abdominal obesity reported dieting more frequently to slim down and these diets precondition adolescents to refrain from eating highly calorific foods such as sweets.

In both sexes adolescent employment was positively associated with abdominal obesity. Some authors have investigated the link between obesity and family socioeconomic variables (Monteiro et al. 2004; Fernandes et al. 2011) and found that the prevalence of AO has increased in the low- and middle-income brackets, challenging public health authorities and contributing to increased inequalities in health. A possible explanation may be linked by the fact that the consumption of unhealthy foods (sugar-sweetened beverage and ultra-processed food) (Monteiro et al. 2011; Claro et al. 2012) has increased mainly in the lower socioeconomic level. This is because AO not only impacts the individual's health, but also impacts the country's health expenditure, since direct and indirect costs of treatment are high (World Health Organization 2004).

Among the important individual factors, directly associated coma AO is the genetic predisposition. In a recent meta-analysis, European researchers found that adolescents with genes that predispose the accumulation of fat is more likely (odds ratio = 3.54) to be obese than their peers without these genes (Bradfield et al. 2012). However, the population genetic analyses should be undertaken with care, as highlighted in an editorial. Veerman (2011) reported that genetic screening in the population is less important than analysing social and environmental factors associated with obesity, because 'genes may co-determine who becomes obese, but our environment determines how many become obese'.

One constraint of the present study is its cross-sectional design, so causality can therefore not be established. Another important limitation is the evaluation of modifiable behaviours, which was self-reported. However, it would be difficult to use more accurate methods, such as direct observation, since logistics are complicated and expensive in a population-based epidemiological study.

Abdominal obesity is associated with different factors for male and female adolescents, indicating the complexity of drivers for AO. Interpretation could help public health planners to come up with appropriate interventions to prevent obesity in adolescents. Multi-component interventions must be carried out in such programmes so as to change lifestyle behaviours and, more importantly, they must be adaptable to each sex, involving specific activities, since risk factors differ between the sexes.

In the context of promoting healthy behaviours among adolescents it has been observed that interventions carried out at school have positive effects when combined with printed educational materials and changes in the school (Dobbins et al. 2009). van Sluijs et al. (2007) showed in their study that interventions in schools were more successful when they used several activities and were monitored by parents and the community at large. Therefore, given the high prevalence of obesity reported in the present study, it should be repeated that interventions should be carried out in order to reduce the prevalence of AO-associated risk behaviours, preferably through programmes to reduce this disease that are integrated into the curriculum of the school, where adolescents spend a large part of their day; the programmes should be monitored by parents and teachers.

CONCLUSIONS

In summary, the results of this study enable the following conclusions to be drawn: (i) the prevalence of abdominal obesity is high among adolescents regardless of gender; (ii) risk behaviour patterns of adolescents differ between genders, as does the distribution of socioeconomic and demographic variables; and (iii) abdominal obesity in female adolescents is associated with the family's socioeconomic variables and eating habits, while in males it is associated with having a job and eating habits.

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REFERENCES

2001. Executive summary of the third report of The National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA 285:2486–2497

ABEP. 2006. Brazilian Association of Research Institute. Brazilian criteria for economic classification. Availabe online at: www.abep.org, accessed

Arvidsson D, Slinde F, Hulthèn L. 2005. Physical activity questionnaire for adolescents validated against doubly labelled water. Eur J Clin Nutr 59:376–383.

Barquera S, Hernandez-Barrera L, Tolentino ML, Espinosa J, Ng SW, Rivera JA, Popkin BM. 2008. Energy intake from beverages is increasing among Mexican adolescents and adults. J Nutr 138: 2454–2461.

Bradfield JP, Taal HR, Timpson NJ, Scherag A, Lecoeur C, Warrington NM, Hypponen E, Holst C, Valcarcel B, Thiering E, Salem RM, Schumacher FR, Cousminer DL, Sleiman PM, Zhao J, Berkowitz RI, Vimaleswaran KS, Jarick I, Pennell CE, Evans DM, St Pourcain B, Berry DJ, Mook-Kanamori DO, Hofman A, Rivadeneira F, Uitterlinden AG, van Duijn CM, van der Valk RJ, de Jongste JC, Postma DS, Boomsma DI, Gauderman WJ, Hassanein MT, Lindgren CM, Mägi R, Boreham CA, Neville CE, Moreno LA, Elliott P, Pouta A, Hartikainen AL, Li M, Raitakari O, Lehtimäki T, Eriksson JG, Palotie A, Dallongeville J, Das S, Deloukas P, McMahon G, Ring SM, Kemp JP, Buxton JL, Blakemore AI, Bustamante M, Guxens M, Hirschhorn JN, Gillman MW, Kreiner-Møller E, Bisgaard H, Gilliland FD, Heinrich J, Wheeler E, Barroso I, O'Rahilly S, Meirhaeghe A, Sørensen TI, Power C, Palmer LJ, Hinney A, Widen E, Farooqi IS, McCarthy MI, Froguel P, Meyre D, Hebebrand J, Jarvelin MR, Jaddoe VW, Smith GD, Hakonarson H, Grant SF. 2012. A genome-wide association meta-analysis identifies new childhood obesity loci. Nat Genet 44: 526–531.

Brazilian Ministry of Health. 2007. Healthy eating for adolescents. General Coordination of Food and Nutrition Policy. Brasilia-DF: Brazilian Ministry of Health.

Claro RM, Levy RB, Popkin BM, Monteiro CA. 2012. Sugar-sweetened beverage taxes in Brazil. Am J Public Health 102:178–183.

Coutinho L, Scazufca M, Menezes P. 2008. Methods for estimating prevalence ratios in cross-sectional studies. Rev Saude Publica 42: 992–998.

Daratha KB, Bindler RC. 2009. Effects of individual components, time, and sex on prevalence of metabolic syndrome in adolescents. Arch Pediatr Adolesc Med 163:365–370.

de Almeida CA, Pinho AP, Ricco RG, Elias CP. 2007. Abdominal circumference as an indicator of clinical and laboratory parameters associated with obesity in children and adolescents: comparison between two reference tables. J Pediatr (Rio J) 83:181–185.

de Moraes A, Fulaz C, Netto-Oliveira E, Reichert F. 2009. [Prevalence of metabolic syndrome in adolescents: a systematic review]. Cad Saude Publica 25:1195–1202.

de Moraes AC, Fadoni RP, Ricardi LM, Souza TC, Rosaneli CF, Nakashima AT, Falcão MC. 2011. Prevalence of abdominal obesity in adolescents: a systematic review. Obes Rev 12:69–77.

de Onis M, Onyango A, Van den Broeck J, Chumlea W, Martorell R. 2004. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food Nutr Bull 25:S27–S36.

Després J, Lemieux I. 2006. Abdominal obesity and metabolic syndrome. Nature 444:881–887.

Dobbins M, De Corby K, Robeson P, Husson H, Tirilis D. 2009. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6–18. Cochrane Database Syst Rev :CD007651.

Duquia RP, Dumith SEC, Reichert FF, Madruga SW, Duro LN, Menezes AM, Araújo CL. 2008. [Epidemiology of elevated triciptal and subscapular skinfolds in adolescents]. Cad Saude Publica 24: 113–121.

Egger G, Swinburn B. 1997. An "ecological" approach to the obesity pandemic. BMJ 315:477–480.

Fernandes R, Christofaro D, Buonani C, Monteriro H, Cardoso J, Freitas-Junior I, Machado D. 2011a. Performance of body fat and body mass index cutoffs in elevated blood pressure screening among male children and adolescents. Hypertens Res In Press.

Fernandes RA, Christofaro DG, Cardoso JR, Ronque ER, Freitas Júnior IF, Kawaguti SS, Moraes AC, Oliveira AR. 2011b. Socioeconomic status as determinant of risk factors for overweight in adolescents. Cien Saude Colet 16:4051–4057.

Ferreira A, Oliveira C, França N. 2007. Metabolic syndrome and risk factors for cardiovascular disease in obese children: the relationship with insulin resistance (HOMA-IR). J Pediatr (Rio J) 83:21–26.

Freedman D, Serdula M, Srinivasan S, Berenson G. 1999. Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr 69:308–317.

Gabbay M, Cesarini P, Dib S. 2003. [Type 2 Diabetes in children and adolescents: literature review]. J Pediatr (Rio J) 79:201–208.

Gigante D, Minten G, Horta B, Barros F, Victora C. 2008. [Nutritional evaluation follow-up of the 1982 birth cohort, Pelotas, Southern Brazil]. Rev Saude Publica 42(Suppl 2):60–69.

Goncalves H, Hallal PC, Amorim TC, Araujo CL, Menezes AM. 2007. [Sociocultural factors and physical activity level in early adolescence]. Rev Panam Salud Publica 22:246–253.

Government B. 2007. Healthy eating for adolescents. Brasilia-DF: Brazilian Ministry of Health.

Jolliffe C, Janssen I. 2007. Development of age-specific adolescent metabolic syndrome criteria that are linked to the Adult Treatment Panel III and International Diabetes Federation criteria. J Am Coll Cardiol 49:891–898.

Karelis AD, St-Pierre DH, Conus F, Rabasa-Lhoret R, Poehlman ET. 2004. Metabolic and body composition factors in subgroups of obesity: what do we know? J Clin Endocrinol Metab 89:2569–2575.

Kotlyarevska K, Wolfgram P, Lee JM. 2011. Is waist circumference a better predictor of insulin resistance than body mass index in u.s. Adolescents? J Adolesc Health 49:330–333.

Lee S, Kuk JL, Hannon TS, Arslanian SA. 2008. Race and gender differences in the relationships between anthropometrics and abdominal fat in youth. Obesity (Silver Spring) 16:1066–1071.

Lobstein T, Baur L, Uauy R. 2004. Obesity in children and young people: a crisis in public health. Obes Rev 5(Suppl 1):4–104.

Mahmood M, Saleh A, Al-Alawi F, Ahmed F. 2008. Health effects of soda drinking in adolescent girls in the United Arab Emirates. J Crit Care 23:434–440.

Malcon MC, Menezes AM, Chatkin M. 2003. [Prevalence and risk factors for smoking among adolescents]. Rev Saude Publica 37:1–7.

Mercer JG, O'Reilly LM, Morgan PJ. 2004. Increasing the impact of European obesity research in preparation for the European research area: a report on the 2003 European Commission Obesity Workshop. Obes Rev 5:79–85.

Mokha JS, Srinivasan SR, Dasmahapatra P, Fernandez C, Chen W, Xu J, Berenson GS. 2010. Utility of waist-to-height ratio in assessing the status of central obesity and related cardiometabolic risk profile among normal weight and overweight/obese children: the Bogalusa Heart Study. BMC pediatrics 10:73.

Monteiro C, Moura E, Conde W, Popkin B. 2004. Socioeconomic status and obesity in adult populations of developing countries: a review. Bull World Health Organ 82:940–946.

Monteiro CA, Levy RB, Claro RM, de Castro IR, Cannon G. 2011. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. Public Health Nutr 14: 5–13.

Moraes AC, Delaporte TR, Molena-Fernandes CA, Falcão MC. 2011. Factors associated with medicine use and self medication are different in adolescents. Clinics (Sao Paulo) 66:1149–1155.

Moreira S, Ferreira A, Lima R, Arsa G, Campbell C, Simões H, Pitanga F, França N. 2008. Predicting insulin resistance in children: anthropometric and metabolic indicators. J Pediatr (Rio J) 84: 47–52.

Nagy E, Vicente-Rodriguez G, Manios Y, Béghin L, Iliescu C, Censi L, Dietrich S, Ortega FB, De Vriendt T, Plada M, Moreno LA, Molnar D. 2008. Harmonization process and reliability assessment of anthropometric measurements in a multicenter study in adolescents. Int J Obes (Lond) 32(Suppl 5):S58–S65.

Neovius M, Linné Y, Rossner S. 2005. BMI, waist-circumference and waist-hip-ratio as diagnostic tests for fatness in adolescents. Int J Obes (Lond) 29:163–169.

Ogden CL, Carroll MD, Kit BK, Flegal KM. 2012. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. JAMA 307:483–490.

Okorodudu DO, Jumean MF, Montori VM, Romero-Corral A, Somers VK, Erwin PJ, Lopez-Jimenez F. 2010. Diagnostic performance of body mass index to identify obesity as defined by body adiposity: a systematic review and meta-analysis. Int J Obes (Lond) 34:791–799.

Petersen K, Dufour S, Savage D, Bilz S, Solomon G, Yonemitsu S, Cline G, Befroy D, Zemany L, Kahn BB, Papademetris X, Rothman DL, Shulman GI. 2007. The role of skeletal muscle insulin resistance in the pathogenesis of the metabolic syndrome. Proc Natl Acad Sci U S A 104(12):587–594.

Pirouznia M. 2001. The association between nutrition knowledge and eating behavior in male and female adolescents in the US. Int J Food Sci Nutr 52:127–132.

Ramírez-López G, González-Villalpando C, Salmerón J, González-Ortiz M, Valles-Sánchez V, Triglycerides and high-density lipoprotein cholesterol are associated with insulinemia in adolescents. Salud Publica Mex 48:293–299.

Romanzini M, Reichert FF, Lopes AAS, Petroski EL, de Farias Júnior JC. 2008. [Prevalence of cardiovascular risk factors in adolescents]. Cad Saude Publica 24:2573–2581.

Secretaria de Estado Educação do Paraná S. 2007. SEED em números. Maringá: Secretaria de Estado da Educação do Paraná.

Snethen J, Broome M, Cashin S. 2006. Effective weight loss for overweight children: a meta-analysis of intervention studies. J Pediatr Nurs 21:45–56.

Strauch ES, Pinheiro RT, Silva RA, Horta BL. 2009. Alcohol use among adolescents: a population-based study. Rev Saude Publica 43: 647–655.

Strong W, Malina R, Blimkie C, Daniels S, Dishman R, Gutin B, Hergenroeder A, Must A, Nixon P, Pivarnik JM, Rowland T, Trost S, Trudeau F. 2005. Evidence based physical activity for school-age youth. J Pediatr 146:732–737.

Taylor R, Jones I, Williams S, Goulding A. 2000. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3–19 y. Am J Clin Nutr 72: 490–495.

Taylor RW, Grant AM, Williams SM, Goulding A. 2010. Sex differences in regional body fat distribution from pre- to postpuberty. Obesity (Silver Spring) 18:1410–1416.

Tzotzas T, Kapantais E, Tziomalos K, Ioannidis I, Mortoglou A, Bakatselos S, Kaklamanou M, Lanaras L, Kaklamanos I. 2008. Epidemiological survey for the prevalence of overweight and abdominal obesity in Greek adolescents. Obesity (Silver Spring) 16: 1718–1722.

UN. 2007. Atlas of human development in Brazil. In: Development, P.U.N. (Ed.). Brasilia-DF: United Nations.

van Sluijs EM, McMinn AM, Griffin SJ. 2007. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. BMJ 335:703.

Veerman JL. 2011. On the futility of screening for genes that make you fat. PLoS Med 8:01114.

Victora C, Huttly S, Fuchs S, Olinto M. 1997. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol 26:224–227.

Wang Y, Monteiro C, Popkin B. 2002. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. Am J Clin Nutr 75:971–977.

World Health Organization. 2004a. Global school-based student health survey, Available online at: http://www.who.int/school_youth_health/media/en/gshs_chile_questionnaire2004.pdf, accessed

World Health Organization 2004b. WHO global strategy on diet physical activity and health. Food Nutr Bull 25:292–302.

Yannakoulia M, Karayiannis D, Terzidou M, Kokkevi A, Sidossis L. 2004. Nutrition-related habits of Greek adolescents. Eur J Clin Nutr 58:580–586.