Rev Paul Pediatr. 2014;**32(3)**:241–246.

REVISTA PAULISTA DE PEDIATRIA

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ORIGINAL ARTICLE

Sociodemographic and behavioral factors associated with body adiposity in adolescents☆

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Received 26 November 2013; accepted 5 March 2014

KEYWORDS
Abdominal obesity;
Adiposity;
Adolescent health

Abstract
Objective: To identify sociodemographic and behavioral factors associated with abdominal obesity (AO) and high body fat percentage (high BF%) in adolescents from the city of Curitiba-PR.
Methods: The sample consisted of 1,732 adolescents, aged 11 to 19 years, of both genders. The triceps and calf skinfolds were measured for the calculation of BF%, as well as the waist circumference. A questionnaire was completed by adolescents with the following variables: gender, age, type of residence, socioeconomic status, time spent watching TV on weekdays and weekends, and daily energy expenditure. Logistic regression was used to measure the association of sociodemographic and behavioral variables with abdominal obesity and high BF%.
Results: Female adolescents were more likely to have high BF% (OR: 2.73; 95% CI: 2.32-3.33), but were less likely to have abdominal obesity (OR: 0.58; 95% CI: 0.44-0.78). Older individuals (16-19 years) were more likely to have high BF% (OR: 1.36; 95% CI: 1.02-1.83). The older age groups (13-15 years and 16-19 years) had an inverse association with abdominal obesity. Regarding daily energy expenditure, the less active individuals were more likely to present high BF% (OR: 1.36; 95% CI: 1.07-1.71) and obesity (OR: 1.40; 95% CI: 1.09-1.80).
Conclusions: Interventions to increase physical activity levels in young people should be designed in order to combat excess body fat should designed to combat excess adiposity.

DOI refers to: 10.1590/1984-0462201432315
☆Study conducted at Universidade Federal do Paraná, Curitiba, PR, Brazil.
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PALAVRAS-CHAVE
Obesidade abdominal;
Adiposidade;
Saúde do adolescente

Fatores sociodemográficos e comportamentais associados à adiposidade corporal em adolescentes

Resumo

Objetivo: Identificar fatores sociodemográficos e comportamentais associados à obesidade abdominal (OA) e ao percentual de gordura corporal elevado (%GC elevado) em adolescentes de Curitiba-PR.

Métodos: A amostra probabilística foi composta por 1.732 adolescentes, de 11 a 19 anos, de ambos os sexos, da rede pública de ensino. Foram coletadas as medidas de dobras cutâneas tricipital e panturrilha para o cálculo do %GC, além da medida da circunferência da cintura. Um questionário foi preenchido pelos adolescentes para avaliação das seguintes variáveis: sexo, idade, tipo de residência, nível socioeconômico, tempo gasto assistindo à TV durante a semana e o fim de semana, além do gasto energético diário. A regressão logística foi utilizada como medida de associação dos fatores sociodemográficos e comportamentais com a obesidade abdominal e o percentual de gordura corporal elevado.

Resultados: As meninas apresentaram maior chance de ter o %GC elevado (OR: 2,73; IC95%: 2,32-3,33). Em contrapartida, têm menor chance de ter obesidade abdominal (OR: 0,58; IC95%: 0,44-0,78). Indivíduos mais velhos (16-19 anos) apresentaram maior chance de ter o %GC elevado (OR: 1,36; IC95%: 1,02-1,83). Em contrapartida, as faixas etárias mais elevadas (13-15 anos e 16-19 anos) tiveram uma associação inversa com a obesidade abdominal. Em relação ao gasto energético diário, os indivíduos menos ativos apresentaram maior chance de ter %GC elevado (OR: 1,36; IC95%: 1,07-1,71) e obesidade abdominal (OR: 1,40; IC95%: 1,09-1,80).

Conclusões: Intervenções relacionadas ao aumento nos níveis de atividade física na população jovem devem ser elaboradas para o combate do excesso de adiposidade corporal.

Introduction

The current epidemiological scenario shows that overweight and obesity are health problems at an alarming proportion in the world young population.[1] In 2010, international data observed that 43 million children worldwide were overweight or obese, of whom 35 million come from developing countries. The worldwide prevalence of childhood overweight and obesity increased from 4.2% in 1990 to 6.7% in 2010, and these prevalence rates are expected to reach 9.1% in 2020.[2]

In Brazil, the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE)[3] estimated that in only three decades (1975-2009), the population of overweight Brazilian adolescents increased from 3.7% to 21.7% among males, and from 7.6% to 19.4% among females. The evolution of obesity also follows the upward trend described for overweight. As these nutritional conditions are associated with the development of several health disorders (such as dyslipidemia, insulin resistance, and hypertension),[4] the control of excess body fat is the key to promoting health among young individuals.

Epidemiological studies[5,6] have sought to identify body adiposity (overall or in the abdominal region) and to estimate the proportion of adolescents with abnormal values. However, it is also vital to identify the main factors associated with excess adiposity in adolescents. Its determinants comprise a complex set of biological, behavioral, and environmental factors that are interrelated and potentiate each other.[1] Thus, to propose actions for an effective intervention in reducing excess body fat, it is necessary to know the set of factors associated with this condition in young individuals.Considering this evidence, the present study aimed to determine the prevalence and sociodemographic and behavioral factors associated with high body fat percentage (BF%) and abdominal obesity in a random sample of adolescents from public schools in Curitiba, state of Paraná, Brazil.

Method

This was a cross-sectional study performed with adolescents enrolled from the sixth grade of elementary schools to second year of high school in the public schools of Curitiba city. To estimate the sample size needed for this study, the following parameters were considered: (i) population of 115,524 adolescents; (ii) a confidence level of 95%; (iii) sampling error of 3 percentage points; (iv) prevalence of the outcome of interest of 50% (which considers a maximum variance and overestimates the sample size), resulting in a minimum sample of 1,057 adolescents.[7] A design effect of 1.4 was added to correct the error related to the multistage process of sample selection,[7] as well as an allowance for possible losses and refusals of 20%. Therefore, a total sample of 1,776 adolescents was estimated.

The sample selection for this study was based on a multistage sampling process. In the first stage, all state and

municipal schools were stratified according to each of the nine regional administrative sectors of the city. In the second stage, subjects were randomly drawn from five schools in each administrative region, so that each school would represent one of the school grades of interest. In the third stage, a simple random selection was performed of one to three classes according to the number of students required for a certain administrative region.

All adolescents from the chosen class were invited to participate in the study, resulting in a total of 1,812 adolescents. Some adolescents were excluded from the final sample: 17 adolescents were older than 19 years (0.94%); 12 did not properly fill out the questionnaires (0.66%); five did not undergo anthropometric measurements (0.28%); and 29 (1.6%) were considered prepubertal, considering the self-assessment of pubic hair proposed by Tanner.[8] These prepubertal adolescents were excluded from the sample due to physiological, morphological, and behavioral differences, in relation to pubertal and post-pubertal individuals. Therefore, the non-response rate was 3.48%, and the final study sample consisted of 1,749 adolescents.

Data collection was performed between September of 2010 and June of 2011 by a trained team from the Center for Sports and Exercise Research (CEPEE - UFPR). Waist circumference (WC) was measured using an inelastic tape with the anthropometric measurement scale of 1 mm, at the midpoint between the last rib and the iliac crest. Abdominal obesity was determined considering the 75th percentile proposed by Fernández *et al*,[9] specific for age and gender. The triceps and calf skinfolds were measured following the recommendations of Callaway *et al*[10] and BF% was estimated as proposed by Slaughter *et al*[11] predictive equations. Three measures were performed in each of these anatomical points, following international recommendations;[12] the mean of the three measurements was considered in the predictive equations of BF%. The cutoffs ≥25% in females and ≥20% in males were considered in order to determine which adolescents had elevated BF%.[11]

A questionnaire was completed by adolescents to evaluate the following variables: gender, age, type of residence, socioeconomic status, time spent watching TV during the week and on weekends, in addition to daily energy expenditure. The age was calculated in decimal years and classified into three age groups: 11 to 12 years, 13 to 15 years, and 16 to 19 years. The type of residence in which the adolescents lived was self-reported (house/two-story house or apartment). Socioeconomic status was obtained by criteria established by the Brazilian Association of Research Companies.[13] This criterion grouped the adolescents in eight socioeconomic levels (level A1 to level E), based on a score that combines material goods, educational level of the household head, and number of employees at home. For purposes of analysis, adolescents were grouped into three categories: A1+A2 (best condition); B1+B2; and C1+C2+D+E (worst condition).

Daily energy expenditure was obtained by the Three-Day Physical Activity Recall (3DPAR) developed by Bouchard *et al*,[14] and the predictive equations were used to estimate the relative daily energy expenditure (kcal/kg/day). During the analysis, the mean of the three days of the recall was used. The adolescents were grouped into three categories according to the modified Cale proposal:[15] very active (≥40 kcal/kg/day), moderately active (between 37 and 39.9 kcal/kg/day) and little active (<37 kcal/kg/day).

Time spent watching TV daily was assessed by completing the Youth Risk Behavior Survey Questionnaire, previously adapted and validated for the Brazilian population.[16] Two questions were considered related to time spent watching TV on normal days, of which one question was about weekdays and the other about weekends. The answers to these questions were grouped and, considering the cutoff of two hours daily, classified into four categories: (i) did not watch TV for two or more hours during the entire week; (ii) watched TV for two or more hours only on weekends; (iii) watched TV for two or more hours only on weekdays; and (iv) watched TV for two or more hours daily.

Analyses of simple and relative frequency were performed for categorical data presentation. The differences in the proportions of high BF% and abdominal obesity among categories of independent variables were evaluated using the chi-squared test for linear trend and heterogeneity testing. The association between the independent variables, high BF%, and abdominal obesity was performed by logistic regression with backward stepwise selection. The bivariate analysis was performed for all variables; those with $p<0.25$ remained in the multivariate model. The final model considered an independent variable significantly associated with the outcome (high BF% or abdominal obesity) when it achieved a significance level of $p<0.05$.

The study was approved by the International Review Board of Federal University of Paraná (CAAE: 5371.0.000.091-10). All adolescents received permission from parents/guardians to participate in the study by signing an informed consent.

Results

The final study sample had a higher proportion of female adolescents (52.1%), aged 13-15 years (56.9%), who were of socioeconomic level B (61.6%), and lived in a house or two-story house (89.9%). Most of the adolescents (64.9%) watched TV for two or more hours daily, while 25.4% were insufficiently active. Considering the indicators of adiposity, 40.1% of adolescents had high BF%, and 12.2% had abdominal obesity.

Table 1 shows the values of absolute and relative frequency of adolescents with high BF% and abdominal obesity. A higher proportion of high BF% was observed among females, whereas abdominal obesity was more often observed in males. Higher proportions of high BF% were also observed among adolescents with lower daily energy expenditure and who lived in an apartment. Higher rates of abdominal obesity were found in the younger age groups.

Table 2 shows associations of high BF% and abdominal obesity with sociodemographic and behavioral factors. High BF% was associated with gender (female), age group (16-19 years), and daily energy expenditure (moderately active and little active). Abdominal obesity was associated with little active individuals. However, the female gender and older age groups (13-15 years and 16-19 years) were protective factors.

Table 1 Frequency of adolescents with high body fat percentage (BF%) and abdominal obesity according to the independent variables, Curitiba, Brazil (n=1,742).

Variables	High BF%			Abdominal obesity		
	n	%	*p*	n	%	*p*
Gender						
Male	258	30.8	<0.01[a]	126	15.1	<0.01[a]
Female	443	48.6		87	9.5	
Age range (years)						
11-12	71	43.6	0.43[b]	33	20.2	<0.01[b]
13-15	378	38.0		137	13.8	
16-18	252	42.7		43	7.2	
Socioeconomic level						
A (best condition)	43	41.3	0.18[b]	12	11.5	0.55[b]
B	445	41.3		128	11.9	
C/D/E (worst condition)	213	37.6		73	12.9	
Type of residence						
House/ Two-story house	618	39.3	0.04[a]	188	12.0	0.39[a]
Apartment	83	47.4		25	14.2	
DEE (kcal/kg/day)						
Very active (≥40.0)	338	36.8	0.02[b]	106	11.5	0.56[b]
Moderately active (37,0-39.9)	174	45.0		52	13.4	
Little active (<37.0)	189	42.6		55	12.4	
Time spent watching TV						
<2 hours every day	89	40.1	0.99[b]	29	13.1	0.65[b]
2+ hours on the weekend	86	37.4		21	9.1	
2+ hours during the week	77	47.5		21	13.0	
2+ hours daily	449	39.6		142	12.5	

BF%, percentage of body fat; DEE, daily energy expenditure.
[a]Chi-squared test for heterogeneity.
[b]Chi-squared test for linearity.

Discussion

Elevated body adiposity is a risk factor for several cardiovascular diseases, and studies identifying factors associated with its presence in individuals of all ages are relevant.

The results of this study showed that 12.2% of adolescents had abdominal obesity, which was higher in males (15.1%) when compared to females (9.5%). Similar prevalence and higher value in males were also identified in another national study, with a similar age group, which identified a prevalence of central obesity of 15.2% and 8.5% for males and females, respectively.[17] Another study, conducted in Recife, identified a similar prevalence of abdominal obesity of 14.9%, taking into account both genders.[18]

Table 2 Association between high BF%, abdominal obesity, and sociodemographic and behavioral factors, Curitiba, Brazil (n=1,742).

Variables	Elevated BF%[a]		Abdominal obesity[a]	
	OR	95% CI	OR	95% CI
Gender				
Male	1		1	
Female	2.73	(2.32-3.33)	0.58	(0.44-0.78)
Age range (years)				
11-12	1		1	
13-15	1.09	(0.87-1.37)	0.63	(0.41-0.96)
16-18	1.36	(1.02-1.83)	0.29	(0.18-0.49)
Socioeconomic level				
A (best condition)	1.08	(0.88-1.33)	0.79	(0.41-1.54)
B	1.1	(0.71-1.70)	0.86	(0.63-1.17)
C/D/E (worst condition)	1		1	
Type of residence				
House/ Two-story house	1		1	
Apartment	1.39	(0.99-1.96)	1.12	(0.71-1.78)
DEE (kcal/kg/day)				
Very active (≥40.0)	1		1	
Moderately active (37.0-39.9)	1.49	(1.17-1.91)	1.10	(0.84-1.45)
Little active (<37.0)	1.36	(1.07-1.71)	1.40	(1.09-1.80)
Time spent watching TV				
<2 hours every day	1		1	
2+ hours a week	1.27	(0.92-1.76)	0.64	(0.35-1.17)
2+ hours on the weekend	0.95	(0.70-1.29)	0.99	(0.54-1.84)
2+ hours daily	0.96	(0.75-1.22)	0.89	(0.58-1.38)

OR, odds ratio; 95% CI, 95% confidence interval; BF%, percentage of body fat; DEE, daily energy expenditure.
[a]Analysis adjusted for variables with p<0.25 in the bivariate analysis.

When comparing the prevalence of the present study with those of international studies, a recent systematic review[5] showed that the prevalence of abdominal obesity in adolescents in developing countries ranged from 3.8% to 51.7%, and in developed countries, from 9.3% to 33.2%. However, it is noteworthy that a large portion of these discrepancies between studies may be due to different criteria for determining abdominal obesity.

Regarding BF%, it was observed that 40.1% of the adolescents in the present study had elevated total body fat. These estimates are higher compared to other national studies that considered the increased values of triceps and subscapular skinfolds[19] and percentage of total fat.[20] However, in the present study, the prevalence of increased values were higher in females, different from other studies, which found a higher prevalence of increased values in males.[19,20] The high proportion of elevated BF% observed in this study demonstrates the upward trend of recent decades,[6] and is an alarming factor, especially for future generations.

Considering this evidence, severe consequences to the health of the world's youth population, including high rates of dyslipidemia, high blood pressure, and metabolic syndrome, will be verified if no intervention actions to decrease overall obesity and adiposity in specific regions of the body, such as central adiposity, are done.[4]

Some risk subgroups for high BF% and abdominal obesity were highlighted in the study. Adolescent females represented a subgroup of high risk for elevated adiposity, when compared with their male counterparts. In contrast, female gender was a protective factor against abdominal obesity. This difference observed in adolescents reflects the differences in body composition between males and females, as gains in body fat resulting from environmental factors are most evident in peripheral regions for females and in the central region of the body for males.[21]

The results of the present study indicate a contrast in the association between age, elevated BF% and abdominal obesity in the assessed adolescents.

Older adolescents (16-19 years) were more likely to have elevated BF% compared to younger ones (11 and 12). This same trend was shown by Minatto *et al*,[22] who observed that younger individuals (14-15 years) had a protective factor (OR: 0.58, 95%CI: 0.37-0.90) for high adiposity compared to older individuals (16-17 years). Considering such results, it is observed that young individuals tend to have a lower degree of physical activity and exhibit sedentary behaviors during adolescence,[23] which might contribute to increased adiposity as they become older.

However, when analyzing the central adiposity indicator, the results of the present study demonstrated that being an older teenager (13-15 or 16-19 years) was a protective factor against abdominal obesity. Previous studies[24,25] disagree with the results found. However, the cutoff points used in the present study are not specific for the Brazilian population, which may have generated this contradictory result.

Daily energy expenditure was inversely associated with high BF% and abdominal obesity among adolescents in the present study. These results corroborate the literature, indicating that low levels of physical activity can lead to health problems, including increased adiposity and its unfavorable distribution.[23]

However, the time spent watching TV daily did not show a significant association with the two assessed indicators of adiposity. These data are similar to those obtained in previous studies for abdominal obesity[26] and elevated BF%.[27] These results demonstrate that the total energy expenditure may be better associated with these variables, as even individuals who spent many hours watching TV can perform high-intensity activities when they are not involved in this sedentary activity. Moreover, other sedentary activities were not considered in this study, such as lightweight crafts and the use of computers, tablets, and smartphones.

Socioeconomic status was not associated with high BF% and abdominal obesity in the present study. However, national studies[19,22,28] have suggested this association. Duquia *et al*[19] and Minatto *et al*[22] demonstrated that higher socioeconomic levels were positively associated with elevated indicators of adiposity assessed. Similarly, Romanzini *et al*[28] observed that abdominal obesity was more prevalent in the higher socioeconomic levels. However, individuals of lower economic levels may also exhibit low levels of physical activity and poor diet with excess calories and fat, similar to individuals of higher socioeconomic levels, which is the probable reason for the absence of this association in the present study.

The study did not observe a significant association between type of residence and indicators of adiposity; no study that aimed to correlate these variables was retrieved in the literature. The type of residence probably did not reflect on the participation of individuals in physical activities, as the spaces available for physical activity in communities and schools can be shared by both groups, regardless of the type of residence.

The present study had some limitations. One related to the possibility of reverse causality in the association between the variables, which is inherent to cross-sectional studies. The other is consistent with the use of questionnaires for data collection, which may be influenced by recall and estimation bias, especially in relation to measures of daily energy expenditure and time spent watching TV. Despite the observed limitations in the present study and in several other national publications on this subject, this study is relevant, as it is one of the few using BF% as an indicator of overall adiposity. Moreover, Brazil is a country with continental dimensions and with great cultural variability across its different regions. Thus, this research adds regional information concerning risk factors associated with adiposity in adolescents.

The findings of the present study represent an important reference for future epidemiological surveys and interventions to reduce obesity in children and adolescents.

In conclusion, the results indicated that the subgroups at risk for abdominal obesity and elevated BF% may vary according to the indicator considered, especially when considering sociodemographic factors. Regarding behavioral factors, the results support the literature, which indicates higher chances of both overall and abdominal obesity in less active individuals. Interventions aimed at increasing levels of physical activity among young people must be developed to fight excess body fat. Additionally, future longitudinal studies should be performed in order to confirm the results observed in cross-sectional studies and to verify possible causal associations.

Conflicts of interest

The authors declare no conflicts of interest.

Funding

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES/CNPq).

References

1. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012;70:3-21.
2. De Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. Am J Clin Nutr 2010;92:1257-64.
3. Brasil - Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009. Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil [cited 2010 Aug 27]. Available from: <http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pof/2008_2009_encaa/pof_20082009_encaa.pdf>
4. Czernichow S, Kengne AP, Stamatakis E, Hamer M, Batty GD. Body mass index, waist circumference and waist-hip ratio: which is the better discriminator of cardiovascular disease mortality risk? Evidence from an individual-participant meta-analysis of 82 864 participants from nine cohort studies. Obes Rev 2011;12:680-7.
5. De Moraes AC, Fadoni RP, Ricardi LM, Souza TC, Rosaneli CF, Nakashima AT *et al*. Prevalence of abdominal obesity in adolescents: a systematic review. Obes Rev 2011;12:69-77.
6. Olds TS. One million skinfolds: secular trends in the fatness of young people 1951-2004. Eur J Clin Nutr 2009;63:934-46.
7. Luiz RR, Magnani MM. A lógica da determinação do tamanho da amostra em investigações epidemiológicas. Cad Saude Colet (Rio J) 2000;8:9-28.
8. Tanner JM. Growth at adolescence. Oxford: Blackwell Scientific Publications; 1956.
9. Fernández JR, Redden DT, Pietrobelli A, Allison DB. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. J Pediatr 2004;145:439-44.
10. Callaway CW, Chumlea WC, Bouchard C, Himes J, Lohman TG, Martin A *et al*. Circumferences. In: Lohman TG, Roche AF, Martorell R, editors. Anthropometric standardization reference manual. Champaign: Human Kinetics Books; 1988.
11. Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, Van Loan MD *et al*. Skinfold equations for estimation of body fatness in children and youth. Hum Biol 1988;60:709-23.
12. Harrison GG, Buskirk ER, Carter JE, Johnston FE, Lohman TG, Pollock ML *et al*. Skinfold thicknesses and measurement technique. In: Lohman TG, Roche AF, Martorell R, editors. Anthropometric standardization reference manual. Champaign: Human Kinetics; 1988. p. 55-60.
13. Brasil - Associação Brasileira de Empresas de Pesquisa. Critério de classificação econômica brasil - CCEB [cited 2009 Nov 15]. Available from: http://www.abep.org/new/criterioBrasil.aspx
14. Bouchard C, Tremblay A, Leblanc C, Lortie G, Savard R, Thériault G. A method to assess energy expenditure in children and adults. Am J Clin Nutr 1983;37:461-7.
15. Cale S. Self-report measures of children's physical activity: recommendations for future development and a new alternative measure. Health Educ J 1994;53:439-53.
16. Guedes DP, Lopes CC. Validation of the Brazilian version of the 2007 youth risk behavior survey. Rev Saude Publica 2010;44:840-50.
17. Christofaro DG, Ritti-Dias RM, Fernandes RA, Polito MD, Andrade SM, Cardoso JR *et al*. High blood pressure detection in adolescents by clustering overall and abdominal adiposity markers. Arq Bras Cardiol 2011;96:465-70.
18. Pinto IC, Arruda IK, Diniz Ada S, Cavalcanti AM. Prevalence of overweight and abdominal obesity according to anthropometric parameters and the association with sexual maturation in adolescent schoolchildren. Cad Saude Publica 2010;26:1727-37.
19. Duquia RP, Dumith Sde C, Reichert FF, Madruga SW, Duro LN, Menezes AM *et al*. Epidemiology of elevated triciptal and subscapular skinfolds in adolescents. Cad Saude Publica 2008;24:113-21.
20. Fernandes RA, Rosa CS, Silva CB, Bueno DR, Oliveira AR, Freitas Júnior IF. Accuracy of different body mass index cutoffs to predict excessive body fat and abdominal obesity in adolescents. Rev Assoc Med Bras 2007;53:515-9.
21. Geer EB, Shen W. Gender differences in insulin resistance, body composition, and energy balance. Gend Med 2009;6 (Suppl 1):S60-75.
22. Minatto G, Pelegrini A, Silva DA, da Silva AF, Petroski EL. Association between inadequate body composition and sociodemographic factors in adolescents. Rev Paul Pediatr 2011;29:553-9.
23. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC *et al*. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. Int J Behav Nutr Phys Act 2011;8:98.
24. Janssen I, Shields M, Craig CL, Tremblay MS. Prevalence and secular changes in abdominal obesity in Canadian adolescents and adults, 1981 to 2007-2009. Obes Rev 2011;12:397-405.
25. Griz LH, Viégas M, Barros M, Griz AL, Freese E, Bandeira F. Prevalence of central obesity in a large sample of adolescents from public schools in Recife, Brazil. Arq Bras Endocrinol Metabol 2010;54:607-11.
26. Cavalcanti CB, Barros MV, Menêses AL, Santos CM, Azevedo AM, Guimarães FJ. Abdominal obesity in adolescents: prevalence and association with physical activity and eating habits. Arq Bras Cardiol 2010;94:350-7.
27. Silva DA, Pelegrini A, de Lima ES, Petroski EL. Epidemiology of whole body, peripheral, and central adiposity in adolescents from a Brazilian state capital. Eur J Pediatr 2011;170:1541-50.
28. Romanzini M, Pelegrini A, Petroski EL. Prevalence of abdominal obesity and associated factors in adolescents. Rev Paul Pediatr 2011;29:546-52.