Original Article

Abdominal Obesity in Adolescents: Prevalence and Association with Physical Activity and Eating Habits

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Abstract

Background: Abdominal obesity in adolescents is associated with cardiovascular and metabolic diseases, but its prevalence and the factors associated with its occurrence are unknown.

Objectives: To determine the prevalence of abdominal obesity in adolescents, and to evaluate whether the indicators of physical activity and dietary habits are associated with the occurrence of abdominal obesity in adolescents.

Methods: The sample included 4138 high school students (14-19 years), selected by cluster sampling in two stages. We obtained data using the Global School-based Health Survey, and anthropometric measurements were taken for determination of overweight and abdominal obesity. Logistic regression was used for analysis of behavioral factors associated with the occurrence of abdominal obesity. The identification of cases of abdominal obesity was performed by waist circumference analysis, using age- and gender-related cutoff points as reference.

Results: The mean age was 16.8 years (s = 1.4), and 59.8% of subjects were female. The prevalence of abdominal obesity was 6% (95%CI: 5.3-6.7), and it was significantly higher among girls (6.7%, 95%CI: 5.8-7.8) than among boys (4.9%, 95%CI: 3, 9-6, 0). In the crude analysis, gender and overweight were associated with the occurrence of abdominal obesity. The analysis adjustment by logistic regression allowed us to observe that physical activity was significantly associated with the occurrence of obesity in this group (OR = 0.7; 95% CI: 0.49-0.99), regardless of the presence of overweight.

Conclusions: The prevalence of abdominal obesity was low compared to that observed in international studies, and physical activity was a factor associated with the occurrence of this event in adolescents. (Arq Bras Cardiol 2010; 94(3):350-356)

Key words: Obesity; adolescent; epidemiology; motor activity.

Introduction

Obesity is a global health problem whose prevalence is increasing even in developing countries[1,2], and in younger populations[3-5]. Between 1980 and 2000, the estimated prevalence of overweight and obesity in children increased up to 5-fold in developed countries, and up to 4-foldin developing countries[6,7]. In Brazil, the proportion of overweight children and adolescents also increased from approximately 4.1% (1974/1975) to 13.9% (1996/1997)[7].

In studies with adults, abdominal obesity was found to be a risk factor for cardiovascular events and mortality[8,9]. In adolescents, the accumulation of abdominal fat has been identified as a risk factor for the occurrence of cardiovascular and metabolic diseases[10-12]. In addition, increased abdominal fat is associated with elevated blood pressure[13], higher triglyceride concentration[14], and hyperinsulinemia[15].

In recent decades, studies with different population subgroups showed that there has been a significant increase in mean waist circumference values or in the prevalence of abdominal obesity in adolescents of both genders[16-19]. Despite the upward trend, there is still considerable lack of information and conflicting results regarding the factors associated with obesity among adolescents. Available evidence suggests that the practice of structured and vigorous physical activity is inversely associated with waist circumference values[20,21]. However, Ortega et al[22] observed an association between physical activity and abdominal adiposity only in adolescents with low levels of cardiovascular fitness. As for eating habits, Francis et al[23] concluded that a high consumption of soft drinks and a low intake of fruits and vegetables are food indicators associated with greater abdominal fat accumulation.

A review of studies on abdominal obesity conducted in Brazil showed that the samples were very heterogeneous with respect to age[24]. The studies with more homogeneous samples with respect to age included four studies with elderly subjects,

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Manuscript received June 10, 2009; revised manuscript received August 7, 2009; accepted August 18, 2009.

and three studies with children, but none of them had an exclusive sample of adolescents. The objective of this study was to determine the prevalence of obesity in adolescents, and to evaluate whether the indicators of physical activity and dietary habits are associated with the occurrence of obesity in adolescents.

Methods

This was a cross-sectional epidemiological study, conducted as part of the project called "Lifestyles and Health Risk Behaviors in High School Students in the State of Pernambuco". The study protocol was approved by the Human Research Ethics Committe of the Hospital Agamenon Magalhães (Recife). The participation of the subjects was voluntary and anonymous, and we adopted the use of a negative term of consent (passive parental consent form). No personal identification was allowed in the instruments to ensure the anonymity of responses.

The target population was limited to state public high school students in the State of Pernambuco, aged between 14 and 19 years. Considering all the administrative managements (federal, state, municipal, and private), the subjects enrolled in state public schools accounted for about 80% of all high school students in Pernambuco. The sample size was determined in such a way as to meet the various objectives of the project, which included an evaluation of exposure to ten behavioral health risk factors, anthropometric measurements, and blood pressure values at rest (a factor that was not analysed in this study).

To calculate the sample size, we used the following criteria: population of approximately 353 thousand subjects, confidence interval of 95%, and sampling error of 3 percentage points. Since this was a study that involved analysis of several factors, the prevalence estimate was set at 50%, and the sample design effect was set at 4 times the minimum size of the sample. This would represent a sample of 4217 subjects. With this sample design, it would be possible to analyze the association between independent variables and the occurrence of abdominal obesity, with the possibility of detecting odds ratios (OR) of 1.2 or higher as significant, using a confidence level of 95%, and a statistical power of 80%.

We tried to ensure that the sample represented the target population, considering its distribution as per geographical region, shift enrollment (day school or night school), and school size (small—less than 200 students; average—200 to 499 students; and large—500 students or more). Students enrolled in the morning and afternoon shifts were grouped into a single category (students in day classes). The regional distribution was observed by the number of schools in each of the 17 regional education management offices of the State Education Department.

To select the required sample, we used a cluster sampling procedure in two stages, and "school" and "class" represented, respectively, the sampling units (clusters) in the first and in the second stage. All public schools in the State of Pernambuco were considered eligible for inclusion in the study. In the first stage we adopted, as the stratification criterion, the density of schools in each sub-area of the State (Regional Education Management Offices/Gere), according to size; Thus, proportionally more schools were drawn in the regions where the density was also higher. In the second stage, we considered the density of classes in selected schools by shift (day and night) as a criterion to draw those in which the questionnaires would be applied. All students in the selected classes were invited to participate in the study, regardless of their age. After the application, the questionnaires answered by students who were above the target age range (over 19 years) were excluded. Data collection was performed from April to October 2006. The questionnaires were applied in the classroom, without the presence of teachers, by six graduate students (three physical education professionals, two nurses, and a doctor), who had participated in previous training to standardize the data collection procedures. The subjects were continuously assisted by these interviewers (always two per class), who could answer questions and assist in filling out the information.

To measure the independent variables, we used the translated version of the Global School-based Student Health Survey (GSHS) proposed by the World Health Organization (WHO), available at the following address: www.who.int/chp/GSHS/en. The questionnaire consisted of ten modules: 1. personal characteristics, 2. consumption of alcohol and drugs; 3. eating habits; 4. hygiene; 5. feelings and relationships; 6. physical activities; 7. behavior in school; 8. sexual behavior; 9. smoking habit; and 10. violent behavior.

Before starting data collection, a pilot study was conducted to determine indicators of measurement reproducibility, and to test the applicability of the instrument. Data from the pilot study were collected from two municipal public schools in Recife, in a sample of 138 adolescents, aged 14 to 19 years (59 girls). The indicators of reproducibility (test-retest consistency) were moderate to high in most items of the instrument, and the coefficient of concordance (kappa) varied from 0.52 to 1.00.

A Plenna stadiometer (model 206) was used to determine height values, with an accuracy of 0.5 centimeters (measurement range from 120 to 220 centimeters), whereas weight assessment was effected by using a previously calibrated Plenna electronic scale (Sport model) (measurement range from 30 to 150 kilograms). Body weight (kg) and height (cm) were assessed according to the standard measurement procedures proposed in the literature[25]. Waist circumference was measured by using an anthropometric tape, considering the smaller circumference between the iliac crest and first rib as the anatomical point to perform the measurement[26]. The study subjects wore light clothing and no shoes during the measurements.

The dependent variable in this study was the "occurrence of abdominal obesity" determined by analysis of the measurement of the waist circumference. The cutoff points suggested by Taylor et al[27] were used to identify cases of abdominal obesity. The selection of this assessment reference was due to the results presented by Adams et al[28] in a study conducted to evaluate the sensitivity and specificity of two reference charts for waist circumference in children and adolescents.

The independent variables were: participation in physical education classes (yes/no); exposure to sedentary behavior on weekdays and weekends (exposed/non-exposed); level of physical activity (active/insufficiently active); low frequency of fruit consumption (exposed/non-exposed); low frequency of vegetable consumption (exposed/non-exposed); and high frequency of soft drink consumption (exposed/non-exposed).

Participation in physical education classes was established by weekly frequency of attendance in class, and data were grouped into two categories: attend and does not attend. TV watching time was separately assessed for weekdays and weekends, which were analyzed as two independent variables. Those who reported watching TV daily for a period of three or more hours were classified as "exposed" to excessive TV watching time.

Fruit, vegetable, and soft drink consumption was determined by analyzing the frequency of intake during the 30 days preceding the survey, considering the following response regarding the habitual consumption in the last 30 days: no consumption, <1 time per day, 1 time per day, 2 times per day, 3 times per day, and 4 or more times per day. Adolescents who reported a daily consumption of soft drinks and an occasional consumption (<1 time per day) of fruit and vegetables were classified as being exposed to an inadequate consumption pattern of these foods.

We considered the frequency and length of moderate- to vigorous-intensity physical activity that the adolescent engages in during a typical week to derive a measurement of the level of physical activity. The subjects who reported participating in at least 60 minutes of moderate- to vigorous-intensity physical activity for 5 or more days per week were classified as physically active, whereas the others were classified as insufficiently active.

The following variables were considered as potential intervening factors (confounding and effect modifiers): gender, age (14-16/17-19 years), ethnicity/skin color (white/non-white), shift (day/night), grade (1st/2nd/3rd), occupational status (worker, non-worker), maternal education (≤ 8 years, 9-11 years, and 12 years or more of schooling), place of residence (urban/rural), and overweight (determined by classification of body mass index). The occurrence of overweight was determined in accordance with the cutoff points for body mass index (BMI = weight/height^2) proposed by the International Obesity Task Force (IOTF) and published by Cole et al[29] All independent and intervening variables, except BMI, were self-reported.

The procedure for final tabulation of the data was performed using the program EpiData, resorting to a dual input and, afterwards, to the comparison of the data files created to detect and correct errors. Automatic range checks and data entry consistency checks were also adopted.

The analysis was performed using the software SPSS for Windows (version 10). To evaluate the association between variables, we resorted to the application of the chi-square test, and, for ordinal scale variables, the chi-square test for trend. Multivariable analysis was done using the binary logistic regression, considering the occurrence of abdominal obesity as the outcome. Multivariate analysis was carried out with a two-level adjustment for the variables involved: first, there was an adjustment for gender, age, skin color/ethnic group, and overweight; and second, there was an adjustment for gender, age, skin color/ethnic group, overweight, and other behavioral factors included in the study as independent variables. In the final regression model, significantly associated factors were found for which the p value was less than 0.05.

This study was funded by the National Council for Scientific and Technological (CNPq Process # 486023/2006-0).

Results

We visited 76 schools (11% of all state schools in the State), in 44 municipalities, which represented 23% of the municipalities of Pernambuco. We effectively interviewed and evaluated 4,138 students aged between 14 and 19 years (mean 16.8 years, s=1.4); 59.8% of the subjects were female.

Of the students present in the schools at the time of data collection visits (n=4,297), 83 refused to participate in the study (1.9% of refusals), and 62 others completed the questionnaire, but did not agree to allow us to measure their waist circumferences. Therefore, the final sample (n=4,138) represented 98.1% of the original group (n=4,217).

The demographic and socioeconomic characteristics are presented in Table 1. Table 2 shows mean values and the corresponding standard deviations of the patients' characteristics regarding age and anthropometric factors.

The prevalence of abdominal obesity was 6% (95% CI: 5.3-6.7), significantly higher ($p < 0.05$) among girls (6.7%, 95% CI: 5.8-7.8) than among boys (4.9%, 95% CI: 3.9-6.0). Table 3 presents the prevalence of abdominal obesity, according to demographic, socioeconomic and school-related factors.

In the bivariate analysis, along with gender, overweight also significantly discriminated the occurrence of abdominal obesity. The proportion of adolescents with abdominal obesity was 44.8% (95% CI: 40.3, 49.4) among those adolescents classified as overweight, whereas among those classified as normal weight, the prevalence was only 0.9% (95% CI: 0.6, 1.3).

We then performed an analysis with adjustment for confounders and potential effect modifiers (intervening variables). In the first adjustment, the following variables were included, in addition to overweight: gender, age and skin color. In this group, physical activity was found to be a factor significantly associated with the occurrence of abdominal obesity.

Another analysis with an even more comprehensive adjustment was also performed, including the behavioral factors considered in this study, besides the variables already mentioned: physical activity practice indicators, exposure to sedentary behavior (TV watching time), and eating habits (consumption of fruit, vegetables and soft drinks). The results

Table 1 – **Gender-stratified demographic and socio-economic characteristics of the study sample**

Variable	Boys		Girls		All	
	%	n	%	n	%	n
Age (years)						
14	3.2	52	5.5	135	4.5	187
15	12.0	199	17.9	442	15.5	641
16	20.3	338	23.3	576	22.1	914
17	29.5	491	24.3	600	26.4	1,091
18	21.6	360	18.3	453	19.6	813
19	13.5	225	10.8	267	11.9	492
Skin color/ethnic group						
White	25.0	414	25.4	626	25.2	1,040
Black	3.5	58	1.5	38	2.3	96
Brown/mulatto	66.9	1,109	68.2	1,682	67.6	2,791
Indigenous	0.9	15	0.6	15	0.7	30
Yellow	3.4	56	4.1	100	3.8	156
Other	0.4	6	0.2	6	0.3	12
Shift						
Day	53.9	897	60.4	1,491	57.8	2,388
Night	46.1	767	39.6	979	42.2	1,746
Grade						
1st	45.9	760	43.8	1,078	44.6	1,838
2nd	31.0	514	32.4	797	31.8	1,311
3rd	23.1	382	23.9	588	23.5	970
Work						
No	69.3	1,142	84.7	2,085	78.5	3,227
Yes	19.2	317	9.8	241	13.6	558
Trainee	5.8	96	3.2	80	4.3	176
Volunteer	5.7	94	2.3	56	3.6	150
Maternal education						
≤8 years of schooling	69.4	1,074	74.4	1,744	72.4	2,818
9-11 years of schooling	22.4	347	20.3	475	21.1	822
≥12 years of schooling	8.1	126	5.3	124	6.4	250
Live with parents						
Yes	68.2	1,117	60.7	1,489	63.7	2,606
No	31.8	520	39.3	964	36.3	1,484
Place of Residence						
Urban	78.2	1,295	79.5	1,952	79.0	3,247
Rural	21.8	361	20.5	503	21.0	864

Table 2 – **Means (standard deviations) for age and anthropometric characteristics of the sample, stratified by gender**

Variable	Boys	Girls	All	p value*
Age (years)	16.9 (1.3)	16.6 (1.4)	16.8 (1.4)	0.00
Weight (kg)	61.5 (10.3)	52.9 (9.5)	56.3 (10.7)	0.00
Height (cm)	171.0 (6.9)	158.8 (6.0)	163.7 (8.8)	0.00
BMI (kg/m^2)	21.0 (3.0)	20.9 (3.4)	20.9 (3.2)	0.00
Waist circumference (cm)	72.4 (6.7)	67.5 (7.4)	69.5 (7.5)	0.52

**p value associated with the t-test to compare means between boys and girls.*

remained unchanged, preserving the statistically significant association between the level of physical activity and the occurrence of abdominal obesity (Table 4).

The regression analysis was repeated, replacing the overweight variable (categorical) by the BMI measurement (numerical) as a means to obtain a better adjustment for the intervention of this variable in the analysis of the association between independent variables and the study outcome. Despite a slight change in the magnitude of the OR values, the observed association (physical activity and abdominal obesity) remained unchanged.

Discussion

In Brazil, as far as is known, this is the first school-based and statewide epidemiological study conducted to determine the prevalence of abdominal obesity and its associated factors in adolescents[24]. This study showed that the prevalence of abdominal obesity was low compared to that seen in similar studies conducted with Indian[30], Australian[31], and American[17] teenagers. In addition, we observed that the occurrence of abdominal obesity is significantly associated with physical activity, but showed independence both in relation to exposure to sedentary behavior (TV watching time) and in the frequency of consumption of fruit, vegetables and soft drinks.

This study was conducted with a relatively large sample, which is representative of the adolescents (14 to 19 years) enrolled in public high schools in the State of Pernambuco. The demographic, socioeconomic and behavioral factors considered in the analysis were obtained through the use of a questionnaire that had been previously tested and showed a good level of test-retest reproducibility. The anthropometric measurements were performed by graduate-level health professionals (graduate students), who were previously trained to standardize the measurements and reduce inter- and intra-examiner errors. It is also noteworthy that this study simultaneously explored the possible association between two behavioral factors (physical activity and exposure to sedentary behavior) and the prevalence of obesity among adolescents.

It is important, however, to interpret carefully the prevalence estimates reported in this study, mainly due to the use of a reference evaluation constructed from a

Table 3 - **Prevalence of abdominal obesity stratified by gender**

Variable	Boys		Girls		All	
	%	n	%	n	%	N
Age (years)						
14-16	6.6	39	5.8	67	6.1	106
17-19	3.9	42	7.5	99	5.9	141
P value	0.14		0.94		0.78	
Skin color/ethnic group						
White	6.3	26	5.4	34	5.8	60
Non White	4.4	55	7.2	132	6.0	187
P value	0.129		0.134		0.740	
Physical education classes						
No	5.4	54	6.8	113	6.2	167
Yes	4.1	27	6.6	53	5.5	80
P value	0.230		0.893		0.318	
Physical activity						
Insufficiently active	5.4	52	6.8	118	6.3	170
Active	4.1	29	6.5	48	5.3	77
P value	0.213		0.784		0.201	
Weekday TV watching (h/day)						
<3 h/day	5.3	35	7.7	79	6.7	114
3+ h/day	4.6	46	6.0	87	5.4	133
P value	0.515		0.099		0.078	
Weekend day TV watching (h/day)						
<3 h/day	5.0	45	6.6	77	5.9	122
3+ h/day	4.7	36	6.9	89	6.0	125
P value	0.760		0.866		0.893	
Fruit consumption						
Daily	4.1	25	6.4	49	5.4	74
Occasional	5.3	56	6.9	117	6.3	173
P value	0.246		0.673		0.241	
Vegetable consumption						
Daily	6.3	39	5.6	49	5.9	88
Occasional	4.1	42	7.3	116	6.0	158
P value	0.42		0.106		0.862	
Soft drink consumption						
Daily	4.9	46	6.9	113	6.1	159
Occasional	4.9	35	6.2	51	5.6	86
P value	0.969		0.557		0.512	

Table 4 - **Behavioral factors associated with the occurrence of abdominal obesity in adolescents**

Variable	Crude OR (95% CI)	Partially Adjusted OR (95% CI) **	Adjusted OR (95% CI) ***
Physical education classes			
No	1	1	1
Yes	0.87 (0.66-1.14)	1.25 (0.88-1.78)	1.20 (0.91-1.86)
Physical activity			
Insufficiently active	1	1	1
Active	0.82 (0.63-1.10)	0.71* (0.50-0.99)	0.70* (0.49-0.99)
Weekday TV watching (h/day)			
<3 h/day	1	1	1
3+ h/day	0.79 (0.61-1.03)	0.77 (0.56-1.07)	0.73 (0.51-1.05)
Weekend day TV watching (h/day)			
<3 h/day	1	1	1
3+ h/day	1.02 (0.79-1.32)	0.93 (0.67-1.29)	1.05 (0.74-1.81)
Fruit consumption			
Daily	1	1	1
Occasional	1.18 (0.89-1.57)	1.19 (0.84-1.69)	1.24 (0.86-1.81)
Vegetable consumption			
Daily	1	1	1
Occasional	1.02 (0.78-1.34)	0.94 (0.67-1.32)	0.93 (0.65-1.32)
Soft drink consumption			
Daily	1	1	1
Occasional	0.91 (0.70-1.20)	1.03 (0.73-1.44)	1.11 (0.78-1.59)

*p <0.05, ** Adjustment for gender, age, ethnicity and overweight; *** Adjustment for gender, age, ethnicity, overweight and other behavioral factors mentioned in the study.*

study conducted among adolescents in New Zealand[27]. The measurements of behavioral risk factors for health were self-reported, and there is a possibility of bias in the classification of exposure. There is also the possibility of reverse causality, which is an inherent characteristic of the cross-sectional design adopted for the development of this study. Finally, it should be noted also that the data used in developing this study were collected among subjects of a single Brazilian state, and students in public schools do not represent the adolescent population as a whole.

Therefore, the generalization of results must be made with considerable caution.

Internationally, the available studies have focused mainly on the analysis of trends in relation to the absolute measurement of waist circumference[18,19] or on verifying trends regarding other anthropometric indicators such as the waist/height ratio[17]. Few studies have reported the prevalence of abdominal obesity in adolescents[16,30,31], and all references employed evaluation procedures different from those used in this study. Therefore, comparisons are significantly impaired.

Despite the limitations already mentioned, the evidence from this study suggests that, compared to the results of international studies, the prevalence of obesity among adolescents in this region of Brazil is significantly lower. Examining data from the 1997 U.S. National Diet and Nutrition Survey study, Li et al[16] found a prevalence of approximately 14% among boys and 17% among girls. In a study conducted among Indian teenagers, Anjama et al[30] found a prevalence of approximately 12%, which amounted to 19.6% in adolescents whose parents were diabetic. Sellers et al[31] identified increased waist circumference values in 26.2% of the participants in a cohort study conducted among Aboriginal Australian children and adolescents.

Despite methodological differences, particularly on strategies for analysis and operational definition of variables, the results of this study are convergent with the evidence reported by Klein-Platat et al[20] that there is an inverse association between physical activity and waist circumference. In addition, similar to what was observed in this study, the association between these factors remained unchanged even after adjustment for exposure to sedentary behavior (TV watching time, use of computer/videogames, and reading), and body mass index. These results suggest that the prevention of abdominal obesity in this population group must be based on interventions that focus more on promoting physical activity than on reducing exposure to sedentary behaviors.

Performing periodic surveys may provide similar evidence on the upward trend in the prevalence of abdominal obesity, supporting the formulation and early development of control measures. Analytical approaches are needed to identify factors associated as well as to analyze the correlation between the occurrence of abdominal obesity and other health-related events such as hypertension and dyslipidemia. The latter research approach is particularly urgent because of the controversy about the association between abdominal obesity and the occurrence of cardiovascular disease, as identified in the study conducted by Janiszewski et al[32].

Another aspect that deserves to be investigated is the value of clinical assessment of abdominal obesity as a predictor of cardiovascular risk as compared to the analysis of body mass index, as noted by Klein et al[33].

Acknowledgments

The researchers thank the students and teachers of the high schools that participated in the project.

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