

Meal habits and anthropometric indicators in adolescents from public and private schools of the metropolitan region of *Rio de Janeiro*

Consumo de refeições e indicadores antropométricos em adolescentes de escolas públicas e privadas da região metropolitana do Rio de Janeiro

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ABSTRACT

Objective

To describe meal consumption habits and assess their associations with anthropometric indicators.

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Support: Conselho Nacional de Desenvolvimento Científico e Tecnológico (Grant 47667/2011-9), Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (Grants E26/110.847/2009, E-26/ 110.626/2011, and E-26/110.774/2013), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Grant 23038.007702/2011-5).

Article based on the master's dissertation of the author ML DE CNOP, entitled "*Consumo de refeições e indicadores antropométricos em adolescentes da região metropolitana do Rio de Janeiro: estudo transversal em escolas públicas e particulares*". Universidade Federal do Rio de Janeiro; 2013.

Como citar este artigo/How to cite this article

De Cnop ML, Monteiro LS, Rodrigues PRM, Estima CCP, Veiga GV, Pereira RA. Meal habits and anthropometric indicators in adolescents from public and private schools of the metropolitan region of Rio de Janeiro. *Rev Nutr.* 2018;31(1):35-47. <https://doi.org/10.1590/1678-98652018000100004>



Methods

A cross-sectional study was performed on 1,749 elementary and high school students from public and private schools in the city of *Rio de Janeiro*, Brazil (mean age=15.3 years), who were selected for the baseline of the Longitudinal Study for Nutritional Assessment of Adolescents. Meal habits and meals consumed in the company of parents were assessed using a self-administered questionnaire. The consumption of the main meals was categorized as regular (daily) or irregular (≤ 6 times a week). The meal consumption profile was considered either satisfactory (breakfast, lunch, and dinner consumed on a daily basis) or unsatisfactory. Body Mass Index, waist-to-height ratio, and body fat percentage were calculated. The association between meal consumption habits and anthropometric indicators was estimated using multivariate logistic regression models, adjusted for age and sex and stratified according to the type of school.

Results

Regular lunch consumption was more frequent among private schools students, who also had higher frequency of eating dinner irregularly. Among students from private schools, the unsatisfactory meal consumption profile and irregular meal habits were associated with being overweight, having a high waist-to-height ratio, and increased body fat percentage. Among students from public schools, it was observed association between being overweight with irregular breakfast habits.

Conclusion

In adolescents, the association between meal habits and weight status may be modulated by socioeconomic condition.

Keywords: Adolescents. Anthropometry. Body composition. Cross-Sectional Studies. Nutritional status.

RESUMO

Objetivo

Este artigo tem como objetivo descrever os hábitos de consumo de refeições e avaliar sua associação com indicadores antropométricos.

Métodos

Trata-se de estudo de desenho transversal em que foram analisados 1.749 estudantes do ensino fundamental e médio, de escolas públicas e privadas, selecionadas no município do Rio de Janeiro (idade média=15,3 anos), investigados no estudo de base do Estudo Longitudinal de Avaliação Nutricional de Adolescentes. Os hábitos de consumo de refeições e a realização de refeições na presença dos pais foram avaliados por meio de questionário autoaplicado, sendo categorizadas em regular (diariamente) e irregular (≤ 6 vezes/semana). O perfil de consumo de refeições foi considerado satisfatório (quando desjejum, almoço e jantar eram realizados diariamente) ou insatisfatório. Foram calculados o Índice de Massa Corporal, a razão cintura/estatura e o percentual de gordura corporal. A associação entre hábitos de consumo de refeição e indicadores antropométricos foi estimada por meio de modelos de regressão logística multivariados, ajustados por idade e sexo e estratificados segundo o tipo de escola.

Resultados

O consumo regular do almoço mostrou-se mais comum entre alunos de escolas privadas, os quais também apresentaram frequência mais elevada de realização irregular do jantar. Entre alunos de escolas privadas, o perfil insatisfatório e o consumo irregular de refeições se associaram com o excesso de peso, a razão cintura/estatura elevada e percentual de gordura corporal aumentado. Por outro lado, entre alunos de escolas públicas, a associação com excesso de peso foi encontrada para o consumo irregular do desjejum.

Conclusão

Em adolescentes, a associação entre hábitos de refeições e condição de peso é, possivelmente, modulada pela condição socioeconômica.

Palavras-chave: Adolescentes. Antropometria. Composição corporal. Estudos transversais. Estado nutricional.

INTRODUCTION

Irregular meal habits are often observed in adolescents, especially skipping breakfast [1-5]

and the replacement of dinner with snacks [6-8]. These behaviors are associated with changes in body composition indicators such as high body mass index [9]. These behaviors are also

associated with metabolic changes such as changes in blood glucose level [10], as well as with low school performance [11] and low quality of diet [3,12].

The rate of skipping breakfast among Brazilian adolescents varies between 16% and 51%, and the frequency of replacement of dinner with snacks varies between 21% and 42% [1,5,8,13]. There is evidence that regular omission of main meals may be associated with weight changes [13,14] and with unhealthy eating habits in adolescents [4,5].

Adolescents eating with their parents has been associated with healthy eating habits in general [5,6,15,16]. However, an aspect that has not yet been explored in the literature is the possible relationship between the presence of parents at meals and the nutritional status of adolescents. The influence of socioeconomic factors on the association between eating habits and adiposity indicators is also being newly considered in studies in Brazil [9,13,17] and in other countries [15,18-20].

In this context, this study was carried out with the objective of describing meal habits of adolescents and to estimate the magnitude of the association between meal habits and anthropometric and body composition indicators, taking into account the role of socioeconomic variables.

METHODS

This cross-sectional study analyzed baseline data obtained in the baseline of the Longitudinal Study of Nutritional Evaluation of Adolescents (ELANA), which was undertaken in adolescents between 10 and 19 years of age. The sample size was estimated at 1,200 students in high school (50% from public and 50% from private schools) and 1,200 in elementary school (50% from public and 50% from private schools). This sample size allowed for the assessment,

in the longitudinal study, of each of the strata, with a minimum variation of one unit of Body Mass Index (BMI), a type I error rate of 5%, and a test power of 80%. The sample size also allowed for lack of follow-up from up to 20% of respondents.

All the students who were enrolled in the first grade of high school and in the sixth grade of elementary school in two public schools and four private schools in the metropolitan region of *Rio de Janeiro* were invited to participate in the study. The schools were selected for convenience and had already been the subject of previous studies developed by the same research group. In addition, we evaluated the number of students in each school to allow for comparability between the strata.

Adolescents with physical disabilities that did not allow for anthropometric evaluations were considered ineligible for the study as well as those who were taking medications related to obesity and pregnant adolescents were also ineligible.

Data were collected between February and August 2010 by examiners who were submitted to standardization trainings on anthropometric measurements according to the procedures proposed by Habicht [21]. Information on meal consumption was obtained using a self-administered structured questionnaire which was subsequently reviewed by field researchers.

Anthropometric measurements

All the adolescents were weighed using an electronic, portable scale with a capacity of up to 150kg and variation of 50g. Height was measured twice using a portable stadiometer that could measure up to 200cm, with a variation of 0.1cm. The mean of the two measurements was used as long as the difference between them did not exceed 0.5cm; if the difference exceeded this value, two new measurements were taken until

two measures with an acceptable difference were obtained. The adolescents were weighed and measured barefoot and wearing lightweight clothing. Weight and height measurements were taken in accordance with the procedures described by Gordon *et al.* [22]. BMI (weight/height²) was estimated and categorized into four levels: underweight (BMI <-2.0 EZ), normal weight (-2.0 EZ < BMI < +1.0 EZ), overweight (+1.0 EZ < BMI < +2.0 EZ), and obese (BMI > +2.0 EZ), based on the BMI distribution curves presented in 2007 by the World Health Organization [23].

Waist circumference was measured with a inextensible 150cm measuring tape with a variation of 0.1cm, with the adolescent standing, abdomen relaxed, arms alongside the body, feet together, and weight equally divided between both legs. The site for the measurement was the smallest circumference of the torso [24]. Two measurements were taken, and the maximum acceptable difference between the measurements was 1cm [25]. The mean of the two measurements was used to calculate the Waist-to-Height Ratio (WHR), which was categorized as adequate (≤ 0.50) or elevated (> 0.50) [26].

We assessed body composition by bioelectrical impedance analysis using a four-pole device RJL System® 101Q model (Rudolph J. Liedtke System, Clinton Township, Michigan, United States of America) whose use has been approved in children and adolescents [27]. To estimate the lean body mass of adolescents from 10 to 19 years of age, the values of resistance, weight, and height were incorporated into an equation, as described by Houtkooper *et al.* [28]. Body fat (kg) was estimated by calculating the difference between body mass (kg) and lean body mass (kg) to estimate the proportion (%) of Body Fat (%BF). Proportions equal to or greater than 25% for boys and 30% for girls were considered to indicate excess body fat because these were the limits proposed by Williams *et al.* [29] as the predictors of morbidity in this age group.

Meal consumption habits

The frequency of consumption of breakfast, lunch, and dinner, as well as snacking as a replacement for lunch or dinner, was assessed through responses to the question: "How many times a week do you eat the following meals?" included in the self-assessment questionnaire for adolescents with the following response options: "daily", "5 to 6 times a week", "3 to 4 times a week", "1 to 2 times a week", and "never or almost never". We also evaluated the frequency of eating breakfast and dinner in the presence of the adolescent's parents, using the same response options.

The frequency of consumption of main meals (breakfast, lunch, dinner) and the frequency of eating breakfast and dinner with parents were categorized as regular when consumed daily and irregular when the adolescent reported consuming these meals six or fewer times per week.

The meal consumption profiles were categorized as satisfactory or unsatisfactory. A satisfactory profile was defined as an adolescent who ate the three main meals on a daily basis; conversely, when the adolescent reported not having consumed three main meals daily, he or she was considered to have an unsatisfactory meal profile [4].

Statistical analyses

The following variables were considered as independent variables: the meal consumption profile (satisfactory or unsatisfactory); the frequency of breakfast, lunch, and dinner and breakfast and dinner with the parents (regularly or irregularly). The following variables were considered as dependent variables: weight [not overweight (underweight and normal weight); or overweight (overweight and obese)]; WHR (adequate or elevated); and %BF (adequate or

high). The associations between the independent and dependent variables were estimated using multivariate binary logistic regression models and adjusted for age and sex, estimating the *Odds Ratios* (OR) and respective 95% Confidence Intervals (95%CI). Models were developed according to the type of school, which was used as a proxy for socioeconomic status [15]. In assessing the association between the consumption of breakfast and dinner in the presence of parents and the dependent variables, the models were also adjusted by the frequency consumption of breakfast and dinner (regular or irregular).

The Longitudinal Study of Nutritional Evaluation of Adolescents (ELANA) project was approved by the Research Ethics Committee of the *Instituto de Medicina Social* (Institute of Social Medicine) of the *Universidade Estadual do Rio de Janeiro* (State University of *Rio de Janeiro*) (CAAE 0020.0.259.000-09). Participation in the research was voluntary and conditioned on the

authorization of the parents, who signed consent forms with clear terms for children under 18 years of age, or by the students themselves if they were over 18 years.

RESULTS

A total of 1,749 adolescents were included in the study (high school = 973; elementary school=776) (Figure 1), corresponding to 85.0% of the adolescents who were eligible to participate in the study. Of these, 45.2% were in public schools and 50.1% were male. The high school and elementary school students had mean ages of 15.3 years (standard deviation=0.9 years) and 11.3 years old (standard deviation=1.2 years), respectively.

Higher frequencies of excess weight (24.0 vs. 17.3%, $p<0.01$), elevated WHR (14.6 vs. 10.1%, $p=0.01$), and elevated body fat percentage (32.1 vs. 23%, $p<0.01$) were observed for students

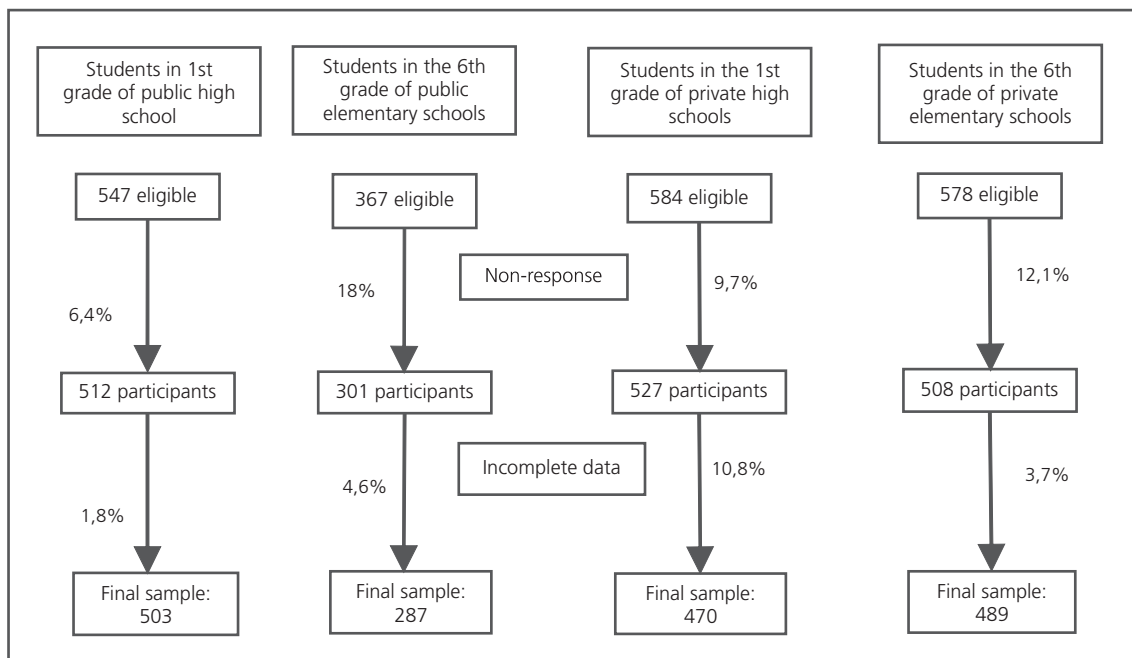


Figure 1. Eligible adolescents and study participants, percentage of non-responses and exclusions and final sample size. *Rio de Janeiro* (RJ), Brazil, 2010.

in private schools when compared to those for students in public schools (Table 1).

Compared to public school students, private school students had a higher frequency of regular (daily) lunch consumption (83 vs. 72%, $p < 0.001$) and lower frequency of replacing lunch with snacks (2 vs. 7% $p < 0.001$). In contrast, students from public schools had higher frequencies of regular dinner consumption (61 vs. 51%, $p < 0.001$) and dinner in the presence of their parents (45 vs. 40%, $p = 0.06$) when compared to those in private school students (Figure 2). There were no significant differences in unsatisfactory meal consumption profiles between public and private school students (Figure 2).

Among students in private schools, there was a greater probability of being overweight

among those with unsatisfactory meal consumption profile (omission or replacement of one or more of the three main meals per day) (OR=1.58, 95%CI=1.19; 2.11), irregular breakfast consumption (six or less times per week) (OR=1.57, 95%CI=1.19; 2.07), and irregular breakfast consumption in the presence of parents (OR=1.42, 95%CI=1.03; 1.95). Among students in public schools, the association with excess weight was found only for adolescents with irregular breakfast consumption (OR=1.48, 95%CI=1.07; 2.06) (Table 2).

An unsatisfactory meal consumption profile (OR=1.65, 95%CI=1.10; 2.48), irregular breakfast consumption (OR=1.50, 95%CI=1.03; 2.19), irregular lunch consumption (OR=1.66, 95%CI=1.04; 2.67), and irregular dinner consumption (OR=1.52, 95%CI=1.05; 2.22) were associated

Table 1. Characteristics of adolescents from public and private schools in the metropolitan region of *Rio de Janeiro* (RJ), Brazil. n=1.749, 2010.

	Total		Public schools (n=790)	Private schools (n=959)	p-value*
	n	%			
<i>Sex (%)</i>					
Male	873	49.9	47.2	52.1	0.04
Female	876	50.1	52.8	47.9	
<i>Education level (%)</i>					
High school	973	53.3	63.7	49.0	<0.01
Elementary School	776	44.7	36.3	51.0	
<i>Age</i>					
<15 years old	969	52.8	39.0	65.2	<0.01
≥15 years old	867	47.2	61.0	34.8	
<i>WHR^{a,b}</i>					
Adequate	1529	87.4	89.9	85.4	0.01
Elevated	220	12.6	10.1	14.6	
<i>Percent total body fat^c</i>					
Adequate	1255	71.8	77.0	67.5	<0.01
Elevated	494	28.2	23.0	32.1	
<i>Weight status^d</i>					
Underweight	32	1.9	2.4	1.3	<0.01
Normal Weight	1091	62.4	69.7	56.3	
Overweight	367	21.0	17.3	24.0	
Obesity	259	14.8	10.5	18.4	

Note: *Chi-square test; ^aWHR = waist-to-height ratio; ^bElevated WHR: waist-to-height ratio >0.50 (HARA et al. [26]); ^cElevated body fat: Percent total body fat >25% in boys and 30% in girls [29]; ^dOverweight: Body Mass Index (BMI: weight / height²) >1 Z-score [23].

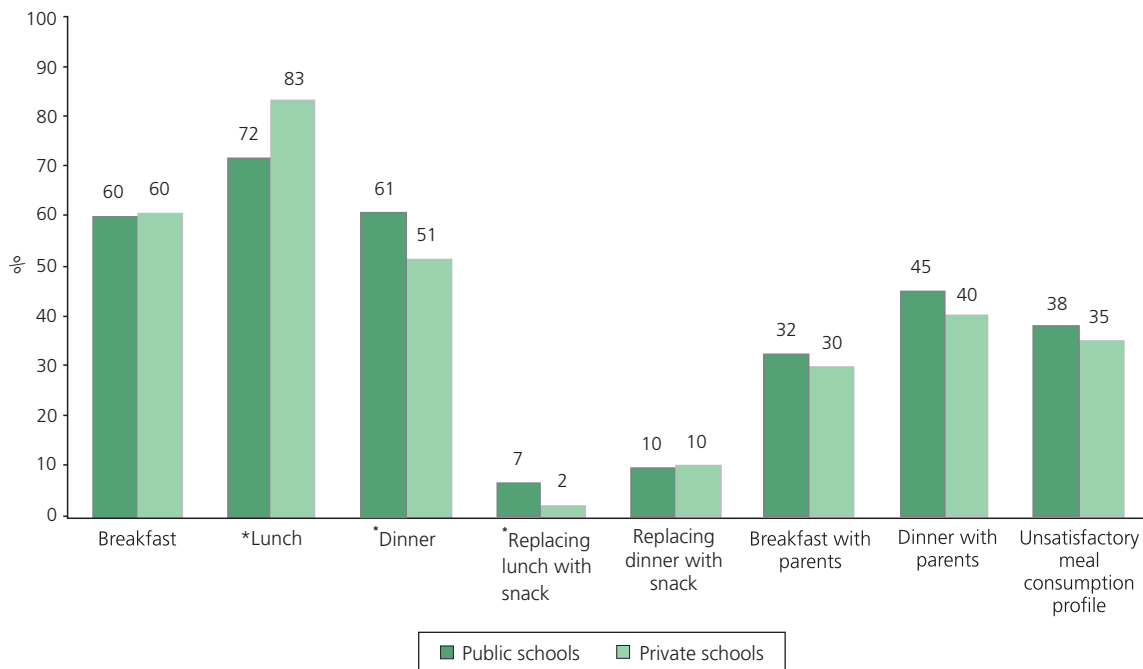


Figure 2. Regular meal consumption**, breakfast and dinner in the presence of parents, and unsatisfactory meal consumption profile*** in adolescents (n=1.749) of public schools (n=790) and private schools (n=959) in the metropolitan region of *Rio de Janeiro* (RJ), Brazil, 2010.

Note: *Chi-square test; (p<0,01); **Regular meal consumption: daily consumption of meal; ***Unsatisfactory meal consumption profile: omission or replacement of one or more of the three main meals per day.

with an increased chance of elevated WHR in private school students regardless of sex and age. There was no association between meal consumption and elevated WHR among public school students (Table 2).

Multi-adjusted models also indicated that adolescents from private schools with unsatisfactory meal consumption profiles (OR=1.65, 95%CI=1.22; 2.21), irregular breakfast consumption (OR=1.47, 95%CI=1.12; 1.95), and irregular dinner consumption (OR=1.35, 95%CI=1.03; 1.78) were also more likely to have high body adiposity. Likewise, there was no association between meal consumption and elevated WHR in public school students (Table 2).

DISCUSSION

Among adolescents from public and private schools in *Rio de Janeiro*, irregular

consumption of breakfast and dinner was observed with high frequency; however, irregular breakfast consumption and unsatisfactory meal consumption profiles were associated with indicators of adiposity only among students in private schools.

The rate of irregular breakfast consumption among the students in this sample was comparable to that observed in the 2012 *Pesquisa Nacional de Saúde do Escolar* (PeNSE, National School Health Survey), which showed that 38% of Brazilian adolescents ate breakfast less than five times a week [5]. The omission of breakfast has been related to a reduced diet quality [4,5,12]. In addition, breakfast is considered to be the meal that provides the most significant amounts of dietary calcium and vitamin D daily [2]. The omission of breakfast may result in the reduced consumption of

Table 2. Association (Odds Ratio [OR] and 95% Confidence Interval [95%CI])* between meal consumption profile and anthropometric indicators of adiposity in adolescents from public and private schools, metropolitan region of *Rio de Janeiro* (RJ), Brazil, 2010.

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Variables	Public schools		Private schools	
	OR (95%CI)	p-value	OR (95%CI)	p-value
<i>Meal consumption profile</i>				
Excess body weight according to BMI ^a				
Satisfactory	1.0		1.0	
Unsatisfactory	1.26 (0.89; 1.76)	0.19	1.58 (1.19; 2.11)	<0.01
<i>Breakfast consumption</i>				
Regular	1.0		1.0	
Irregular	1.48 (1.07; 2.06)	0.02	1.57 (1.19; 2.07)	<0.01
<i>Lunch consumption</i>				
Regular	1.0		1.0	
Irregular	1.00 (0.70; 1.42)	0.98	1.18 (0.83; 1.69)	0.35
<i>Dinner consumption</i>				
Regular	1.0		1.0	
Irregular	1.03 (0.74; 1.43)	0.87	1.22 (0.93; 1.60)	0.15
<i>Breakfast with parents^d</i>				
Regular	1.0		1.0	
Irregular	1.38 (0.95; 2.01)	0.09	1.42 (1.03; 1.95)	0.03
<i>Dinner with parents^e</i>				
Regular	1.0		1.0	
Irregular	1.14 (0.82; 1.59)	0.43	1.16 (0.88; 1.53)	0.30
Elevated WHR ^b				
<i>Meal consumption profile</i>				
Satisfactory	1.0		1.0	
Unsatisfactory	1.13 (0.69; 1.85)	0.63	1.65 (1.10; 2.48)	0.02
<i>Breakfast consumption</i>				
Regular	1.0		1.0	
Irregular	1.50 (0.92; 2.41)	0.10	1.50 (1.03; 2.19)	0.04
<i>Lunch consumption</i>				
Regular	1.0		1.0	
Irregular	1.91 (0.53; 1.55)	0.72	1.66 (1.04; 2.67)	0.04
<i>Dinner consumption</i>				
Regular	1.0		1.0	
Irregular	1.12 (0.69; 1.82)	0.65	1.52 (1.05; 2.22)	0.03
<i>Breakfast with parents^d</i>				
Regular	1.0		1.0	
Irregular	1.39 (0.79; 2.42)	0.25	1.34 (0.86; 2.11)	0.20
<i>Dinner with parents^e</i>				
Regular	1.0		1.0	
Irregular	1.26 (0.78; 2.05)	0.35	1.09 (0.74; 1.60)	0.66

Table 2. Association (Odds Ratio [OR] and 95% Confidence Interval [95%CI])* between meal consumption profile and anthropometric indicators of adiposity in adolescents from public and private schools, metropolitan region of *Rio de Janeiro* (RJ), Brazil, 2010.

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Variables	Public schools		Private schools	
	OR (95%CI)	p-value	OR (95%CI)	p-value
Elevated body fat ^c				
<i>Meal consumption profile</i>				
Satisfactory	1.0		1.0	
Unsatisfactory	1.17 (0.81; 1.68)	0.40	1.65 (1.22; 2.21)	<0.01
<i>Breakfast consumption</i>				
Regular	1.0		1.0	
Irregular	1.41 (1.00; 1.98)	0.05	1.47 (1.12; 1.95)	0.01
<i>Lunch consumption</i>				
Regular	1.0		1.0	
Irregular	1.28 (0.89; 1.85)	0.18	1.30 (0.91; 1.86)	0.15
<i>Dinner consumption</i>				
Regular	1.0		1.0	
Irregular	1.24 (0.87; 1.75)	0.23	1.35 (1.03; 1.78)	0.03
<i>Breakfast with parents^d</i>				
Regular	1.0		1.0	
Irregular	1.50 (0.99; 2.27)	0.06	1.25 (0.90; 1.74)	0.19
<i>Dinner with parents^e</i>				
Regular	1.0		1.0	
Irregular	1.07 (0.75; 1.51)	0.73	1.77 (0.88; 1.56)	0.27

Note: *Values adjusted by sex, age; ^aBMI>+1 Z-score; ^bElevated WHR: waist-to-height ratio >0.50 [26]; ^cElevated body fat: Percent total body fat >25% in boys and 30% in girls [29]; ^dAdjusted for sex, age and breakfast consumption; ^eAdjusted for sex, age and dinner consumption.

these nutrients, which may contribute to the development of osteoporosis in adulthood since the bone deposition of calcium is highest during adolescence [30,31]. Similar findings were reported in studies conducted in Brazil [13], Finland [7], Canada [32], and Australia [33]. These findings were confirmed in longitudinal studies that indicated a direct association between irregular breakfast consumption and increased BMI Z-score among African [34] and Finnish [9] adolescents. However, a study involving low-income African-American adolescents did not find an association between irregular breakfast habits and BMI [35].

Another frequently observed practice among young people is the replacement of main

meals with snacks, which may contribute to an increase in the consumption of high energy-dense and low-nutritional value foods [36], which may compromise the energy balance and lead to excess weight gain [1]. Among adolescents, the replacement of lunch and dinner with snacks contributes to the reduced consumption of the traditional staple foods that are important sources of vitamins, minerals, and fiber [37]. The frequent replacement of lunch and/or dinner with snacks probably results from factors related to changes in the adolescents' lifestyle, such as lack of time, convenience [38], media influence, taste preferences [39], as well as the habit of eating away-from-home [40]. However, in the present study, the replacement

of lunch with a snack was most frequent among public school students, even though this meal was offered daily and free of charge in the schools [41].

The present study considered the type of school as an indicator of socioeconomic status. The *Estudo de Riscos Cardiovasculares em Adolescentes* (ERICA, Study of Cardiovascular Risks in Adolescents) developed in 2013-2014 in a nationwide representative sample, showed that the regularity of breakfast consumption was most frequent among private school students [17]. In a study of Palestinian adolescents in Gaza City, there was a direct association between socioeconomic status and the number of meals consumed daily [18]. Finally, based on PeNSE data, Azeredo *et al.* [5] showed that public school students had higher-quality diets compared to private school students.

Eating habits are related to both food choices [3,4] and metabolic changes [42], which allows hypotheses to be put forth to explain the association between meal consumption profiles and excess weight. Farshchi *et al.* [42] proposed that carbohydrate and lipid metabolism may be modulated by the frequency of meal consumption. These authors also associated irregular meal consumption frequency with a reduction in the thermogenic effect of foods and to elevated energy intake, indicating a potential mechanism by which these habits can affect energy balance and lead to long-term weight gain.

In this study, unsatisfactory meal consumption profiles were associated with unfavorable anthropometric indicators. Similar results were reported in studies conducted in Brazil with adolescents, in which regular or satisfactory patterns of meal consumption (indicating a higher frequency of meal consumption per day) were associated with lower BMI values [13,14]. Studies conducted in other countries have reported similar findings regarding the number of meals consumed daily and anthropometric indicators [6,7,9].

In a study conducted in *Duque de Caxias, Rio de Janeiro, Brazil*, Estima *et al.* [13] observed that boys with poor eating habits and those who skipped breakfast had a higher mean BMI and larger waist and hip circumferences. However, these associations were not statistically significant among girls.

The association between meal consumption habits and body composition and central fat deposition indicators has not yet been fully elucidated. More studies of the association between these habits and a more specific measure of adiposity, such as the percentage of body fat, could shed more light on this relationship, considering that BMI is incapable of reflecting the considerable changes in body composition that occur during adolescence, such as the greater accumulation of fat in girls and muscle mass in boys [43]. Therefore, body composition is an important aspect of the nutritional assessment of adolescents [26,28]. Regarding fat distribution, the WHR has been proposed as a good indicator of abdominal fat accumulation during this growth phase and has been associated with morbidity in adolescents [26]. In this study, the body fat percentage and the WHR were associated with unsatisfactory meal profiles and irregular consumption of breakfast and dinner among private school students.

A study in *Rio de Janeiro* found that boys with unsatisfactory meal pattern had a higher waist circumference mean than that in those with satisfactory meal pattern [13]. Similarly, Gómez-Martínez *et al.* [19] observed that adolescents in Spain who ate breakfast regularly had lower means of waist circumference and skinfold measurements. The results of international studies have indicated an inverse association between the number of daily meals and the risk of excess abdominal adiposity [9,20].

In this study, the irregularity of parents' presence at breakfast was associated with increased rates of excess weight in adolescents from private schools. A United States population-

based study reported a direct association between the frequency of breakfast consumption and a lower risk of overweight/obesity [15]. Some authors have observed that adolescents who ate meals with their parents were more likely to have healthy eating habits [6,16], which supports the association found in the present study. However, this issue remains controversial, since other studies did not observe the same association [44,45].

The results of this study should be interpreted while taking into account some limitations, particularly regarding the type of sample assessed, the cross-sectional design, the possibility of no evaluated confounding factors, and the need of considering the stage of sexual maturation in the assessment of adiposity indicators. The use of a sample selected for convenience limits the extrapolation of results; however, the observed results are in agreement with studies performed with representative samples [5,7,9,13]. We cannot rule out the possibility that obese or overweight adolescents may omit meals as a practice with the goal of reducing their weight; thus, the association between meal consumption and anthropometric indicators observed in this study may be the result of reverse causality, which is a limitation of cross-sectional studies. However, the results of longitudinal studies support the hypothesis that regular meal habits may be associated with a lower risk of overweight and obesity in adolescents [9,24].

Unstudied confounding factors may be present in the associations analyzed in this study, such as usual food consumption, physical activity level, and parents' weight status. In addition, no information was obtained on the times when meals were consumed or their composition, which limits the evaluation of the nutritional quality of the meals and their impact on body weight. Another possible limitation of the study was that it did not consider the stage of sexual maturation of the adolescents in the assessment of adiposity indicators, which could confer

greater specificity to weight classifications. Cintra *et al.* [46] defined cutoff points for assessing excess body fat according to the stage of sexual maturation. However, the cut-off points used in this study to categorize excess body fat had a discriminatory ability in assessing the association between meal consumption and this condition.

The major strength of this study is the assessment of associations in different socioeconomic contexts (public and private schools). The results show that irregular consumption of main meals is related not only to BMI but also to other indicators of adiposity and body fat distribution, which, in general, are not well studied in the literature. This relationship was evidenced particularly among adolescents from private schools. Thus, these findings suggest that socioeconomic status may play a role in the association between meal habits and body weight since differences in these findings were observed according to the type of school, which is a potential indicator of socioeconomic status.

The results of the present study indicate the need of encouraging schools to offer breakfast; there is also the need of valuing regular meal consumption habits in the health promotion programs aiming adolescents.

CONTRIBUTORS

ML DE CNOP participated in data collection, management and analysis, interpretation of results, and in the manuscript conception, drafting, and final edition; LS MONTEIRO participated in data analysis, interpretation of the results, and in the manuscript design and revision; PRM RODRIGUES participated in data analysis, interpretation of the results, and in the manuscript design and revision; CCP ESTIMA participated in the interpretation of the results, manuscript design and final revision; GV VEIGA participated in the study conception, research supervising, collaborated in the interpretation of the results and in the manuscript final edition. RA PEREIRA participated in the study conception, data analysis, interpretation of the results, manuscript conception, writing and final edition.

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Received: July 31, 2017

Final version: November 17, 2017

Approved: December 19, 2017