Overweight in adolescents: exploring potential risk factors

Excesso de peso em adolescentes: explorando potenciais fatores de risco

Exceso de peso en adolescentes: explorando potenciales factores de riesgo

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ABSTRACT

Objective: To estimate the prevalence of overweight and to identify associations with sociodemographic, biological and lifestyle factors in adolescents from Florianopolis, Santa Catarina, Brazil.

Methods: Cross-sectional study carried out in 2007 with a probabilistic sample of 1,590 schoolchildren aged from 11 to 14 years old. The prevalence of overweight, based on body mass index, was estimated by the Brazilian reference and the International Obesity Task Force (IOTF). Multivariate analysis expressed as odds ratios were used to identify associations with sociodemographic, biological and lifestyle factors among adolescents.

Results: The prevalence of overweight was 19.3% (24.5% in boys and 14.5% in girls) using the IOFT reference, and 25.8% (31.8% in boys and 20.5% in girls) by the Brazilian reference. Among male adolescents, overweight was positively associated with unbalanced food consumption and inactive commuting to school. Among girls, the factors associated with overweight were: mother's overweight, unbalanced food consumption and discordance between stages for sexual maturity indicators.

Conclusions: The consumption of foods with high nutritional value was a protective factor against overweight among adolescents. This finding reinforces the importance of actions aimed at changing behaviors related to the family environment by encouraging the incorporation of healthy eating and active leisure time.

Key-words: adolescent; overweight; obesity; risk factors.

RESUMO

Objetivo: Estimar a prevalência de excesso de peso e identificar associações com fatores sociodemográficos, biológicos e de estilo de vida em adolescentes de Florianópolis, Santa Catarina.

Métodos: Estudo transversal, conduzido em 2007, com amostra probabilística de 1.590 escolares de 11 a 14 anos. Estimou-se a prevalência do excesso de peso, com base no índice de massa corpórea, por meio da referência brasileira e da *International Obesity Task Force* (IOTF). Análises multivariadas expressas como razão de chance foram usadas para identificar associações com fatores sociodemográficos, biológicos e de estilo de vida dos adolescentes.

Resultados: A prevalência de excesso de peso foi de 19,3% (24,5% de meninos e 14,5% de meninas), pela referência IOTF, e de 25,8% (31,8% de meninos e 20,5% de meninas), pelo critério brasileiro. Entre os adolescentes do sexo masculino, o excesso de peso associou-se positivamente com a não realização de refeições estruturadas e com o deslocamento não ativo para a escola. Entre as meninas, o excesso de peso materno, a não realização de refeições estruturadas e

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diferenças interestágios de maturação sexual compuseram o elenco dos fatores associados ao excesso de peso.

Conclusões: A realização de refeições com alimentos de alto valor nutricional apresentou-se como um fator de proteção para o excesso de peso entre os adolescentes. Essa constatação reforça a necessidade de ações com vistas a modificar comportamentos relacionados ao ambiente familiar, incentivando a incorporação de hábitos alimentares saudáveis e o lazer ativo.

Palavras-chave: adolescente; sobrepeso; obesidade; fatores de risco.

RESUMEN

Objetivo: Estimar la prevalencia de exceso de peso e identificar asociaciones con factores sociodemográficos, biológicos y de estilo de vida en adolescentes de Florianópolis (Santa Catarina, Brasil).

Métodos: Estudio transversal, conducido en 2007, con muestra probabilística de 1.590 escolares de 11 a 14 años del municipio de Florianópolis. La prevalencia del exceso de peso, basada en el índice de masa corporal, se estimó mediante la referencia brasileña de Conde y Monteiro (2006) y de la *International Obesity Task Force* (IOTF). Análisis multivariados expresados como razón de posibilidades fueron usadas para identificar asociaciones con factores sociodemográficos, biológicos y de estilo de vida de los adolescentes.

Resultados: La prevalencia de exceso de peso fue de 19,3% (24,5% niños y 14,5% niñas) por la referencia IOTF y de 25,8% (31,8% niños y 20,5% niñas), por el criterio brasileño. Entre los adolescentes del sexo masculino, el exceso de peso fue asociado positivamente con la no realización de comidas estructuradas y con el desplazamiento no activo hacia la escuela. Entre las muchachas, el exceso de peso materno, la no realización de comidas estructuradas y presentar diferencias inter-etapas de maturación sexual compusieron el elenco de los factores asociados al exceso de peso.

Conclusiones: La realización de comidas con alimentos de alto valor nutricional se presentó como un factor de protección para el exceso de peso entre los adolescentes. Esta constatación refuerza la necesidad de acciones con vistas a modificar comportamientos relacionados al ambiente familiar, incentivando la incorporación de hábitos alimentares sanos y el ocio activo.

Palabras clave: adolescente; sobrepeso; obesidad; factores de riesgo.

Introduction

Many studies have shown an increasing trend in overweight among children and adolescents in the United States[1], in Europe[2] and in Latin America[3]. In Brazil, the prevalence of overweight among children and adolescents increased from 4.1 to 13.9% between 1974 and 1997[4]. More recent data from household budget surveys (HBS-2002/2003[5] and 2008/2009[6]), indicated that the prevalence of excess weight in adolescence (10 to 19 years) increased from 16.6 to 21.7% among boys and from 15.1 to 19.4% among girls[6].

Excess body fat during growth is an important predictor of cardiovascular risk factors in adulthood. Arterial hypertension, type II diabetes, dyslipidemia and metabolic syndrome are major problems related to overweight in children and adolescents[7,8]. Besides, excess weight in adolescence carries negative psychological effects, related to the construction of body image, depression, and behavioral problems[9].

Obesity is a multifactorial disease, and the interactions between the potential determining factors are considered complex. There is a consensus that environmental, lifestyle, and genetic factors are directly related to body composition[10]. In adolescence, increased body mass index (BMI) has been associated mainly with sedentary behaviors (TV, video game and computer) and with an unhealthy dietary pattern, related to the consumption of foods with low nutrient density[11,12].

These associations are well established, but other factors have shown relationship with excess weight in adolescence and deserve to be further investigated. Discordant Tanner stages for sexual maturation, for instance, are associated with complications related to obesity, type II diabetes, and cardiovascular disease increase[13]. Likewise, sociodemographic characteristics, aspects related to the family environment, and regular physical activity have shown to be determining in this process. Therefore, the aim of this study was to estimate the prevalence and identify potential risk factors (sociodemographic, behavioral and biological) associated with overweight (including obesity) in adolescents from 11 to 14 years in the municipality of Florianópolis, state of Santa Catarina.

Method

The present analysis is a cross-sectional study conducted in Florianópolis from April to October 2007. The

schools participating in this study were from a random sampling for a previous survey conducted in 2002 on the prevalence of overweight and obesity in the municipality of Florianópolis[14]. In 2002, the study used a probabilistic cluster sampling design. The schools were grouped into four stratum, by geographic area (center/continent and beaches) and by type of school (public and private). Within each stratum, there was a random selection of schools with equal probability. Of the total of 87 schools (33 public and 54 private), 11 public and six private were selected. In each school selected, all classes were included and all the children attending the first four grades were invited to participate, but only 7 to 10 years old children were included.

In 2007, the sample of students recruited in these schools was formed by two groups of students: 1) those who in 2002 were 7–10 years old and who in 2007 were within the range of 11–14 years old; 2) students aged 11–14 years, randomly selected, with equal probability, in each of the schools. The first group was included with the purpose of following the students who participated in the prevalence study in 2002[14]. In the census conducted by the Municipal Secretariat of Education were located 1,100 students who participated in the research in 2002, of which 735 participated in the present study. The sample size of the second group was calculated considering the school population of 28,060 in the age range from 11–14 years, prevalence of excess weight of 12.6%[4], with a margin of error of three percentage points (two-tailed) and a sample design effect of 1.5. This calculation totaled 700 adolescents. With the margins of error for losses, the estimated sample was 800 adolescents aged from 11 to 14 years. Finally, the sampling process resulted in the participation of 865 new adolescents and 735 adolescents who had participated in the research in 2002. Data from 10 participants were excluded due to lack of complete anthropometric data. The criteria for inclusion of adolescents were based on three pieces of information: 1) to be enrolled; 2) do not present any sort of physical or mental disability diagnosed; 3) to return the term of consent signed by parents.

The data were weighted according to the probability of respondents being selected and took into account the population density of schoolchildren in the stratified sample design. The weights of the sample were used for prevalence estimates.

Information collected included anthropometric measurements (weight, height, skinfold thickness and body circumferences). For the present study we used the measurements of weight and height. Other data were obtained with the use of three questionnaires: 1) illustrated questionnaire to obtain data on the type of transport used in commuting to school and types of food consumed the day before the interview; 2) structured questionnaire to assess physical activities performed outside the school environment, sedentary activities, and hours of sleep; 3) structured questionnaire to obtain parents' sociodemographic data (income, weight, height, age) and birth weight of the adolescent.

The consent form was signed by the parents and an oral agreement was obtained from adolescents. The research was approved by the Research Ethics Committee at UFSC (protocol n. 028/06).

Anthropometric measurements were performed according to the Lohman protocol[15]. The team participated in the pilot study and the training on the standardization of anthropometric measurements to measure errors intra and inter raters[16]. Body weight was measured with adolescents wearing light clothes and without shoes. An electronic scale with capacity of 180kg and a scale of 100g were used. For the height measurement, a 0.1-mm scale stadiometer was used. BMI was calculated with weight (kg) divided by height (m) squared. Excess weight and obesity were estimated using cutoff points of BMI for age and sex by the International Obesity Task Force (IOTF)[17] and the Brazilian criteria[18]. For the analyses of association between overweight and exploratory variables the IOTF cutoffs were used[17].

Maternal nutritional status was assessed by BMI with self-reported weight and height. The classification of excess weight (≥25kg/m^2) followed the recommendations of the World Health Organization[19]. The variable maternal overweight was classified dichotomously (yes or no).

Adolescents were analyzed according to the type of school they attended, public or private. In relation to age, adolescents were classified according to the four ages that composed the sample (11 to 14 years).

The birth weight of adolescents (in grams) was informed by parents or guardians, who were instructed to consult the health booklet. Birth weight was classified as low birth weight (<2,500g), normal weight (≥2,500–3,999g) or high birth weight (≥4,000g)[20].

Stages of growth of pubic hair and breasts and male genitals were used according to the model proposed by Tanner[21], illustrated in spreadsheets. The students self-reported individually stages of growth of these characters after receiving guidance on the use of the spreadsheet. For

the analyses, the inter-stage differences were: matched stages (same stage for pubic hair and breasts/genitals), early pubic hair in one or two stages in relation to breast/genitals, or delayed pubic hair in one or two stages in relation to breast/genitals.

Information on food consumption and school transport were evaluated using the Previous Day Food Questionnaire (PDFQ-3), previously validated[22]. The variable related to the meals regarded as complete (structured) was based on the composition of foods high in nutrient density. The three main meals (breakfast, lunch and dinner) were considered structured when there was consumption of at least one item from each of the following groups: starch (rice, beans, bread, pasta, and crackers), fruits and vegetables (fruit juice , fruits, and vegetables) and animal protein (beef, chicken, seafood, eggs, milk, cheese, yogurt, chocolate milk). Regarding snacks, we used the same criterion, but with mandatory use of at least one food of high nutritional density of any group. For the analyses, the adolescents were classified dichotomously: to have or not three structured meals and two snacks a day. Commuting to school was ranked active (walking and cycling) or passive (car, bus and motorcycle or bike ride).

The students answered a questionnaire containing questions about sports outside physical education classes, sedentary behavior (TV, video game, computer) and hours of sleep. The habit of playing sports in addition to physical education classes was classified dichotomously (yes/no). Data regarding the time dedicated to sedentary activities were collected regarding the average of weekdays and weekends and grouped into a single variable. Sedentary behavior was categorized as: 0–3h, >3h and ≤6h and >6h daily. The hours of sleep were collected regarding the night before and classified into two categories: <8 and ≥8h of sleep.

Data were processed with the program EpiData 3.2, with double entry. Analyses were performed with STATA 9.0 statistical software (STATA Corp. College Station, Texas USA), corrected for complex sample design by using the STATA SVY set of commands, which incorporates the ponderations relevant to the estimation of variances. The prevalence of overweight was estimated for the categories of each independent variable. The level of significance between proportions

Table 1 - Weight, height and body mass index of boys and girls adolescents

	Boys				Girls			
Age (years)	11	12	13	14	11	12	13	14
n	177	214	205	157	189	225	241	182
Weight (kg)								
Mean	42.9	46.2	53.3	58.2	41.8	46.7	50.2	54.2
Standard Deviation	10.6	10.1	11.3	12.7	9.6	10.1	9.3	9.8
P25	34.8	38.5	45.4	49.8	35.7	40.5	43.9	47.4
P50	41.5	45.0	51.4	56.0	41.2	45.0	48.7	52.5
P75	47.6	52.7	60.3	65.0	46.9	50.9	55.2	59.7
Height (cm)								
Mean	148.7	153.4	161.2	166.4	149.6	154.3	158.8	160.2
Standard Deviation	8.4	7.9	8.1	8.6	7.5	6.9	6.9	6.8
P25	143.3	148.1	156.5	161.7	144.6	150.5	154.4	155.1
P50	147.6	153.1	160.8	166.5	150.0	154.3	158.7	160.3
P75	153.6	158.5	167.2	172.1	155.2	158.5	163.4	164.7
BMI (kg/m²)								
Mean	19.2	19.5	20.4	20.9	18.5	19.5	19.9	21.0
Standard Deviation	3.5	3.1	3.3	3.6	3.2	3.5	3.3	3.2
P25	16.7	17.4	17.9	18.7	16.3	17.2	17.8	18.8
P50	18.6	18.7	19.7	20.0	18.0	18.8	19.4	20.5
P75	21.1	21.2	22.7	22.0	19.9	21.2	21.3	22.8

was evaluated using the chi-square test for heterogeneity or linear trend. For risk estimates, odds ratios (OR), with a confidence interval of 95% were calculated, using bivariate and multivariate logistic regression. Variables with a significance level lesser than or equal to 0.20 were included in multivariate logistic regression by the backward method. Statistical significance was set at $p<0.05$.

Results

The present study evaluated 1,590 students, 753 boys and 837 girls. The students who refused to participate, or who did not get parental consent totaled 289 (148 males and 141 females), but they were replaced by students previously indicated for replacement in the sampling process.

Table 1 describes the anthropometric characteristics of the sample according to sex. There was a gradual and expected evolution of weight and BMI in relation to age groups investigated, in both sexes. The same trend was observed for height among boys. For girls aged 13 and 14 years, there was a trend toward height stabilization.

Table 2 presents the prevalence of obesity and overweight (including obesity) by age and sex, according to the IOTF[17] and Brazil[18] references. The prevalence of obesity and overweight (including obesity) was higher among boys, regardless of the diagnostic criteria used. There was also a non-linear behaviour of the prevalence of obesity and overweight (including obesity) among the age groups, in both sexes. For all age groups assessed, prevalence rates were higher using the reference curves

Table 2 - Prevalence of obesity and overweight (including obesity) in adolescents according to the reference curves of body mass index from the International Obesity Task Force and Brazil 2006

Age	n	IOTF			Brazil*		
		Mean	95%CI		Mean	95%CI	
Boys - Obesity							
11	177	7.4	1.6	13.1	7.4	1.6	13.1
12	214	4.3	1.5	7.1	3.4	0.1	6.6
13	205	3.5	1.0	6.0	3.5	1.0	6.0
14	157	5.3	2.9	7.7	7.6	2.4	12.8
All	753 754	5.0	2.9	7.0	5.2	3.0	7.3
Overweight (including obesity)							
11	177	28.3	16.5	40.1	33.8	20.8	46.8
12	214	21.6	15.8	27.3	28.9	21.8	35.9
13	205	24.9	19.3	30.5	35.8	29.9	41.8
14	157	23.9	16.1	30.7	28.0	20.8	35.1
All	753	24.5	20.4	28.6	31.7	26.1	37.3
Girls - Obesity							
11	189	3.4	1.8	8.8	4.8	1.3	11.0
12	225	3.5	0.3	7.4	5.0	0.1	9.1
13	241	2.4	0.8	3.9	3.0	0.7	5.3
14	182	2.0	0.3	3.7	3.6	0.9	6.3
All	837	2.8	1.1	4.6	4.1	1.4	6.7
Girls - Overweight (including obesity)							
11	189	13.5	4.6	22.4	18.8	7.5	30.1
12	225	15.8	7.9	23.0	25.9	20.9	30.9
13	241	10.9	7.7	14.0	15.6	12.3	18.9
14	182	18.9	14.0	23.9	21.9	17.0	26.8
All	837	14.5	10.2	18.8	20.4	16.9	24.0

IOTF: International Obesity Task Force; *Conde & Monteiro, 2006[18]; 95%CI: 95% confidence interval.

of the Brazilian criteria[18], regardless of sex. The inclusion of the follow-up group did not introduce bias in the estimates given that there was no statistically significant difference between the two groups of students regarding the prevalence of overweight (including obesity), regardless of the diagnostic criteria used (e.g. follow-up group – 18.9% (95%CI 16.1–21.7) versus new group of students – 21% (95%CI 18.2–21.7); (IOTF criteria).

Table 3 presents the prevalence of overweight (including obesity), and crude and adjusted odds ratios, for boys.

Table 3 - Crude and adjusted analysis for overweight and associated factors among male adolescents

Variables	n	Overweight (%)	Crude OD 95%CI	*p*	Adjusted OR 95%CI	*p*
School (system)				0.028		0.074
Public	192	22.03	1.00		1.00	
Private	561	30.12	1.52 (1.05–2.20)		1.43 (0.95–2.14)	
Age (completed years)				0.620		
11	177	28.03	1.00			
12	214	21.62	0.69 (0.38–1.25)			
13	205	24.95	0.84 (0.45–1.56)			
14	157	23.93	0.79 (0.41–1.52)			
Maternal Excess Weight (BMI≥25kg/m²)*				0.129		0.070
No	448	21.70	1.00		1.00	
Yes	252	30.47	1.58 (0.85–2.92)		1.77 (0.94–3.33)	
Birth weight (g)				0.049		0.107
<2,500	92	19.59	1.00		1.00	
2,500–3,999	577	24.38	1.32 (0.63–2.76)		1.46 (0.62–3.42)	
≥4,000	83	31.68	1.90 (0.86–4.16)		1.94 (0.80–4.66)	
Sexual maturation						
Differences inter-stages				0.904		
Matched stages	447	23.85	1.00			
Early pubic hair	138	27.36	1.20 (0.60–2.37)			
Delayed pubic hair	161	22.68	0.93 (0.66–1.31)			
Structured meals				0.006		0.024
No	289	31.72	1.00		1.00	
Yes	464	20.03	0.53 (0.36–0.80)		0.59 (0.39–0.92)	
Sports outside school				0.838		
Yes	566	24.80	1.00			
No	171	23.87	0.95 (0.55–1.62)			
Transportation to school				0.021		0.017
Active	361	21.34	1.00		1.00	
Passive	390	27.68	1.41 (1.06–1.86)		1.36 (1.06–1.73)	
Sedentary activities (h/days)				0.105		0.476
0–3h	213	23.12	1.00			
>3≤6h	361	24.37	1.07 (0.63–1.79)		1.02(0.60–1.74)	
>6–10h.	170	26.46	1.19 (0.66–2.14)		1.26(0.67.2.33)	
Hours of sleep/day				0.345		
<8	294	26.78	1.00			
≥8	440	22.98	0.81 (0.51–1.28)			

*Response rate of 93%; 95%CI: 95% confidence interval; OR: odds ratio; BMI: body mass index.

Adolescents boys attending private schools were more likely to be overweight, however, these differences did not remain statistically significant after adjustment for other variables. Adolescents whose mothers were classified as having excess weight had 58% greater prevalence of overweight. In bivariate analyses, there was a positive relation and a linear gradient for birth weight in relation to excess weight; however, this association did not remain statistically significant in the final model.

Among behavioral variables, adolescents who reported more time spent in sedentary activities showed the highest prevalence of overweight in the crude analyses. The hours of sleep were inversely proportional to the prevalence of overweight, but without significant differences. The use of passive forms of transportation to school and skipping structured meals proved to be factors associated with excess weight, even after adjusting for other predictors.

Table 4 presents the prevalence of overweight (including obesity), and crude and adjusted odds ratio for girls. Adolescents attending private schools presented significantly lower prevalence of overweight (including obesity) compared

Table 4 - Crude and adjusted analysis for overweight and associated factors among female adolescents

Variables	n	Overweight (%)	Crude OR 95%CI	*p*	Adjusted OR 95%CI	*p*
School (system)				0.021		0.053
Public	616	17.24	1.00			
Private	221	8.78	0.45 (0.24–0.86)		0.54 (0.29–1.00)	
Age (completed years)				0.565		
11	189	13.51	1.00			
12	225	15.89	1.29 (0.62–2.32)			
13	241	10.91	0.78 (0.38–1.60)			
14	182	19.00	1.50 (0.71–3.16)			
Maternal excess weight (BMI≥25kg/m²)*				0.000		0.000
No	510	8.65	1.00			
Yes	288	26.32	3.77 (2.24–6.32)		3.37 (2.10–5.41)	
Birth weight (g)				0.527		
<2,500	98	15.02	1.00			
2,500–3,999	693	14.18	0.93 (0.48–1.79)			
≥4,000	43	20.67	1.47 (0.53–4.04)			
Sexual maturation						
Differences inter-stages				0.020		0.022
Matched stages	447	13.14	1.00			
Early pubic hair	201	8.76	0.63 (0.36–1.10)		0.67 (0.34–1.32)	
Delayed pubic hair	179	25.63	2.27 (1.29–4.01)		2.39 (1.24–4.60)	
Structured meals				0.001		0.004
No	384	21.38	1.00		1.00	
Yes	453	9.07	0.36 (0.22–0.60)		0.41 (0.24–0.69)	
Sports outside school				0.218		
Yes	424	13.52	1.00			
No	404	15.88	1.20 (0.87–1.65)			
Transportation to school				0.825		
Active	378	14.23	1.00			
Passive	457	14.90	1.05 (0.62–1.77)			
Sedentary activities (h./day)				0.047		0.204
0–3h	244	12.08	1.00			
>3≤6h	434	14.71	1.25 (0.68–2.30)		1.27 (0.66–2.44)	
>6–10h	154	18.71	1.67 (0.78–3.58)		1.56 (0.76–3.21)	
Hours of sleep/day				0.314		
< 8	305	16.22	1.00			
≥ 8	527	13.67	0.81 (0.53–1.24)			

*Response rate of 95.2%; 95%CI: confidence interval; OR: odds ratio; BMI: body mass index.

to those who studied in public schools. In adjusted analyses, this trend was also observed, but with a borderline confidence interval (OR 0.53; 95%CI 0.29–1.00). The prevalence of overweight (including obesity) increased significantly with maternal overweight, even after adjusting for other predictors. Discordant stages for sexual maturity indicators doubled the chance of overweight when girls had breasts in more developed stages than pubic hair. In the adjusted model, among the behavioral variables, only the consumption of structured meals proved to be a protective factor for overweight (including obesity). Additionally, it is worth noting that in the crude analysis, there was a positive association with linear gradient between sedentary behavior and overweight, and the lowest prevalences were observed among adolescents who reported sleeping more than 8 hours and playing sports outside school.

Discussion

The study found several factors associated with overweight (including obesity) for boys and girls, confirming its multicausal nature and with specific characteristics to each gender. The use of a cross-sectional study design gives the study inherent limitations related to reverse causality, especially related to behavioral variables. Some information, such as food intake, sleep hours and hours of sedentary activity, were recalled by adolescents and are subject to recall bias and socially desirable behaviors. In this sense, the self-reported information to determine maternal BMI and the pubertal phase of adolescents may be subject to misinterpretation. However, studies have shown high degree of correlation between measures of height and weight referred and those found in adults (r=0.85–0.97)[23,24]. Regarding sexual maturation, studies show a moderate to high correlation (r=0.60–0.71) for pubertal measures from self-assessment and that performed by a specialized professional[25,26].

There was high prevalence of overweight (including obesity), regardless of the criteria of BMI used, particularly among boys. The prevalence of overweight estimated using the Brazilian reference was greater than with IOTF (25.8 versus 19.3%). The differences are expected because the criteria differ by country of origin and ethnic particularities associated to the large variability of BMI in childhood[27].

The analyses revealed that attending public school increases the chances for overweight in female adolescents, whereas for boys, this effect is reversed. Nevertheless, for both sexes, these differences have not been shown significant in the final model, among girls this trend had already been observed in another study in Florianopolis with the same age group[28]. Different behaviors of boys and girls related to esthetics, diets for weight loss, and the consumption of foods with low energy density, notoriously more prevalent among girls and higher social strata, are plausible hypotheses for this reality.

The observed association between maternal nutritional status and overweight in adolescents is similar to the findings of other studies conducted in Brazil[29] and elsewhere[30,31]. The habits of life marked by an obesogenic environment, coupled with genetic inheritance are identified as important agents of obesity. In this study, maternal overweight increased the odds for overweight, regardless of gender and type of school, even if in the case of boys, it has not been sustained in the final model. This finding provides good indicatives for public policies on prevention, which should be linked to the household regardless of sociodemographic conditions.

Sexual maturity is closely related to levels of body fat, especially among girls. The differences between the stages of sexual maturation can offer indicatives of physical growth, reproductive functions, and BMI[13]. In the present study, discording stages and excess weight were significant among girls. When breast development proved to be ahead of pubic hair in one or two stages, the risk for overweight has more than doubled (OR 2.39; 95%CI 1.24–4.60). The results were similar to findings in a study with U.S. adolescents[13]. Discrepancies between puberty stages may be a reflection of changes in hormonal balance, and it is plausible to presume that they affect physical growth, the process of sexual maturation, and body composition.

Boys and girls presented similar behaviors in relation to the characteristics of meals and overweight. Eating in a structured way in the main meals of the day showed a protective effect for excess weight. On the other hand, the absence of healthy and traditional food in meals may indicate that adolescents are consuming foods with high energy density in greater quantities or reducing the number of meals during the day. It is possible that skipping structured meals is considered part of a strategy for reducing body weight, because restrictive diets and with little variation in foods are customarily employed in an attempt to lose weight[32].

Commuting to school and its relationship with excess weight is still poorly investigated in Brazil. Most studies explore physical activity related to leisure, but it must be

considered that commuting and leisure are the contexts that comprise almost all the physical activity of children and adolescents. In this study, the passive forms of transportation increased the chances for overweight in children, regardless of other factors investigated. Undoubtedly, the issues surrounding the adoption of active transportation by adolescents go beyond personal motivations and incorporate safety and accessibility issues. Therefore, public policies in this direction should be encouraged.

For both sexes, sedentary behavior increased the odds of overweight (including obesity), although in the final models this association was not sustained. There is evidence that one of the possible consequences of prolonged exposure to sedentary forms of leisure is related to lower consumption of fruits and vegetables and the inadequate distribution of macronutrients[33]. Likewise, it is speculated on the likely decreased levels of physical activity with the advent of electronic forms of leisure. A meta-analysis showed a negative association between watching TV, computer use, and physical activity[34]. However, these hypotheses need further investigation so that they can clarify these associations and assign a possible causal effect.

It is important to highlight that certain patterns of behavior go beyond sociodemographic questions and constitute key points for intervention programs. Eating habits, for instance, are reflections of family culture and can directly influence nutritional status at any stage of life. Therefore, prevention policies should be conducted in order to modify behaviors related to family environment, in all social strata. Actions must be implemented to encourage active leisure to the detriment of the use of computers and television, along with the incorporation of healthy eating habits, including eating proper meals with high nutritional density foods.

Finally, the findings indicate that overweight was associated with different factors between boys and girls, except for skipping structured meals, whose effect was independent of sociodemographic variables. Among girls, the relationship with endocrine factors linked to sexual maturation, along with maternal nutritional status were the most important risk factors for overweight. On the other hand, in boys, the association of overweight with passive commuting to school and attending private schools indicate a scenario that should be better observed in new studies.

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