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ORIGINAL

Sociodemographic and behavioral characteristics of obese students with sleep problems in Southern Brazil

Características sociodemográficas e comportamentais de escolares com obesidade e problemas de sono no Sul do Brasil

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ABSTRACT

Objective

This study estimated the combined prevalence of insufficient number of hours of sleep per day and excess body adiposity among young students. The sociodemographic and behavioral characteristics associated with this concurrent health conditions were investigated.

Methods

This is a cross-sectional school-based study of 975 participants aged 11-14 years in *Florianópolis, Santa Catarina* state, Brazil. Body adiposity was assessed based on tricipital and subscapular skinfold measurements

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and classified according to Lohman. The total number of hours of sleep per day was reported by the students' parents/guardians, and it was classified as follows: as <8 hours per day and ≥8 hours per day. Data on sociodemographic characteristics, food consumption, and physical activity were collected using a self-administered questionnaire. The chi-square test and multinomial logistic regression with a 5% significance level were used to evaluate the association between the variables.

Results

The combined prevalence of insufficient number of hours of sleep per day and excess body adiposity was 25.1% (CI95%:20.7-29.9). The sociodemographic and behavioral factors predictive of these conditions were as follows: 13-14 year age group and household monthly income in the intermediate tertile.

Conclusion

The concurrent presence of insufficient sleep and excess body adiposity was found in a little more than a quarter of the students investigated. The population subgroups belonging to the 13-14 year age group and intermediate tertile of income were more likely to have concurrent insufficient number of hours of sleep per day and excess body adiposity.

Keywords: Adiposity. Adolescents. Cross-sectional studies. Sleep.

RESUMO

Objetivo

Este trabalho estimou a prevalência conjunta de horas insuficientes de sono/dia e excesso de adiposidade corporal em escolares, bem como verificou as características sociodemográficas e comportamentais correlatas.

Métodos

Trata-se de estudo transversal de base escolar, realizado com 975 participantes de 11 a 14 anos de idade, em Florianópolis (SC). A adiposidade corporal foi avaliada por mensuração das dobras cutâneas tricipital e subescapular, sendo classificada segundo Lohman. O total de horas de sono/dia foi relatado pelos pais/responsáveis dos escolares, e posteriormente classificado em <8 horas por dia e ≥8 horas por dia. Os dados de condições sociodemográficas, consumo alimentar e atividade física foram levantados por questionário autopreenchível. Utilizou-se o teste Qui-quadrado e a regressão logística multinomial, com nível de significância de 5% para avaliação das associações.

Resultados

A prevalência conjunta de horas insuficientes de sono/dia e excesso de adiposidade corporal foi de 25,1% (IC95%:20,7-29,9). Os fatores sociodemográficos e comportamentais preditores a essa condição foram faixa etária de 13 a 14 anos e renda mensal no tercil intermediário.

Conclusão

O estudo concluiu que pouco mais de um quarto dos estudantes apresentou, concomitantemente, horas insuficientes de sono/dia e excesso de adiposidade corporal. Os subgrupos populacionais pertencentes à faixa etária entre 13 e 14 anos e ao tercil intermediário de renda foram mais propícios a apresentar simultaneamente horas insuficientes de sono/dia e excesso de adiposidade corporal.

Palavras-chave: *Adiposidade. Adolescentes. Estudos transversais. Sono.*

INTRODUCTION

There is a bidirectional causal relationship between hours of sleep and body adiposity, in which in sufficient sleep affects the regulation of basal energy metabolism, and consequently it increases body adiposity [1,2]. Similarly, excess body adiposity is associated with greater consumption of unhealthy foods and decrease in physical activity, which contributes to reduced sleep quality, excessive sleepiness, and consequent decreased sleep duration [1-4].

A systematic review study identified the 16.6%-35.8% prevalence of overweight and obesity in adolescents aged 12-19 years in Latin

America, accounting for approximately 16.5-21.1 million adolescents with excess adiposity body [5]. In Brazil, a research carried out between 2013 and 2014 with a representative sample of students found that prevalence of overweight of 17.1% and prevalence of obesity of 8.4% among adolescents aged 12-17 years between 2013 and 2014 [6].

Shortened daily sleep duration is another problem affecting the adolescent population. A study using data from surveys conducted from 1905-2008 identified a secular trend to decline daily sleep duration among children and adolescents [7]. The National Sleep Foundation recommends at least eight hours of sleep per day for children and adolescents [8]. In Brazil, the prevalence of insufficient daily sleep (<8 hours/day) among adolescents ranged from 33.4% to 53.6%, according to the regions evaluated [9,10].

Excess body adiposity in adolescence is associated with health complications (dyslipidemias, glucose intolerance, and hypertension) and obstructive sleep apnea, which results in poor sleep quality and reduced sleep duration [11]. Insufficient sleep can have negative impacts on health, such as increased blood pressure, increased levels of ghrelin, and decreased levels of leptin, which leads to increased hunger and contributes to excess body adiposity [1].

Factors associated with excess body adiposity in male adolescents who were public school students from families with high income, high maternal education, high consumption of unhealthy foods, and who were not engaged in physical activities include prevalence of excess of body adiposity [3,4,6,12]. It has been found that older adolescents [7] who come from families with lower monthly income [13] and lower maternal education [14], consume higher amounts of calorie food [4], and are sedentary [3] have a tendency to get less hours of sleep on a daily basis.

There are several studies in the literature addressing the relationship between sleep duration and excess body adiposity [3,9,12,15]. However, few studies have investigated using same model of analysis the concurrent presence of sleep duration and body adiposity, despite the evidence of the interrelationship between these factors [1-4]. Nevertheless, investigating simultaneous risk factors is important because the effects of combined factors on health are greater than those of individual factors [1,11]. Furthermore, simultaneously investigating excess body adiposity and insufficient sleep in adolescents allows us to verify the extent to which this particular group of students can be traced and overlooked in terms of strategies for coping with poor health conditions.

Therefore, the objective of this study was to estimate the combined prevalence of insufficient number of hours of sleep per day and excess body adiposity among students aged 11-14 years, and to verify the sociodemographic and behavioral characteristics associated with this concurrent health conditions.

METHODS

This is a cross-sectional school-based study linked to a research project financially supported by the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq, National Council for Scientific and Technological Development) – Case nº483955/2011-6- carried out from September 2012 to June 2013 in the city of *Florianópolis*, *Santa Catarina*, Southern Brazil. The procedures for calculation of sample size sampling, and data collection and analysis have been described in a previous study [16]. A probabilistic sample of students aged 11-14 years enrolled in public (municipal, state, and federal) and private middle and high schools in *Florianópolis* was used. According to information from the 2013 school census, the total number of students in this age group in *Florianópolis* was 26,075 individuals. The method of cluster sampling was used.

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The response rate was 52.8%. The comparison between the students investigated and those who were not included in the present study, indicated a higher percentage of girls ($p<0.001$) aged 11-12 years ($p<0.001$) enrolled in private schools, compared to those attending public schools ($p<0.001$). The variable 'school grade' of the respondents did not have a significant difference when compared with that of the group of students who were not investigated ($p=0.464$) (data not shown in the Tables/Figures).

Since the present study used a set of information to examine issues different from those addressed in the broader previous study, the statistical power, which refers to the probability of rejecting a false null hypothesis (*i.e.*, to determine that there is no difference when in fact there is) [17], was calculated and values >80% were considered adequate to prevent this error. In the present study, power <80% was considered insufficient to investigate associations between behaviors related to the number of hours of sleep per day and body adiposity and the variables gender, household monthly income, and maternal education. For the other associations, the calculated power was equal to or greater than 80%.

The exclusion criteria were as follows: students with physical disabilities (understood as a complete or partial change of one or more segments of the human body) which could hinder anthropometric assessment and pregnant students. Students whose parents/guardians did not sign the Informed Consent Form and those that despite having parental consent refused to participate in the study were considered refusal or loss of subjects.

The fieldwork team was previously trained, and the anthropometric measurements were made according to the standard assessment protocol of the International Society for the Advancement of Kinanthropometry (ISAK) [18]. The intra and inter-rater technical error of measurements was calculated (coefficient $R\geq0.92$) and were considered satisfactory for the fieldwork [19]. A pilot study was also carried out at a school that was not included in the final sample of this study aiming at the adaptation of the instruments and establishment of the field work routine.

Information regarding sleep habits was obtained using a structured questionnaire sent to the parents/guardians containing the following question referring to the past six months: How many hours does your child usually sleep a night? The response options for this question were as follows: <5 hours, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours, 10 hours, 11 hours, and >11 hours. Thus, considering that this is a categorical variable, there is no need for normality testing since the variable was dichotomized. Given the lack of consensus regarding national guidelines for classifying sleep duration in children and adolescents [20], the responses obtained were dichotomized into <8 hours of sleep and >8 hours of sleep, according to the National Sleep Foundation [8] and national studies [9,20].

Body Adiposity was assessed based on subscapular (SSF) and Tricipital (TSF) skinfold thickness measurements. Based on these measurements, Body Adiposity (BA) was estimated using the Lohman's prediction equation [17]. Lohman's equation is given as follows: percentage of BA=1.35x(TSF+SSF)-0.012x(TSF+SSF)-Intercept. The intercept, also known as constant, varies according to individual's sex and age. Lohman [17] suggested constants for boys and girls aged 7, 10, 13, and 16 years. In the present study, Lohman's constants for youth aged 13 years we considered. For the ages of 11, 12, and 14 years, the constants suggested by Pires-Neto & Petroski [21] we considered; these authors developed these constants to be used in this Lohman's equation [17] based on a sample of Brazilian children and adolescents. Therefore, the constants used in the equation were different for boys and girls according to their age (Boys aged: 11 years =4.7, 12 years =5.0, 13 years =5.4, and 14 years =5.7;

Girls aged: 11 years =2.7; 12 years =3.0; 13 years =3.4; and 14 years =3.6). Thus, based on the Lohman's classification [17], boys with %BA ≥20.1 and girls with %CA≥25.1 were classified as having excess body adiposity. Measurements of skinfold thickness were performed using a Lange® adipometer (Beta Technology, *Santa Cruz*, California, United States of America) with a 1mm scale at two anatomic sites (triceps and subscapular). Three non-consecutive skinfold measurements were performed, and the arithmetic mean was used as the final measure.

Information regarding students' identification and sociodemographic status were obtained, respectively, using information provided by the schools (sex, date of birth, type of school, and school grade) and using a self-administered questionnaire, which was attached to the Informed Consent Form, containing questions about total household income and parental education. Statistical analyses were carried out considering the following: gender was classified as male and female, age of the students was categorized into 11-12 and 13-14 years, and the school type was classified as public or private. Household monthly income was categorized into tertiles, and maternal education was categorized into 0-8 years, 9-11 years, and >12 years of schooling.

Information regarding physical activity was obtained by asking the adolescents a question related to their engagement in physical activity other than physical education classes; the answer options were either "yes" or "no". Data on the variable 'consumption of unhealthy food' was collected using an updated version of the *Questionário Alimentar do Dia Anterior* (QUADA, Previous Day Food Questionnaire), which is composed of 21 food groups that are repeatedly evaluated according to six different meals (breakfast, mid-morning snack, lunch, mid-afternoon snack, dinner, and late-evening snack) [22]. This questionnaire does not specify the number of servings, but it identifies the frequency of consumption of each food group in the past 24 hours (ranging from none to six times). The following foods belonging to six of the food groups investigated by QUADA were considered as unhealthy foods: sweetened beverages (including soft drinks and artificial fruit juices), sweets, packaged snacks, French fries, and fast food. Subsequently, in order to verify compliance with the recommendations of the *Guia Alimentar para a População Brasileira* (GAPB, Dietary Guidelines for the Brazilian Population) [23], the number of times that each food group was selected by the respondents was summed up and classified as: no consumption of unhealthy foods, consumption 1-2 times/day, and consumption>3 times/day [16]. This categorization was based on that used in a previous study, which sought to follow the guidelines of the GAPB [23].

For the joint analysis of the variables 'hours of sleep' and '% of body adiposity', four distinct groups of students were formed (hours of sleep ≥8 hours/day without excess body adiposity; hours of sleep ≥8 hours/day with excess body adiposity; hours of sleep <8 hours/day without excess body adiposity; and hours of sleep <8 hours/day with excess body adiposity). The socioeconomic and behavioral characteristics of these groups were compared to each other.

The Rao-Scott chi-square test was used to investigate the association of the students' characteristics in terms of body adiposity and total number hours of sleep per day. Subsequently, multinomial logistic regression was used to obtain odds *ratio* (OR) adopting 95% confidence intervals (CI95%). The category sleep hours ≥8 hours/day without excess body adiposity was considered as the reference. Associations between all independent variables were investigated considering a *p*-value <0.10; however, no statistical significance was found in these associations. All analyses were corrected for the design effect and sampling plan using the svyset command. In the adjusted analysis, all variables were inserted at the same level, regardless of the *p*-value in the crude analysis,

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and those with *p*-value ≤0.20remained in the model, according to the backward elimination method. To evaluate the final model, a saturated model was estimated so that its adjustment parameters could be compared to each other. In these comparisons, the coefficient of multiple determination (R^2), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) were estimated. The significance of the variables inserted in the models was verified using the Wald test. Statistical analysis was carried out using the Stata statistical package (Statistical Software for Professionals; StataCorp, College Station, Texas, United States of America), version 13.0.

The present study was approved by the Ethics Committee for Research on Humans of the *Universidade Federal de Santa Catarina* (UFSC, Federal University of *Santa Catarina*), protocol nº 120341/2012. The Informed Consent Form signed by the parents/guardians consisted of an authorization for students to participate in the research.

RESULTS

A total of 975 students aged 11-14 years were investigated. The majority of these students were female (53.4%) aged 11-12 years (55.5%) who attended public school (64.7%). The household monthly income of the students was divided into tertiles. The mothers of approximately four in ten of the investigated students (37.1%) had educational level greater than or equal to 12 years, and six in ten students (61.1%) consumed unhealthy foods once or twice a day. Of the 975 students evaluated, 11.3% were not engaged in extracurricular physical activities. Approximately half of the students in the sample were sleep deprived (48.6%) and had excess body adiposity (47.5%). One in four students (25.1%) showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity (Table 1).

The odds *ratios* among the students who showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity were higher for the adolescents aged 13-14 years (OR:1.96; CI95%:1.16-3.30) and for those whose families were in the intermediate tertile of income (OR:2.29, CI95%:1.30-4.03). The students who were not engaged in physical activities had higher odds of showing concurrent presence of insufficient number of hours of sleep per day (<8 hours) and no excess body adiposity (OR:1.82; CI95%:1.01-3.26). Moreover, the odds *ratios* among the students showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity were lower for those who consumed three or more servings of unhealthy foods (OR:0.37; CI95%:0.21-0.67) (Table 2).

DISCUSSION

The combined prevalence of insufficient number of hours of sleep per day and excess body adiposity estimated in the present study was 25.1%. In a study with similar sample and same cutoff point for insufficient sleep and body adiposity found a prevalence of 12.3% [15]. In another study, the prevalence of adolescents who slept less than <8 hours/day was significantly higher for obese than for non-obese individuals (80.0% *vs* 63.0%, *p*=0.04) [4]. Similarly, a study with a sample of 3,311 European adolescents aged 12.5-17.49 years found that sleeping <8 hours/day was significantly associated with high body weight and/or adiposity (body fat, body mass index, waist circumference, and hip circumference) among adolescents in an analysis adjusted for sexual maturation [24]. In the present study, a possible justification for the high prevalence of students who students showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity is related to the adolescents' behavioral changes, such

Table 1. Characteristics of students aged 11-14 years in the sample investigated. *Florianópolis* (SC), Brazil, 2012/2013.

Variables	Total sample (n)	% (CI95%)
Gender		
Male	446	46.6 (41.7-51.5)
Female	529	53.4 (48.5-58.2)
Age (years)		
11-12	578	55.5 (44.8-65.7)
13-14	397	44.5 (34.2-55.2)
Type of school[a]		
Public	635	64.7 (43.1-98.6)
Private	340	35.2 (13.1-57.7)
Household Monthly income (tertiles)[a]		
1[st]tertile (R$120-R$1,510)	333	33.2 (9.3-70.9)
2[nd]tertile (R$1,600-R$3,000)	298	31.7 (23.5-41.1)
3[rd]tertile (R$3,100-R$3,0000)	338	35.1 (7.7-78.7)
Maternal Education[a]		
0 - 8 years	261	27.6 (7.3-64.9)
9 -11 years	315	35.2 (20.8-52.9)
≥12 years	336	37.1 (7.5-81.0)
Consumption of Unhealthy Foods		
Do not consume unhealthy foods	206	24.3 (17.3-33.1)
Consume 1-2/day	599	61.1 (55.3-66.5)
Consume ≥ 3 /day	169	14.6 (11.1-18.9)
Extracurricular Physical Activity[a]		
No	105	11.3 (7.0-17.8)
Yes	841	88.7 (82.2-93.0)
Hours of sleep[a]		
<8 hours of sleep	474	48.6 (39.0-58.3)
≥8 hours of sleep	501	51.4 (41.6-60.1)
Body Adiposity[a]		
Without excess	523	52.5 (42.9-61.9)
With excess	452	47.5 (38.1-57.1)
Hours of Sleep/Body Adiposity		
Sleep ≥8 hours/without excess BA	282	27.7 (23.6-32.2)
Sleep<8 hours/without excess BA	241	23.2 (19.4-27.4)
Sleep ≥8 hours/with excess BA	219	24.0 (20.6-27.8)
Sleep<8 hours/with excess BA	233	25.1 (20.7-29.9)

Note: [a]Ignored values for the variables; CI: Confidence Interval; BA: Body Adiposity.

as the increase in the use of electronic devices (television, computer, and videogame) at night, which leads to increased psychophysiological arousal due to the bright light exposure found in these devices. It also causes worsening sleep quality and reduces total sleep time. Moreover, longer exposure to electronic media is directly associated with higher consumption of empty-calorie foods, which positively contributes to an increase in body adiposity [25].

Table 2. Association of number of hours of sleep per dayand body adiposity with sociodemographic and behavioral characteristicsamong students aged 11-14 years in the sample investigated. *Florianópolis* (SC) Brazil, 2012/2013.

Variables[b]	Sleep <8 hours Without excess BA		Sleep ≥8 hours With excess BA		Sleep <8 hours With excess BA	
	n (%)	OR (CI95%)[a]	n (%)	OR (CI95%)[a]	n (%)	OR (CI95%)[a]
Total	241 (23.2)	(19.4-27.4)	219 (24.0)	(20.6-27.8)	233 (25.1)	(20.7-29.9)
Gender						
Male	119 (23.5)	1.00	95 (23.8)	1.00	97 (22.9)	1.00
Female	122 (23.0)	1.26 (0.80-2.02)	124(24.2)	1.15 (0.72-1.83)	136 (26.9)	1.11 (0.69-1.76)
Age (years)						
11-12	133 (20.6)	1.00	148 (27.7)	1.00	113 (20.6)	1.00
13-14	108 (27.2)	1.56 (0.89-2.73)	71 (18.4)	0.88 (0.57-1.37)	120 (31.9)	1.96 (1.16-3.30)
Type of school						
Public	156 (21.9)	1.00	141 (25.0)	1.00	147(24.1)	1.00
Private	85 (24.3)	0.87 (0.46-1.62)	78 (23.2)	1.11 (0.60-2.07)	86 (25.9)	0.96 (0.56-1.65)
Household Monthly Income (tertiles)						
1st tertile (R$120-R$1510)	79 (22.6)	1.00	81 (27.6)	1.00	61 (17.6)	1.00
2nd tertile (R$1600-R$3000)	70 (22.5)	1.04 (0.77-2.11)	61 (21.6)	1.03 (0.51-2.08)	89 (31.4)	2.29 (1.30-4.03)
3rd tertile (R$3100-R$30000)	91 (24.0)	1.21 (0.69-2.73)	77 (23.5)	0.80 (0.41-1.58)	79 (25.3)	1.38 (0.66-2.85)
Maternal Education						
0-8 years	61 (20.3)	1.00	57 (24.9)	1.00	52 (20.4)	1.00
9-11 years	65 (18.6)	1.03 (0.57-1.90)	82 (29.0)	1.31 (0.83-2.07)	86 (27.8)	1.28 (0.71-2.34)
≥12 years	92 (26.2)	1.75 (0.95-3.20)	69 (20.7)	0.86 (0.48-1.51)	85 (25.5)	1.15 (0.66-2.00)
Consumption of Unhealthy Foods						
Do not consume unhealthy foods	40 (20.5)	1.00	64 (30.8)	1.00	47 (22.5)	1.00
Consume 1-2 times/day	145 (23.1)	0.96 (0.59-1.59)	128 (23.0)	0.72 (0.43-1.22)	157 (27.8)	1.03 (0.59-1.80)
Consume ≥3 times/day	56 (28.0)	0.97 (0.55-1.71)	26 (16.7)	0.37 (0.21-0.67)	29 (18.2)	0.52 (0.22-1.21)
Extracurricular Physical Activity						
Yes	206 (22.2)	1.00	200 (25.1)	1.00	198 (24.7)	1.00
No	26 (28.2)	1.82 (1.01-3.26)	15 (18.4)	1.05 (0.50-2.19)	32 (31.1)	1.75 (0.94-3.28)

Note: The final model composed of the variables age, monthly income, consumption of unhealthy foods, and extracurricular physical activity had pseudo R^2=0.0340; AIC=3,269.12; and BIC=3,701.72. The saturated model had the following fit indices: pseudo R^2=0.0369; AIC=3,576.16; and BIC=3,589.83; the null model had the following fit indices: pseudo R^2=0; AIC=3,816.64;and BIC=3,817.71.

[a]Adjusted analysis for all independent variables; [b]Category referring to sleep ≥8 hours/without excess body adiposity.

BA: Body Adiposity; OR: *Odds Ratio*; CI: Confidence Interval; AIC: Akaike Information Criterion; BIC: Bayesion Information Criterion.

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The present study found that the adolescents aged 13-14 years had higher odds of having fewer hours of sleep per day and having excess body adiposity compared to 11-12 year-old adolescents. The findings regarding fewer hours of sleep/day among older adolescents corroborate those of other authors [9,26]. Furthermore, the results obtained in the present study regarding the excess body adiposity and older students, corroborate those of a study carried out in Saudi Arabia, in which the group of students aged 13-18 years had a higher prevalence of overweight, obesity, and severe obesity (26.6%-19.6%, 10.6%-7.9%, and 2.4%-1.5%, respectively) than children aged 5-12 years [27]. Older adolescents have increased academic demands and increased exposure to extracurricular activities, which could justify their fewer hours of sleep/day [26]. In addition, as adolescents get older, there is increased participation in social activities, such as hanging out with friends and parties, in which the consumption of easily accessible foods such as fast foods is common, which could possibly justify the excess body adiposity in older adolescents [4].

As for the concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity, higher odds *ratios* were identified among adolescents whose families were in the intermediate tertile of income. Similar results were found in a study carried out with students from the state of *Santa Catarina*, Brazil, which reported higher odds ratios among students who showed sleep deprivation (<8 hours of sleep) and came from families with high and average monthly income, 31% (OR:1.31; CI95%:1.14-1.35) and 68% (OR:1.68;CI95%:1.24-2.28), respectively, when compared to students from families with low monthly income [26]. Another study carried out with students from the city of *Rio Branco, Acre*, Brazil, found that students with excess body adiposity were those from upper middle-class families (OR:1.97; CI95%:1.00-2.89) and upper-class families (OR:2.43; CI95%:1.19-4.95) [12]. The *Pesquisa de Orçamentos Familiares* (POF, Family Budget Survey) has indicated that in the southern region of the country, the families with a monthly income of R$1,245.00-$2,490.00 (income similar to that of families in the intermediate tertile of income) spend only 6.1% of their income on disease prevention and health promotion [28]. The low investment to avoid health risk factors that lead to health problems associated with sedentary life style and poor eating habits could possibly justify the results obtained in the present study for the students who showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and excess body adiposity [24].

In the present study, it was found that the odds *ratios* among the students who showed concurrent presence of insufficient number of hours of sleep per day (<8 hours) and no excess body adiposity were higher for those who were not engaged in extracurricular physical activities. Similar results were found in a study carried out with 802 Omani adolescents aged 15-18 years, which reported that although the subjects had a sedentary lifestyle characterized by an average of 6.7 hours of sleep and consumption of high-calorie foods, they had a normal body mass index (less than 25kg/m^2) [29]. However, a different result was found in a study with a sample composed of 1,231 6 to 10-year-old boys and girls from Stockholm, Sweden, revealing that moderate-to-vigorous physical activity increased sleep efficiency the following night [3]. As for physical activity and excess body adiposity, the results obtained in the present study were also contrary to those obtained in a study with 741 students aged 14-18 years in *Rio Branco, Acre*, Brazil, in which the insufficiently active students had higher odds of developing excess body adiposity (OR:2.52, CI95%:1.60-3.95) when compared to active students [12]. Although the literature has reported a direct association between physical activity and better sleep duration and body adiposity prognosis [24], engagement in physical activity will only

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bring beneficial health effects to adolescents if they are good quality activity programs and are regularly performed with sequential goals. However, the instrument used in the present study to identify the engagement in physical activities does not allow verifying important aspects of the physical activity (volume, frequency, intensity, and duration); thus, it was assumed that the physical activities performed by the students were not enough to promote changes in body fat.

It is also worth emphasizing that the odds *ratios* among the students who slept ≥8 hours/day and had excess body adiposity were smaller for those who consumed ≥3 servings of unhealthy foods a day. With regard to food consumption, the results obtained in this study are contrary to those reported in the literature, which showed a direct association between fewer hours of sleep/day, excess body adiposity, and inadequate food consumption [4,30]. An example is the study carried out with 410 female students aged 18 to 28 years in Iran, which found that girls who slept less than 6 hours a day were more likely to have excessive body adiposity and poorer diet quality, which was rich in high-energy-density foods and simple carbohydrates [30]. In a study involving 240 adolescents aged 16-19 years, it was found that those who slept <8 hours a day consumed a higher proportion of calories from fats (35.9%±6.7%:p=0.004). After adjustment, short sleep duration was significantly associated with an average increase by 2.2% in the daily consumption of calories from fat [4]. A possible justification for the lower odds of sleeping sufficient number of hours per day and higher consumption of unhealthy foods could be due to metabolic alterations resulting from the increased consumption of these foods (which are nutritionally poor and high in fat) since hunger and sleep are mutually regulated by the hypothalamic-pituitary axis [1]. Although the literature has identified a direct relationship between high intake of unhealthy foods and excess body fat [5], in the present study, there was an inverse relationship between these same variables, which may be due to the instrument used to verify this information. The instrument does not does not specify the number of servings consumed but the frequency of daily consumption of these foods, and despite the higher frequency of consumption of unhealthy foods, the number of servings may not have been sufficient to negatively affect body fat.

Even though there was no association of type of school (public or private) with hours of sleep/day and body adiposity, private school students have a better socioeconomic level, which allows greater access to consumer goods such as electronics. These amenities may contribute to the adoption of long periods of sedentary behavior, a factor that is directly associated with insufficient sleep and excess body adiposity [25]. Moreover, although the investigation of the relationship between school hours and aspects related to hours of sleep/day hours and body adiposity was not the objective of the present study, the literature has reported that students who go to school in the morning or at night had more insufficient number of hours of sleep per day (<8 hours) [9]. It is likely that these students may also be more susceptible to changes in body adiposity, due to the relationship between these factors [1-4]. The working schedule of working adolescents can also directly affect the concurrent presence of hours of sleep/day and body adiposity since work is an important factor for the increase of sleep disorders (excessive daytime sleepiness) that may contribute to reduce the number of hours of sleep per day and increase body adiposity [20].

One limitation of the present study is the questionnaire used to collect information regarding sleep habits since the questions considered night school only. Another limitation is that fact that the questionnaire used to identify the frequency of consumption of unhealthy food (QUADA, *Questionário Alimentar do Dia Anterior*/Previous Day Food Questionnaire), was validated for children aged 6-11 years. However,

it was assumed that students aged 12-14 years would have enough cognitive abilities to answer the questionnaire and generate reliable data. The insufficient statistical power of the sample to investigate some associations (gender, household monthly income, and maternal education) is also considered a limitation of the present study. Thus, further studies are necessary including different sample sizes in order to allow the extrapolation of the results to the population of interest. Other limitations are the high percentage of sample loss and the sampling without reweighting since the differences found in the distribution of the frequencies between the evaluated and non-evaluated students were 45.4% and 54.6% for gender; 57.4% and 42.6% for the age group 11-12 years; and 47.3% and 52.7% for the age group 13-14 years. As for the type of school, the differences found were: 62.4% and 37.5% for municipal schools; 41.4% and 58.6% for state schools; 58.1% and 41.9% for federal government schools; and 60.8% and 39.2% for private schools, which suggests possible selection bias. However, it is worth highlighting the adherence to the high standards of methodological rigor in the present study by providing all research team members with adequate training and by the use of validated instruments for data collection, which confers reliability to the results. Additionally, aiming to partially correct possible bias caused by refusal or loss of subjects, the percent differences between the respondents and the eligible population was also considered in the calculation of the sampling weight. Furthermore, it has been reported that studies involving adolescents have lower adherence rates than those observed with other age groups [16]. Moreover, measuring the contribution of engagement in physical activity using a self-administered questionnaire is a limitation of this study. Therefore, further studies are recommended with inclusion of instruments that allow the accurate identification of relevant information about the volume and intensity of the physical activity performed.

CONCLUSION

Due to health problems associated with insufficient number of hours of sleep per day and excess body adiposity among adolescents, the implementation of actions aimed to prevent diseases related to these conditions are of extreme importance. These actions could include holding talks and seminars in schools for students, teachers, and parents addressing this topic and providing information about the consequences of insufficient sleep and excess body adiposity. Accordingly, the subgroups of adolescents aged 13-14 years in the intermediate tertile of income would benefit from these actions.

CONTRIBUTORS

All authors contributed equally to the conception and design of this study, data analysis and interpretation, discussion of results, and manuscript writing.

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