Association between sleep indicators and eating habits in adolescents

Associação entre indicadores do sono e hábitos alimentares em adolescentes

Asociación entre indicadores de sueño y hábitos alimentarios en adolescentes

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Abstract
Objective: To analyze the association between sleep quality indicators and eating habits in adolescents. Material and Methods: This is a cross-sectional study conducted with adolescents (age 10-19 years) followed up at the Adolescent Outpatient Clinic. Anthropometric and body composition parameters, sleep quality indicators, and eating behavior were evaluated. Body composition was measured using electrical bioimpedance. Sleep quality was assessed by the Pittsburg Sleep Quality Index (PSQI), excessive daytime sleepiness by the Epworth Sleepiness Scale (ESS), eating behavior was assessed by the Brazilian Food Frequency Questionnaire (FFQ). Linear regression analyses were used to verify the association between outcome and independent variables. Results: Thirty-five adolescents (mean age 12.9 ± 2.0 years old) were evaluated. There was a significant association between BMI and daytime sleepiness (p=0.010), fat mass (%), and sleep quality (p=0.046) while drinking at least 5 glasses of water was associated with sleep efficiency (p=0.029). Adjusted linear regression showed that BMI (β= -0.364; p=0.001) and age (β= -0.30; p<0.001) were negatively associated with hours of sleep, whereas blood pressure (β= 0.196; p<0.001) and the frequency of consumption of the group of cereals, tubers, and pasta (β=1.451; p<0.001) were positively associated. Conclusion: Adolescents with a higher % fat mass and BMI showed worse sleep quality and daytime sleepiness. Drinking at least five glasses of water can improve sleep efficiency. The consumption of cereals, tubers, and pasta, can contribute to longer sleep duration.
Keywords: Adolescent; Feeding behavior; Sleep.

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Resumo
Objetivo: Analisar a associação entre indicadores de qualidade do sono e hábitos alimentares em adolescentes. Material e Métodos: Trata-se de um estudo transversal realizado com adolescentes (10-19 anos) acompanhados no Ambulatório do Adolescente. Foram avaliados parâmetros antropométricos e de composição corporal, indicadores de qualidade do sono e comportamento alimentar. A composição corporal foi medida por bioimpedância elétrica. A qualidade do sono foi avaliada pelo Índice de Qualidade do Sono de Pittsburg (PSQI), a sonolência diurna excessiva pela Escala de Sonolência de Epworth (ESS), o comportamento alimentar foi avaliado pelo Questionário Brasileiro de Frequência Alimentar (QFA). Análises de regressão linear foram utilizadas para verificar a associação entre o desfecho e as variáveis independentes. Resultados: Foram avaliados 35 adolescentes (idade média de 12,9 ± 2,0 anos). Houve associação significativa entre IMC e sonolência diurna (p=0,010), massa gorda (%) e qualidade do sono (p=0,046) enquanto beber pelo menos 5 copos de água foi associado à eficiência do sono (p=0,029). A regressão linear ajustada mostrou que o IMC (β= -0,364; p=0,001) e a idade (β= -0,30; p<0,001) associaram-se negativamente com as horas de sono, enquanto a pressão arterial (β= 0,196; p<0,001) e o frequência de consumo do grupo de cereais, tubérculos e massas (β=1,451; p<0,001) foram positivamente associadas. Conclusão: Adolescentes com maior % de massa gorda e IMC apresentaram pior qualidade do sono e sonolência diurna. Beber pelo menos cinco copos de água pode melhorar a eficiência do sono. O consumo de cereais, tubérculos e massas pode contribuir para uma maior duração do sono.
Palavras-chave: Adolescente; Comportamento alimentar; Sono.

Resumen
Objetivo: Analizar la asociación entre indicadores de calidad del sueño y hábitos alimentarios en adolescentes. Material y Métodos: Se trata de un estudio transversal realizado con adolescentes (10-19 años) en seguimiento en el Ambulatorio de Adolescentes. Se evaluaron parámetros antropométricos y de composición corporal, indicadores de calidad del sueño y conducta alimentaria. La composición corporal se midió por impedancia bioeléctrica. La calidad del sueño fue evaluada por el Índice de Calidad del Sueño de Pittsburgh (PSQI), la somnolencia diurna excesiva por la Escala de Somnolencia de Epworth (ESS), la conducta alimentaria fue evaluada por el Cuestionario Brasileño de Frecuencia de Alimentos (FFQ). Se utilizaron análisis de regresión lineal para verificar la asociación entre el resultado y las variables independientes. Resultados: Treinta y cinco adolescentes fueron evaluados (edad media 12,9 ± 2,0 años). Hubo una asociación significativa entre el IMC y la somnolencia diurna (p=0,010), la masa grasa (%) y la calidad del sueño (p=0,046), mientras que beber al menos 5 vasos de agua se asoció con la eficiencia del sueño (p=0,029). La regresión lineal ajustada mostró que el IMC (β= -0,364; p=0,001) y la edad (β= -0,30; p<0,001) se asociaron negativamente con las horas de sueño, mientras que la presión arterial (β= 0,196; p<0,001) y la la frecuencia de consumo del grupo cereales, tubérculos y pastas (β=1,451; p<0,001) se asoció positivamente. Conclusión: Los adolescentes con mayor % de masa grasa e IMC presentaron peor calidad de sueño y somnolencia diurna. Beber al menos cinco vasos de agua puede mejorar la eficiencia del sueño. El consumo de cereales, tubérculos y pastas puede contribuir a una mayor duración del sueño.
Palabras clave: Adolescente; Comportamiento alimentario; Dormir.

1. Introduction

Pediatric obesity remains a major public health concern worldwide (De Onis, Blössner, & Borghi, 2010). Epidemiological data from Brazil draw attention, especially considering the adolescent population, due to the increasingly early appearance of comorbidities associated with weight (IBGE, 2011).

Different behaviors may be related to the development and maintenance of obesity across adolescence. In this scenario, accumulating evidence indicates sleep duration and quality as possible risk factors (Hayes et al., 2018). In this phase, both the homeostatic mechanism and circadian cycle are related to physiological changes in sleep, such as delay and elongation of the phases, called disturbance of the delayed sleep-wakefulness phase, causing both falling asleep and waking up to occur a little later (Carskadon, 2011).

Although the sleep recommendation for adolescents is approximately nine hours per night (Carskadon, 2011), 61% of students had a sleep duration of fewer than eight hours per night and 46% reported that they never or rarely had a good night's sleep. Del Ciampo, Louro, Del Ciampo, and Ferraz (2016), observed that 45% of Brazilian adolescents slept less than nine hours a night, 90% reported difficulties falling asleep, and 44.7% reported delays in waking up. In addition, during the day, 70% felt sleepy, indicating poor sleep quality and daytime sleepiness.

During adolescence, sleep patterns may suffer psychosocial influences, such as night outings, excessive school activities, and external concerns, resulting in reduced sleep duration, and making the adolescents more vulnerable to changes in sleep, and, consequently, to increased chances of weight gain (Hagenauer & Lee, 2012). Thus, when considering these aspects, a chronic insufficient sleep pattern among adolescents is considered a public health problem according to the American Academy of Pediatrics (Owens, 2014).

Shorter sleep duration has been associated with a higher body mass index (BMI), greater use of technology, and low physical activity in children and adolescents (Hayes et al., 2018), and this scenario was well described by Crowley, Wolfson, Tarokh, and Carskadon (2018), as a perfect storm model. Thus, adolescents who sleep less, specifically those who sleep later, engage in unhealthy diets, such as higher consumption of energy foods, foods with poor nutrients, greater consumption of snacks and sweet drinks (Ferranti et al., 2016; Santos et al., 2021). Further understanding of these associations will help to inform the development of future interventions.

Thus, concerning body composition, eating habits, and their association with sleep quality, total sleep duration, and efficiency, the literature is still restricted and the findings described seem somewhat controversial and inconclusive, specifically in adolescents. Therefore, the current study aimed to verify the association between sleep quality indicators and eating behavior in adolescents.

2. Methodology

This is a cross-sectional study, carried out at the Adolescent Outpatient Clinic, located in the city of Recife, Pernambuco/Brazil. The study was approved by the Ethics Committee (CAAE : 30874620.5.0000.5207) and signed consent was obtained from parents/guardians and assent from children/adolescents.

Sample

The sample was composed of adolescents aged between 10 and 19 years, of both sexes, who attended the nursing consultation during the data collection period. The exclusion criteria adopted were adolescents with physical, intellectual disabilities, neurological disease, pregnant women, and adolescents with degenerative diseases that make it impossible to participate in the research procedures.

Anthropometric indicators and body composition

Body mass was measured using an electronic digital scale (Líder®, modelP-200C, ID: LD1050), with a maximum capacity of 200 kg and a minimum of 2 kg, and a sensitivity of 100g. Adolescents were weighed wearing light clothes and without shoes (Jelliffe, 1968). Height was measured with a vertical anthropometer (Líder®, modelP-200C, ID: LD1050), according to the method of Jelliffe (1968). Based on these measurements, BMI was calculated [BMI=weight (kg)/height (m)²]. The nutritional status of the adolescents was determined according to the WHO Z-score recommendation, (Onis et al., 2007) adopted by the Brazilian Ministry of Health (Ministry of Health, 2011), using WHO AnthroPlus Software (version 1.0.4).

Waist circumference was measured at the midpoint between the lower rib and the superior iliac spine at the end of normal expiration using an inelastic tape to the nearest 0.1 cm (Heyward & Stolarczyk, 1996). Circumferences below or equal to the 90th percentile were adopted as without risk factors for metabolic alteration (Freedman, Serdula, Srinivasan, & Berenson, 1999).

Body composition was determined with electrical bioimpedance (BIA), using tetrapolar bioimpedance (BIA 1010, SANNY, São Paulo, Brazil), which provides an estimative of fat percentage, lean mass, fat mass, and body water. The adolescents were in the supine position with relaxed legs and arms, without any contact with other body parts. The electrodes

were placed on the dominant side of the body; four skin electrodes were placed on the dorsal side of the hand and foot proximal to the metacarpal-phalangeal joint and between the distal prominences of the radius and ulna and between the medial and lateral malleoli the ankle, respectively (Lukaski, 1987).

Sleep Quality

Sleep quality was assessed using the PSQI, which has previously been validated for Brazilian adolescents (Bertolazi et al., 2011). This instrument assesses the quality of sleep concerning the previous month and consists of 19 self-administered questions, grouped into seven domains, distributed on a scoring scale from 0 to 3, allowing a total score of up to 21 points. Scores from five points are indicative of a bad sleep pattern, classifying the participants into "good sleepers" and "bad sleepers" (Bertolazi et al., 2011). Sleep efficiency was calculated through the percentage of time spent sleeping in bed, by dividing the amount of time spent sleeping (in minutes) by the total time spent in bed (in minutes) (Reed & Sacco, 2016).

Daytime sleepiness

Excessive daytime sleepiness (EDS) was assessed by the Epworth Sleepiness Scale (ESS), which was also tested and validated in Brazil, presenting a reliability coefficient of the 8 items with a Cronbach alpha value of 0.83 (Bertolazi, 2008). Respondents provide a rating, on a 4-point scale (0 to 3), of their usual chances of napping or falling asleep while participating in eight different activities. The sum of the scores can vary from 0 to 24. Scores from 10 points already indicate some degree of daytime sleepiness, that is, the higher the score, the greater the sleepiness propensity of the person in daily life (ASP) (Bertolazi, 2008).

Eating Habits

The usual food intake was evaluated using the Brazilian Food Frequency Questionnaire (FFQ) (Fumagalli et al., 2008). The adolescents and their legal representatives were asked about the frequency of food intake during the previous month. Food intakes not previously described in this questionnaire were added. The information provided in the FFQ was transformed into daily frequencies according to Araujo et al. (2010).

The assessment of healthy eating behaviors was carried out as described in Barufaldi et al. (2016). The following eating behaviors were also considered healthy: consumption of breakfast, drinking water and eating meals with parents or guardians (Barufaldi et al., 2016).

Sexual maturation

Sexual maturation was evaluated according to the criteria established by Tanner (1955). The procedure for assessing the stage of sexual maturation is performed by examining breasts (B) and pubic hair (P), for females, and genitals (G) and pubic hair (P), for males (Tanner, 1955). Only volume and aspect of breasts were used for girls and the characteristics of the external genitalia for boys, thus avoiding the bias of racial and maturation factors as well as pubic hair removal.

Blood pressure

Systolic and diastolic blood pressure (SBP and DBP, respectively) measurements were performed according to the recommendations described in the VII Brazilian Hypertension Guideline (Malachias et al., 2016), using a blood pressure monitor with manual sufflation (Missouri® Model Adolescents and Adults). To perform the measurements of blood pressure, the right arm was used, with the adolescent in a sitting position. The consolidation was carried out in at least two moments for

more reliability. SBP and DBP were defined as normal blood pressure for levels below the 90th percentile according to sex, age, and height, as recommended by the Brazilian Society of Cardiology (Malachias et al., 2016).

Statistical analysis

Initially, an exploratory analysis of the data was performed to identify the presence of errors in the entry of information or the presence of inconsistencies (outliers). Subsequently, the normality of data distributions was verified with the Shapiro-Wilk test and inspection of histograms. After these procedures, to analyze the differences between the sexes (boys and girls), the Student t-test was used for independent samples or the non-parametric correspondent Mann-Whitney test (U). Values are presented as mean ± standard deviation. To examine aspects related to adolescent eating behavior and its association with sleep indicators, some variables were categorized. The Pearson's chi-square test (χ^2) was used to analyze the association between these variables. Linear regression analyses were performed to investigate the association between anthropometric indicators and body composition, blood pressure, biological maturation, eating behavior and the frequency of food consumption by food group with the dependent variables sleep hours, daytime sleepiness, and sleep quality. For all analyses, a crude univariate model and a multivariate model were performed, using a backward method. All variables were considered in the adjusted analysis and those that presented $p < 0.20$ or contributed to the model's adjustment index were retained for the regression models. The data are expressed as regression coefficients (β), with their respective 95% confidence intervals, adjusted determination coefficient (R^2), and significance values. All analyses were performed using the Statistical Package for the Social Sciences (SPSS, Inc. Chicago, IL, version 25.0), with a significance level of $p < 0.05$.

3. Results

The sample was composed of 35 adolescents (60% female). The distribution of subject characteristics, including sleep parameters, frequency of food consumption by food group, and social variables is shown in table 1. Significant differences were identified between boys and girls only in fat mass (%), lean mass (%), and total body water (%). The other variables did not show statistically significant differences. Although there were no differences in sexual maturation, girls were 0.46 years older than boys.

Table 1 - Descriptive characteristics of the adolescents and comparisons between the sexes.

Variables	All (N=35)	Boys (N=14)	Girls (N=21)	t/U	p - value
Anthropometry and body composition	M±SD	M±SD	M±SD		
Age (years) [§]	12.96 ± 2.07	13.03±1.89	12.90±2.22	0.186	0.749
BMI (kg/m^2) [€]	21.02 ±4.61	19.64±3.64	21.94±5.02	-1.568	0.126
Waist circumference (cm) [€]	74.38 ±10.44	71.66±8.85	76.75±11.39	-1.375	0.180
Fat mass (%) [€]	29.42 ±8.82	25.32±8.65	32.15±8.01	-2.354	**0.026**
Fat mass (kg) [€]	15.54 ±8.58	12.48±7.27	17.58±8.94	-1.850	0.074
Total body water (%) [€]	57.19 ±9.22	62.56±9.80	53.61±6.96	2.955	**0.007**
Total body water (l) [€]	29.16 ±8.26	32.50±10.74	26.94±5.29	1.796	0.090
Sexual maturation (score) [€]	3.18 ±1.38	2.92±1.50	3.38±1.31	-0.842	0.409
Food frequency					
Milk and dairy products [€]	2.29 ± 1.95	3.04±2.52	1.84±1.49	1.054	0.326
Breads and cereals [€]	3.48 ± 1.36	3.50±0.84	3.47±1.64	0.047	0.964
Fats [§]	1.59 ± 0.86	1.77±0.85	1.48±0.89	0.664	0.622
Tuber and pasta cereals[€]	2.76 ± 1.22	2.57±0.95	2.88±1.39	-0.523	0.609
Fruits [€]	3.01 ±1.42	3.81±1.69	2.53±1.05	1.667	0.137
Legumes [§]	0.83±0.38	0.72±0.47	0.89±0.33	-0.776	0.465
Vegetables [€]	1.32 ±1.13	1.41±1.63	1.26±0.81	0.209	0.841
Meat and eggs[§]	3.60±2.22	2.85±1.09	4.05±2.64	-1.273	0.515
Drinks [€]	5.63±2.07	5.10±1.56	5.94±2.34	-0.858	0.406
Sweet drinks [§]	1.37±1.06	1.26±1.04	1.43±1.12	-0.302	0.768
Sweets and miscellaneous [€]	2.45±1.98	1.86±1.25	2.80±2.30	-1.055	0.309
Fat or oil in preparation[§]	1.87±0.61	1.50±0.54	2.10±0.56	-2.092	0.059
Sleep Indicators					
Hours of sleep (h) [§]	9.08±1.72	9.14±1.45	9.04±1.90	0.168	0.986
Sleep efficiency (%) [§]	92.62±8.51	91.13±10.66	93.62±6.82	0.776	0.565
Sleep quality (points) [§]	3.57±2.48	4.42±2.27	3.00±2.50	1.745	0.060
Daytime sleepiness[€]	8.86±4.23	8.57±5.31	9.05±3.45	-0.296	0.770

€ - student t-test; § - Mann-Whitney *U*. BMI: Body Mass Index. Source: Authors.

Table 2 shows the analysis of the association between sex, anthropometric parameters, body composition, blood pressure, sexual maturation and sleep quality, sleep efficiency, and daytime sleepiness. It was observed that only the fat percentage showed a significant association with sleep quality (good and poor quality). In this study, 66.7% of the adolescents were in the highest category for percentage fat mass, and this group presented poor sleep quality. Regarding daytime sleepiness, only BMI showed a significant association. Thus, individuals with a higher BMI present an increased possibility of having daytime sleepiness. In addition, it was observed that sleep efficiency and healthy eating behaviors, only daily water consumption

showed a significant association (p=0.029), demonstrating that adolescents who consume five glasses or more of water may have better sleep efficiency, the other variables of healthy eating behaviors did not show a significant association (p>0.05).

Table 2 - Association between sex, age, BMI, waist circumference, blood pressure, body composition, sexual maturation and daily water consumption of adolescents, and sleep quality, sleep efficiency, and daytime sleepiness.

Variables	Sleep quality			Sleep efficiency			Daytime sleepiness		
	Good Quality	Low Quality	P- value	Restorative	Non-restorative	P - value	Absence of drowsiness	Somnolence	P - value
Sex									
Male	09 (33.3)	05 (62.5)	0.139	11 (39.3)	03 (42.9)	0.863	08 (44.4)	06 (35.3)	0.581
Female	18 (66.7)	03 (37.5)		17 (60.7)	04 (57.1)		10 (55.6)	11 (64.7)	
BMI/Age (kg/m^2)									
Adequate	17 (63.0)	05 (62.5)	0.981	17 (60.7)	05 (71.4)	0.475	15 (83.3)	07 (41.2)	**0.010**
Overweight (Overweight + Obesity)	10 (37.0)	03 (37.5)		11 (39.3)	02 (28.6)		03 (16.7)	10 (58.8)	
Waist circumference									
No risk factor for metabolic disease	17 (63.0)	07 (87.5)	0.193	21 (75.0)	03 (42.9)	0.101	13 (72.2)	11 (64.7)	0.632
Risk factor for metabolic disease	10 (37.0)	01 (12.5)		07 (25.0)	04 (57.1)		05 (27.8)	06 (35.3)	
Blood pressure									
Normal	10 (55.6)	05 (83.3)	0.238	13 (65.0)	02 (50.0)	0.486	08 (61.5)	07 (63.6)	0.916
Elevated + hypertension	08 (44.4)	01 (16.7)		07 (35.0)	02 (50.0)		05 (38.5)	04 (36.4)	
Fat mass (%)									
Adequate	06 (75)	09 (33.3)	**0.046**	11 (39.3)	04 (57.1)	0.332	10 (55.6)	05 (29.4)	0.118
Overweight (Overweight + Obesity)	02 (25)	18 (66.7)		17 (60.7)	03 (42.9)		08 (44.4)	12 (70.6)	
Sexual maturation									
Pre-teen	08 (29.6)	04 (50.0)	0.480	08 (28.6)	04 (57.1)	0.429	07 (38.9)	05 (29.4)	0.294
Pubescent	11 (40.7)	03 (37.5)		12 (42.9)	02 (28.6)		05 (27.8)	09 (52.9)	
Post- teen	08 (29.6)	01 (12.5)		08 (28.6)	01 (14.3)		06 (33.3)	03 (17.6)	
Daily water consumption									
Drink at least 5 glasses	06 (42.9)	01 (50.0)	0.700	04 (30.8)	03 (100.0)	**0.029**	02 (33.3)	05 (50)	0.515
Drink ≤ 4 glasses	08 (57.1)	01 (50.0)		09 (69.2)	00 (0.0)		04 (66.7)	05 (50)	

Values are presented in absolute terms and relative frequency. Pearson's chi-square test and Fisher's exact test. Boldface indicate a significant difference. Source: Authors.

In the present study, only the regression models with the variables that better contributed to the model's adjustment index are shown. Thus, Table 3 presents the results of the linear regression concerning the hours of sleep. It was observed that age (p=0.037) and BMI (p=0.001) presented a significant negative relationship with an hour of sleep, while SBP (p=<0.001) and consumption of the group of cereals, tubers, and pasta showed a positive association (p=<0.001). These variables explained 93% (R^2= 0. 930) of hours of sleep.

Table 3 - Analysis of linear regression between hours of sleep, age, body mass index, blood pressure, and a group of cereals, tubers, and pasta.

		Crude analysis			Adjusted analysis		
	Variables	**β**	**CI 95%**	**P value**	**B**	**CI 95%**	**P value**
Hours of sleep	Age (years)	0.253	-0.027 to 0.534	0.075	-0.301	-0.575 to -0.026	0.037
	BMI (kg/m²)	-0.010	-0.142 to 0.122	0.882	-0.364	-0.520 to -0.208	0.001
	Blood pressure (mmHg)	0.043	-0.013 to 0.099	0.124	0.196	0.131 to 0.261	<0.001
	Cereals, tubers, and pasta group	0.741	0.055 to 1.428	0.036	1.451	0.974 to 1.928	<0.001

Note: R^2= 0. 930; β – regression coefficient. Source: Authors.

4. Discussion

This study aimed to verify the association between sleep quality indicators and eating habits in adolescents. Firstly, according to our findings, adolescents with higher values of % fat mass had the worst sleep quality, whilst drinking at least five glasses of water per day tended to be associated with better sleep efficiency. In addition, adolescents who were overweight or obese had more daytime sleepiness.

Previous studies have also assessed the relationship between these variables independent of the magnitude or sense (Al-Haifi et al., 2016). Thus, it is possible to infer that the lower the number of hours slept per night, the greater the chances of the individual having greater body weight, percentage fat, waist circumference, BMI, and, consequently, the greater the chance of developing overweight or obesity (Magee et al., 2009; Santana et al., 2022). For example, Magee et al. (2009) showed that sleep restriction alters the hormonal regulation of appetite in a manner predictive of increased energy intake.

Although the mechanisms by which one seeks to explain the existence of these correlations are not sufficiently clarified and elucidated in the literature. In this sense, the main explanation reported is that insufficient hours of sleep can impair or decrease plasma leptin concentrations and increase ghrelin concentrations (Gonzaga et al., 2016). These hormones are responsible for sending information to the brain about energy balance and, respectively, the feeling of satiety and energy expenditure or hunger and fat production.

According to our results, drinking more than five glasses of water showed better sleep efficiency. In one study with adolescents from Taiwan a total of 656 boys (53.2%) and girls (46.8%), ranging in age from 13–18 years were studied. It was observed that adequate sleep was associated with adopting a healthy diet, including drinking at least 1.5 liters of water (Chen et al., 2006). On the other hand, Franckle et al. (2015) found no significant associations between sleep duration and drinking water. Thus, in the present study, the direction of the association could not be assessed given the cross-sectional nature of the data. Future longitudinal studies will be needed to further consider causality.

Another finding of the present study was the negative association between hours of sleep and age. With the advancing stages of maturation during puberty, there is a decrease in the speed of melatonin secretion, thus decreasing the necessary

hours of sleep per night (Aguilar Cordero et al., 2014). This partially clarifies the inverse relationship found between hours of sleep and age, since an advance in the stages of maturity is expected with increasing age, although biological maturation did not show a significant association. Adolescence is an important developmental stage where sleep is strained both in duration and timing by a host of factors, some modifiable and others not. Evidence of a relatively stable need for approximately nine hours of sleep per day on average, maturational modifications in bioregulatory processes, sleep homeostasis, and the circadian timing system, represent non-modifiable challenges (Crowley et al., 2018).

Regarding the negative association found between hours of sleep and BMI in the present study, other studies also corroborate this finding, reporting associations between shorter hours of sleep and higher BMI scores in adolescents (Chehal et al., 2022; Hayes et al., 2018) In this sense, a study carried out with adolescents (n=1586; 11-14 years) identified an inverse correlation between total sleep time and body mass index (β = -0.829, p = 0.021). (Ferranti et al., 2016) One factor that may explain these findings is the hormonal alterations observed in adolescents with restricted sleep concentrations. (Gonzaga et al., 2016)

In situations of sleep restriction, there is an increase in the levels of cortisol in adolescents. This hormone is involved in the maintenance of blood pressure at normal levels, thus, excessive production will consequently lead to an increase in blood pressure levels (Aguilar Cordero et al., 2014). Therefore, the positive correlation found between hours of sleep and systolic blood pressure of adolescents was not following the literature, considering that in this study it was identified that for each additional hour of sleep, there was an increase of 0.196 in pressure, however, under normal conditions, this finding has no clinical repercussions (Santos et al., 2018).

As a result, individuals with sleep deprivations tend to be more hungry, have a larger appetite, and feel a greater need to consume carbohydrates, foods containing a greater energy value (Duraccio et al., 2022; Gonzaga et al., 2016; Kahlhöfer et al., 2016), and these changes favor weight gain (Kahlhöfer et al., 2016). In addition, sleep restriction in adolescents can interfere with the metabolism of glucose and lipids, causing a reduction in insulin sensitivity and changes in the regulation of the glycemic profile, which causes insufficient or impaired glucose uptake in the intracellular environment (P. Chen et al., 2021). Thus, the individual tends to feel a greater need to eat food with a high glycemic index (Magee et al., 2009). In this scenario, a study observed a positive association (p= 0.02) between more hours of sleep and increased intake of foods with a low glycemic index (Kelly et al., 2016).

In turn, the consumption of cereals, tubers, and pasta in this research, seemed to have a protective effect on the hours of sleep, that is, the higher the frequency of consumption of this food group, the longer the duration of sleep. It is suggested, therefore, that this event occurred because part of the foods which make up this group are rich in low glycemic index carbohydrates.

Sleeping earlier was associated with an increase in the intake of healthy foods with a low glycemic index, fruits, and dairy products. Long-term food choices are factors that impact the development of obesity (Kelly et al., 2016). In this context, a healthy lifestyle, especially better food choices, can have a positive impact on sleep. The somatization of the well-known health problems of overweight and poor sleep quality can have very serious consequences in the medium and long term for adolescents, such as the early appearance of comorbidities. The current study highlights the need to include assessments of food consumption and sleep quality in order to bring about improvements in health indicators, especially in adolescents who already have higher percentages of BMI and poorer diet quality.

In this sense, the importance of this study is in the sense of contributing to support strategies aimed at adolescent health, considering sleep, its determinants and eating behavior as an important aspect as part of this care.

The findings of the present study must be interpreted considering the following limitations. This is a cross-sectional study, and therefore it is not possible to define causality. The results of the questionnaires can be affected by recall and

seasonality bias, however, all questionnaires used in this study were previously validated. In addition, electrical bioimpedance was used, which provides reliable results of body composition. The findings highlight that obesity prevention needs a multidisciplinary approach, especially considering that both sleep and food choices are modifiable practices.

5. Conclusion

In conclusion, adolescents with a higher percentage of fat mass tend to have poorer sleep quality, while consuming at least five glasses of water a day is likely to improve sleep efficiency. Having a high BMI can increase daytime sleepiness. In addition, the consumption of cereals, tubers, and pasta food groups can contribute to hours of sleep. It is also concluded that adolescents with a higher consumption of sweetened drinks tend to present an increase in PSQI scores, which represents worse sleep quality. The need for future research is suggested, especially longitudinal studies, which use objective measures of duration and quality of sleep to better clarify the causality of these events.

Declaration of interest

The authors have stated that they had no interests that might be perceived as posing a conflict or bias.

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