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Overweight in adolescents: a possible association between sleep quality and eating behavior according to sex

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ABSTRACT

Introduction: Obesity is a multifactorial disease affecting adolescent sleep quality and binge eating.

Objective: to analyze adolescents' sleep quality and possible binge eating according to sex and nutritional status.

Methods: 108 adolescents (n = 51 male and n = 57 female) aged between 10 to 18 years were recruited. Body composition was assessed by bioelectrical impedance, in which the following variables were collected: body weight, body fat percentage, and resting metabolic rate. The Z-score was calculated and classified by height and weight as eutrophic and overweight. Subsequently, the adolescents answered the Brazilian version of the Pittsburgh Sleep Quality Index (PSQI) questionnaire and the binge eating - Periodic Eating Compulsion Scale (BES) questionnaire to assess possible periodic eating compulsion.

Results: In the anthropometric analysis, male adolescents showed greater height (p<0.0001), body weight (p<0.05), resting metabolic rate (p<0.0001), total body water (p<0.0001), lean mass (p<0.0001), fat-free mass (p<0.0001) and skeletal muscle mass (p= 0.01) compared to female adolescents. However, female adolescents had a higher body fat percentage when compared to male adolescents (p= 0.01). In addition, overweight adolescents of both sexes had higher BES scores compared to eutrophic ones (p<0.05), with higher scores for females compared to males (p<0.05). However, no differences were observed between overweight and eutrophic individuals of both sexes for PQSI (p>0.05).

Conclusion: Binge eating was identified in both sexes and may be related to poor sleep quality.

KEYWORDS

Youth; eating habits; Sleep quality, Obesity.

RESUMEN

Introducción: La obesidad es una enfermedad multifactorial que afecta la calidad del sueño y los atracones en los adolescentes.

Objetivo: analizar la calidad del sueño y los posibles atracones en adolescentes según sexo y estado nutricional.

Métodos: se reclutaron 108 adolescentes (n = 51 hombres y n = 57 mujeres) con edades entre 10 y 18 años. Se midió el Z-score y se clasificó por estatura y peso corporal en eutróficos y sobrepeso. Posteriormente, los adolescentes respondieron la versión brasileña del cuestionario Pittsburgh Sleep Quality Index (PSQI) y el cuestionario Binge Eating Scale (BES) para evaluar la posible compulsión alimentaria periódica.

Resultados: En los análisis antropométricos, los hombres adolescentes presentaron mayor estatura (p<0,0001), peso corporal (p<0,05), tasa metabólica basal (p<0,0001), agua corporal total (p<0,0001), masa magra (p<0,0001) masa libre de grasa (p<0,0001) y masa muscular esquelé-

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tica (p= 0,01) en comparación con las mujeres adolescentes. Sin embargo, las mujeres adolescentes presentaron mayor porcentaje de grasa en comparación con los hombres (p= 0,01). Además, los adolescentes sobrepeso de ambos sexos presentaron puntajes BES más altos en comparación con los eutróficos (p<0,05), con puntajes más altos para las mujeres en comparación con los hombres (p<0,05). Sin embargo, no se observaron diferencias entre sobrepeso y eutróficos de ambos sexos para PQSI (p>0,05).

Conclusión: Los atracones se identificaron en ambos sexos y pueden estar relacionados con la mala calidad del sueño.

PALABRAS LLAVE

Adolescencia; hábitos alimentarios; Calidad de sueño; obesidad.

INTRODUCTION

Obesity is characterized by the excessive accumulation of adipose tissue in the organism, being a complex condition with multifactorial etiology[1-3]. When started in childhood or adolescence, obesity can persist into adulthood and bring consequences for health, such as associated comorbidities[1,2,4]. The impacts of obesity on adolescent health are not limited to physical aspects; studies also show psychological alterations, such as depression, anxiety, low self-esteem, eating disorders[2,5], and circadian cycle disorders[2,5,6]. Sleep is a complex physiological process mainly influenced by neurological and other systems such as cardiovascular, immune, endocrine, and nervous[6]. The sleep-wake cycle varies throughout life and depends on sex, age, lifestyle, housing, workplace, neighborhood, ethnicity, culture, and socioeconomic aspects[7].

However, the quality, time, regularity, and non-interruption of sleep are determining factors for a healthy lifestyle, and changes in any of these aspects can lead to changes in the circadian cycle[6]. Changes that are caused by modern habits, such as: sleeping less and being more exposed to screens, and these factors can be associated with weight gain, in addition to the development of diseases such as diabetes mellitus (DM) and cardiovascular diseases (CVD), that are, Chronic Non-Transmissible Diseases (NCD's), mental health problems, such as depression, anxiety, eating, mood and personality disorders, impairment of immune homeostasis and cognitive functions that are impaired, with a probable increase in the probability of errors and accidents, in addition to negatively impacting more caloric food choices[6-8].

Because of this, sleeping less can lead to compulsions, such as binge eating, defined as the excessive consumption of a large amount of food in a short period, accompanied by emotional distress and a feeling of lack of control over the foods consumed[9]. When the event, as mentioned earlier, occurs at least once a week (in the last three months) and is accompanied by compensatory behaviors aimed at weight loss, it is called Binge Eating Disorder (BED)[9]. This impulsive behavior represents a common symptom in some eating disorders such as nervous bulimia, BED, and atypical eating disorders[10]. In adolescents, this behavior is even more worrying since it is a symptom that has higher rates of onset in this phase, with a prevalence of 1% to 3% in this population, with about twice as many girls reporting compulsion when eating compared to boys and also because of the negative impact on self-esteem, body image and emotional development[5,11,20].

Furthermore, psychological and binge eating problems are associated with higher body mass index (BMI), the development of different NCDs, and psychological distress[9,11-13]. Faced with the multifactorial etiology of obesity and the repercussions that it can trigger on the health of adolescents, the aims of the present study were: (i) to verify possible associations between sleep quality and binge eating in adolescents; (ii) to compare sleep quality and binge eating according to sex and nutritional status of adolescents.

METHODS

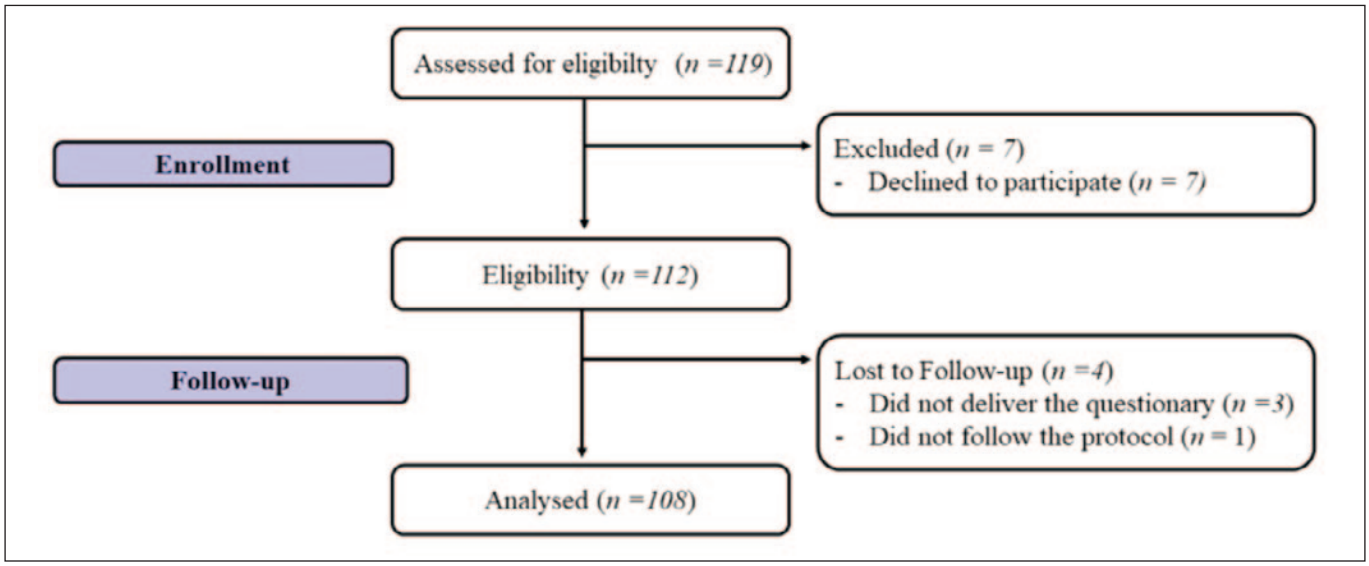
Study design

This study presents a cross-sectional, observational, descriptive, and quantitative design. The non-probabilistic sample comprised 108 adolescents aged 10 to 18 (13.7 ± 2.5 years old), 51 males and 57 females living in Maringá, Paraná, Brazil. The information about the participants is presented in Figure 1.

Inclusion and exclusion criteria

Adolescents were recruited who agreed to participate in the study and were following the established inclusion criteria: *(i)* over ten years and under 18 years old and *(ii)* who followed the four-hour fasting protocol to perform the body composition assessment in bioelectrical impedance (protocol was previously sent to all study participants). The exclusion criteria following were: *(i)* adolescents who used drugs that could regulate appetite and psychotropic drugs; *(ii)* who did not perform the pre-established assessments; *(iii)* adolescents with a pacemaker, and *(iv)* bedridden or adolescents who used wheelchairs. All guardians signed a consent form authorizing the adolescents to participate in the present study. Collections were carried out in person at the Physiology Laboratory of the Institution of Higher Education and Municipal and State schools around the University between November 2021 to April 2022. This study was approved by the Research Ethics Committee in humans local, by opinion number 29016720.20000.5539, following all the recommendations proposed in resolution 466/2012 of the Ministry of Health of the Brazilian government and the declaration of Helsinki.

Figure 1. Flowchart of the present study



Participants

Participants were divided according to sex and z-score for the classification of nutritional status. Of the female (n= 57) sample: 29 were eutrophic, 11 were overweight, seven were obese, and ten were severely obese. Of the male (n= 51) sample: 19 were eutrophic, ten were overweight, ten were obese, and 12 were severely obese. However, for the statistical analysis, the adolescents were divided into eutrophic vs. overweight (which included overweight, obesity, and severe obesity).

Instruments and Procedures

Participants were recruited through school advertisements, social networks (Instagram), pamphlets distributed in schools, and Basic Health Units near the University. After contact, on a predetermined day and at a scheduled time, the adolescents were submitted to the following procedures: *(i)* interview with the application of a detailed anamnesis on the health profile of each participant; *(ii)* measurement of height, body weight and body composition – bioelectrical impedance and *(iii)* completion of the questionnaires [sleep quality - Pittsburgh Sleep Quality Index (IQSP) and binge eating - Periodic Eating Compulsion Scale (BES)]. The instrument details are presented in the sections below.

Interview and anamnesis

During the interview and anamnesis, the adolescents were asked about any comorbidity associated with obesity, continuous use of medications, and lifestyle habits.

Anthropometry and body composition

Height was measured using a stadiometer after the participant was positioned correctly - standing, with the spine and arms extended, heels together side by side, head erect, and anterior to the device[14]. Body composition was measured using biolectrical impedance (InBody 570®, Seoul, South Korea), using the following variables: body weight, height, body mass index (BMI), body fat percentage, and resting metabolic rate, according to Sena et al.[15]. In addition, the classification between eutrophic and overweight was performed according to the Z-score, height-for-age (cm), where, the development of overweight is diagnosed over +1 SD of the median and obesity over +2 SD of the median, as recommended for this diagnosis in children and adolescents[16].

Pittsburgh Sleep Quality Index (PSQI)

The questionnaire from the Brazilian version of the PSQI, translated, adapted, and validated for the Brazilian population[17], was used to analyze sleep quality. It consists of 19 questions classified into seven categories: subjective sleep quality; sleep latency; sleep duration; sleep efficiency; daytime dysfunction; use of sleeping medication, and sleep disorders, each with a score ranging from 0 to 3. The sum of the scores for the seven components can range from 0 to 21. For sleep to be considered good quality, the score on the PSQI must be ≤ 5; when greater > 5, it is of low quality[17].

Binge Eating Scale (BES)

The BES questionnaire, translated and adapted into Portuguese by Freitas et al.[18], was used to identify possible binge eating and its severity. The BES corresponds to a Likert-type questionnaire with 16 items. Individuals with a score ≤ 17 are considered without binge eating; those between 18 to 26 are classified as having moderate binge eating, and those with scores ≥ 27 have severe binge eating.

Statistical Analysis

Data were tabulated in the Excel program (version 2013, Microsoft, United States of America). The Statistica program (Version 12.0, Stasoft, United States of America) was used for data analysis. Preliminarily, data normality was tested using the Kolmogorov-Smirnov test. For characterization of the sample, data were expressed as mean (±) standard deviation, using the t-test for comparison between independent groups (female vs. male). The Chi-square test was used for descriptive analysis of the adolescents' nominal categorical variables of the PSQI and BES, with the data presented in relative frequency (%). About inferential statistics, a two-way analysis of variance (ANOVA) was performed in order to compare possible intragroup (eutrophic vs. overweight) and intergroup (female vs. male) differences. Subsequently, the Bonferroni post-hoc test was applied to identify possible differences between groups. In addition, the effect size was calculated using Cohen's d (1988): 0.20 (*small effect*), 0.50 (*moderate effect*), and 0.80 (*large effect*). To verify the relationship between sex variables (female and male), Z score, BES, and PSQI, linear regression analysis was performed. For all analyses, a significance value of 5% was assumed.

RESULTS

The sample size consisted of 108 adolescents, aged between 10 to 18 years (13.7 ± 2.5 years old), 57 female adolescents (age: 14.1 ± 2.3 years old) and 51 adolescents from male (age: 13.5 ± 2.4 years old), with no significant difference between them (p>0.05) (Table 1). In the comparative analysis between anthropometric parameters and body composition of female and male adolescents, it was observed that male adolescents had greater height (p<0.0001), body weight (p= 0.03), resting metabolic rate baseline (p<0.0001), total body water (p<0.0001), lean mass (p<0.0001), fat-free mass (p<0.0001), skeletal muscle mass (p= 0.0001) when compared to females (Table 1). In addition, female adolescents had a higher body fat percentage than males (p = 0.01). However, no significant difference was observed in BMI and visceral fat between sex (p>0.05) (Table 1).

In the analysis of the PSQI according to sex, it was observed that female participants had sleep quality classified as "good" in 57.9% of the female sample vs. 52.9% of males (Table 2). However, male adolescents had poor quality sleep in 22.8% of the female sample vs. 39.3% of the male (Table 2). Furthermore, 19.3% of the female adolescents and 7.8% of the male sample had sleep disorders, but with no significant difference between them (p>0.05) (Table 2).

Regarding the BES, it was found that 80.7% of the female sample vs. 94.1% of males showed no symptoms of binge eating. However, female adolescents scored both moderate and severe binge eating higher when compared to males (moderate binge eating: 15.8% female vs. 3.9% male; severe binge eating: 3.5% female vs. 2.0% male), but without significant difference between groups (p>0.05) (Table 2).

In the BES classification of female and male adolescents between eutrophic and overweight, it was found that obese

Table 1. Characterization of the sample

Variables	*Female* (*n*=57)	*Male* (*n*=51)	*P*
Age (years old)	14.1 ± 2.3	13.5 ± 2.4	*p>0.05*
Height (cm)	159.3 ± 7.8	166.5 ± 10.1*	*p= 0.0002*
Body Weight (kg)	62.9 ± 20.5	71.4 ± 19.9*	*p= 0.009*
Body Mass Index (kg/cm^2)	24.6 ± 7.0	25.7 ± 6.7	*p>0.05*
Total Body Water (L)	28.9 ± 6.0	35.6 ± 35.5 ± 6.9*	*p<0.0001*
Lean Body Mass (kg)	37.0 ± 7.7	45.7 ± 8.9*	*p<0.0001*
Fat-Free mass (kg)	39.7 ± 8.3	48.5 ± 9.5*	*p<0.0001*
Skeletal Muscle Mass (kg)	21.2 ± 4.8	28.0 ± 4.8*	*p<0.0001*
Body Fat Percentage (%)	29.5 ± 13.8*	23.6 ± 14.2	*p= 0.01*
Visceral Fat (Level)	10.3 ± 6.1	9.7 ± 6.9	*p>0.05*
Resting metabolic rate (kcal)	1239 ± 214.6	1419 ± 204.8*	*p<0.0001*

Note: data as expressed as mean and standard deviation (±); * = p<0.05.

Table 2. Relative frequency according to the Pittsburgh Sleep Quality Index classification and Binge Eating Scale according to gender

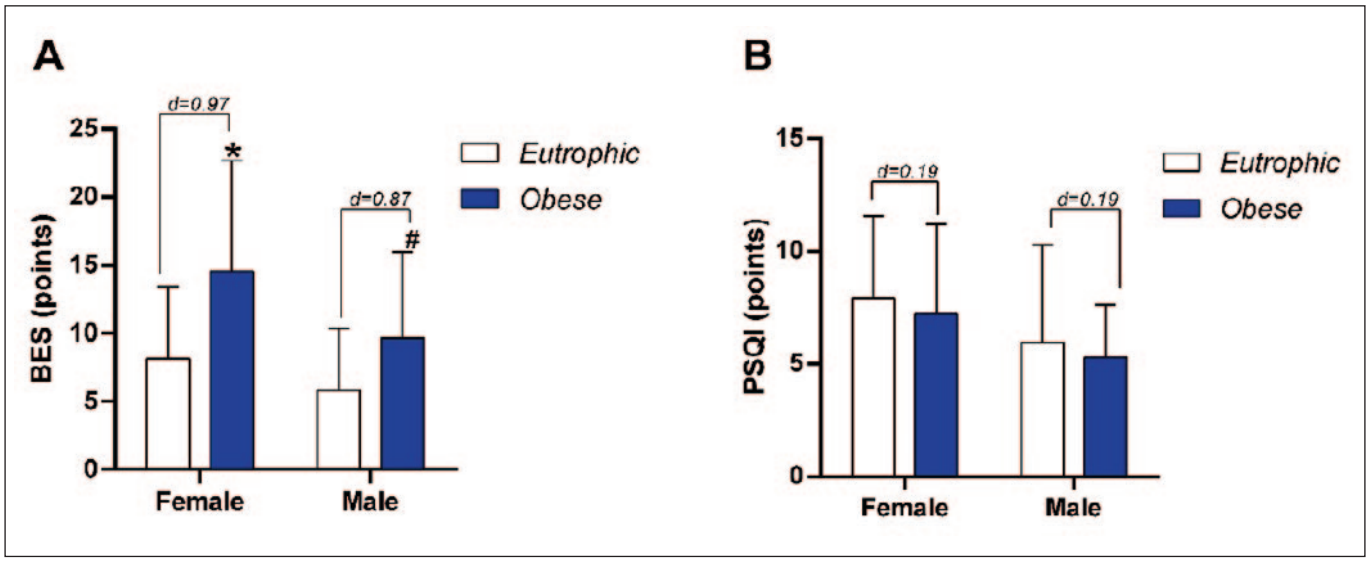
SEX	PSQI in adolescents according to sex			p-value
	Good	Poor	Presence of disorder	
Female	57.9 %	22.8 %	19.3 %	p = 0.08
Male	52.9 %	39.3 %	7.8 %	
	BES in adolescents according to sex			**p-value**
	Without BES	**Moderate BES**	**Severe BES**	
Female	80.7 %	15.8 %	3.5 %	p = 0.10
Male	94.1 %	3.9 %	2.0 %	

Note: data as expressed by relative frequency (%); PSQI = Pittsburgh Sleep Quality Index; BES = Binge Eating Scale.

adolescents had higher BES scores when compared to eutrophic adolescents (p= 0.001; d= 0.97). Regarding males, no significant difference was observed between overweight and eutrophic individuals in the BES score (p>0.05). Comparison of BES between sex indicated that obese adolescents had higher BES scores than overweight adolescents (p= 0.02) (Figure 2A). Regarding the PQSI, no significant differences were observed between eutrophic and overweight adolescents when compared to eutrophic adolescents of both sexes (p>0.05; d= 0.19 – small, for both sexes) (Figure 2B). Figure 2 shows the BES and PSQI scores between male and female adolescents according to nutritional status.

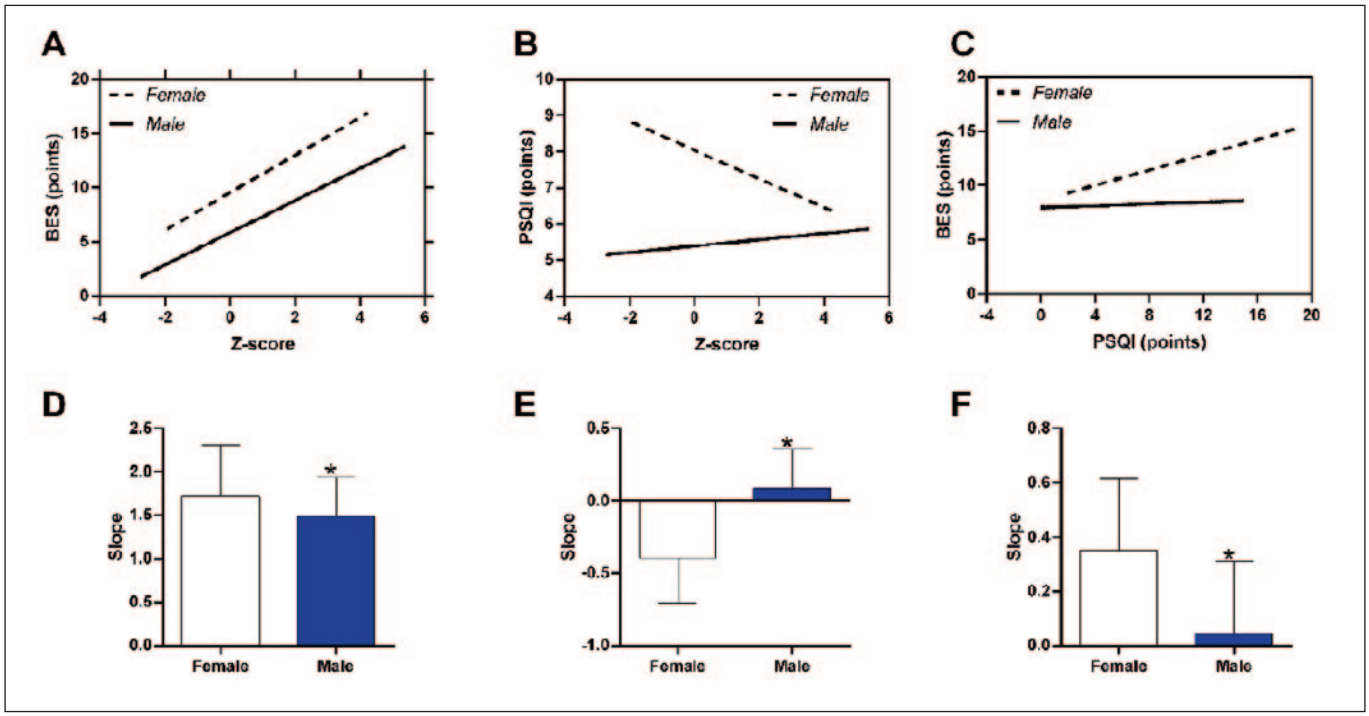
In the linear regression analysis between BES and Z-score, it was observed that both females and males showed positive regression (female slope = 1.73; p = 0.004; male = 1.48; p = 0.002), with the male adolescent having a lower relationship value between the variables (p = 0.01) (Figure 3A and 3D). Furthermore, the relationship between PSQI and Z-score was positive for male adolescents (slope = 0.08; p>0.05), while females were negative (slope = - 0.39; p>0.05). However, when comparing the lines between females and males, a significant difference (p<0.001) was observed (Figure 3B and 3E). When comparing the BES and PSQI ratio, both sexes showed a positive correlation (female slope = 0.35; p>0.05; male = 0.04; p>0.05); however, the comparison be-

Figure 2. Binge Eating Scale (BES) and Pittsburgh Sleep Quality Index (PSQI) scores among male and female adolescents according to nutritional status



Note: data as expressed as mean and standard deviation (±); BES= Binge Eating Scale; PSQI = Pittsburgh Sleep Quality Index; A = BES score by weight classification; B = PSQI score by weight rating; * = difference between obese and eutrophic individuals ($p < 0.05$). # = difference between male and female obese adolescents ($p < 0.05$).

Figure 3. Pearson correlation analysis for score variables on the binge eating scale and sleep quality index according to nutritional status in male and female adolescents



Note: (±); BES = binge eating scale; PSQI = sleep quality index; A = BES linear regression to the Z-score of male and female adolescents; B = Linear regression of the PSQI to the Z-score of male and female adolescents; C = Linear regression of BES to PSQI of male and female adolescents; D = comparison of the slope of the BES regression lines to the Z-score of male and female adolescents; E = comparison of the slope of the PQSI regression lines to the Z-score of male and female adolescents; F = comparison of the slope of the BES regression lines to the PSQI of male and female adolescents; In D, E, and F = data as expressed as a mean and standard deviation; * = difference between male and female adolescents ($p < 0.05$).

tween the lines was statistically lower in males when compared to females ($p<0.05$) (Figure 3C and 3F). Figure 3 shows the correlations between the BES, PSQI, and nutritional status of the adolescents participating in the present study.

DISCUSSION

The present study aimed, first, to verify possible associations between sleep quality and binge eating in adolescents; and, second, to compare sleep quality and binge eating according to the sex and nutritional status of adolescents. The main results suggest that BED is present in overweight adolescents of both sexes. However, no statistically significant difference was observed in the analyzed adolescents' sleep quality, even with a slight tendency for males to have poor sleep quality (39.3%) compared to females (22.8%). The results of the analyzes carried out in this study showed that obese adolescents, both female and male, were more predisposed to binge eating than eutrophic ones since they scored higher on the BES. However, the score was lower in overweight male adolescents than in overweight females. These data are consistent with the scientific literature on binge eating, which indicates that binge eating is more prevalent in overweight adolescents[19,20]. Complementary studies indicate that binge eating is more prevalent in female adolescents. This symptom is associated with a higher BMI, and adolescents with higher body fat were associated with severe binge eating[19,21,22]. These possible associations can be observed by regression analysis, in which a higher Z-score is related to a higher BES score, and BES and Z-score values are different between sex.

From this, female adolescents are more likely to develop binge eating because they are more exposed and vulnerable to aesthetic and social factors[23]; because adolescents are a risk group for the development of eating disorders, and the media is a contributing factor in dysfunctional eating behavior[24]. These aesthetic changes in adolescents are associated with inappropriate behavior during eating[25]. The fact that female adolescents have more psychiatric comorbidities, such as anxiety and depression, as this may be related to negative feelings inherent to body image, could be an influencing factor in eating behavior since there is a positive association between psychiatric problems and binge eating and, which consequently may influence anthropometric data[20,26]. However, weight changes can be related to eating problems and poor sleep quality.

The sleep-obesity relationship is well-established in adolescents and adults[27]. In the present study, however, no statistically significant difference was observed between both sexes' sleep quality and nutritional status. However, the negative response in the linear regression in female adolescents is noteworthy, in which higher Z-score values are associated with lower PSQI scores, a fact that was the opposite in male adolescents. The responses of male adolescents align with evidence from previous studies in which overweight adolescents have a shorter duration and poor sleep quality[28-30], which was not observed in females. Because the assessment is carried out using a self-assessment instrument, it is believed that individuals may have a different perception of their experiences and, consequently, a variety of data found in the scientific literature[31].

When comparing the BES and PSQI by sex, it was found that there was a positive correlation in both; however, the response of female adolescents was higher than that of male adolescents. The PSQI, with higher scores (above 5 points), indicates a lower sleep quality, which may favor binge eating[17]. The relationship between the two factors follows the literature in which it is observed that individuals with binge eating tend to have sleep problems[27]. Poor sleep quality is a common complaint among many individuals with psychopathologies and may be an essential variable in the development and course of eating disorders, which manifest symptoms mainly in adolescence[27]. Due to the scarcity of studies and many of them being inconclusive about this relationship between BE and sleep quality[27], further studies are needed to promote adequate treatment for these disorders in adolescents.

As a weakness, is necessary to investigate longitudinally the effects of the relationship between sleep quality and possible signs of binge eating, especially in adolescents, since the scientific literature does not fully clarify this information[32,33]. In addition, the association and comparison between the related variables, according to the sex and nutritional status of the participants, shows that different factors may be investigated in new studies, such as eating disorders, lifestyle, epigenetics, and genetics.

In summary, the results of this study point to the importance of sleep quality and its relationship with binge eating in adolescents. The association between these variables, also considering the sex and nutritional status of the participants, highlights the need for a more integrative approach to preventing and promoting the health of the youth population. Understanding these interactions can help identify higher-risk groups and develop effective strategies to prevent and treat overweight in adolescence. Therefore, it is essential to include an assessment of sleep quality and binge eating symptoms in public policies to promote and prevent obesity for a more complete and adequate approach.

CONCLUSIONS

The association between sleep-binge eating according to sex was not identified, but a positive correlation was observed between higher PSQI scores and higher BES scores in both sexes. Female participants with overweight had a higher prevalence of binge eating symptoms than eutrophic girls and boys, regardless of the Z-score. Sleep quality with nutritional status showed a positive correlation only for male participants.

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