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ASSOCIATION BETWEEN TOTAL DURATION AND SLEEP QUALITY WITH ANTHROPOMETRIC INDICATORS, FOOD BEHAVIORS AND CONSUMPTION OF ADOLESCENTS: AN INTEGRATIVE REVIEW

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ABSTRACT

Aim: To investigate the association between total duration and quality of sleep with anthropometric indicators, and food behaviors and consumption of adolescents. **Method:** An integrative review was carried out by analyzing published articles indexed in the MEDLINE and PUBMED databases, which present results from original studies, in English, Portuguese, and Spanish, published in the last ten years, and related to sleep, food behaviors and consumption, and anthropometric indicators in adolescents. The methodological quality was assessed through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Initially, 430 articles were found and after applying the exclusion criteria and reading the full texts, 11 articles were selected to compose this review. **Data synthesis:** The studies that met the eligibility criteria were published from 2010, carried out on different continents. In general, the studies identified a positive association between sleep quality, daytime sleepiness, anthropometric indicators, food behaviors and consumption, and anthropometric measures. Only one study showed a negative association among the variables. **Conclusion:** Sleep pattern is a risk factor for the maintenance of food behaviors and consumption, which favors changes in body composition and should be considered in the promotion of a better quality of life for adolescents and obesity prevention programs.

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INTRODUCTION

The prevalence of obesity among children and adolescents and the consequences of this condition have increased considerably in the last 30 years[1]. In 2010, approximately 43 million individuals in this population were considered overweight or obese worldwide[2]. In Brazil, according to the National School Health Survey, in 2016, among schoolchildren aged between 13 and 17 years, the prevalence of overweight was from 23.7%[3]. It is known that some factors can interfere in the development or maintenance of this condition, among which we can mention the duration and quality of sleep, which are reported in the literature as contributing to overweight or obesity in the adolescent population[4,5].

In this context, a longer sleep duration was associated with better diet quality and higher levels of physical activity[6],while a shorter total sleep time reduced the chances of consuming vegetables and fruits compared to a regular sleep duration[7]. The mechanism by which these associations can be explained refers to the metabolic alterations that sleep restriction can cause. Studies have identified that sleep restriction was related to the low production of hormones such as leptin, glucose, and insulin and high levels of ghrelin[8,9]. These hormones are responsible for sending information on the energy balance to the brain, promoting the feeling of satiety or hunger, thus, individuals with sleep deprivation tend to present more hunger and appetite, feeling a greater need to consume carbohydrates[7,10,11]. However, studies on these associations and especially

eating behavior, specifically in the adolescent population, are still scarce and the results on the association between sleep, diet quality, and anthropometric indicators remain inconclusive. Accordingly, the current study aims to investigate the association between total duration and quality of sleep with anthropometric indicators, and food behaviors and consumption of adolescents. An integrative review study was carried out as are search strategy, as this type of study seeks to identify the existing evidence in the literature related to this topic. A synthesis of the studies associating these variables, in adolescents, could help to clarify the magnitude and meaning of these associations, explaining possible divergences, in order to add to and advance information on an important gap in the knowledge.

MATERIALS AND METHODS

An integrative review was carried out, structured based on the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), to synthesize the results obtained in research that deals with the topic in question, systematically, orderly, and comprehensively. The question that guided this review was: "Is there an association between total duration and quality of sleep with anthropometric indicators and food behaviors and consumption in adolescents?" To answer this guiding question, a bibliographic survey was carried out through online access to the Biblioteca Virtual de Saúde (BVS [Virtual Health Library]) and Pub Med. For the search strategy, the descriptors "overweight", "adolescent", "diet", and "sleep" were used to perform the intersection between the descriptors with the Boolean digit AND between allsearche quations. MEDLINE databases were used, limited to the last 10 years (2010-2019).

Portuguese, and Spanish. Studies that: (a) omitted the age of the participants and (b) diagnosed sleep-related illnesses, such as narcolepsy, sleep obstruction, or others, were excluded. Initially, 430 articles were found. Of these 203 were duplicated, totaling 227 studies. After reading the titles and abstracts, only 36 were listed. Next, these texts were read in full and the exclusion criteria applied. Thus, only 11 articles met all the eligibility criteria and composed this review (Figure 1).

DATA SYNTHESIS

Of the articles found, five were performed in North America (45.5%), two in Asia (18.2%), one in Oceania (9%), and three in Europe (27.3%) (Table 1). No studies were found from South America, implying that no studies have been carried out in Brazil on the theme and within the criteria established for this population (Table 1). One study focused only on the female population[12], while all the others included both sexes in the sample (Table 1). In relation to data collection, all were carried out through a survey. All studies had a transversal methodological design and were published between the years 2010 and 2019. The total sample of the selected articles was 37,100 participants. The sample size of the studies presented great diversity, varying from 42 to 9866 subjects. Regarding the variables studied related to sleep (quality and daytime sleepiness), these included anthropometric indicators (BMI, fatmass, leanmass), food behaviors and consumption, anthropometric measures, physical activity, and screen time (Table 2). All studies evaluated adolescent food consumption alone or in parallel with eating behavior (Table 2). Food consumption was assessed using food frequency questionnaires, and one study also added the 24-hour food
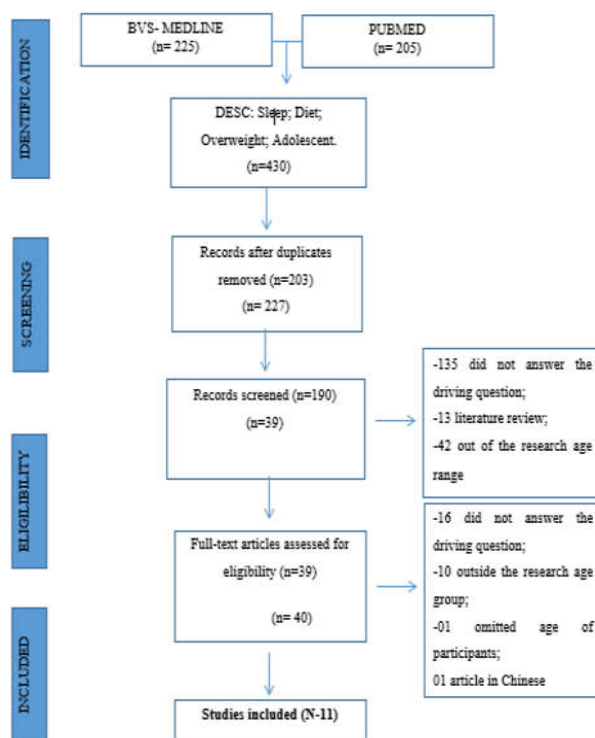
Figure 1. Diagram of article selection, according to the PRISMA model

The following eligibility criteria were established: (a) Cross-sectional studies, control cases, cohorts, and clinical and experimental trials that specifically addressed the topic; (b) study subjects aged from 10-19 years; (c) studies in English,

record[13]. After assessing the food-frequency of each participant, two studies separately calculated the total daily energy value of each adolescent's consumption[12,14]. Three studies evaluated eating behavior in parallel with consumption.

Table 1. Distribution of articles according to author/year, continent, sample, group studied, and variables

Continent	Author/Year	Sample number	Group studied	Instrument used to assess sleep	Variables
North America	Khan et al, 2015	5560	10 and 11 years (female: 52%)	EAT-III Project Questionnaire	Quality of the diet (food consumption, variety, adequacy, and balance), weight, physical activity and duration, and quality of sleep
North America	Franckle et al, 2015	2456	10.6 (1.5) (female: 51%)	Sleep duration was assessed based on hours slept with the cutoff point ≥10 h / day (ideal) vs. -10 h / day (insufficient)	Sleep, BMI, food consumption
North America	Kelly et al, 2016	119	12–17 years female	Children's Sleep Habits Questionnaire	Total caloric intake and eating in the absence of hunger, sleep duration, and daytime sleepiness
North America	Asarnow et al, 2017	42	15.5 years (female: 58%)	The sleepiness scale	Food choices for breakfast and sleep
North America	Menon et al, 2019	9866	11-17 years (female: 51%)	Cutoff point: 11–13 years: 9–11 h / night, 14–17 years: 8-10 hours / night (based on research Youth Risk Behavior Surveillance System- YRBSS)	Overweight or obesity (BMI); physical activity, screen time, fruit and vegetable consumption, and sleep
Asia	Al-Haifi et al, 2015	906	14-19 years (male:51.1%)	Sleep was assessed based on the number of hours slept (below 7 hours and 7 hours or more)	Sleep, sedentary behavior, obesity, and eating habits (food behaviors and consumption)
Asia	Levers-Landis et al, 2016	315	13-18 years (female: 64.1%)	Children's Sleep Habits questionnaire	Sleep duration and regularity and dietary intake and food-related cognition
Oceania	Hayes et al, 2018	186	12 - 17 years (female: 62.4%)	"Pittsburgh Sleep Quality Index" and "Insomnia Severity Index (ISI)"	BMI, sleep, eating habits (behaviors and consumption), physical activity, and screen time
Europe	Stea et al, 2014	2432	15-17 years	Sleep duration was assessed based on hours slept, with the cutoff point <8 h / night (insufficient)	Sleep, BMI, eating habits (food behaviors and consumption), physical activity habits, sedentary behavior, smoking habits, and academic performance.
Europe	Ferranti et al, 2016	1586	11- 14 years (female: 54.6%)	Pediatric Daytime Sleepiness Scale (PDSS)	BMI and fat mass, as well as unhealthy eating behaviors (having breakfast, lunch, and dinner) and sleep
Europe	Nuutinen et al, 2017	4262	13-15 years (female: 51.2%)	Own questionnaire	Sleep duration and quality, physical activity (BP), screen time, junk food, fruit and vegetable intake, weight and height

Table 2. Essential results of the association between the variables sleep, eating habits, and anthropometric indicators in adolescents

Author/Year	Dependent variables	Independent variables	Result (OR and/or IC)
Stea, 2014	Sleep duration	BMI, eating habits, physical activity habits, sedentary behavior, smoking habits, academic performance	Health risk behaviors were associated with short sleep duration, such as: having an irregular pattern of meals (skipping main meals) (OR = 1.33; CI = 1.05-1.68); intake of sweets/candies P4 times/week (OR = 0.51; CI = 0.32-0.83).
Khan, 2015	Quality of the diet, weight, and physical activity	Sleep duration and quality	Longer sleep duration was statistically significantly associated with decreased risk of overweight and obesity (OR = 0.82, 95% CI: 0.73, 0.91).
Franckle, 2015	Sleep	BMI, food consumption	Children who reported insufficient sleep duration (-10 h of sleep/24 h) consumed vegetables less frequently ($\beta = -0.11$, 95% CI: -0.20, -0.03), soda more frequently ($\beta = 0.16$, 95% CI: 0.08, 0.24), and sugary drinks more frequently ($\beta = 0.22$, 95% CI: 0.09, 0.35)
Al-Haifi, 2015	Sleep	Sedentary behavior, obesity, and eating habits	Among girls, sleep duration was significantly associated with BMI ($p <0.05$). The consumption of breakfast (both sexes) and milk (boys only) was positively associated with sleep duration ($p <0.05$). In contrast, consumption of fast foods (both sexes), sugar-sweetened drinks (only for boys), and potato sweets (girls only) were negatively associated with sleep duration ($p <0.05$).
Levers-Landis, 2016	Reported sleep duration and regularity	Dietary intake and food-related cognitions	Higher consumption of sugary drinks ($\beta = 0.23$; $p = 0.006$) and food concerns ($\beta = 0.09$; $p = 0.02$) were significant predictors of changes in bedtime (sleeping later). The consumption of beverages sweetened with sugar was a significant predictor of awakening time ($\beta = 0.50$; $p = 0.02$).
Kelly, 2016	Total caloric intake and eating in the absence of hunger	Sleep duration and daytime sleepiness	Sleep duration was positively associated with higher energy consumption ($\beta = 1.39$, SE = 0.62, $p = 0.03$). So the girls who reported more sleep consumed more energy during lunch (1.39 kcal more). Daytime sleepiness was associated with a greater chance of presenting objective binge eating (OR = 8.65, CI = 1.78, 42.16, $p = 0.009$).
Ferranti, 2016	BMI, fat mass, unhealthy eating behaviors	Sleep	An inverse correlation was found between total sleep time and body mass index ($\beta = -0.829$, $p = 0.021$), fat mass ($\beta = -0.526$, $p = 0.025$), and waist circumference ($\beta = -0.426$, $p = 0.045$).
Asarnow, 2017	Food choices for breakfast	Sleep	Adolescents who started sleeping earlier ate significantly more foods with a low glycemic index ($p = 0.02$, d = 0.75, 95% CI) and more milk calories ($p = 0.02$, d = 0.75, 95 CI %
Nuutinen, 2017	Sleep duration and quality, physical activity (BP), screen time, junk food, fruit and vegetable intake	Weight and height	Bad sleep was not associated with behaviors related to excessive food consumption
Hayes, 2018	BMI	Sleep, eating habits, physical activity, and screen time	Changes in bedtime, especially variations on weekends, were associated with a greater severity of overweight ($\beta = 0.20$; $p = 0.005$); Worse sleep quality was associated with unhealthy eating habits (food behaviors and consumption) ($\beta = -0.21$; $p = 0.050$).
Menon, 2019	Overweight or obesity (BMI)	Physical activity, screen time, fruit and vegetable consumption, and sleep	Not meeting the recommendations for sleep and the consumption of fruits and vegetables showed significant associations with overweight and obesity in the unadjusted model (OR: 1.11; CI: 0.96–1.27)

CI, Confidence Interval; OR, *Odds ratio*.

For this, they used the weekly frequency with which each adolescent had breakfast, lunch, and dinner (mainmeals)[15,16,17], this being considered a regular/ideal mealpattern for mainmeals everyday of the week[17]. Considering the subjectivity of sleep quality, in the studies, this pattern was determined from scales that specifically evaluate the outcome variable, such as: the Pittsburgh Sleep Quality Index (n: 1; 9.1%), Children's Sleep Habits questionnaire (N: 2; 18.2%), sleepiness scale (n: 1; 9.1%), and Pediatric Daytime Sleepiness Scale (PDSS) (n: 1; 9.1%). These scales consider several aspects related to the quality of sleep, as well as its duration in hours, classifying adolescents as good sleepers or bad sleepers through a fixed score on the scale[4,12,14,16,18]. Two studies (18.2%)[6,19] used their own scales to assess more than one aspect related to sleep, however one was carried out with the parents of adolescents aged 10-11 years[6]. Four studies (36.3%)[13,15,17,10] were based only on the number of hours slept per night to assess sleep patterns, with cutoff points: seven hours (≥7 ideal) [15], eight hours [17], and ≥10 hours/day (ideal)[13], and one of these studies[20] varied the cutoff point according to age, so from 11–13 years, from 9–11 hours/night was considered ideal and from 14 to 17 years, 8-10 hours /night. Regarding short sleep duration and high risks for developing obesity, 92.3% of the studies reported a positive association between these factors. It is important to highlight that self-reported measures were used for sleep and eating behavior variables (BMI, questionnaires, food records).

DISCUSSION

The articles selected for this review studied the association between sleep, food behaviors and consumption, and nutritional status through the BMI directing overweight and obesity. In the studies, associations were observed between shorter sleep duration and high BMI, greater use of technology, and less physical activity in children and adolescents[4,12,14,18]. Adolescents who sleep less have an unhealthy diet, specifically, those who sleep later present higher consumption of foods with high energy value, foods that are low in nutrients, and sweet drinks, reduced physical activity, and low consumption of fruits, vegetables, and dairy products[4,12,14,16,18]. Short sleep duration and poor sleep were associated with an increase in BMI, fat mass, and consumption of unhealthy foods, such as consumption of sweets and snacks, while a longer sleep duration was associated with the intake of fruits and vegetables[18]. Corroborating this finding, a study carried out in Canada with 5,560 adolescents aged 10 and 11 years identified that a longer duration of sleep was significantly associated with a reduced risk of overweight and obesity, as well as a better-quality diet and greater levels of physical activity[6]. Other important aspects to be highlighted concerned bedtime on weekends, short sleep, the habit of sleeping later, or greater changes in bedtime, which were associated with greater severity of excess weight and longer sleep time, screen use, less healthy eating practice, and less physical activity[16].

As there is no consensus in the literature regarding how this association can promote weight gain, several hypotheses were raised in the studies to justify these findings. Some studies justified that the short duration, as well as poor quality of sleep, can cause imbalances in the hormones that regulate hunger, decreasing the circulating level of leptin and increasing ghrelin, thus causing an increase in appetite and fat and carbohydrate intake[4,14]. In addition, sleep disorders increase morning cortisol levels, and reduce insulin sensitivity and growth hormone secretion, supporting these associations[18]. Another justification presented states that reducing sleep increases the opportunity to eat, especially when waking time is spent on sedentary activities and using screens. In addition to this fact, there is a preference in young people for fast food, sugary drinks, and sweets. This combination favors weight gain among adolescents[15]. Considering that the recommendation for sleep time for adolescents proposed by the National Sleep Foundation and the American Academy of Sleep is around 9 –9.25h per night[21], the cutoff points adopted by some studies[15,17], which considered the ideal time for sleep ≤8h / night may have been underestimated. All the studies analyzed had an observational methodological design and, therefore, it was not possible to establish a cause and effect relationship between the variables studied. The variables of quality and duration of sleep showed a statistically significant association with obesogenic behaviors[4,12,14,16,18]. However, in the study carried out in Finland with 4262 adolescents aged between 13 and 15 years, poor sleep quality was not associated with eating behaviors[19]. In the aforementioned study, there was an adjustment in the regression analyses where the educational aspiration of the adolescent could reflect the parents' level of education, considering that the latter can be a determinant in children's food choices.

Taking this aspect in to consideration, even though some adolescents were categorized as bad sleepers, it was identified that the parents' level of education, in general, was considered good, which may have reflected in more than half of the adolescents having healthy eating habits. This fact could explain, at least in part, the lack of associations between poor sleep and overweight[19]. Despite the growing number of obesity cases among children and adolescents in Brazil[2], there are still few studies which examine this association or investigate mechanisms that support these findings. Thus, it is necessary to expand the research that addresses this theme in adolescent populations, presenting a promising field of research. It is worth mentioning the need to develop strategic measures to promote forms of intervention that are sufficiently effective to mitigate the negative effects of poor sleep quality and eating behavior in this population. In this sense, this integrative review study advances an alert that aspects related to low duration and poor quality of sleep may favor the emergence of unhealthy practices in terms of food and even consequences for diseases such as obesity. However, some limitations need to be mentioned, such as the low number of articles found, and the instruments used to collect information related to sleep, which were carried out indirectly. The results found are significant, and provide added information on this important theme, however they should be interpreted with caution because of the variability observed in the designs of the studies and the magnitude of the associations found.

Conclusion

The results of this review demonstrated the existence of a relationship between duration and quality of sleep as a contributing factor to the development of obesity through healthy food consumption and behaviors. Therefore, an inadequate sleep pattern is an important modifiable risk factor that should be taken in to account as a potential target when promoting a better quality of life for adolescents and in obesity prevention programs.

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