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Association between sleep quality indicators and consumption of ultra-processed foods in adolescents

Associação entre indicadores da qualidade do sono e consumo de alimentos ultraprocessados em adolescentes

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ABSTRACT

Objective
To investigate the association between sleep quality indicators and the consumption of ultra-processed foods in adolescents.

Methods
An integrative review was carried out, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses criteria. The search strategy was carried out using the descriptors "adolescent", "ultra-processed foods" and "sleep" in the MedLine, SciELO, Scopus, Lilacs and PubMed databases, considering original studies on the investigation topic published in English, Portuguese and Spanish, without any date restriction. Methodological quality was assessed using the Checklist for Analytical Cross-Sectional Studies of the Joanna Briggs Institute. Initially, 79 articles were found. After reviewing the titles and abstracts, 17 papers were selected. Following a complete review the exclusion criteria were applied. Only 09 articles met the eligibility criteria.

Results
Three studies described associations between greater consumption of ultra-processed foods and shorter sleep duration in adolescents; one study showed an association between the consumption of ultra-processed foods and poor sleep quality in adolescents; one study described the association of greater chances of insomnia with greater consumption of ultra-processed foods. Four studies did not report significant results regarding the main question of our survey.

Conclusion
An association was identified between the consumption of ultra-processed foods and adolescent changes in the quality and duration of sleep, as well as in the ability to fall asleep and maintain continuous sleep.

Keywords: Adolescent. Food processed. Sleep.

RESUMO

Objetivo
Investigar a associação entre indicadores da qualidade do sono e o consumo de alimentos ultraprocessados em adolescentes.

Métodos
Foi realizada uma revisão do tipo integrativa, estruturada com base nos critérios do Preferred Reporting Items for Systematic Reviews and Meta-Analyses. A estratégia de busca foi realizada utilizando os descritores "adolescent", "ultra-processed foods" e "sleep" nas bases de dados MedLine, SciELO, Scopus, Lilacs e PubMed, considerando estudos originais, nos idiomas inglês, português e espanhol, publicados sem limite temporal de ano, relacionados à temática estudada. A qualidade metodológica foi avaliada por meio do Checklist for Analytical Cross Sectional Studies of the Joanna Briggs Institute. Inicialmente foram encontrados 79 artigos. Após a leitura dos títulos e resumos 17 estudos foram selecionados. Em seguida estes artigos foram lidos na íntregra e os critérios de exclusão aplicados. Apenas 09 artigos atenderam aos critérios de elegibilidade e foram selecionados para compor esta revisão.

Resultados
Três estudos descreveram associações entre o maior consumo de alimentos ultraprocessados e menor duração do sono em adolescentes; um estudo apresentou associação entre o consumo de alimentos ultraprocessados e a má qualidade do sono em adolescentes; um estudo descreveu a associação de maiores chances de insônia com o maior consumo de alimentos ultraprocessados. Quatro estudos não relataram resultados significativos quanto ao questionamento principal que conduz a presente revisão.

Conclusão
Identificou-se associação entre o consumo de alimentos ultraprocessados e modificações em aspectos relacionados à qualidade e duração do sono, bem como à capacidade de adormecer e manter um sono contínuo em adolescentes.

Palavras-chave: *Adolescente. Alimentos ultraprocessados. Sono.*

INTRODUCTION

Consumption of Ultra-Processed Foods (UPF) accounts for 20% of the Brazilian population caloric intake, worsening the epidemiological outlook of food and nutrition due to the dominance of the food industry products, characterized by high levels of compounds that are harmful to health [1,2].

Such foods are defined by the NOVA classification (a name, not an acronym) as formulations based on industrial sources of energy and dietary components, especially unhealthy fats, starches, free sugars and salt, in addition to additives, which intensify the sensory impact; such foods include soft drinks, packaged sweet or savory snacks, reconstituted meat products and pre-prepared frozen dishes [3].

Among the main consequences of UPF consumption are changes in nutritional status in all populations, including adolescents, favoring the development of the so-called Noncommunicable Chronic Diseases (NCDs) such as obesity, dyslipidemia and metabolic syndrome, occurring simultaneously with inadequate consumption of essential nutrients such as vitamins and minerals, impairing adolescents' development [4,5]. It is estimated that approximately 340 million adolescents are obese worldwide, of which 3.4 million live in Brazil [6,7]. A few studies conducted in Brazil report frequent consumption of UPF the adolescent population with increased energy-dense foods intake and high consumption of carbohydrates and sodium, in contrast to the lower intake of proteins and fibers [8-10]. Other studies report that the high prevalence of UPF consumption in adolescents was

associated with eating while watching television, daily television time of more than three hours and using a cell phone, negatively influencing their anthropometric and atherogenic indices [11,12].

In this scenario, some studies have observed that changes in sleep quality have been associated with greater UPF consumption [13,14]. In a study conducted by Knébel et al. [15], it was observed that UPF consumption is associated with shorter sleep duration; sleep duration is a physiological state which is essential for adolescent growth and development, in addition to acting directly on hormonal and behavioral regulation [16].

However, documented evidence on the association between UPF consumption and indicators of sleep quality in adolescents is limited and the findings somewhat inconsistent. There is evidence, though, that changes in adolescent sleep can affect food reward processes and that poor sleep quality can increase UPF consumption, due to greater neural stimuli resulting from sleep restriction, which further leads individuals to consume high amounts of UPF [13,17].

A recent systematic scientific review reported that adolescents who slept less than eight hours consumed a higher proportion of calories from fat and carbohydrates contained in fast food, sweets, and savory snacks compared to adolescents who slept eight hours or more [18]. In this connection, given the need for further clarification on the direct interference of UPF consumption in the sleep-related parameters, this study's objective was to verify and describe the existence of associations between indicators related to sleep quality, as well as daytime sleepiness, and consumption of ultra-processed foods in adolescents, through an integrative review of the literature, seeking to answer the following guiding question: Is there an association between the consumption of ultra-processed foods and the quality, total duration of sleep, and daytime sleepiness in adolescents?

METHODS

This is an integrative review, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria, with the purpose of synthesizing the results obtained in research on the topic in question, in a systematic, orderly and comprehensive manner. For the search strategy, the descriptors "adolescent", "ultra-processed foods" and "sleep" were used through the intersection with the Boolean operators AND or OR, between the search equations inserted in the Medical Literature Analysis and Retrievel System Online (MedLine), Scientific Electronic Library Online (SciELO), *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (Lilacs), Scopus, and PubMed databases, with no year limitation for inclusion. The following eligibility criteria were established: (a) Cross-sectional studies, case-control studies, cohorts, clinical and experimental trials that specifically addressed the topic; (b) age of the study subjects or mean age between 10-19 years; (c) studies published in English, Portuguese and Spanish. Studies were excluded if: (a) they addressed food consumption not associated with sleep; (b) omitted the age of the participants; (c) were not scientific articles; (d) diagnosed sleep-related diseases, such as narcolepsy, obstructive sleep apnea or others. The data collected from the studies included were organized in Microsoft Excel tables. The verification of the eligibility criteria, titles, abstracts and full texts were independently reviewed by two investigators.

RESULTS

Initially, 79 articles were found in the electronic databases, 38 of which were excluded for being duplicates, leaving 41 articles for reviewing the titles and abstracts. A total of 17 articles were selected for full review, of which 8 were excluded and 09 were included at the end of the process

following the eligibility criteria. The search and selection steps of the articles included are described in Figure 1.

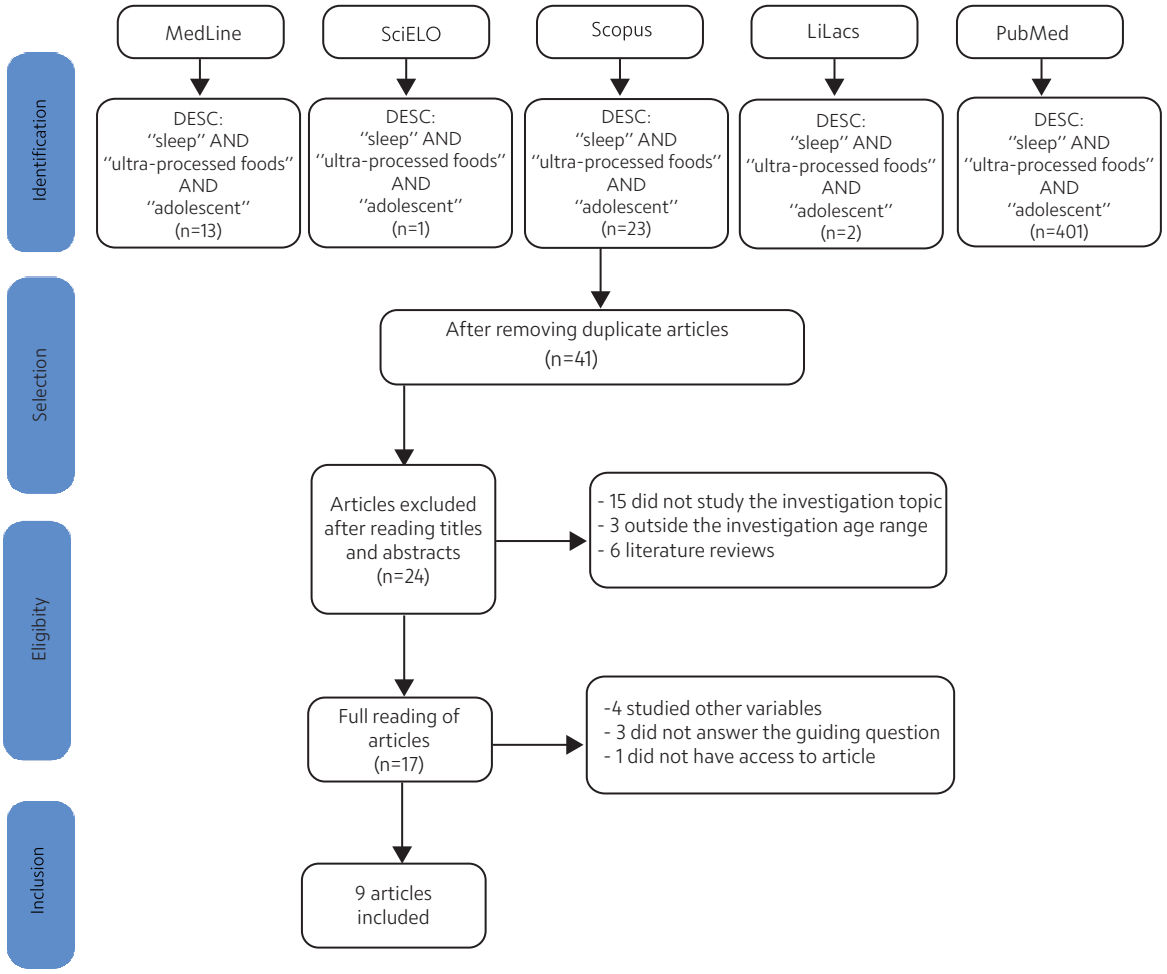

Figure 1 – Flowchart of article selection, according to the Prisma scale.

Note: DESC: Descriptors; Lilacs: *Literatura Latino-Americana e do Caribe em Ciências da Saúde*; MedLine: Medical Literature Analysis and Retrievel System Online; SciELO: Scientific Electronic Library Online.

Regarding the risk of bias involving the articles, a cross-sectional method was used in eight studies that were assessed for risk according to the Checklist for Analytical Cross Sectional Studies of the Joanna Briggs Institute, which consists of 8 questions that must be answered with "Yes", "No" or "Unclear". The risk depends on the percentage of "Yes" answers to the questions. Thus, and based on their rates, the score of each article was calculated and classified as high (80-100%), regular (50-79%) or low (<50%). Thus, we found that all studies that had a cross-sectional methodological design presented a low risk of bias, as described in Table 1.

Another study included in this review used an experimental methodological design [19]. In terms of UPF consumption and sleep outcomes, three studies described associations between greater UPF consumption and shorter sleep duration in adolescents [15,19,20], with such consumption being

Table 1 – Evaluation of articles according to the Checklist for Analytical Cross Sectional Studies of the Joanna Briggs Institute.

Author (year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Yes (%)	Risk[1]
Werneck et al. (2018) [21]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Sousa et al. (2020) [16]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Costa et al. (2021) [22]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Santos et al. (2021) [20]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Knébel et al. (2022) [15]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Lane et al. (2022) [14]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Silva et al. (2022) [12]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low
Oliveira et al. (2023) [23]	Y	Y	Y	Y	U	U	Y	Y	75.0	Low

Note: [1] The Risk of bias was ranked as "high" when they reached less than 50% of positive answers, "moderate" when the study reached 50 to 69% of positive answers, and "low" when the study reached 70% or more of positive answers. Q: Question; Y: Yes; N: No, U: Unclear.

characterized mostly by salty and sweet snacks [15,20], in addition to sugary drinks [15,19]. Regarding sleep quality, one study showed an association between UPF consumption and poor sleep quality in adolescents [16]. Regarding insomnia, one study described the association of higher chances of insomnia with greater UPF consumption [14].

Among the studies included, four did not report significant results regarding the main question addressed in our review, although they reported great UPF consumption by adolescents [12,21-23] and its association with other variables, such as high screen time [23] and total sedentary behavior [22].

Table 2 shows the distribution of papers according to author/year, study design, sample, instruments to assess variables and outcomes related to sleep and consumption of ultra-processed foods. The articles selected totaled a sample of 108.704 participants. The sample size of the studies varied from 93 to 100.839 adolescents (Table 2).

Table 2 – Consumption of ultra-processed foods and association with sleep-related outcomes in adolescents.

1 of 2

Author, year	Study design	Sample	Sleep analysis method	Food consumption analysis method	Sleep outcomes	UPF consumed
Werneck et al. (2018) [21]	Cross-sectional	100.839 teenagers from public and private schools in Brazil	Insomnia assessed by the question: "Over the past 12 months, how often did you have insomnia due to a worry? (A) Never; (B) Rarely; (C) Sometimes; (D) Often; (E) Very often." Insomnia rating for reports of often and very often	UPF consumption assessed by intake in the last week (0 times, 1 to 3 times and more than 4 times)	No association between UPF consumption and sleep variables ↑ Total time watching television and total sitting time associated with insomnia	NA
Sousa et al. (2020) [16]	Cross-sectional	2.499 teenagers aged 18 to 19, from São Luís, Maranhão, Brazil	Sleep quality assessed using the Pittsburgh Sleep Quality Index (PSQI), which investigates subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances and use of sleeping medications (scores from 0 to 4 = good sleep quality; scores above 4 = poor sleep quality)	FFQ	UPF consumption associated with poor sleep quality	NR
Costa et al. (2021) [22]	Cross-sectional	1.010 teenagers from schools in Florianópolis, São José and Palhoça (municipalities in the Greater Florianópolis mesoregion) in Santa Catarina, Brazil	Usual sleep duration calculated by weighting weekend sleep duration by 2 and weekday sleep duration by 5 and dividing the resulting value by 7	R24h	No association between UPF consumption and sleep variables ↑ UPF consumption associated with total sedentary behavior and inversely associated with total physical activity	Salty fried foods, sweets, soft drinks, sausages and fast food

Table 2 – Consumption of ultra-processed foods and association with sleep-related outcomes in adolescents.

Author, year	Study design	Sample	Sleep analysis method	Food consumption analysis method	Sleep outcomes	UPF consumed
Santos et al. (2021) [20]	Cross-sectional	1.384 teenagers aged 10 to 14, from public schools in João Pessoa, Paraíba, Brazil	Sleep restriction analyzed by bedtime and wake-up times on days with and without classes (short sleep duration = less than 9 hours/night) Sleep quality assessed by subjective analysis of participants (poor and regular - negative quality; good, very good, excellent and positive - positive quality)	Multiple Source Method (MSM) program that uses R24h, food records and FFQ	UPF consumption associated with short sleep duration in adolescents under 12 years of age	Packaged snacks, fried snacks, baked snacks and pizzas, instant noodles, candies, lollipops, chewing gum, caramel, gelatin
Duraccio et al. (2022) [19]	Experimental	93 teenagers aged 14-17; 63% female	Sleep duration assessed by actigraphy and nighttime diaries (short sleep - about 6.5 hours/ healthy sleep - about 9.5 hours)	R24h	↓ Sleep duration associated with greater consumption of UPF, carbohydrate grams, foods with higher glycemic load, and lower consumption of fruits and vegetables	Sugary drinks
Knébel et al. (2022) [15]	Cross-sectional	750 teenagers, 52.8% female, aged 10-16 from Florianópolis, Santa Catarina, Brazil	Sleep duration assessed by the question "On average, how many hours do you sleep per day during the week and on weekends?" Answers between: <6, 6, 7, 8, 9, 10 and >10 h	Consumption assessed by the intake in the last seven days of five types of food (fruits, vegetables, salty snacks, sweets and sugary drinks)	↑ UPF consumption associated with shorter sleep duration	Chips, sweets and sugary drinks
Lane et al. (2022) [14]	Cross-sectional	733 female adolescents aged 12-18 from schools in Mashhad and Sabzevar, northeastern Iran	Insomnia assessed by the Insomnia Severity Index (ISI) questionnaire, stratified into four categories (0 – None, 1-mild, 2-moderate, 3-severe and 4-Very Severe). Individuals are considered to have insomnia when their score is >7 Daytime sleepiness assessed by the Epworth Sleepiness Scale (ESS-IR) – classification of sleepiness in eight daily situations from 0 to 3, with 0 indicating no daytime sleepiness and 24 indicating more excessive daytime sleepiness	FFQ	↑ UPF consumption associated with increased chances of insomnia	Packaged industrialized breads, sausages and other reconstituted meat products, confectionery, ice cream, among others
Silva et al. (2022) [12]	Cross-sectional	964 teenagers aged 18 to 19 from São Luís, Maranhão, Brazil	Sleep duration verified by accelerometry in hours	FFQ	No association between the degree of food processing and sleep duration in adolescents	NA
Oliveira et al. (2023) [23]	Cross-sectional	432 teenagers aged 14 to 19, from public and private schools in Minas Gerais, Brazil.	Sleep duration analyzed by hours of sleep in 24 hours (adequate sleep duration = 8 to 10 hours/ day)	FFQ and subsequent classification of foods into three groups, according to the degree of processing: natural or minimally processed foods, industrialized foods used as ingredients in culinary preparations and ultra-processed foods	No association between UPF consumption and sleep variables ↓ Intake of natural or minimally processed foods associated with inadequate sleep duration ↑ UPF consumption was associated with high screen time	Breads, cookies, ice cream, chocolates, candies/ sweets, snacks, soft drinks, nuggets, hot dogs, hamburgers and sausages

Note: FFQ: Food Frequency Questionnaire; NA: Not Applicable; NR: Not Reported; R24h: 24-hour recall.

DISCUSSION

The main findings of our review indicate that greater UPF consumption is directly associated with changes in sleep-related aspects, such as poor quality and short sleep duration and insomnia in adolescents. These findings were observed in five of the nine studies included, which demonstrates

the importance of investigating the mechanisms involved in the processes that link UPF consumption and the sleep-related outcomes in this population.

It is understood that the consumption of UPF acts as a risk factor for diseases, disorders and pathological conditions related to food intake, such as Chronic Non-Communicable Diseases (NCDs), which include Diabetes *Mellitus* (DM), cardiovascular diseases, as well as a higher risk of mortality caused by these pathological conditions. In parallel, we noted that the consumption of UPF significantly influences the global burden of diseases, which is enhanced by the associations of food and sleep, since these behaviors influence each other [24,25].

In physiological terms, circadian changes during adolescence trigger a tendency to stay awake for longer periods of time, which is due, at least in part, to daily activities such as classes, wake-up times, social responsibilities and more screen time, which increases the risk of reduced sleep time and possible sleep disorders [26]. In this connection, the data reported indicate that the consumption of UPF when associated with short sleep duration demonstrates a relationship not only with the food consumed, but also with the time or the meal in which such consumption occurred, since salty snacks are generally eaten as dinner or evening snack, suggesting that adolescents who stay awake later tend to look for foods from this food group [20].

Studies suggest that in this condition sleep duration can influence adolescents eating pattern, so that consequently short sleep duration plays an important role in the development of obesity, directly interfering with the individuals' endocrine, neurological and behavioral mechanisms [27]. In line with these findings, a meta-analysis that investigated the association between sleep duration and obesity in children and adolescents indicated that short sleep duration can increase the risk of obesity in children and adolescents, more significantly in individuals aged between 3 and 13 years, while long sleep duration was beneficial in preventing obesity [28].

Although the recommendations for hours of sleep required in adolescents aged 13-18 years are variable (i.e.: 7-10 hours/day), studies indicate that the high prevalence of changes in sleep duration and quality in this population represents a public health problem, contributing to the development of changes in the cognitive health of these individuals (cognitive processing speed and working memory), emotional health (mood changes, difficulties in regulating emotions and psychiatric disorders) and physical and metabolic health (negative associations between short sleep duration and obesity, cardiometabolic biomarkers of adiposity, Diabetes Mellitus and asthma) [26,29].

In line with the findings mentioned in this review, a meta-analysis describes the existence of a significant association between higher consumption of UPF and sleep-related outcomes, mainly shorter sleep duration and sleep quality, indicating in its crude analysis, a greater chance of observing the aforementioned outcome in children and/or adolescents [30]. In this connection, in a school-based cross-sectional study that included approximately 74,589 adolescents from 1,247 schools in 124 Brazilian municipalities, the coexistence of obesogenic behaviors among Brazilian adolescents was observed and the factors associated with the presence of these behaviors were evaluated; the authors concluded that great UPF consumption, long screen time, the habit of snacking watching television and irregular breakfast frequency were the main factors for the development of such behaviors [12].

Still regarding the impacts of short sleep duration on food intake, data suggest that sleeping less than five hours per night increases energy-dense food intake in relation to adequate normal sleep, enhancing the sensation of appetite and consequently increasing the intake of calories, carbohydrates, fat and snack, decreasing the overall quality of the diet [25]. The scientific literature reports associations between short sleep duration and greater opportunity to eat due to increased

time awake, changes in appetite-regulating hormones, such as leptin, ghrelin and adiponectin - glucagon-like peptide 1 and orexin, as well as the processes of valuing food rewards [24,25].

Sleep deprivation is described as a chronic stressor that alters homeostasis, triggering chronic activation of the hypothalamic-pituitary (HPA) axis, which in turn alters glucose metabolism, promotes insulin resistance, and influences appetite-related hormones that change satiety levels [31,32]. This cascade of events, mainly involving ghrelin and leptin, results in increased food intake, with increased dopamine release, consequently increasing sugar preference, and increased appetite through Neuropeptide Y (NPY), stimulating fat accumulation [31,32].

The findings reported by Sousa et al. [16] showed a greater energy contribution from the intake of UPF in adolescents, compared to another population-based study conducted by Louzada et al. [33] that used data from the Pesquisa de Orçamento Familiar (POF, Brazilian Household Budget Survey; 2008-2009), indicating a greater energy contribution from high calorie foods such as UPF.

This scenario is of concern as highly processed foods generate an inflammatory state in adolescents related to the metabolic syndrome [16]. In fact, the literature shows that great UPF consumption results in an inflammatory response, either due to the dietary composition itself, rich in fats, sugar and salt, but also due to the chemical additives used in their composition, indicating that greater UPF consumption is a risk factor for poor sleep quality [16,34].

On the other hand, diets rich in foods containing tryptophan, an amino acid that directly affects sleep regulation and increases serotonin production, reducing sleep latency; other natural foods rich in phytonutrients, substances present in foods of plant origin, were associated with greater total sleep time and greater sleep efficiency, as well as fewer awakenings or fragmented sleep during the night. Such results are possibly related to the activity of serotonin and melatonin [35]. The relationship between tryptophan depletion or its availability reduction prevents adequate serotonin synthesis and, consequently, reduces sleep quality [35].

The above findings rekindle the discussion on the relationship between sleep and diet, since these two intrinsic health factors can have an influence on each other. It is certainly well documented that insufficient sleep negatively affects food intake; from another perspective, experimental data indicate that whole diets rich in fruits, vegetables, legumes and other dietary tryptophan and melatonin sources have demonstrated potential protective factors for better sleep quality [25].

Given this scenario, where the data already available illustrate a cyclical relationship between these lifestyle factors, there is a clear need for future research to confirm a causal impact of dietary patterns on sleep and to elucidate the underlying mechanisms. It is also important to highlight that our study has limitations that ought to be considered. Due to the diversity of methodologies used, the complexity is understood and the challenge of combining data from different research designs is perceived; however, it is imperative to establish an integrative review as a valid instrument of Evidence-Based Practice, especially in the current scenario, in which there is a growing demand for efficient and efficacious practices in different fields, such as health, education and public policies.

CONCLUSION

Based on the different studies reviewed in our work, a direct association was observed between adolescents' UPF consumption and changes in their sleep quality and duration aspects, as well as in their ability to fall asleep and maintain continuous sleep. Such outcomes were observed mostly

in observational studies. In this framework, there is a need for more experimental, longitudinal studies and clinical trials involving individuals belonging to the population studied, enhancing the elucidation of the interconnected mechanisms between food consumption and sleep.

In view of these reflections, it is expected that these findings can favor the promotion of interventions and public policies for the production and marketing of ultra-processed foods, and health education actions including food and nutrition education to promote adequate and healthy food consumption, as well as the adoption and maintenance of healthy lifestyle habits, including adolescents' healthy sleep duration routine.

REFERENCES

1. Santos FS, Dias MS, Mintem GC, Oliveira IO, Gigante DP. Processamento de alimentos e fatores de risco cardiometabólicos: revisão sistemática. Rev Saúde Pública. 2020;54:70. https://doi.org/10.11606/s1518-8787.2020054001704
2. Figueiredo AVA, Recine E. A regulação de produtos alimentícios ultraprocessados: o desafio de governar o mercado. Cad Saúde Pública. 2021;37:Sup1:e00207220. https://doi.org/10.1590/0102-311X00207220
3. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018; 21(1):5-17. https://doi.org/10.1017/S1368980017000234
4. Martins PFA, Faria LRC. Alimentos ultraprocessados: uma questão de saúde pública. Comun Ciênc Saúde, 2018; 29:Sup1:14-17
5. Andretta V, Siviero J, Mendes KG, Motter FR, Theodoro H. Consumo de alimentos ultraprocessados e fatores associados em uma amostra de base escolar pública no Sul do Brasil. Ciênc Saúde Colet. 2021;26(4):1477-88. https://doi.org/10.1590/1413-81232021264.04422019
6. Ministério da Saúde (Brasil). Instrutivo para o cuidado da criança e do adolescente com sobrepeso e obesidade no âmbito da Atenção Primária à Saúde. Brasília: Ministério da Saúde; 2022 [cited 2023 Jan 7]. Available from: http://189.28.128.100/dab/docs/portaldab/publicacoes/instrutivo_crianca_adolescente.pdf
7. Organização Mundial da Saúde. Dia Mundial da Obesidade 2022: acelerar ação para acabar com a obesidade. Genebra: OMS; 2022 [cited 2023 Jan 15]. Available from: https://www.paho.org/pt/noticias/4-3-2022-dia-mundial-da-obesidade-2022-acelerar-acao-para-acabar-com-obesidade
8. Crisóstomo JM, Rodrigues LAR, Nascimento LM, Viola PCAF, Frota KMG. Consumption of ultra-processed foods and anthropometric indicators in adolescents, adults, and the elderly in a capital city in northeastern Brazil. Rev Nutr. 2022;35:e210052. https://doi.org/10.1590/1678-9865202235e210052
9. D'Ávila HF, Kirsten VF. Consumo energético proveniente de alimentos ultraprocessados por adolescentes. Rev Paul Pediatr. 2017;35(1):54-60. https://doi.org/10.1590/1984-0462/;2017;35;1;00001
10. Lima LR, Nascimento LM, Gomes KRO, Martins MCC, Rodrigues MTP, Frota KMG. Associação entre o consumo de alimentos ultraprocessados e parâmetros lipídicos em adolescentes. Ciênc Saúde Colet. 2020;25(10):4055-64. https://doi.org/10.1590/1413-812320202510.24822018
11. Nascimento LM, Monteiro NVN, Vilar TM, Sousa CRL, Frota KMG. The influence of ultra-processed food consumption in anthropometric and atherogenic indices of adolescents. Rev Nutr. 2021;34:e200036. https://doi.org/10.1590/1678-9865202134e200036
12. Silva TPR, Matozinhos FP, Gratão LHA, Rocha LL, Inácio MLC, Oliveira CF, et al. A coexistência de comportamentos obesogênicos entre adolescentes brasileiros e seus fatores associados. BMC Public Health. 2022;22. https://doi.org/10.1186/s12889-022-13708-6
13. Duraccio KM, Krietsch KN, Zhang N, Whitacre C, Howarth T, Pfeiffer, et al. The impact of short sleep on food reward processes in adolescents. J Sleep Res. 2021;30(2):e13054. https://doi.org/10.1111/jsr.13054
14. Lane KE, Davies IG, Darabi Z, Ghayour-Mobarhan M, Khayyatzadeh SS, Mazidi M. The Association between Ultra-processed foods, quality of life and insomnia among adolescent girls in northeastern Iran. Int J Environ Res Public Health. 2022;19(10):6338. https://doi.org/10.3390/ijerph19106338

15. Knébel MTG, Matias TS, Lopes MVV, Santos PC, Bandeira AS, Silva KS. Clustering of physical activity, sleep, diet, and screen-based device use associated with self-rated health in adolescents. Int J Behav Med. 2022;29(5):587-96. https://doi.org/10.1007/s12529-021-10043-9

16. Sousa RDS, Bragança MLBM, Oliveira BR, Coelho CCNDS, Silva AAMD. Association between the degree of processing of consumed foods and sleep quality in adolescents. Nutrients. 2020;12(2):462. https://doi.org/10.3390/nu12020462

17. Jensen CD, Duraccio KM, Barnett KA, Carbine KA, Stevens KS, Muncy NM, et al. Sleep duration differentially affects brain activation in response to food images in adolescents with overweight/obesity compared to adolescents with normal weight. Sleep. 2019;42(4):zsz001. https://doi.org/10.1093/sleep/zsz001

18. Doan N, Parker A, Rosati K, van Beers E, Ferro MA. Sleep duration and eating behaviours among adolescents: a scoping review. Health Promot Chronic Dis Prev Can. 2022;42(9):384-97. https://doi.org/10.24095/hpcdp.42.9.02

19. Duraccio KM, Whitacre C, Krietsch KN, Zhang N, Summer S, Price M, et al. Losing sleep by staying up late leads adolescents to consume more carbohydrates and a higher glycemic load. Sleep Res Soc. 2022;45(3):1-10. https://doi.org/10.1093/sleep/zsab269

20. Santos EVO, Almeida ATC, Ferreira FELL. Duração do sono, excesso de peso e consumo de alimentos ultraprocessados em adolescentes. Ciênc Saúde Colet. 2021;26(12):6129-39. https://doi.org/10.1590/1413-812320212612.30862020

21. Werneck AO, Vancampfort D, Oyeyemi AL, Stubbs B, Silva DR. Associations between TV viewing, sitting time, physical activity and insomnia among 100,839 Brazilian adolescents. Psychiatr Res. 2018;269:700-6. https://doi.org/10.1016/j.psychres.2018.08.101

22. Costa BGG, Chaput JP, Lopes MVV, Malheiros LEA, Silva KSD. Associations between sociodemographic, dietary, and substance use factors with self-reported 24-hour movement behaviors in a sample of Brazilian adolescents. Int J Environ Res Public Health. 2021;18(5):2527. https://doi.org/10.3390/ijerph18052527

23. Oliveira IR, Maciel NMS, Costa BT, Soares ADN, Gomes JMG. Association between abdominal obesity, screen time and sleep in adolescents. J Pediatr. 2023;99(1):45-52. https://doi.org/10.1016/j.jped.2022.02.007

24. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-Processed Foods and Health Outcomes: A narrative review. Nutrients. 2020;12(7):1955. https://doi.org/10.3390/nu12071955

25. Zuraikat FM, Wood RA, Barragán R, St-Onge MP. Sleep and diet: Mounting evidence of a cyclical relationship. Annu Rev Nutr. 2022;41:309-32. https://doi.org/10.1146/annurev-nutr-120420-021719

26. Galvan A. The need for sleep in the adolescent brain. Trends Cogn Sci. 2020;24(1):79-89. https://doi.org/10.1016/j.tics.2019.11.002

27. Sluggett L, Wagner SL, Harris RL. Sleep duration and obesity in children and adolescents. Can J Diabetes, 2019;43(2):146-52. https://doi.org/10.1016/j.jcjd.2018.06.006

28. Deng X, He M, He D, Zhu Y, Zhang Z, Niu W. Sleep duration and obesity in children and adolescents: evidence from an updated and dose-response meta-analysis. Sleep Med. 2021;78:169-81. https://doi.org/10.1016/j.sleep.2020.12.027

29. Tarokh L, Short M, Crowley SJ, Fontanellaz-Castiglione CEG, Carskadon MA. Sleep and circadian rhythms in adolescence. Curr Sleep Med Rep. 2019;5:181-92. https://doi.org/10.1007/s40675-019-00155-w

30. Delpino FM, Figueiredo LM, Flores TR, Silveira EA, Silva dos Santos F, Werneck AO, et al. Intake of ultra-processed foods and sleep-related outcomes: A systematic review and meta-analysis. Nutrition. 2023;106:111908. https://doi.org/10.1016/j.nut.2022.111908

31. Dashti HS, Scheer FA, Jacques PF, Lamon-Fava S, Ordovás JM. Short sleep duration and dietary intake: Epidemiologic evidence, mechanisms, and health implications. Adv Nutr. 2015;6(6):648-59. https://doi.org/10.3945/an.115.008623

32. St-Onge MP, McReynolds A, Trivedi ZB, Roberts AL, Sy M, Hirsch J. Sleep restriction leads to increased activation of brain regions sensitive to food stimuli. Sleep restriction leads to increased activation of brain regions sensitive to food stimuli. Am J Clin Nutr. 2012;95(4):818-24. https://doi.org/10.3945/ajcn.111.027383

33. Louzada MLC, Martins APB, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Alimentos ultraprocessados e perfil nutricional da dieta no Brasil. Rev Saúde Pública. 2015;49:38. https://doi.org/10.1590/S0034-8910.2015049006132

34. Martins GM. Associação entre consumo de alimentos ultraprocessados e marcadores inflamatórios em adolescentes de escolas públicas em São Luís-MA [dissertação]. Maranhão: Universidade Federal do Maranhão; 2018.

35. Binks H, E Vincent G, Gupta C, Irwin C, Khalesi S. Effects of diet on sleep: a narrative review. Nutrients. 2020;12(4):936. https://doi.org/10.3390/nu12040936

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