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Effect of Ultra-Processed Foods Consumption on Sleep Disturbances among Brazilian Adults' Population: A Propensity Score Matching Approach

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Abstract

Background: Diet, exercise and sleep are three pillars of a healthy life. These lifestyle factors influence one another in complex and dynamic ways. Consistent evidence exists about the bidirectional relationship between sleep patterns and food intake.

Objectives: We aim to assess the effect of the ultra-processed food(UPF) consumption on sleep disturbances in a sample of the Brazilian adults.

Method: We analyzed 77,298 persons aged 18 and older from the Brazilian National Health Survey (2019). A Propensity Score Matching (PSM) approach was used to address confounding bias and balance the matched exposed and control groups. The population average treatment effect (PATE) and the population average treatment effect on the treated (PATT) were estimated. Also, the Absolute Risk Increase and the Relative Risk Increase were computed.

Results: The findings revealed that Brazilian adults who consumed UPF experienced small but statistically significant sleep disturbances compared to non-UPF users. Furthermore, salty UPF showed small but significant worsening of sleep compared to sweet UPF users.

Conclusion: The consumption of UPF is associated with sleep disturbances in Brazilian adults. The consumption of salty UPF had a more significant effect on sleep disorders than sweet UPF in the overall population. However, among individuals who already consumed sweet or salty UPF, these foods had a more significant effect on sleep disorders. To gain a deeper understanding of the complex relationship between UPF consumption, sleep disorders, and their impact on health and quality of life, further research is needed, including precise measurements and consideration of personality traits using prospective designs.

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Introduction

Diet, exercise and sleep are three pillars of a healthy life. These lifestyle factors influence one another in complex and dynamic ways (1). The evidence suggests a complex, bidirectional relationship between sleep quality and duration and diet, and their interactions subsequently affect the risk of developing diverse physical and mental diseases (2).

Sleep is essential for human functions; sufficient time and good quality sleep is fundamental for physical and mental health (3-5). A healthy adult's recommended amount of sleep is at least seven hours (6). Growing evidence suggests that sleep patterns, such as short (<7 h) and long (>9 h) sleep duration, can increase the risk of chronic disease (7).

Sleep disorders are considered a risk factor for many diseases, including cardiovascular events, hypertension, and type 2 diabetes. They are also associated with problems in functioning, occupational safety, reduced productivity, risk of neuropsychiatric disorders and increased utilization of health services (8,9-11).

According to the Brazilian National Health Survey's data, the prevalence of sleep disturbances increased from 28.9% in 2013 to 35.1% in 2019 (12). Drager et al. (2022) reported a 65.5% prevalence of poor sleep quality among the general population in Brazil (13). This figure is consistent with two previous studies reporting 46.7% and 64.9% sleep complaints among the general population in the Sao Paulo state (14,15).

On the other hand, in recent decades, food processing has drastically changed to address consumer preferences, and processed foods are gradually displacing home-prepared meals and the consumption of fresh fruit and vegetables in typical diets. For a long time, the lack of a proper definition and classification of "processed food were crucial limitations to evaluating the role and impact of food processing on health status (16). In 2010, a Brazilian group of researchers coordinated by Monteiro proposed the NOVA food classification system (17). The NOVA classification system groups all foods according to the nature, extent and purposes of the industrial processes they undergo. This system includes four incrementally processed groups: (1) unprocessed or minimally processed food, (2) processed culinary ingredients, (3) processed food, and (4) ultra-processed food(17).

The Ultra-processed foods (UPF) are industrial formulations made entirely or mainly from substances extracted from foods (oils, fats, sugar, starch, and proteins), derived from food constituents (hydrogenated fats and modified starch), or synthesized in laboratories from food substrates or other organic sources (flavour enhancers, colours, and food additives used to make the product hyper-palatable) (18). UPF include, amongst others, carbonated soft drinks; sweet, fatty, or salty crackers; candies; ice creams; pastries; margarine; instant noodles; sausages and many others (18).

The processes and the ingredients used in the manufacture of UPF make them highly convenient (ready-to-eat, almost imperishable), highly attractive (hyper-palatable) for consumers, and highly profitable (low-cost ingredients, long shelf-life) for their manufacturers, all of which explain its substantial and growing consumption around the world (19-21).

Ultra-processed products have increased their incorporation in the Brazilian diet (22,23). About 40% of Brazilian teenagers consume at least one of the following UPF daily: sweets, candies, chocolates, chewing gum, chocolates or lollipops, soft drinks and salted processed/ultra-processed foods, such as hamburger, ham, bologna, salami, sausage, sausage, instant noodles, packaged snacks and crackers (24). Higher consumption of added sugar from UPF has been associated with worse quality (25) and short sleep (26) in adolescents and young adults. In a recent systematic review, Oliveira et al. (2021) reported that the contribution of UPF range from 23.0 - 51.2% of the Total Energy Intake (TEI) in Brazilian adults (27). Another Brazilians' studies showed considerable variability in the percent of TEI obtained from UPF in the last three years, ranging from 17.7% to 25.8% of total energy intake in the adult population (28-33).

Vast evidence exists about the bidirectional relationship between sleep patterns and food intake. Clinical studies have shown that sleep restriction leads to increased energy intake from snacks and intake of energy-dense foods in healthy individuals (34-39). Although reverse causation has received much less attention, there is evidence to support that food choices and dietary patterns affect sleep patterns. In a literature review, St-Onge et al. (2016) found that dietary patterns favor high carbohydrate and fat intakes and are associated with worse sleep quality (40).

In this context, considering how important sleep is for people's health and quality of life, this study aimed to assess the effect of UPF consumption on sleep disturbances in a Brazilian representative sample of the adult population, applying a propensity score matching (PSM) approach to address potential covariate imbalance between individuals with and without UPF consumption.

Method

Study population

This observational cross-sectional study is based on the last Brazilian National Health Survey, or *Pesquisa Nacional de Saude (2019-PNS)*, conducted by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatistica ,(IBGE) in Portuguese) in partnership with the Ministry of Health (41). The 2019-PNS is a household-based survey representative of the Brazilian noninstitutionalized population at the national, regional, state, and primary metropolitan area levels. The selected sample originated from an IBGE master sample, stratified into three cluster stages: census tracts selected with proportional probability, households selected by simple random and individuals aged 15 or over randomly selected within each household. The interviews were carried out between August 2019 and March 2020 by trained teams using smartphone devices programmed with the survey questionnaire and the processes of criticizing the variables. A total of 90,846 households and 275,323 individuals were interviewed. The response rate for households was 93.6% (41). The current data includes registers from 86,844 surveys corresponding to people aged 18 or more who were considered able to answer the questionnaire and who answered the modules about the perception of health status, lifestyles and chronic diseases by themselves. The effect of UPF consumption on sleep problems was estimated.

Measures

Exposure variables

The exposure constitutes self-reported UPF consumption. The 2019-PNS survey assessed the dietary intake using 24h recall. A ten-item questionnaire was applied: *"Yesterday, did you drink or eat"*: a soft drink? Fruit juice in a box or can or powdered soft drink? Chocolate drink or flavored yoghurt? Packaged snacks or salty crackers? Sweet crackers, filled cake or packaged cake? Ice cream, chocolate, gelatin, flan or other industrialized desserts? Sausages or ham? Hotdog or hamburger? Margarine, mayonnaise, ketchup or other industrialized sauces? Instant noodles, packaged soup, frozen lasagna or other industrialized "ready-to-eat frozen dishes"? The response options are; yes, or no. Then, the total number of UPF consumed was added for each individual, and a binary variable was created. Those who did not consume any UPF were categorized as a control group, and those with one or more UFP consumed were considered the exposed group. As the UPF list in the survey is extended, and following the same method mentioned above, binary variables for salty UPF-proxy of trans fats intake- and sweets

UPF-proxy of refined or other industrial sugar intakes- were built to explore the effect of both types of UPFs on sleep disturbances separately.

Outcome variable

The outcome variable focused on self-reported sleep disturbances, obtained through the question: *In the past two weeks, how often have you had sleep problems, such as difficulty to fall asleep, frequently waking up during the night or sleeping more than usual?* The response options are: *"none of the days", "less than half the days", "more than half the days", and "almost every day"*. For the current analyses, a binary variable was arranged; those who answered *"none of the days"* were considered a reference group, and those who answered any other options were considered the interest group.

Covariates

The questionnaires of the 2019-PNS survey collected detailed information on geographic, sociodemographic and health factors. Age, sex, marital status, region, urban residence, education level, physical activity, sedentary behaviors (sitting time watching television and sitting time using computer at home) and some chronic diseases such as diabetes mellitus and hypercholesterolemia were considered as potential confounders and included in the propensity score model. These covariates are chosen for their theorized association with both the exposed and the outcome variables and because they are not in the causal pathway between exposure and outcome. Initially, ethnicity, hypertension, income deciles variables, depression, hypnotic use, alcohol consumption and smoking habits were included in the propensity score model; however, after several UPF propensity score model specifications, the balancing properties were not satisfied and dropped. After dropping missing values of the covariates, the sample was reduced to 77,298 participants.

Sex, marital status, urban residents, diabetes mellitus and higher cholesterol levels were included as dichotomous variables. Age, region of residence, physical activity and sedentary behaviors were included as categorical variables. Age was categorized into five aged groups: 18-29, 30-39, 40-49,50-59 and 60 or older. Persons aged 60 or older were the reference group. Brazil is divided into five regions: North, Northeast, Central West, Southeast and South. The South region was considered as a reference group.

Physical activity was arranged into three ordinal categories: physically inactive (<150 min/week), recommended (150-300 min/week) and over-trained (>300 min/week). The over-trained category was the reference group. Sedentary behavior variables were arranged into three ordinal categories by each dimension: little time (does not watch TV/ does not use computer, tablets or cell at home or less than 2 hr/day), moderate time (two hours to less than 6 hours/day) and many time (six hours or more/day). The reference group spent little time watching TV or using a computer. The highest education status achieved was an ordinal discrete with seven levels according to derived values from the 2019-PNS.

Statistical analyses

Statistical analyses were performed using STATA version 14.0 (Stata Corp, TX, USA). Descriptive statistics were performed to provide a profile of the general characteristics of the sample. The statistical significance was tested using Wald's chi-square statistic for categorical variables and t-test for continuous variable and a level of significance of 5% in the test was accepted.

A propensity score method with a matching strategy (PSM) to reduce confounding bias was applied. PSM seeks to create two equal groups by matching them on a range of covariates that affect the propensity to UPF consumption status and sleep problems. The propensity score was estimated using the *pscore* command with logistic model (42). In this model, UPF consumption status was regressed on observed characteristics. The covariates included in this model were: age, sex, marital status, region, urban residence, education level, physical activity, sitting time watching television, sitting time using computer, diabetes mellitus and higher cholesterol level. The missing register of these variables was excluded. Also, the survey weight was included in the propensity score model to estimate the average treatment effect (ATE), maintaining the external validity; then, the results could be generalizable to the national population (43). A balanced propensity score across exposed and control groups was assessed by examining a graph of propensity scores across these groups and double-checking with covariates standardized mean differences (43).

The matching strategy was conducted with *the psmatch2* command (42,44). The PSM model was estimated using a one-to-one nearest-neighbor matching technique without replacement and with a 0.005 caliper level, which means an exposed participant was matched with a comparison participant when the propensity scores for the two could be no farther than 0.005 logits apart. Subsequently, the balance in the matches sample between the exposed and control was evaluated using the pstest command to get standardized mean differences.

Once an acceptable balance has been achieved, the Absolute Risk Increase (ARI) and the Relative Risk Increase (RRI) were computed to compare outcomes between exposed and control participants in the matched sample. Finally, the average treatment effect on the treated (ATT) and in the population (ATE) were estimated using the *teffects psmatch* command with one-to-one nearest-neighbor without caliper (44). The standard errors were calculated with Abadie-Imbens standard. Because of differences in the composition list of UPF, the analysis for salty and sweets UPF was repeated to estimate the effects of salty and sweets UPF's effects on sleep disturbances separately.

Results

Based on the analysis of a sample of 77,298 individuals, it was found that 37% of people experienced sleep disturbances within the last two weeks, while 82% consumed UPF. Among those with sleep disturbances, 18% did not consume any UPF, while 82% consumed at least one UPF. Of the UPF consumers, 45% consumed a combination of salty and sweet UPF, while 22% exclusively consumed salty UPF and 15% exclusively consumed sweet UPF. The geographic and socio-demographic characteristics of the sample population, according to sleep disturbances categories, are presented in Table 1.

Table 1. Socio-demographic characteristics of the final sample according Sleep disturbances categories. 2019-PNS

Characteristics	**Sleep Disturbances**	
	No day (n:48,773)	**One o more day (n:28,525)**
Ultra-processed foods (% consumption) *	80%	82%
Age groups		
18-29 year-old **	17.50%	12.50%
30-39 year-old **	21.80%	17.70%
40-49 year-old n.s.	18.90%	19.40%
50-59 year-old**	17.10%	20.50%
60 or more years**	24.70%	29.90%
Sex (% women) **	49.00%	65.00%
Marital status (% married) n.s.	42.00%	19.00%
Urban residence (%) **	78.00%	81.00%
Education level **		

Unscholarly **	7.10%	8.90%
Incomplete ElemSch **	29.20%	32.90%
Complete ElemSch *	7.40%	6.90%
Incomplete HighSch **	6.10%	5.50%
Complete HighSch **	28.50%	24.60%
Incomplete GradSch n.s.	4.60%	4.60%
Graduated n.s.	17.10%	16.70%
**Region ** **		
north **	18.90%	17.00%
northeast **	32.70%	36.10%
central west **	12.10%	11.10%
southeast n.s.	22.90%	23.00%
south *	13.50%	12.80%
**Physical activity ** **		
inactive (<150 min/week) **	72.80%	75.50%
recommended (150-300 min/week) **	17.10%	15.70%
overtrained (>300 min/week)**	10.10%	8.70%
**Sitting time watching television ** **		
little time (do not - <2 hours/day) **	58.30%	54.60%
moderate time (2 hours - < 6 hours/day) *	36.90%	38.30%
many time (> 6 hours/day) **	4.80%	7.10%
**Sitting time using computer at home ** **		
little time (do not - <2 hours/day) n.s.	68.10%	69.20%
moderate time (2 hours - < 6 hours/day) **	24.90%	23.40%
many time (> 6 hours/day)*	7.00%	7.40%
**Diabetes mellitus ** **	7.30%	11.90%
Hypercholesterolemia**	12.40%	23.60%
**Survey weight (avg.) (Std) ** **	1.28(1.90)	1.23 (1.84)

* : pvalue < 0,05 ; ** :p-value < 0,001 ; n.s.: non significant

ElemSch: Elementary School ; HighSch: High School ; GradSch : Graduate School

The principal food groups contributing to the salty UPF intake in subjects with sleep disturbances were margarine, mayonnaise, ketchup or other industrialised sauces (42%), hotdog or hamburger (28%), packaged snacks or salty crackers (24%), Sausages or ham (24%) and instant noodles, packaged soup, frozen lasagne or other industrialised ready-to-eat frozen dishes (6%). Soft drinks (27%), sweet crackers, filled cake or packaged cake (22%), fruit juice in a box or can or powdered soft drinks (21%), ice cream, chocolate, gelatine, flan or other industrialised desserts (18%) and chocolate drink or flavoured yoghurt (13%), were the main contributors to sweets UPF intakes in the sample.

The propensity score was used to reduce confounding bias. The propensity score model was built using a logit regression with UPF consumption as the outcome variable and the potential confounders as explanatory variables. Once a propensity score has been calculated, the similar distribution -"balance"- across exposed and control groups was examined. The overlap of the distribution of the propensity scores across these groups was considered satisfactory (Figure 1).

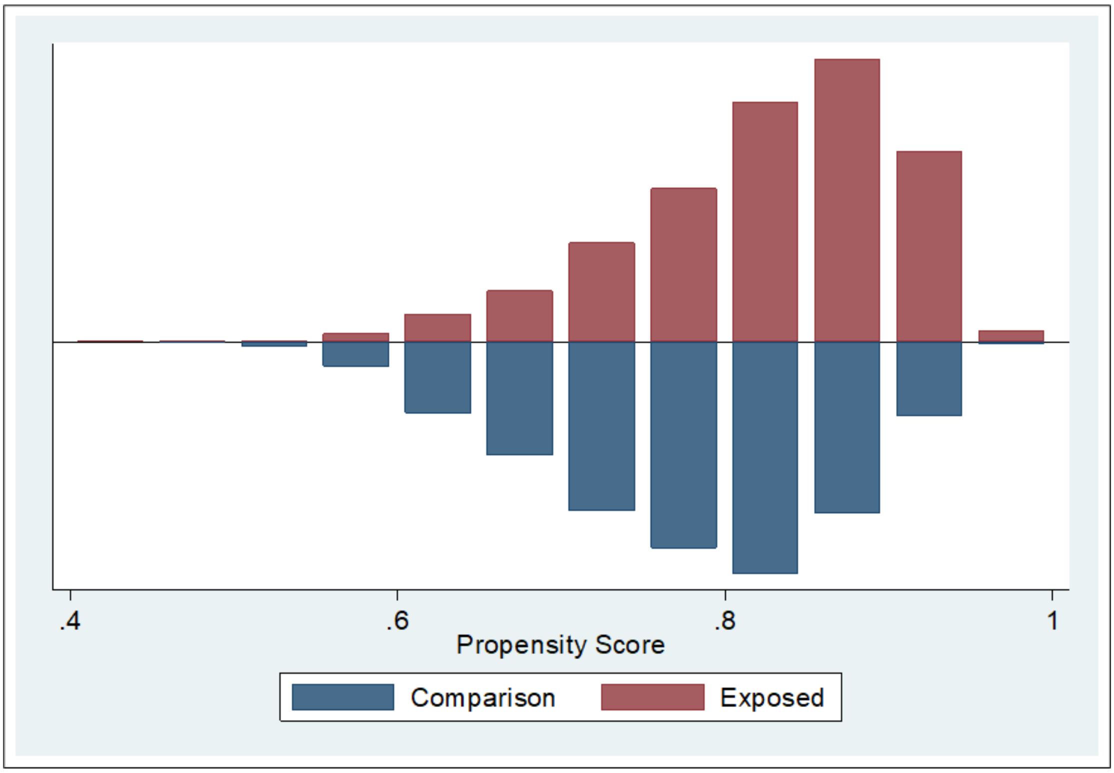

Figure 1. Distribution of Propensity Score across Exposed and Comparison Groups. 2019-PNS

The standardized mean differences also checked the balance between the exposed and control groups. The standardized mean differences for all the covariates was 16.9%. However, some covariates, grouped age (40.0%), sitting time using the computer at home (32.7%), region (26.6%) and education level (26.6%), were higher than 25% cu-toff proposed by Austin (2010) suggesting a population difference exists in these covariates (45).

For the estimation of the exposure effect model, a PSM model was estimated using a one-to-one nearest-neighbor matching technique without replacement and with a 0.005 calliper level. The matching procedure reduces the sample size to 28,157 observations. The post-matching results revealed that the overall standardized mean difference between exposed and control groups was 2.3%, meaning that covariates are balanced.

The PSM model balances well the matched exposed and control groups. The imbalanced covariates in the propensity score model reduced their standardized mean differences in the PSM model; age groups (91.5%), sitting time using a computer at home (89.5%), region (87.6%) and education level (94.4%), considering the matching procedure successful (Table 2).

Once suitable matches were achieved, ARI and RRI were computed. In the matched sample, the ARI increased to 0.023 (95%C.I.= -0.034 – -0.011), meaning that those who consume UPF have a 2.3% higher risk of having sleep disturbances than those that do not consume UPF. On the other hand, the RRI increased by 0.062 (95%C.I.= -0.094 – -0.030), implying that the risk of having sleep disturbances increased by 6.2% in subjects that consume UPF.Having satisfied themselves that matching had substantially decreased differences between the exposed and control groups, the Population Average Treatment Effect (PATE) and Population Average Treatment Effect on the Treated (PATT) were estimated. The PATE represents the average difference in sleep disturbances if everyone in the sample consumes UPF compared to everyone who does not consume UPF. On the other hand, the PATT

Table 2. Balance among exposed and comparison groups before and after Propensity Score Matching. Standardized mean differences.

Covariates	**Before Matching (n:77,298)**			**After Matching (n:28,157)**		
	UPF consump*	**non-UPF consump**	*p-value*	**UPF consump***	**non-UPF consump**	*p-value*
Age groups	3.0987	3.6507	0.000	3.6971	3.6502	0.003
Women	0.54931	0.56196	0.006	0.57417	0.56216	0.042
Urban residence	0.8063	0.7133	0.000	0.70588	0.71355	0.156
Married	0.40799	0.42902	0.000	0.44231	0.42889	0.023
Education level	4.0513	3.5158	0.000	3.4865	3.5166	0.213
Region	2.8536	2.5096	0.000	2.4675	2.51	0.004
Physical activity	1.3566	1.3644	0.201	1.3743	1.3638	0.186
Sitting time/television	1.497	1.4419	0.000	1.4395	1.4421	0.706
Sitting time/computer	1.6032	1.4069	0.000	1.3864	1.407	0.002
Diabetes mellitus	0.08257	0.12094	0.000	0.12774	0.12084	0.08
Hypercholesterolemia	0.16086	0.18692	0.000	0.19928	0.18698	0.009
Survey weight	1.3168	1.0101	0.000	0.99221	1.0103	0.276

* UPF consump: Ultra-processed foods consumption.

represents the comparison of sleep disturbances in everyone who consumes UPF if they had not consumed UPF.

In the matched sample, the estimated PATE coefficient was 0.015 (95%C.I.= 0.002 – 0.028; p = 0.03), meaning that subjects in the survey's target population that consumed UPF the day before had significantly 1.5% more sleep disturbances than those who did not consume UPF. On the other hand, the estimated PATT coefficient was 0.0130 (95%C.I.= -0.002 – 0.028; p = 0.09), meaning that the average effect of UPF consumption the day before increases sleep disturbances by 1.3% in individuals who consumed UPF. However, this trend was not statistically significant.

Regarding the salty UPF consumption, the ARI increase of 0.020 (95%C.I.= -0.029 – -0.012) and the RRI increase of 0.056 (95%C.I.= -0.080 – -0.032) in the matched sample. That means that those who consume salty UPF have a 2.0% higher risk of having sleep disturbances than those who do not consume salty UPF, and the risk of having sleep disturbances increased by 5.6% in subjects that consume salty UPF. In this cohort, the estimated PATE was 0.021 (95%C.I.= 0.011 – 0.030; p < 0.0001), meaning that subjects in the population that consumed salty UPF the day before had significantly 2.1% more sleep disturbances than those who did not consume salty UPF. On the other hand, the estimated PATT was 0.015 (95%C.I.= 0.004 – 0.026; p = 0.007), meaning that the average effect of salty UPF consumption the day before significantly increases sleep disturbances by 1.5% in individuals who consumed salty UPF.

Finally, in subjects consuming sweets UPF, the ARI increase of 0.026 (95%C.I.= -0.034 – -0.011) and the RRI increase of 0.070 (95%C.I.= -0.092 – -0.048) in the matched sample. That means that those who consume sweets UPF have a 2.6% higher risk of having sleep disturbances than those who do not consume sweets UPF, and the risk of having sleep disturbances increased by 7.0% in subjects that consume sweets UPF. In this cohort, the estimated PATE was 0.016(95%C.I.= 0.007 – 0.025; p = 0.001), meaning that subjects in the population that consumed sweets UPF the day before had significantly 1.6% more sleep disturbances than those who did not consume sweets UPF. On the other hand, the estimated PATT was 0.019 (95%C.I.= 0.009 – 0.030; p < 0.0001), meaning that the average effect of sweets UPF consumption the day before significantly increases sleep disturbances by 1.9% in individuals who consumed sweets UPF.

Discussion

In Brazil, most previous studies addressing the relationship between UPF consumption and sleep disturbances focusing on the adolescent population all relied upon observational studies, concluding that higher UPF consumption among Brazilian adolescents is associated with poor sleep quality (23, 46-49). While there are limited studies on assessing the effects of UPF in the adult population, Menezes-Júnior et al. (2022), in a cross-sectional study during the COVID-19 pandemic in two medium-sized cities in the south-central region of Minas Gerais, Brazil, found that adults with higher consumption of UPF concomitant with lower consumption of fresh and minimally processed foods are associated with a higher chance of poor sleep quality (50). Compared to this study, which showed a two-fold increase in poor sleep quality, our study involving a larger population sample showed a small but statistically significant effect of UPF consumption on sleep disturbances.

With a representative sample and PSM model, an advanced statistical approach designed to address the potential selection bias commonly seen in observational studies, this study confirms the effect of UPF consumption and sleep disturbances in the Brazilian adults.

In the matched sample, the Population Average Treatment Effect (PATE) showed a small significant effect of UPF consumption on sleep disturbances, i.e., the estimated average effect of UPF consumption on sleep disturbances was small in the entire sample. In turn, the Population Average Treatment Effect on the Treated (PATT) was slightly inferior to the PATE, i.e., the estimated average effect of UPF consumption on sleep disturbances for individuals who consumed UPF was slightly smaller. On the other hand, both population risk measures showed slightly increased sleep disturbances associated with UPF consumption.

A possible explanation for the weak effect of UPF consumption on sleep disturbances in this sample could be the existence of the opposite effect of some relevant covariates on both variables, equalizing their mutual impacts. For example, in both genders, the more aged the participants, the average intake of UPF decreases while the prevalence rate of sleep disorders increased. Sleep disturbances are known to increase with age and thus might have counter-balanced the effect of UPF consumption. A similar pattern was observed with education level. Furthermore, extensive evidence exists about the bidirectional relationship between food intake and sleep patterns (34-40). Then, it is not surprising to observe in this study that PATE and PATT effects of UPF consumption on sleep disturbances result attenuated. Due to the complex interactions between these two conditions and the set of associated covariates, the magnitude and direction of the effect of one on the other could be better understood through vector analysis.

The results of the separate analysis for salty and sweets UPF consumption were relevant to this study. The estimated PATE effect of salty UPF consumption on sleep disturbances was higher than that of sweets UPF on the overall population. Conversely, the estimated PATT effect of sweets UPF consumption on sleep disturbance was higher than that of salty UPF on individuals who already consumed sweets and salty UPF, respectively.

The macronutrient composition of the UPF in the questionnaire is unknown. However, it is possible to sustain that these findings support the idea that higher saturated fat and carbohydrate intake are associated with poor quality sleep (40,51,52). In this study, 46% of individuals had a mixed salty and sweets UPF diet, and 21% and 15% consumed only salty or sweets UPF, respectively.

This study has several strengths. First, it had a large and representative sample, making the findings more reliable and applicable to the general population. Second, it included all UPF identified in the NOVA group four in the Survey questionnaire, which enhanced the analysis and enabled easy comparison with other research results. Lastly, the PSM approach reduce the chances of selection bias in observational studies, increasing the generalizability of their findings.

However, there are some limitations. First, data was collected based on self-reported evaluation of sleep disturbance and UPF consumption, then standardized measurement of exposure and outcome variables must be necessary. Second, data on UPF consumption was derived from a single 24 h recall, which could have affected the significance of the findings. This tool needs to be administered several times to reflect the typical diet. Third, although the PSM method helped to reduce the selection bias, the analysis was performed based on cross-sectional data. It would be better if longitudinal data sets would be available. Fourth, some potential confounders, such as ambient lighting during sleep and personality, were not included in the model for formulating propensity scores as we did not collect the data; thus, hidden confounding may remain because matching only controls for observed variables.

Conclusion

The study shows a slightly significant effect of UPF consumption on sleep disturbances and a slightly increased risk of sleep disturbances associated with UPF consumption among Brazilian adults. The effect of salty UPF on sleep disturbances was higher than that of sweet UPF on the population. Conversely, sweet UPF had a higher effect on sleep disturbances in individuals already consuming sweet UPF than salty UPF intake in individuals already consuming salty UPF. Further research with more accurate measurements for UPF consumption and sleep disturbance, including personality traits and prospective designs, should be carried out to clarify the causality and underlying mechanisms of the complex relationship between these two common disorders affecting health outcomes and quality of life.

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https://www.ibge.gov.br/estatisticas/downloadsestatisticas.htmlcaminho=PNS/2019/Microdados/Dados.

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