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ORIGINAL ARTICLE

Ultra-Processed Food Consumption is Associated with Alcoholic Beverage Drinking, Tobacco Smoking, and Illicit Drug Use in Adolescents: A Nationwide Population-Based Study

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Abstract

Background Although evidence suggests that ultra-processed food (UPF) consumption may trigger addictive behaviors, the association between UPF intake and psychoactive substances remains unclear among adolescents, a group especially vulnerable to addiction and its potentially harmful effects on health.

Objective To analyze the association between the consumption of UPF and alcohol, tobacco, and illicit drugs in adolescent students.

Method This cross-sectional study analyzed data from the National School-Based Health Survey (PeNSE 2019), which collected information from a representative population-based sample of students aged 13–17 years in Brazil. UPF consumption was self-reported in a 24-h recall. Lifetime and use of alcohol, tobacco, and illicit drugs in the last month were also reported. Multinomial logistic regression models estimated the relative risk ratios (RRR) (95% confidence intervals – CI) because the outcome variables comprised four categories representing varying frequencies of use of psychoactive substances.

Results The mean ± standard error number of different UPF consumed among the 95,074 adolescents included (52.3% girls) was 4.37 ± 0.02. The results from adjusted models revealed that, compared to those who reported low UPF consumption (1st tertile), those who consumed more UPF (3rd tertile) were more likely to report frequent (≥ 3 days in the last month) drinking of alcoholic beverages (RRR = 2.19; 95% CI: 1.87, 2.56), illicit drugs (RRR = 2.22; 95% CI: 1.87, 2.85) and occasional (one or two days in the last month) smoking (RRR = 1.30; 95% CI: 1.05, 1.60).

Conclusions UPF consumption was associated with alcohol, tobacco, and illicit drug use in a national sample of Brazilian adolescents.

Keywords Ultra-processed food · Addiction · Alcohol · Tobacco smoking · Illicit drug use · Survey · Adolescents

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According to the NOVA food classification system (Monteiro et al., 2018a, b), ultra-processed foods (UPF) (e.g., soft drinks, sweets, cookies, snacks, etc.) are those to which refined sugar and salt, fats, and food additives are added through industrial processes to improve their organoleptic properties, enhancing their attractiveness and increasing their consumption (Monteiro et al., 2019). These processes result in foods with high energy content and low nutritional density, i.e., rich in fats and sugar and poor in protein, fiber, minerals, and vitamins (Louzada et al., 2015; Monteiro et al., 2019).

In recent decades, an increase in UPF consumption has been observed in both developed and developing countries (Juul & Hemmingsson, 2015; Monteiro et al., 2010; L. Wang et al., 2021). For instance, a study including data from US youths from the National Health and Nutrition Examination Survey (NHANES) found a significant increase (from 61.4% to 67.0%) in the percentage of total energy from UPF consumption from 1999 to 2018 (L. Wang et al., 2021). Another time trend study including 11 metropolitan Brazilian areas observed an increase from 19.2% to 28.0% of total energy available in household food between 1987 and 2002 (Monteiro et al., 2010). This rise in UPF consumption is independent of socioeconomic status (i.e., this has been found in adolescents in both the upper and lower socioeconomic levels) (Machado et al., 2017; Rocha et al., 2021a, b) and has been connected not only with the direct costs of purchasing UPF but also with indirect social and health costs. In particular, UPF consumption has been associated with lower diet quality (Costa Louzada et al., 2015; Martini et al., 2021) and health problems such as obesity, cardiovascular disease, metabolic syndrome, and total mortality, in addition to mental health disorders such as depression (Cascaes et al., 2022; Chen et al., 2020; Elizabeth et al., 2020; Mesas et al., 2022; Morriss et al., 1997; Passos et al., 2020; Rico-Campà et al., 2019).

The recent debate on the existence of addiction to specific foods has focused on UPF because of their potential addictive effect, possibly due to being simultaneously rich in sugars and fats (Schulte et al., 2015; Whatnall et al., 2022). A systematic review reported a 12% prevalence of food addiction in community samples of children and adolescents (Yekaninejad et al., 2021), which could possibly be associated with UPF consumption. Concretely, frequent consumption of UPF could chronically stimulate brain reward mechanisms, such as dopaminergic sensitization, leading to feelings and behaviors similar to those seen in other addictions, such as withdrawal, craving, and excessive consumption (LaFata & Gearhardt, 2022; Schulte et al., 2015; Volkow et al., 2012). The similarities in the biological and behavioral effects of using UPF and other addictive psychoactive substances such as alcohol, nicotine, and cannabidiol may be particularly worrying for two main reasons. First, unlike alcohol, tobacco and other drugs whose use is commonly prohibited for those under 18 years of age, UPF are freely promoted and sold to all ages, particularly to the very young (Potvin Kent et al., 2019; Torres-Schiaffino & Saavedra-Garcia, 2020). This is of special relevance because early-onset substance use is a significant predictor of drug abuse and dependence (Grant & Dawson, 1998). Second, individuals who are addicted to one substance are more likely to develop addiction to other substances (Witek et al., 2022; Zawertailo et al., 2020).

Adolescence is a critical period of physical and emotional development in which decision-making, planning, and inhibitory control processes are not yet fully developed because, among other reasons, some brain areas, such as the prefrontal cortex, are still immature (Branje et al., 2021; Windle et al., 2018; Wray-Lake et al., 2010). Due to the adaptive challenges that this entails, added to some social aspects such as the progressively greater independence of their parents, adolescents are more vulnerable to risky behaviors that have a significant impact on the family and society (Kieling et al., 2011). Globally, adolescent diets are characterized by low consumption of fruits and vegetables and high

consumption of energy-dense, nutrient-poor foods (Beal et al., 2019). Similarly, a population-based study in Brazil found that nearly one in three adolescents had an unhealthy dietary pattern characterized by an almost daily average frequency of consumption of candies, cookies, crackers and soft drinks (Tavares et al., 2014). On the other hand, the prevalence of substance use, such as alcohol (34.9%) and tobacco (9.3%), in this age group is a public health concern in Brazil (Barbosa Filho et al., 2012) and many other countries (Erskine et al., 2015). In addition to being frequent problems in adolescence, both the consumption of psychoactive substances and UPF have been associated with negative effects on mental health in this age group due to biological and behavioral reasons (Lane et al., 2022a, b; Marx et al., 2021; Patel et al., 2016). For instance, adolescents using alcohol, tobacco and/or illicit drugs are more likely to have depressive symptoms, aggression, self-injury, and suicide ideation and attempts (Klassen et al., 2018; Malta et al., 2018; Moodie et al., 2013). Furthermore, drug use disorders have been ranked among the top twenty leading causes of global disability-adjusted life-years for ages 10 to 24 (Abbafati et al., 2020). Moreover, previous studies linked UPF consumption with elevated symptoms of common mental disorders (Mesas et al., 2022; Werneck et al., 2022).

The cooccurrence of unhealthy lifestyle habits such as the consumption of UPF and psychoactive substances in adolescence is a crucial issue because this cluster effect may result in a synergism that enhances the severity of their separate harmful effects on health (Alzahrani et al., 2014; Ricardo et al., 2019; Whitaker et al., 2021). Most of the evidence on the association between UPF and substance use is based on preclinical studies with animals (Witek et al., 2022), a few epidemiological studies with adults (Amadieu et al., 2021; Schulte et al., 2015) and adolescents (Cummings et al., 2020; M. Wang et al., 2017), mostly focusing on specific UPF such as soft drinks (Atorkey et al., 2021; Fagan et al., 2021; Pengpid & Peltzer, 2019; Shih et al., 2020; Terry-McElrath et al., 2014). Moreover, these studies reported mixed results, and it remains unclear whether and to what extent these behaviors (i.e., UPF consumption and the use of psychoactive substances) are associated among adolescents.

Therefore, the objective of this study was to analyze the association between UPF consumption and alcoholic beverage drinking, tobacco smoking, and illicit drug use in Brazilian adolescents aged 13 to 17 years.

Methods

Study Design and Participants

This cross-sectional study analyzed publicly accessible data from the National School Health Survey (PeNSE), conducted in Brazil in 2019 by a partnership between the Ministry of Health and the Brazilian Institute of Geography and Statistics (IBGE), with support from the Ministry of Education (MEC) (IBGE, 2021). The PeNSE 2019 had a complex sample design that included students from public and private schools between the ages of 13 and 17 from all over the national territory. The student sample size was generated using simple random sampling in each size stratum, taking into account the school's administrative dependence (public or private) and geographic location in Brazil. The classrooms of the enrolled students who regularly attended were selected in each school. As inclusion criteria, all students present on the day of data collection who agreed to participate in the

survey and provided information on sex and age were automatically included in the PeNSE database (IBGE, 2021).

Data were collected at schools by applying an electronic questionnaire available on a Personal Digital Assistant device without the assistance of the researcher. Other details of the PeNSE methodology can be found elsewhere (IBGE, 2021; Oliveira et al., 2017).

From the total initial population of 119,670 participants aged > 13 and < 17 years, we excluded those without complete information for socioeconomic condition ($n = 19{,}257$), UPF consumption ($n = 670$), use of alcohol ($n = 198$), tobacco ($n = 66$) or illicit drug use ($n = 110$) and others without information for any of the other covariates included in the analyses ($n = 4{,}295$) (Fig. 1). Thus, the sample of adolescents included in the present analyses was 95,074 participants (79.4%). Because many individuals had to be excluded due to missing data, a comparative descriptive analysis of the characteristics of the total initial population and the included sample of participants was performed (Supplementary Material, Table S1). In general, the characteristics of both samples were similar, and no difference that could affect the interpretation of the present results was found.

Data Acquisition

The consumption of ultra-processed foods (independent variable) was assessed with a questionnaire that asked adolescents about their consumption (yes or no) in the last 24 h of 13 foods classified as UPF according to the NOVA classification system (Monteiro et al., 2018a, b). A list was presented including the following UPF: soft drinks, industrialized

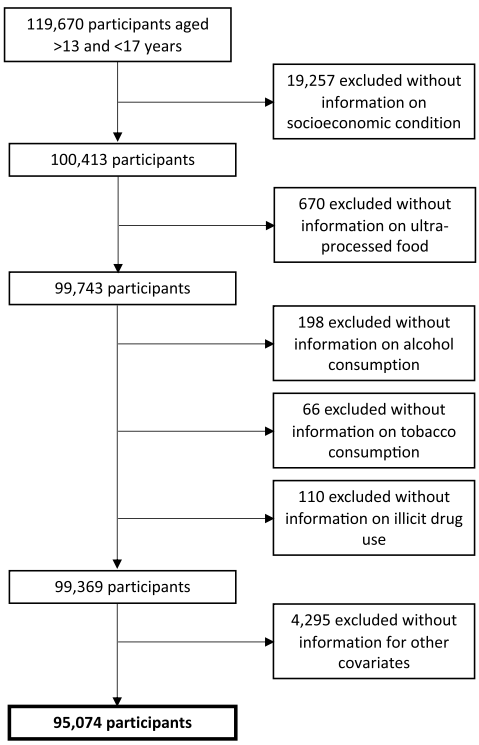

Fig. 1 Flow diagram for study participants

fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks (e.g., packaged chips or crackers), sweet snacks (e.g., sweet cookies, cream cookies, or packet cake), industrialized desserts (e.g., chocolate, ice cream, gelatin, flan), meat products (e.g., sausage, mortadella or ham), industrialized bread (e.g., flatbread, hot dog bun or hamburger bun), margarine, industrialized sauces (e.g., mayonnaise, ketchup), and industrialized ready meals (e.g., instant noodles, packaged soups, frozen lasagna). For the present analysis, after summing the number of UPF reported as consumed (ranging from zero to 13), the adolescents were classified according to the distribution in the sample by tertiles into low (1st tertile, from zero to three UPF), intermediate (2nd tercile, from four to five UPF) and high (3rd tercile, from six to 13 UPF) UPF consumption. In addition, the frequency of consumption in the last seven days was asked for soft drinks and sweets exclusively (the corresponding data for the other UPF are unavailable in the PeNSE database). For these questions, answers were admitted from zero (no consumption) to seven (daily consumption) days.

The use of three psychoactive substances (i.e., alcohol, tobacco and illicit drugs) was reported by the adolescent in response to two questions for each substance. For the consumption of alcoholic beverages, the first question asked was "Have you ever had a glass or a drink of alcohol in your life?". When the answer was negative, the questionnaire omitted further questions on alcohol consumption. When the answer was affirmative, they were asked "In the last 30 days, how many days have you had at least one drink or one dose (i.e., a can or a long neck bottle of beer or vodka-ice or a glass of draft beer or a glass of wine or a dose of "*cachaça/pinga*", vodka, whiskey, etc.) of alcoholic beverages?", with the following response options: "no day in the last 30 days", "1 or 2 days", "3 to 5 days", "6 to 9 days", "10 to 19 days", "20 to 29 days" or "all days". Considering the response to both questions, the adolescents were classified into the following four categories: "never has drunk", "drank at least once in life but not in the last 30 days", "drank 1 or 2 days in the last 30 days", and "drank 3 days or more in the last 30 days".

Similarly, two sequential questions were also asked to collect data on tobacco smoking and illicit drug use. On tobacco smoking, they were first asked "Have you ever smoked a cigarette, even one or two puffs in your life?" and then "In the last 30 days, how many days did you smoke cigarettes?". On illicit drug use, the first question was "Have you ever used a drug such as marijuana (cannabis), cocaine, crack, solvent-based glue, general ether-based inhalants, popper, ecstasy, oxy, MD, skank, and others in your life?", and the second was "In the last 30 days, how many days did you use any drug?". The same method described for classifying adolescents according to alcoholic beverage consumption was used for tobacco smoking and illicit drug use, also generating four categories ranging from "never in life" to "3 days or more in the last 30 days".

Based on previous evidence of their relationship with both UPF (Ricardo et al., 2019; J. B. Silva et al., 2021a, b; Whitaker et al., 2021) and the psychoactive substances examined (Azeredo et al., 2016; Malta et al., 2014; Moodie et al., 2013; R. M. A. Silva et al., 2021a, b), the following covariates were considered potential confounders of the study associations: gender (boys vs. girls); age (13–15 vs. > 15 years, as pre-categorized in the PeNSE database); self-reported race (white/Caucasian vs. nonwhite, i.e., black, "*pardo*", Asian, or indigenous); school location (urban vs. rural); school administration (public vs. private); educational level (secondary vs. primary); parental living (both parents vs. one or no parent); having meals with parents (always or almost always vs. lower frequency); the number of close friends (≥ 3 vs. < 3); free-time physical activity (> 3 vs. ≤ 3 h/week); sedentary time (> 5 vs. ≤ 5 h/day); eating fruit every day (yes vs. no); eating other vegetables every day (yes vs. no); body image satisfaction (unsatisfied vs. satisfied); and bullying

victimization at school in the last 30 days (yes vs. no). The socioeconomic condition was evaluated according to the combination of maternal schooling, possession of material goods (e.g., cell phone, computer, car), and availability of services (e.g., internet, maid) in the household. Then, a principal component analysis was applied to this set of items, and a weighted score was calculated considering the specific load of each item. Finally, the socioeconomic level score was categorized into quartiles, and those in the first quartile were designated as having "lower socioeconomic status" (lower or 1st quartile vs. moderate or higher, i.e., 2nd to 4th quartiles). In addition, the following questions assessed mental health symptoms in the last 30 days: "How often have you felt very concerned about the ordinary things in your daily life such as school activities, sports competitions, homework, etc.?" (worry), "How often have you felt irritated, nervous or bad-tempered by anything?" (irritability), "How often have you felt that no one cares about you?" (loneliness), "How often did you feel sad?" (sadness), and "How often have you felt that life is not worth living?" (helplessness). Considering the response options "1-never", "2-rarely", "3-sometimes", "4-most of the time", and "5-always", each symptom was considered frequent when they answered the last two responses (i.e., "4-most of the time" or "5-always"). We then summed the number of frequent mental symptoms reported for each individual (ranging from one to five).

Statistical Analysis

Descriptive statistics were performed by calculating the relative frequency (%) of the categorical variables and the mean ± standard error of the continuous variables analyzed. To analyze the differences in UPF consumption according to the frequency of psychoactive substance use, the chi-square test was used for categorical variables, and analysis of variance was used for continuous variables.

Multinomial logistic regression models were used to analyze the association between the tertile of UPF consumed (independent variable) and the use of alcohol, tobacco, and illicit drugs (dependent variables). As the dependent variable, each psychoactive substance was studied separately in four categories (ranging from "never in life" to "3 days or more in the last 30 days"). A first unadjusted model was performed to calculate the relative risk ratio (RRR) and the related 95% confidence interval (95% CI) for the 2nd and 3rd tertiles of UPF consumption compared to the 1st tertile (reference category). Next, three models were progressively adjusted as follows (Fig. 2): model 1, adjusted for age, self-reported race, socioeconomic status, school location, school administration, and educational level; model 2, previous model adjusted for parental cohabitation, eating with parents, number of close friends, free-time physical activity, sedentary time, eating fruit every day, and eating other vegetables every day; the variables alcohol consumption, tobacco smoking and illicit drug use in the last 30 days were also included except when they were the dependent variable under analysis; and model 3, previous model adjusted for bullying victimization in the past 30 days, satisfaction with body image and frequency of mental health symptoms.

Finally, the mean weekly frequency (in days) of consumption of soft drinks and sweets was compared with the analysis of variance according to the frequency of use of each psychoactive substance. Bonferroni's post hoc test was used to detect differences between the frequency of use categories for each psychoactive substance.

All statistical operations were conducted with STATA software version 15.0 (Stata Corporation, College Station, TX, USA) considering the parameters of a complex survey design (*svy* commands in Stata).

Fig. 2 Graphical representation of the multinomial regression analyses strategy

Results

Baseline Participant Characteristics

Among the 95,074 adolescents included, approximately half were girls (52.3%) and attended secondary school (46.5%), and most of them studied in public schools (85.9%) located in urban areas (93.0%) (Table 1). The mean ± standard error number of UPF consumed in the last 24 h was 4.37 ± 0.02. Regarding the use of psychoactive substances, the proportion of adolescents who reported never having tried these substances was 36.5% for alcohol, 77.8% for tobacco, and 87.4% for illicit drugs. On the other hand, frequent use (three or more days in the last 30 days) was reported by 11.7% for alcohol, 3.3% for tobacco, and 2.3% for illicit drugs (Table 1).

Salty snacks (49.6%) and sweet snacks (47.1%) were the most consumed UPF in the last 24 h, followed by industrialized breads (42.3%), margarine (41.4%), soft drinks (40.9%) and meat products (39.7%) (Table 2). When each UPF was analyzed separately, it was observed that the more frequent the consumption of alcohol, tobacco and illicit drugs, the greater the probability of reporting consumption of 10 of the 13 foods analyzed ($p < 0.05$) (Table 2).

Relationship Between UPF and Use of Alcohol, Tobacco and Illicit Drugs

The results of the multivariate associations between the number of UPF consumed and the psychoactive substances are presented in tables for the use of alcohol (Table 3), tobacco (Table 4) and illicit drug use (Table 5). Overall, in the unadjusted models, those who consumed six or more UPF (3rd tertile) were more likely to report using each psychoactive substance than those consuming up to three UPF (1st tertile) in the last 24 h. These associations remained after the adjustment for all covariates considered. Specifically, higher consumption of UPF was associated with frequent (≥ 3 days in the last 30 days) drinking of alcoholic beverages (RRR = 2.19; 95% CI: 1.87, 2.56) (Table 3) and illicit drugs (RRR = 2.22; 95% CI: 1.72, 2.85) (Table 5). A similar finding was found in the complete adjusted analysis for occasional smoking (one or two days in the last 30 days) (RRR = 1.30; 95% CI: 1.05, 1.60) (Table 4).

As depicted in Fig. 3, the weekly frequency of consumption of soft drinks and sweets was higher among adolescents who frequently used alcohol, tobacco, and illicit drugs than among their counterparts who never consumed them. Specifically, the mean frequency of soft drink consumption was 2.05 days in the last week, which was higher among those who used alcohol (3.10 days/week), tobacco (3.17 days/week) and drugs (3.45 days/week) more frequently (i.e., three or more days in the last month). The corresponding values considering the frequency of sweet consumption were a minimum of 3.03 days/week among never substance users and 4.13 (alcohol), 3.81 (tobacco) and 4.01 (illicit drugs) days/week among those who used them three or more days in the last month (Fig. 3).

Discussion

Main Findings

Overall, our findings showed that UPF consumption was associated with the use of psychoactive substances (i.e., alcohol, tobacco, and illicit drugs) in a national sample of Brazilian

Table 1 Characteristics of adolescent students aged 13–17 years, Brazil, 2019

Characteristic	Total sample ($n = 95{,}074$) %*
Total	100.0
Sociodemographic and economic	
Age > 15 years	33.4
Girls	52.3
Self-reported white race	36.9
Lower socioeconomic condition	25.4
Urban school	93.0
Public school	85.9
Secondary educational level	46.5
Lifestyle	
Living with both parents	56.1
Having meals with parents	64.8
Having three or more close friends	76.4
Free-time physical activity > 3 h/week	22.1
Sedentary time > 5 h/day	31.9
Eating fruit every day	17.3
Eating other vegetables every day	19.7
Unsatisfied with body image	23.3
Bullying victimization in the last 30 days	40.0
Mental health symptoms, mean ± SE number of symptoms "almost always" or "always"	1.78 ± 0.01
Ultra-processed food consumption (UPF)	
Number of UPF consumed in the last 24 h, mean ± SE number of UPF	4.37 ± 0.02
1st tertile (0–3)	36.0
2nd tertile (4–5)	34.7
3rd tertile (6–10)	29.3
Frequency of soft drink consumption, mean ± SE number of days/week	3.46 ± 0.03
Frequency of sweet consumption, mean ± SE number of days/week	2.36 ± 0.02
Use of psychoactive substances	
Alcoholic beverage drinking	
Never has drunk	36.5
Drank at least once in life but not in the last month	35.8
Drank 1 or 2 days in the last month	16.1
Drank 3 days or more in the last month	11.7
Tobacco smoking	
Never has smoked	77.8
Smoked at least once in life but not in the last month	15.7
Smoked 1 or 2 days in the last month	3.3
Smoked 3 days or more in the last month	3.3
Illicit drug use	
Never has used	87.4
Used at least once in life but not in the last month	7.7
Used 1 or 2 days in the last month	2.6
Used 3 days or more in the last month	2.3

* Except when indicated "mean ± SE". SE: standard error; UPF: ultra-processed foods including soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals

adolescent students. The associations found were robust and independent of sociodemographic, lifestyle, and other health conditions, such as body image satisfaction, bullying victimization, and frequency of mental health symptoms. These results, along with those of other studies in children and adolescents, support the need for public policies to regulate the production and marketing of UPF (Popkin et al., 2021) placed not only in the framework of anti-obesity policies (Khandpur et al., 2020; Monteiro et al., 2010) but also immersed in the prevention of alcohol, tobacco and illicit drugs at early ages.

Comparison with the Available Evidence

These results depicted the association between alcohol, tobacco, or illicit drug consumption and both the number of types of UPF consumed and the frequency of weekly consumption of soft drinks and sweets. Consistently, a study with Israeli adolescents found that those following a "junk-food" dietary pattern (i.e., frequent consumption of soft drinks, salty snacks, cream cakes, and ice cream) were more likely to drink alcoholic beverages and smoke cigarettes (Sinai et al., 2021). The following studies have found similar results with respect to the frequency of consumption of specific UPF and substance use. Soft drink was undoubtedly the most studied UPF in this regard. For instance, the consumption of sugar-sweetened beverages was higher among adolescents reporting more days of alcoholic beverage consumption and a smoking habit (Rocha, Pessoa, et al., 2021). Other studies corroborated these associations considering sugar-sweetened (Shih et al., 2020), carbonated (Atorkey et al., 2021; Pengpid & Peltzer, 2019), and regular (Terry-McElrath et al., 2014) soft drinks. Likewise, in another study with school-aged adolescents, cigarette smoking was associated with soft drinks and fast food consumption (M. Wang et al., 2017). It is noteworthy the consistency observed between our findings and those of studies conducted in adolescents from countries of varied levels of development, employing specific UPF and methodological approaches, particularly on the associations of UPF, alcohol and tobacco. This might suggest that while in adolescence the use of psychoactive substances differs according to economic condition and social vulnerability (Halladay et al., 2020), the consumption of UPF is widespread and associated with substance use in this age group regardless of social class or cultural background.

Conversely, a study with adolescent girls found an inverse longitudinal association between the tendency to consume processed or sweet high-fat foods and the tendency to drink alcohol (Cummings et al., 2017). Another study did not find an association between sugar-sweetened beverages and tobacco smoking (Fagan et al., 2021). It is necessary to consider that discrepancies between studies are possibly due to the characteristics of the samples studied (e.g., sample size, proportion of boys and girls, age range, socioeconomic and cultural aspects, etc.), as well as to methodological aspects that may vary greatly, such as the instrument used to assess diet (e.g., 24-h recall, frequency food questionnaires), the use of psychoactive substances (e.g., validated questionnaires, single questions), and adjustment for confounding factors (among others).

Potential Mechanisms Relating UPF Consumption and Substance Use

Some possible biological and behavioral mechanisms have been suggested to explain the association between UPF consumption and the use of the psychoactive substances

Table 2 Consumption of ultra-processed food (UPF) in adolescent students aged 13–17 years by the use of alcohol, tobacco and illicit drugs, Brazil, 2019

Consumption of UPF in the last 24 h	Total	Alcoholic beverage drinking					Tobacco smoking					Illicit drug use				
		Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value	Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value	Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value
Number of UPF consumed, %																
1st tertile (0–3)	36.0	40.2	35.9	32.3	28.2	< 0.001	37.1	33.4	27.7	30.9	< 0.001	36.9	30.8	30.3	24.4	< 0.001
2nd tertile (4–5)	34.7	34.9	35.4	34.9	31.6		35.0	34.1	36.6	27.1		35.1	33.5	30.5	28.2	
3rd tertile (6–10)	29.3	24.9	28.7	32.8	40.2		27.9	32.5	35.7	42.0		28.0	35.7	39.2	47.4	
Specific UPF consumed, %																
Soft drink	40.9	37.5	39.8	44.0	50.9	< 0.001	39.2	46.4	46.7	49.8	< 0.001	39.6	48.1	51.0	56.9	< 0.001
Industrialized fruit juice	25.2	25.0	24.1	26.3	27.9	0.007	25.2	23.4	30.3	29.7	< 0.001	24.7	26.9	31.6	32.5	< 0.001
Powdered soft drink	25.3	22.4	25.4	27.2	31.8	< 0.001	24.4	26.7	33.9	33.0	< 0.001	24.6	30.1	27.4	35.6	< 0.001
Chocolate drink	26.5	25.0	26.5	27.5	30.0	< 0.001	26.1	27.7	28.2	28.5	0.208	26.1	27.7	29.5	34.6	0.002
Flavored yogurt	16.6	18.1	15.1	16.0	17.1	0.001	16.9	14.7	17.8	17.4	0.037	16.7	15.0	15.5	20.8	0.056
Salty snacks	49.6	47.6	48.9	52.3	54.2	< 0.001	48.6	51.4	59.0	56.0	< 0.001	49.1	51.7	51.3	58.1	0.005
Sweet snacks	47.1	45.8	46.9	48.4	49.7	0.014	46.3	47.9	50.0	49.1	0.003	46.8	48.4	47.3	54.0	0.066
Industrialized desserts	34.1	30.7	34.5	36.9	39.7	< 0.001	33.7	35.0	38.9	36.6	0.052	33.4	39.0	41.2	37.7	< 0.001
Meat products	39.7	36.9	39.6	41.1	46.5	< 0.001	38.7	41.8	42.9	48.8	< 0.001	38.9	43.3	46.6	48.9	< 0.001
Industrialized breads	42.3	39.7	42.4	44.1	47.6	< 0.001	41.8	42.8	42.5	51.2	0.003	41.5	45.3	50.4	52.3	< 0.001

Table 2 (continued)

Consumption of UPF in the last 24 h	Total	Alcoholic beverage drinking					Tobacco smoking					Illicit drug use				
		Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value	Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value	Never	Once in life, none in the last 30 days	1–2 times in the last 30 days	3 + times in the last 30 days	*p*-value
Margarine	41.4	40.6	43.4	40.0	39.4	0.005	41.3	41.6	39.9	43.8	0.651	41.4	41.0	40.7	41.7	0.981
Industrialized sauces	30.8	25.3	30.9	34.6	42.0	< 0.001	29.4	34.9	32.9	41.4	< 0.001	29.5	37.5	41.4	45.8	< 0.001
Industrialized ready meals	20.7	19.9	19.8	23.0	22.7	< 0.001	20.0	21.9	25.9	26.6	< 0.001	20.3	23.1	23.9	23.8	0.016

UPF: ultra-processed foods including soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals. To analyze the differences in UPF consumption according to the frequency of psychoactive substance use, the chi-square test was used for categorical variables and analysis of variance was used for continuous variables

Table 3 Association between ultra-processed food (UPF) consumption and alcoholic beverage drinking in adolescent students aged 13–17 years, Brazil, 2019

Models	Alcoholic beverage drinking		
	Drank at least once in life but not in the last month *vs*. never has drunk	Drank in 1 or 2 days in the last month *vs*. never has drunk	Drank in 3 or more days in the last month *vs*. never has drunk
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Unadjusted model			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.13 (1.03, 1.24)*	1.24 (1.10, 1.41)**	1.29 (1.10, 1.52)**
3rd tertile (6–10)	1.29 (1.17, 1.43)***	1.64 (1.46, 1.84)***	2.31 (1.98, 2.69)***
Model 1			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.17 (1.06, 1.28)**	1.31 (1.15, 1.48)***	1.36 (1.17, 1.59)***
3rd tertile (6–10)	1.40 (1.27, 1.55)***	1.87 (1.67, 2.11)***	2.67 (2.33, 3.07)***
Model 2			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.13 (1.02, 1.26)*	1.26 (1.10, 1.44)**	1.30 (1.10, 1.53)**
3rd tertile (6–10)	1.33 (1.20, 1.48)***	1.70 (1.50, 1.92)***	2.24 (1.92, 2.60)***
Model 3			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.13 (1.02, 1.27)*	1.27 (1.11, 1.45)*	1.31 (1.11, 1.56)**
3rd tertile (6–10)	1.32 (1.19, 1.47)***	1.67 (1.47, 1.89)***	2.19 (1.87, 2.56)***

Values are relative-risk ratios (RRR) (95% confidence intervals) obtained through multinomial logistic regression models. Model 1: adjusted by gender (boys vs. girls), age (> 15 vs. 13–15 years), self-reported race (white vs. nonwhite), socioeconomic condition (lower [1st quartile] vs. moderate or higher [2nd to 4th quartiles]), school location (urban vs. rural), school administration (public vs. private), and educational level (secondary vs. primary). Model 2: previous model adjusted by parental living (both parents vs. one or no parent), having meals with parents (always or almost always vs. lower frequency), number of close friends (≥ 3 vs. < 3), free-time physical activity (> 3 vs. ≤ 3 h/week), sedentary time (> 5 vs. ≤ 5 h/day), eating fruit every day (yes vs. no), eating other vegetables every day (yes vs. no), tobacco smoking in the last 30 days (yes vs. no), and illicit drug consumption in the last 30 days (yes vs. no). Model 3: previous model adjusted by bullying victimization at school in the last 30 days (yes vs. no), body image satisfaction (unsatisfied vs. satisfied) and frequency of mental health symptoms (score from 5 to 25). UPF: ultra-processed foods including soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals. *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

studied. For instance, eating foods rich in sugar and with a high glycemic load, such as UPF (Schulte et al., 2015), generates a blood glucose spike that activates brain reward mechanisms similar to what occurs in other addictive processes (Volkow et al., 2012). Moreover, foods high in fat and carbohydrate, which are common in UPF, have more hedonic value than foods containing only fat or carbohydrate, and this effect is associated with greater recruitment of central reward circuits (DiFeliceantonio et al., 2018). This fat-carbohydrate interaction potentiating food reward was observed in healthy weight but not in individuals with excess weight (Perszyk et al., 2021), which could suggest that when such consumption is frequent and long-lasting in time, sensitization of this neurological pathway may

Table 4 Association between ultra-processed food (UPF) consumption and tobacco smoking in adolescent students aged 13–17 years, Brazil, 2019

Models	Tobacco smoking		
	Smoked at least once in life but not in the last month *vs*. never smoked	Smoked in 1 or 2 days in the last month *vs*. never smoked	Smoked in 3 or more days in the last month *vs*. never smoked
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Unadjusted model			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.08 (0.98, 1.19)	1.40 (1.05, 1.85)*	0.93 (0.75, 1.15)
3rd tertile (6–10)	1.30 (1.15, 1.46)***	1.71 (1.38, 2.13)***	1.81 (1.45, 2.27)***
Model 1			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.14 (1.03, 1.25)**	1.48 (1.14, 1.93)**	0.99 (0.79, 1.24)
3rd tertile (6–10)	1.42 (1.27, 1.60)***	1.88 (1.53, 2.30)***	2.01 (1.59, 2.54)***
Model 2			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.02 (0.91, 1.14)	1.29 (0.98, 1.69)	0.84 (0.66, 1.06)
3rd tertile (6–10)	1.06 (0.94, 1.19)	1.32 (1.07, 1.63)*	1.27 (0.97, 1.67)
Model 3			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.02 (0.92, 1.15)	1.28 (0.98, 1.68)	0.84 (0.66, 1.07)
3rd tertile (6–10)	1.04 (0.93, 1.18)	1.30 (1.05, 1.60)*	1.26 (0.97, 1.64)

Values are relative-risk ratios (RRR) (95% confidence intervals) obtained through multinomial logistic regression models. Model 1: adjusted by gender (boys vs. girls), age (> 15 vs. 13–15 years), self-reported race (white vs. nonwhite), socioeconomic condition (lower [1st quartile] vs. moderate or higher [2nd to 4th quartiles]), school location (urban vs. rural), school administration (public vs. private), and educational level (secondary vs. primary). Model 2: previous model adjusted by parental living (both parents vs. one or no parent), having meals with parents (always or almost always vs. lower frequency), number of close friends (≥ 3 vs. < 3), free-time physical activity (> 3 vs. ≤ 3 h/week), sedentary time (> 5 vs. ≤ 5 h/day), eating fruit every day (yes vs. no), eating other vegetables every day (yes vs. no), alcohol consumption in the last 30 days (yes vs. no), and illicit drug consumption in the last 30 days (yes vs. no). Model 3: previous model adjusted by bullying victimization at school in the last 30 days (yes vs. no), body image satisfaction (unsatisfied vs. satisfied) and frequency of mental health symptoms (score from 5 to 25). UPF: ultra-processed foods including soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals. *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

occur (Temple, 2016), which in turn could lead to increased craving (i.e., the sensation of the need to consume) of substances with similar effects, such as alcohol, nicotine, and cannabidiol, among others (Bollen et al., 2020; Chao et al., 2017). In this line, preliminary evidence suggests that tolerance and withdrawal may occur in response to UPF (Parnarouskis & Gearhardt, 2022).

In addition, it should also be considered that by providing a low density of essential nutrients, especially protein, unsaturated fats and fiber, and a high density of energy, sugars, fats, salt and food additives, the low diet quality of UPF (Martínez Steele et al., 2017)

favors microbiota dysfunction (Cuevas-Sierra et al., 2021) and increases DNA oxidative damage (Edalati et al., 2021) and inflammatory markers (Lane et al., 2022a, b; Martins et al., 2022). Consequently, consuming more UPF increases the risk of nutritional, cardiometabolic and mental health disorders and symptoms (Elizabeth et al., 2020; Louzada et al., 2022; Mesas et al., 2022). Therefore, apart from sharing brain pathways related to addiction to other psychoactive substances, UPF consumption can trigger pathophysiological processes that may increase the incidence of elevated symptoms of common mental disorders (Werneck et al., 2022) and adolescents' vulnerability to other self-destructive behaviors, such as illicit drug use (Temple, 2016; Volkow et al., 2012; Zawertailo et al., 2020). Furthermore, it could be possible that those adolescents who eat more UPF, do this as a coping strategy for emotional relief, tension-reduction, or to deal with stress (Manzoni et al., 2009), which could also be associated with other drugs consumption (Powers & Kutash, 1985). In this sense, it has been previously found that individuals who have higher perceived stress or low ability to manage stress also have a higher energy intake and consumed more sweets and fat foods (Errisuriz et al., 2016; Zellner et al., 2006), which could increase stress levels (Abrams et al., 2022; Tariq et al., 2019) and enhance addiction vulnerability (Sinha, 2008).

From a behavioral perspective, the sale of UPF to minors is not only liberalized but also stimulated by ostensive marketing and specifically directed at this public (Moodie et al., 2013; Torres-Schiaffino & Saavedra-Garcia, 2020), contrary to what happens with alcoholic beverages, cigarettes and illicit drugs such as cannabis, crack, or cocaine. UPF are palatable foods commonly consumed in out-of-home gatherings and stimulated by social motives (Onita et al., 2021), circumstances that also favor the consumption of psychoactive substances, particularly alcohol drinking (Fazzino et al., 2018). However, other psychological reasons besides socialization may also justify the consumption of tasty foods such as UPF by adolescents, such as coping, increasing reward, or conformity (Boggiano et al., 2017). In the family context, eating with family while watching TV was associated with greater intake of UPF, and household availability has increased in recent years (Monteiro et al., 2018a, b). In this regard, it was reported that parental nicotine dependence and frequent alcohol use were associated with increased reward-driven eating behavior by their children, indicating that parental use of psychoactive substances and UPF consumption are also associated in the family context (Cummings et al., 2020).

Limitations

This study has some limitations that should be considered when interpreting its results. The first is the cross-sectional design, which prevents us from stating the existence of a causal relationship between consuming UPF and consequently increasing the frequency of alcohol, tobacco or illicit drug use. Indeed, a previous study reported that appetite and snack urge increased more after alcohol consumption (Rose et al., 2015), which suggests that the association between UPF and alcohol intake could be bidirectional. The second limitation refers to the possible recall and desirability biases resulting from self-reported information on both UPF consumption and substance use. The third limitation is that possible information bias cannot be ruled out because, as alcohol and tobacco consumption are prohibited for those under 18 years of age and drug use is illegal, some adolescents could have omitted or misreported these behaviors. Last, although the large sample size allowed us to adjust the analyses for potential confounding factors, residual confounding is still possible because we did not adjust for body mass index and energy intake, which were unavailable in the PeNSE

Table 5 Association between ultra-processed food (UPF) consumption and illicit drug use in adolescent students aged 13–17 years, Brazil, 2019

Models	Illicit drug use		
	Used at least once in life but not in the last month *vs*. never used	Used in 1 or 2 days in the last month *vs*. never used	Used in 3 or more days in the last month *vs*. never used
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Unadjusted model			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.15 (0.99, 1.33)	1.06 (0.82, 1.37)	1.21 (0.91, 1.62)
3rd tertile (6–10)	1.53 (1.33, 1.77)***	1.71 (1.33, 2.20)***	2.56 (1.96, 3.36)***
Model 1			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.20 (1.03, 1.39)*	1.11 (0.86, 1.43)	1.27 (0.94, 1.71)
3rd tertile (6–10)	1.70 (1.47, 1.96)***	1.89 (1.47, 2.45)***	2.81 (2.17, 3.64)***
Model 2			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.11 (0.94, 1.32)	1.02 (0.78, 1.34)	1.17 (0.85, 1.61)
3rd tertile (6–10)	1.41 (1.20, 1.66)***	1.57 (1.20, 2.05)**	2.31 (1.76, 3.03)***
Model 3			
UPF consumption			
1st tertile (0–3)	Reference	Reference	Reference
2nd tertile (4–5)	1.13 (0.96, 1.35)	1.02 (0.76, 1.34)	1.21 (0.88, 1.66)
3rd tertile (6–10)	1.43 (1.21, 1.69)***	1.54 (1.17, 2.01)**	2.22 (1.72, 2.85)***

Values are relative risk ratios (RRR) (95% confidence intervals) obtained through multinomial logistic regression models. Model 1: adjusted by gender (boys vs. girls), age (> 15 vs. 13–15 years), self-reported race (white vs. nonwhite), socioeconomic condition (lower [1st quartile] vs. moderate or higher [2nd to 4th quartiles]), school location (urban vs. rural), school administration (public vs. private), and educational level (secondary vs. primary). Model 2: previous model adjusted by parental living (both parents vs. one or no parent), having meals with parents (always or almost always vs. lower frequency), number of close friends (≥ 3 vs. < 3), free-time physical activity (> 3 vs. ≤ 3 h/week), sedentary time (> 5 vs. ≤ 5 h/day), eating fruit every day (yes vs. no), eating other vegetables every day (yes vs. no), alcohol consumption in the last 30 days (yes vs. no), and tobacco smoking in the last 30 days (yes vs. no). Model 3: previous model adjusted by bullying victimization at school in the last 30 days (yes vs. no), body image satisfaction (unsatisfied vs. satisfied) and frequency of mental health symptoms (score from 5 to 25). UPF: ultra-processed foods including soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals. *p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

2019 database. Our results support the hypothesis that adolescents with a dietary pattern rich in UPF are more likely to consume other addictive substances. However, because of the cross-sectional design of our study, prospective observational studies are essential to further investigate whether UPF consumption increases the risk of other addictions (i.e., alcohol, tobacco and illicit drugs) or whether these behaviors are merely concurrent. Importantly, the concomitant occurrence of UPF consumption and substance use in early stages of life, such

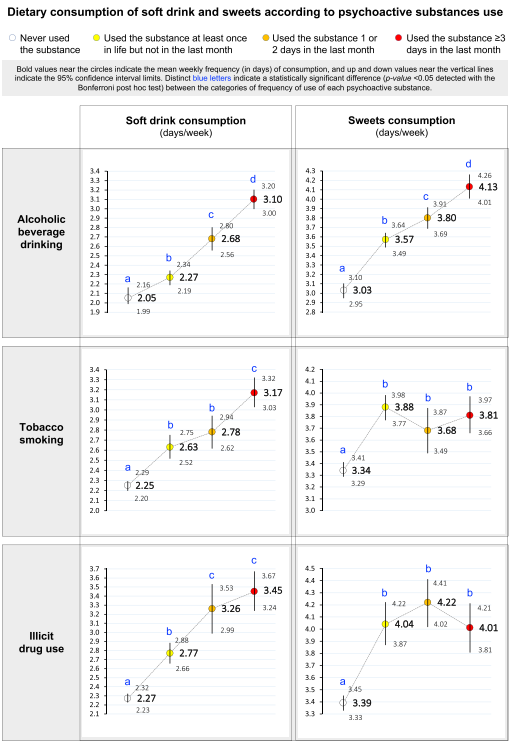

Fig. 3 Mean frequency (days/week) of dietary consumption of soft drinks and sweets according to the frequency of psychoactive substance use

as adolescence, may lead to unhealthy lifestyle habits in the beginning of adulthood (Chassin et al., 1996; Mikkilä et al., 2005; Spear & Swartzwelder, 2014).

Conclusion and Future Directions

In summary, in a large-scale sample of Brazilian adolescents, a higher number of UPF consumed was associated with alcohol, tobacco, and illicit drug use regardless of several confounding factors, including self-perceived body image and bullying victimization. Therefore, future research should consider the increased risk of use of these psychoactive substances and the possible addiction to them resulting from frequent use, among the various adverse health effects of UPF use.

According to our findings, reducing the number of UPF consumed is an important target not only in terms of promoting public health nutrition but also in terms of the prevention of substance abuse and dependence. In addition, our results draw attention to specific UPF consumed very frequently by adolescents and consistently associated with the use of alcohol, tobacco and illicit drugs, such as sweet and salty snacks, industrialized breads and soft drinks. It is important to highlight that high consumption of UPF by adolescents is not a novel problem in Brazil. In the 2009 edition of the PeNSE, some of these UPF topped the list of the most consumed in the unhealthy dietary pattern (Tavares et al., 2014). Similarly, the increasing prevalence of regular alcohol and tobacco use and illicit drug experimentation in adolescence is also a persistent concern in this country (Malta et al., 2014).

Therefore, considering our results and the evidence that supports the association between UPF consumption and the use of other psychoactive substances, it cannot be ruled out that the joint confrontation of both problems through combined intersectoral actions could be more effective than if done in isolation. Because eventually consuming these UPF might increase the risk of using other substances, this study adds to the body of evidence that supports the need for measures to regulate their production (e.g., reducing energy density and increasing nutritional value), distribution (e.g., preventing sales inside or near schools) and commercialization (e.g., increasing taxes and warning on labeling about the risks associated with frequent consumption).

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Author Contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by AEM and RR. The first draft of the manuscript was written by AEM and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability All data used in this study are anonymized and publicly available at https://www.ibge.gov.br/estatisticas/sociais/educacao/9134-pesquisa-nacional-de-saude-doescolar.html?=&t=resultados (accessed on 3 November 2022).

Declarations

Ethics Approval and Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. The 2019 PeNSE project was submitted and approved by the National Committee of Ethics in Research (CONEP) from the National Health Council (CNS) – Report No. 3.249.268 (April 8, 2019). These institutions regulate and approve health research involving human beings, thus seeking to further safeguard the ethical principles and the confidentiality of the information of the adolescents interviewed. Informed consent was obtained from all adolescents involved in the study and from their parents or guardians.

Conflict of Interest AEM, EG, RR, VM-V, EJ-L and JFL-G declare that they have no conflicts of interest.

References

Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., Abd-Allah, F., Abdelalim, A., Abdollahi, M., et al. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A

systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Abrams, K. B., Mei, L., Chen, C. S., Koele, E., Kwan, J., Montes, Z., et al. (2022). The paradoxical association between tension-reduction alcohol outcome expectancies and tension following alcohol consumption. *The American Journal of Drug and Alcohol Abuse, 48*(2), 206–216. https://doi.org/10.1080/00952990.2021.1992772

Alzahrani, S. G., Watt, R. G., Sheiham, A., Aresu, M., & Tsakos, G. (2014). Patterns of clustering of six health-compromising behaviours in Saudi adolescents. *BMC Public Health, 14*, 1215. https://doi.org/10.1186/1471-2458-14-1215

Amadieu, C., Leclercq, S., Coste, V., Thijssen, V., Neyrinck, A. M., Bindels, L. B., et al. (2021). Dietary fiber deficiency as a component of malnutrition associated with psychological alterations in alcohol use disorder. *Clinical Nutrition (edinburgh, Scotland), 40*(5), 2673–2682. https://doi.org/10.1016/j.clnu.2021.03.029

Atorkey, P., Akwei, M., & Asare-Doku, W. (2021). Consumption of carbonated soft drinks among Ghanaian adolescents: Associations with socio-demographic factors, health risk factors and psychological distress. *Nutrition and Health, 27*(3), 329–336. https://doi.org/10.1177/0260106021996933

Azeredo, C. M., Levy, R. B., Peres, M. F., Menezes, P. R., & Araya, R. (2016). Patterns of health-related behaviours among adolescents: a cross-sectional study based on the National Survey of School Health Brazil 2012. *BMJ Open, 6*(11), e011571. https://doi.org/10.1136/bmjopen-2016-011571

Barbosa Filho, V. C., de Campos, W., & da Lopes, A. S. (2012). Prevalence of alcohol and tobacco use among Brazilian adolescents: A systematic review. *Revista De Saúde Pública, 46*, 901–917. https://doi.org/10.1590/S0034-89102012000500018

Beal, T., Morris, S. S., & Tumilowicz, A. (2019). Global Patterns of Adolescent Fruit, Vegetable, Carbonated Soft Drink, and Fast-Food Consumption: A Meta-Analysis of Global School-Based Student Health Surveys. *Food and Nutrition Bulletin, 40*(4), 444–459. https://doi.org/10.1177/0379572119848287

Boggiano, M. M., Wenger, L. E., Burgess, E. E., Tatum, M. M., Sylvester, M. D., Morgan, P. R., et al. (2017). Eating tasty foods to cope, enhance reward, socialize or conform: What other psychological characteristics describe each of these motives? *Journal of Health Psychology, 22*(3), 280–289. https://doi.org/10.1177/1359105315600240

Bollen, Z., Masson, N., Salvaggio, S., D'Hondt, F., & Maurage, P. (2020). Craving is everything: An eye-tracking exploration of attentional bias in binge drinking. *Journal of Psychopharmacology, 34*(6), 636–647. https://doi.org/10.1177/0269881120913131

Branje, S., de Moor, E. L., Spitzer, J., & Becht, A. I. (2021). Dynamics of Identity Development in Adolescence: A Decade in Review. *Journal of Research on Adolescence, 31*(4), 908–927. https://doi.org/10.1111/jora.12678

Cascaes, A. M., Silva, N. R. J. da, Fernandez, M. dos S., Bomfim, R. A., & Vaz, J. dos S. (2022). Ultra-processed food consumption and dental caries in children and adolescents: a systematic review and meta-analysis. *British Journal of Nutrition*, 1–10. https://doi.org/10.1017/S0007114522002409

Chao, A. M., White, M. A., Grilo, C. M., & Sinha, R. (2017). Examining the effects of cigarette smoking on food cravings and intake, depressive symptoms, and stress. *Eating Behavior, 24*, 61–65. https://doi.org/10.1016/j.eatbeh.2016.12.009

Chassin, L., Presson, C. C., Rose, J. S., & Sherman, S. J. (1996). The natural history of cigarette smoking from adolescence to adulthood: Demographic predictors of continuity and change. *Health Psychology, 15*, 478–484. https://doi.org/10.1037/0278-6133.15.6.478

Chen, X., Zhang, Z., Yang, H., Qiu, P., Wang, H., Wang, F., et al. (2020). Consumption of ultra-processed foods and health outcomes: A systematic review of epidemiological studies. *Nutrition Journal, 19*(1), 86. https://doi.org/10.1186/s12937-020-00604-1

Cuevas-Sierra, A., Milagro, F. I., Aranaz, P., Martínez, J. A., & Riezu-Boj, J. I. (2021). Gut Microbiota Differences According to Ultra-Processed Food Consumption in a Spanish Population. *Nutrients, 13*(8), 2710. https://doi.org/10.3390/nu13082710

Cummings, J. R., Ray, L. A., & Tomiyama, A. J. (2017). Food-alcohol competition: As young females eat more food, do they drink less alcohol? *Journal of Health Psychology, 22*(5), 674–683. https://doi.org/10.1177/1359105315611955

Cummings, J. R., Lumeng, J. C., Miller, A. L., Hyde, L. W., Siada, R., & Gearhardt, A. N. (2020). Parental substance use and child reward-driven eating behaviors. *Appetite, 144*, 104486. https://doi.org/10.1016/j.appet.2019.104486

da Costa Louzada, M. L., Martins, A. P. B., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., et al. (2015). Ultra-processed foods and the nutritional dietary profile in Brazil. *Revista De Saude Publica, 49*, 38. https://doi.org/10.1590/S0034-8910.2015049006132

da Louzada, M. L. C., Martins, A. P. B., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., et al. (2015). Impact of ultra-processed foods on micronutrient content in the Brazilian diet. *Revista de Saude Publica, 49*, 45. https://doi.org/10.1590/S0034-8910.2015049006211

da Louzada, M. L. C., Costa, C. D. S., Souza, T. N., da Cruz, G. L., Levy, R. B., & Monteiro, C. A. (2022). Impact of the consumption of ultra-processed foods on children, adolescents and adults' health: scope review. *Cadernos de Saude Publica, 37*(suppl 1), e00323020. https://doi.org/10.1590/0102-311X00323020

DiFeliceantonio, A. G., Coppin, G., Rigoux, L., Edwin Thanarajah, S., Dagher, A., Tittgemeyer, M., et al. (2018). Supra-Additive Effects of Combining Fat and Carbohydrate on Food Reward. *Cell Metabolism, 28*(1), 33-44.e3. https://doi.org/10.1016/j.cmet.2018.05.018

Dos Passos, C. M., Maia, E. G., Levy, R. B., Martins, A. P. B., & Claro, R. M. (2020). Association between the price of ultra-processed foods and obesity in Brazil. *Nutrition, Metabolism, and Cardiovascular Diseases : NMCD, 30*(4), 589–598. https://doi.org/10.1016/j.numecd.2019.12.011

Edalati, S., Bagherzadeh, F., Asghari Jafarabadi, M., & Ebrahimi-Mamaghani, M. (2021). Higher ultra-processed food intake is associated with higher DNA damage in healthy adolescents. *The British Journal of Nutrition, 125*(5), 568–576. https://doi.org/10.1017/S0007114520001981

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

Errisuriz, V. L., Pasch, K. E., & Perry, C. L. (2016). Perceived stress and dietary choices: The moderating role of stress management. *Eating Behaviors, 22*, 211–216. https://doi.org/10.1016/J.EATBEH.2016.06.008

Erskine, H. E., Moffitt, T. E., Copeland, W. E., Costello, E. J., Ferrari, A. J., Patton, G., et al. (2015). A heavy burden on young minds: The global burden of mental and substance use disorders in children and youth. *Psychological Medicine, 45*(7), 1551–1563. https://doi.org/10.1017/S0033291714002888

Fagan, M. J., Di Sebastiano, K. M., Qian, W., Leatherdale, S. T., & Faulkner, G. (2021). The Energy to Smoke: Examining the Longitudinal Association between Beverage Consumption and Smoking and Vaping Behaviours among Youth in the COMPASS Study. *International Journal of Environmental Research and Public Health*, *18*(8). https://doi.org/10.3390/ijerph18083864

Fazzino, T. L., Raheel, A., Peppercorn, N., Forbush, K., Kirby, T., Sher, K. J., et al. (2018). Motives for drinking alcohol and eating palatable foods: An evaluation of shared mechanisms and associations with drinking and binge eating. *Addictive Behaviors, 85*, 113–119. https://doi.org/10.1016/j.addbeh.2018.04.025

Grant, B. F., & Dawson, D. A. (1998). Age of onset of drug use and its association with DSM-IV drug abuse and dependence: Results from the national longitudinal alcohol epidemiologic survey. *Journal of Substance Abuse, 10*(2), 163–173. https://doi.org/10.1016/S0899-3289(99)80131-X

Halladay, J., Woock, R., El-Khechen, H., Munn, C., MacKillop, J., Amlung, M., et al. (2020). Patterns of substance use among adolescents: A systematic review. *Drug and Alcohol Dependence, 216*, 108222. https://doi.org/10.1016/j.drugalcdep.2020.108222

Instituto Brasileiro de Geografia e Estatística (IBGE). Coordenação de População e Indicadores Sociais. PeNSE–National Survey of School Health. Available online: https://www.ibge.gov.br/en/statistics/social/education/16837-national-survey-of-school-health-editions.html?=&t=downloads (accessed on 20 October 2022).

Juul, F., & Hemmingsson, E. (2015). Trends in consumption of ultra-processed foods and obesity in Sweden between 1960 and 2010. *Public Health Nutrition, 18*(17), 3096–3107. https://doi.org/10.1017/S1368980015000506

Khandpur, N., Neri, D. A., Monteiro, C., Mazur, A., Frelut, M.-L., Boyland, E., et al. (2020). Ultra-Processed Food Consumption among the Paediatric Population: An Overview and Call to Action from the European Childhood Obesity Group. *Annals of Nutrition & Metabolism, 76*(2), 109–113. https://doi.org/10.1159/000507840

Kieling, C., Baker-Henningham, H., Belfer, M., Conti, G., Ertem, I., Omigbodun, O., et al. (2011). Child and adolescent mental health worldwide: Evidence for action. *The Lancet, 378*(9801), 1515–1525. https://doi.org/10.1016/S0140-6736(11)60827-1

Klassen, J. A., Hamza, C. A., & Stewart, S. L. (2018). An Examination of Correlates for Adolescent Engagement in Nonsuicidal Self-Injury, Suicidal Self-Injury, and Substance Use. *Journal of Research on Adolescence, 28*(2), 342–353. https://doi.org/10.1111/jora.12333

LaFata, E. M., & Gearhardt, A. N. (2022). Ultra-Processed Food Addiction: An Epidemic? *In Psychotherapy and Psychosomatics, 91*(6), 363–372. https://doi.org/10.1159/000527322

Lane, M. M., Gamage, E., Travica, N., Dissanayaka, T., Ashtree, D. N., Gauci, S., et al. (2022a). Ultra-Processed Food Consumption and Mental Health: A Systematic Review and Meta-Analysis of Observational Studies. *Nutrients, 14*(13), 2568. https://doi.org/10.3390/nu14132568

Lane, M. M., Lotfaliany, M., Forbes, M., Loughman, A., Rocks, T., O'Neil, A., et al. (2022b). Higher Ultra-Processed Food Consumption Is Associated with Greater High-Sensitivity C-Reactive Protein

Concentration in Adults: Cross-Sectional Results from the Melbourne Collaborative Cohort Study. *Nutrients, 14*(16), 3309. https://doi.org/10.3390/nu14163309

Machado, P. P., Claro, R. M., Canella, D. S., Sarti, F. M., & Levy, R. B. (2017). Price and convenience: The influence of supermarkets on consumption of ultra-processed foods and beverages in Brazil. *Appetite, 116*, 381–388. https://doi.org/10.1016/j.appet.2017.05.027

Malta, D. C., Oliveira-Campos, M., do Prado, R. R., Andrade, S. S., de Mello, F. C., Dias, A. J., et al. (2014). Psychoactive substance use, family context and mental health among Brazilian adolescents, National Adolescent School-based Health Survey (PeNSE 2012). *Revista Brasileira de Epidemiologia, 17*(Suppl 1), 46–61. https://doi.org/10.1590/1809-4503201400050005

Malta, D. C., Oliveira, M. M., Machado, I. E., Prado, R. R., Stopa, S. R., Crespo, C. D., et al. (2018). Characteristics associated to a poor self-rated health in Brazilian adolescents, National Adolescent School-based Health Survey, 2015. *Revista Brasileira de Epidemiologia, 21*(suppl 1), e180018. https://doi.org/10.1590/1980-549720180018.supl.1

Manzoni, G. M., Pagnini, F., Gorini, A., Preziosa, A., Castelnuovo, G., Molinari, E., et al. (2009). Can relaxation training reduce emotional eating in women with obesity? An exploratory study with 3 months of follow-up. *Journal of the American Dietetic Association, 109*(8), 1427–1432. https://doi.org/10.1016/J.JADA.2009.05.004

Martínez Steele, E., Popkin, B. M., Swinburn, B., & Monteiro, C. A. (2017). The share of ultra-processed foods and the overall nutritional quality of diets in the US: Evidence from a nationally representative cross-sectional study. *Population Health Metrics, 15*(1), 6. https://doi.org/10.1186/s12963-017-0119-3

Martini, D., Godos, J., Bonaccio, M., Vitaglione, P., & Grosso, G. (2021). Ultra-Processed Foods and Nutritional Dietary Profile: A Meta-Analysis of Nationally Representative Samples. *Nutrients, 13*(10), 3390. https://doi.org/10.3390/nu13103390

Martins, G. M. D. S., da França, A. K. T. C., de Viola, P. C. A. F., de Carvalho, C. A., Marques, K. D. S., Dos Santos, A. M., et al. (2022). Intake of ultra-processed foods is associated with inflammatory markers in Brazilian adolescents. *Public Health Nutrition, 25*(3), 591–599. https://doi.org/10.1017/S1368980021004523

Marx, W., Lane, M., Hockey, M., Aslam, H., Berk, M., Walder, K., et al. (2021). Diet and depression: Exploring the biological mechanisms of action. *Molecular Psychiatry, 26*(1), 134–150. https://doi.org/10.1038/s41380-020-00925-x

Mesas, A. E., González, A. D., de Andrade, S. M., Martínez-Vizcaíno, V., López-Gil, J. F., & Jiménez-López, E. (2022). Increased Consumption of Ultra-Processed Food Is Associated with Poor Mental Health in a Nationally Representative Sample of Adolescent Students in Brazil. *Nutrients, 14*(24), 5207. https://doi.org/10.3390/nu14245207

Mikkilä, V., Räsänen, L., Raitakari, O. T., Pietinen, P., & Viikari, J. (2005). Consistent dietary patterns identified from childhood to adulthood: The Cardiovascular Risk in Young Finns Study. *British Journal of Nutrition, 93*(6), 923–931. https://doi.org/10.1079/BJN20051418

Monteiro, C. A., Levy, R. B., Claro, R. M., de Castro, I. R. R., & Cannon, G. (2010). Increasing consumption of ultra-processed foods and likely impact on human health: Evidence from Brazil. *Public Health Nutrition, 14*(1), 5–13. https://doi.org/10.1017/S1368980010003241

Monteiro, C. A., Cannon, G., Moubarac, J.-C., Levy, R. B., Louzada, M. L. C., & Jaime, P. C. (2018a). The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutrition, 21*(1), 5–17. https://doi.org/10.1017/S1368980017000234

Monteiro, C. A., Moubarac, J.-C., Levy, R. B., Canella, D. S., da Louzada, M. L. C., & Cannon, G. (2018). Household availability of ultra-processed foods and obesity in nineteen European countries. *Public Health Nutrition, 21*(1), 18–26. https://doi.org/10.1017/S1368980017001379

Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J.-C., Louzada, M. L., Rauber, F., et al. (2019). Ultra-processed foods: What they are and how to identify them. *Public Health Nutrition, 22*(5), 936–941. https://doi.org/10.1017/S1368980018003762

Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., et al. (2013). Profits and pandemics: Prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. *Lancet (london, England), 381*(9867), 670–679. https://doi.org/10.1016/S0140-6736(12)62089-3

Morriss, R. K., Wearden, A. J., & Battersby, L. (1997). The relation of sleep difficulties to fatigue, mood and disability in chronic fatigue syndrome. *Journal of Psychosomatic Research, 42*(6), 597–605. https://doi.org/10.1016/S0022-3999(97)89895-9

Oliveira, M. M., Campos, M. O., Andreazzi, M. A. R., & Malta, D. C. (2017). Characteristics of the National Adolescent School-based Health Survey - PeNSE. *Brazil. Epidemiologia e Serviços De Saúde, 26*(3), 605–616. https://doi.org/10.5123/s1679-49742017000300017

Onita, B. M., Azeredo, C. M., Jaime, P. C., Levy, R. B., & Rauber, F. (2021). Eating context and its association with ultra-processed food consumption by British children. *Appetite, 157*, 105007. https://doi.org/10.1016/j.appet.2020.105007

Parnarouskis, L., & Gearhardt, A. N. (2022). Preliminary Evidence that Tolerance and Withdrawal Occur in Response to Ultra-processed Foods. *Current Addiction Reports*. https://doi.org/10.1007/s40429-022-00425-8

Patel, V., Chisholm, D., Parikh, R., Charlson, F. J., Degenhardt, L., Dua, T., et al. (2016). Addressing the burden of mental, neurological, and substance use disorders Key messages from Disease Control Priorities, 3rd edition. *The Lancet*, *387* (10028), 1672–1685 https://doi.org/10.1016/S0140-6736(15)00390-6

Pengpid, S., & Peltzer, K. (2019). High Carbonated Soft Drink Intake is Associated with Health Risk Behavior and Poor Mental Health among School-Going Adolescents in Six Southeast Asian Countries. *International Journal of Environmental Research and Public Health*, *17*(1). https://doi.org/10.3390/ijerph17010132

Perszyk, E. E., Hutelin, Z., Trinh, J., Kanyamibwa, A., Fromm, S., Davis, X. S., et al. (2021). Fat and Carbohydrate Interact to Potentiate Food Reward in Healthy Weight but Not in Overweight or Obesity. *Nutrients, 13*(4), 1203. https://doi.org/10.3390/nu13041203

Popkin, B. M., Barquera, S., Corvalan, C., Hofman, K. J., Monteiro, C., Ng, S. W., et al. (2021). Towards unified and impactful policies to reduce ultra-processed food consumption and promote healthier eating. *The Lancet. Diabetes & Endocrinology, 9*(7), 462–470. https://doi.org/10.1016/S2213-8587(21)00078-4

Potvin Kent, M., Pauzé, E., Roy, E. A., de Billy, N., & Czoli, C. (2019). Children and adolescents' exposure to food and beverage marketing in social media apps. *Pediatric Obesity, 14*(6), e12508. https://doi.org/10.1111/ijpo.12508

Powers, R. J., & Kutash, I. L. (1985). Stress and alcohol. *The International Journal of the Addictions, 20*(3), 461–482. https://doi.org/10.3109/10826088509044926

Ricardo, C. Z., Azeredo, C. M., Machado de Rezende, L. F., & Levy, R. B. (2019). Co-occurrence and clustering of the four major non-communicable disease risk factors in Brazilian adolescents: Analysis of a national school-based survey. *PLoS One, 14*(7), e0219370. https://doi.org/10.1371/journal.pone.0219370

Rico-Campà, A., Martínez-González, M. A., Alvarez-Alvarez, I., de Mendonça, R. D., de la Fuente-Arrillaga, C., Gómez-Donoso, C., et al. (2019). Association between consumption of ultra-processed foods and all cause mortality: SUN prospective cohort study. *BMJ, 365*, 1949. https://doi.org/10.1136/bmj.l1949

Rocha, L. L., Gratão, L. H. A., do Carmo, A. S., Costa, A. B. P., de Cunha, C. F., de Oliveira, T. R. P. R., et al. (2021). School Type, Eating Habits, and Screen Time are Associated With Ultra-Processed Food Consumption Among Brazilian Adolescents. *Journal of the Academy of Nutrition and Dietetics, 121*(6), 1136–1142. https://doi.org/10.1016/j.jand.2020.12.010

Rocha, L. L., Pessoa, M. C., Gratão, L. H. A., de Carmo, A. S., Cunha, C. F., de Oliveira, T. R. P. R., et al. (2021). Health behavior patterns of sugar-sweetened beverage consumption among Brazilian adolescents in a nationally representative school-based study. *PloS One, 16*(1), e0245203. https://doi.org/10.1371/journal.pone.0245203

Rose, A. K., Hardman, C. A., & Christiansen, P. (2015). The effects of a priming dose of alcohol and drinking environment on snack food intake. *Appetite, 95*, 341–348. https://doi.org/10.1016/j.appet.2015.07.016

Schulte, E. M., Avena, N. M., & Gearhardt, A. N. (2015). Which Foods May Be Addictive? The Roles of Processing, Fat Content, and Glycemic Load. *PloS One, 10*(2), e0117959. https://doi.org/10.1371/journal.pone.0117959

Shih, Y. H., Chang, H. Y., Wu, H. C., Stanaway, F. F., & Pan, W. H. (2020). High sugar-sweetened beverage intake frequency is associated with smoking, irregular meal intake and higher serum uric acid in Taiwanese adolescents. *Journal of Nutritional Science, 9*, e7. https://doi.org/10.1017/jns.2020.2

Silva, J. B., Elias, B. C., Warkentin, S., Mais, L. A., & Konstantyner, T. (2021a). Factors associated with the consumption of ultra-processed food by Brazilian adolescents: National Survey of School Health, 2015. *Revista Paulista de Pediatria, 40*, e2020362. https://doi.org/10.1590/1984-0462/2022/40/2020362

Silva, R. M. A., Andrade, A. C. S., Caiaffa, W. T., & Bezerra, V. M. (2021b). Co-occurrence of health risk behaviors and the family context among Brazilian adolescents, National Survey of School Health (2015). *Revista Brasileira de Epidemiologia, 24*, e210023. https://doi.org/10.1590/1980-549720210023

Sinai, T., Axelrod, R., Shimony, T., Boaz, M., & Kaufman-Shriqui, V. (2021). Dietary Patterns among Adolescents Are Associated with Growth, Socioeconomic Features, and Health-Related Behaviors. *Foods, 10*(12), 3054. https://doi.org/10.3390/foods10123054

Sinha, R. (2008). Chronic stress, drug use, and vulnerability to addiction. *Annals of the New York Academy of Sciences, 1141*, 105–130. https://doi.org/10.1196/ANNALS.1441.030

Spear, L. P., & Swartzwelder, H. S. (2014). Adolescent alcohol exposure and persistence of adolescent-typical phenotypes into adulthood: A mini-review. *Neuroscience & Biobehavioral Reviews, 45*, 1–8. https://doi.org/10.1016/j.neubiorev.2014.04.012

Tariq, S., Tariq, S., & Tariq, S. (2019). Association of perceived stress with healthy and unhealthy food consumption among teenagers. *JPMA The Journal of the Pakistan Medical Association, 69*(12), 1817–1821. https://doi.org/10.5455/JPMA.302642278

Tavares, L. F., Castro, I. R., Levy, R. B., Cardoso Lde, O., & Claro, R. M. (2014). Dietary patterns of Brazilian adolescents: Results of the Brazilian National School-Based Health Survey (PeNSE). *Cadernos De Saude Publica, 30*(12), 2679–2690. https://doi.org/10.1590/0102-311x00016814

Temple, J. L. (2016). Behavioral sensitization of the reinforcing value of food: What food and drugs have in common. *Preventive Medicine, 92*, 90–99. https://doi.org/10.1016/j.ypmed.2016.06.022

Terry-McElrath, Y. M., O'Malley, P. M., & Johnston, L. D. (2014). Energy drinks, soft drinks, and substance use among United States secondary school students. *Journal of Addiction Medicine, 8*(1), 6–13. https://doi.org/10.1097/01.Adm.0000435322.07020.53

Torres-Schiaffino, D., & Saavedra-Garcia, L. (2020). Relationship between Marketing to Children on Food Labeling and Critical Nutrient Content in Processed and Ultra-Processed Products Sold in Supermarkets in Lima, Peru. *Nutrients*, *12*(12). https://doi.org/10.3390/nu12123666

Volkow, N. D., Wang, G. J., Fowler, J. S., Tomasi, D., & Baler, R. (2012). Food and Drug Reward: Overlapping Circuits in Human Obesity and Addiction BT - Brain Imaging in Behavioral Neuroscience. In C. S. Carter & J. W. Dalley (Eds.), (pp. 1–24). Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/7854_2011_169

Wang, M., Wang, H., Fei, F.-R., Xu, C.-X., Du, X.-F., & Zhong, J.-M. (2017). The associations between cigarette smoking and health-related behaviors among Chinese school-aged adolescents. *Tobacco Induced Diseases, 15*, 27. https://doi.org/10.1186/s12971-017-0132-0

Wang, L., Martínez Steele, E., Du, M., Pomeranz, J. L., O'Connor, L. E., Herrick, K. A., et al. (2021). Trends in Consumption of Ultraprocessed Foods Among US Youths Aged 2–19 Years, 1999–2018. *JAMA, 326*(6), 519–530. https://doi.org/10.1001/jama.2021.10238

Werneck, A. O., Costa, C. S., Horta, B., Wehrmeister, F. C., Gonçalves, H., Menezes, A. M. B., et al. (2022). Prospective association between ultra-processed food consumption and incidence of elevated symptoms of common mental disorders. *Journal of Affective Disorders, 312*, 78–85. https://doi.org/10.1016/j.jad.2022.06.007

Whatnall, M., Clarke, E., Collins, C. E., Pursey, K., & Burrows, T. (2022). Ultra-processed food intakes associated with "food addiction" in young adults. *Appetite, 178*, 106260. https://doi.org/10.1016/j.appet.2022.106260

Whitaker, V., Oldham, M., Boyd, J., Fairbrother, H., Curtis, P., Meier, P., et al. (2021). Clustering of health-related behaviours within children aged 11–16: A systematic review. *BMC Public Health, 21*(1), 137. https://doi.org/10.1186/s12889-020-10140-6

Windle, M., Gray, J. C., Lei, K. M., Barton, A. W., Brody, G., Beach, S. R. H., et al. (2018). Age sensitive associations of adolescent substance use with amygdalar, ventral striatum, and frontal volumes in young adulthood. *Drug and Alcohol Dependence, 186*, 94–101. https://doi.org/10.1016/j.drugalcdep.2018.02.007

Witek, K., Wydra, K., & Filip, M. (2022). A High-Sugar Diet Consumption, Metabolism and Health Impacts with a Focus on the Development of Substance Use Disorder: A Narrative Review. *Nutrients, 14*(14), 2940. https://doi.org/10.3390/nu14142940

Wray-Lake, L., Crouter, A. C., & McHale, S. M. (2010). Developmental patterns in decision-making autonomy across middle childhood and adolescence: European American parents' perspectives. *Child Development, 81*(2), 636–651. https://doi.org/10.1111/j.1467-8624.2009.01420.x

Yekaninejad, M. S., Badrooj, N., Vosoughi, F., Lin, C.-Y., Potenza, M. N., & Pakpour, A. H. (2021). Prevalence of food addiction in children and adolescents: A systematic review and meta-analysis. *Obesity Reviews, 22*(6), e13183. https://doi.org/10.1111/obr.13183

Zawertailo, L., Attwells, S., deRuiter, W. K., Le, T. L., Dawson, D., & Selby, P. (2020). Food Addiction and Tobacco Use Disorder: Common Liability and Shared Mechanisms. *Nutrients, 12*(12), 3834. https://doi.org/10.3390/nu12123834

Zellner, D. A., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D., et al. (2006). Food selection changes under stress. *Physiology and Behavior, 87*(4), 789–793. https://doi.org/10.1016/J.PHYSBEH.2006.01.014

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