



Is Violence Victimization Associated with the Consumption of Ultra-Processed Food? A Population-Based Study with 96 K Adolescent Students Exploring the Mediating Role of Psychoactive Substance Use

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Abstract

This study analyzed the association between different types of violence victimization and ultra-processed food (UPF) consumption and explored the mediating role of alcohol, tobacco, and illicit drug use on these associations. Cross-sectional study with Brazilian students aged 13–17. Participants reported their UPF consumption, bullying and physical aggression victimization, and use of alcohol, tobacco, and illicit drugs in the last month. Generalized linear regression models and mediation analyses were adjusted for the main confounders. A total of 96,396 adolescent students (52.2% female) were analyzed. In adjusted analyses, the number of UPF consumed was higher in those experiencing bullying victimization ($\beta=0.18$; 95% confidence interval, CI: 0.09, 0.27), aggression from parents or guardians ($\beta=0.27$; 95% CI: 0.16, 0.38) and aggression from others ($\beta=0.31$; 95% CI: 0.13, 0.49). The adjusted mediation models showed that these associations were partially mediated by alcohol, tobacco and illicit drug use. Among adolescents, exposure to violence victimization might potentially drive a rise in the consumption of UPF. Such associations are partially influenced by an increased use of psychoactive substances.

Keywords Violence · Bullying · Diet · Eating behavior · NOVA · Ultra-processed food · Youth

Adolescence is a period of increased susceptibility to engaging in unsafe behavior, and consequently, there is a greater vulnerability to violence victimization (Bozzini et al., 2021). This increased risk-taking behavior can be attributed, among other factors, to the slow maturation of the cognitive-control system, which results in challenges in controlling impulses and considering long-term consequences (Steinberg, 2007). In addition, it can be influenced by changes in body structure and self-image perception, as well as difficulties resulting from the urge to belong to a certain social group and to develop the adolescent's own affective relationships (Bozzini et al., 2021; Pasch et al., 2011). Furthermore, although violence victimization is generally associated with social and economic

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deprivation, violence against adolescents is more frequent but is not exclusive to lower economic classes (Cerna-Turoff et al., 2021; McAra & McVie, 2016).

Violence victimization can impact adolescent physical and mental health, depending on the type, intensity, frequency, and context of the aggression (Semenza et al., 2021). The health outcomes vary from low self-esteem and transient mood disturbances to persistent and harmful conditions such as major depressive disorder and eating behavior disorders, as well as self-harm and suicidal ideation (Renner et al., 2020; Smith et al., 2020; Witte et al., 2015). Additionally, victims of violence are also more susceptible to adopt unhealthy behaviors such as the use of alcohol, tobacco, and illicit drugs, which, in turn, have negative effects on mental health and increase exposure to conflictive situations (Horta et al., 2018; Kaukinen, 2002), creating a potentially destructive vicious cycle for the adolescent.

In addition to the use of psychoactive substances, violence victimization has been preliminarily associated with inadequate nutritional status (Marques et al., 2022) and a deterioration in diet quality, including a reduction in the consumption of healthy foods such as fruits and other vegetables and an increase in the consumption of unhealthy foods, such as ultra-processed foods (UPF) (e.g., sweets, chocolates, soft drinks, chips, cookies, and processed meat) (Albaladejo-Blázquez et al., 2018; Marques et al., 2021). According to the NOVA classification, UPFs are obtained through formulations manufactured from substances derived from foods or synthesized from other organic sources (Monteiro et al., 2018). Ultra-processed foods and beverages are characterized by their affordability, a strong taste appeal, a high energy density, and elevated levels of added sugars, saturated fats, sodium, and various chemical additives; in contrast, they lack sufficient dietary fiber, protein, vitamins, and minerals (Monteiro et al., 2019). As a result, high consumption of UPFs is known to have numerous harmful consequences for adolescents, such as excessive body weight (Louzada et al., 2015), poorer mental health (Mesas et al., 2022; Werneck et al., 2022), and increased consumption of alcohol, tobacco, and illicit drugs (Mesas et al., 2023). The consumption of UPFs has substantially increased in recent years, especially among the younger population (Wang et al., 2021).

While the relationship between violence exposure and certain health behaviors, such as substance abuse, has gained more attention, the specific investigation into the effects of violence victimization on UPF consumption is relatively novel and inconclusive. For instance, in a study with Brazilian adolescent students, the authors found a lower consumption of in natura food and a higher consumption of UPF among adolescent victims when compared with nonvictims of family physical violence (Marques et al., 2021). Their analyses were adjusted for demographic, socioeconomic and family context variables, but no consideration was made of the potential confounding or moderating effect of alcohol and other psychoactive substances consumed (Marques et al., 2021). Another study with Spanish adolescents evaluated the association between bullying and dietary habits, concluding that being bullied was negatively correlated with healthy dietary habits. The authors revealed that dietary habits act as moderators of the association between bullying and depression, although their analyses did not account for potential confounders (Albaladejo-Blázquez et al., 2018).

Since both violence victimization and UPF consumption have negative impacts on physical and mental health in adolescence, further understanding the relationship between these conditions is crucial to identify potential vulnerable population subgroups and design strategies for addressing them. Thus, the objective of this study was to examine the association between different types of violence victimization (bullying, physical aggression from parents or guardians and from others) and UPF consumption in a large population-based

sample of adolescents. Additionally, the study investigated the potential mediating role of alcohol, tobacco, and illicit drug use on these associations.

Methods

Study Design

The data utilized in this cross-sectional study originate from the fourth edition of the National School-Based Health Survey (PeNSE) conducted in 2019 in Brazil. PeNSE is an initiative supported by the Ministry of Education (MEC) included in the Brazilian Surveillance of Risky and Protective Factors for Chronic Diseases. The first edition of PeNSE was carried out in 2009 through a collaboration between the Ministry of Health and the Brazilian Institute of Geography and Statistics (IBGE). All data are anonymized and publicly accessible. PeNSE 2019 adopted a comprehensive sample design covering the entire national territory, including students aged 13 to 17 years from both public and private schools in urban and rural areas across the country. The data collection occurred within the schools, where students directly responded to an electronic questionnaire made available on a personal digital assistant device without the presence of a researcher. Further specific details regarding the sample design can be found in official sources (Instituto Brasileiro de Geografia y Estatística, 2021).

Study Variables

Considering that both the relationship between violence victimization and the consumption of ultra-processed foods, as well as the mediation through psychoactive substances, are complex and, in some cases, bidirectional, the initial framework was described in a theoretical causal diagram built based on previous knowledge available in the scientific literature (Supplemental material, Fig. S1). We used the online tool DAGitty (Textor et al., 2016) to construct a directed acyclic graph (DAG) (Tennant et al., 2021). In addition to providing transparency to the process of selecting relevant main variables and covariables for this study, this method allows the identification of the minimum sufficient adjustment set, which includes all the covariables described above.

Dependent Variable Ultra-processed food consumption: To identify foods as ultra-processed, the NOVA classification system was used (Monteiro et al., 2018). In the PeNSE 2019, adolescents were administered a questionnaire that inquired about the types of food they had consumed in the past 24 h. From the responses, the following 13 food items were identified as UPF: soft drink, industrialized fruit juice, powdered soft drink, chocolate drink, flavored yogurt, salty snacks (e.g., packaged chips or crackers), sweet snacks (e.g., sweet cookie, cream cookie, or packet cake), industrialized desserts (e.g., chocolate, ice cream, gelatin, flan), processed 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). The number of UPFs consumed in the previous 24 h ranged from 0 to 13 and was considered the dependent variable in the present analyses. For descriptive purposes, the number of UPFs consumed was divided according to the distribution in the sample by quartiles, generating the following categories: 1st quartile (0 to

2 UPFs), 2nd quartile (3 or 4 UPFs), 3rd quartile (5 or 6 UPFs) and 4th quartile (7 to 13 UPFs).

Independent Variable Violence victimization: The questions about violence were distributed in different sections of the PeNSE 2019. Bullying victimization was located in the section "Situations at home and at school" and asked, "In the last 30 days, how many times have any of your schoolmates teased, mocked, taunted, intimidated, or made fun of you to the point that you felt hurt, bothered, upset, offended, or humiliated?". The response options were "none in the last 30 days", "once", or "2 or more times". Additionally, in the section "Safety", two other questions inquired about the following violent experiences: "In the last 12 months, how many times were you physically assaulted by your mother, father, or guardian?" and "In the last 12 months, how many times were you physically assaulted by someone other than your mother, father, or guardian?". The response options for both questions were "none in the last 12 months", "once", "2 to 5 times", and "6 or more times". For the present analysis, the last two response options were combined to ensure an adequate sample size and simplify result interpretation.

Mediators Use of psychoactive substances: Adolescents reported their use of three psychoactive substances, namely, alcohol, tobacco, and illicit drugs, in response to two questions for each substance. Regarding alcohol consumption, the first question asked, "Have you ever had a glass or a drink of alcohol in your life?". If 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 of alcoholic beverage?". The response options included "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". Based on the responses to both questions, the adolescents were classified into the following three categories: "never (has drunk)", "previously consumed, but not in the last month", and "consumed in the last month". Similarly, data on tobacco smoking and illicit drug use were collected through two sequential questions. For tobacco smoking, the adolescents 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?". Concerning 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?". Using the same method described for classifying adolescents according to alcoholic beverage consumption, the responses to tobacco smoking and illicit drug use questions also generated three categories, i.e., "never consumed", "previously consumed, but not in the last month", and "consumed in the last month".

Covariates Information on the following covariates was considered: sex (male, female); age (16 to 17 vs. 13 to 15 years); daily consumption of fruits (yes vs. no); daily consumption of other vegetables (yes vs. no); number of close friends (none, 1 or 2, 3 or more); sedentary behavior (0 to 2, > 2 to 5, > 5 h/day); and total physical activity (≤ 1 , > 1 to 6, > 6 h/week). 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. 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. Adolescents were also asked to report the following mental health symptoms that occurred

in the last 30 days: a) "How often have you felt very concerned about the ordinary things in your daily life such as school activities, sports competitions, homework, etc.?", b) "How often have you felt irritated, nervous or bad-tempered by anything?", c) "How often have you felt that no one cares about you?", d) "How often have you felt sad?", and e) "How often have you felt that life is not worth living?".

Statistical Analysis

First, the absolute (n) and relative frequency (%) of the categorical variables were calculated for the total number of participants. Then, generalized linear models were used to analyze the association between the number of UPFs consumed (dependent variable, continuous, ranging from 0 to 13 UPFs) and the three types of violence victimization (independent variables recoded in three categories ["none", "once", "two or more times"]: bullying victimization; physical aggression from parents and from others). Initially, unadjusted models were used to estimate the β -coefficient and the related 95% confidence interval (CI) for experiencing victimization "once" and "two or more times" compared to not experiencing it (reference category) during the time frame considered for each type of violence (Model 1). Next, the other three models were progressively adjusted as follows: Model 2: adjusted for sex, age group, socioeconomic status, number of close friends, daily fruit consumption, daily consumption of other vegetables, sedentary behavior and total physical activity; Model 3: model 2 adjusted for alcohol consumption, tobacco smoking, and illicit drug use; and Model 4: model 3 adjusted for the number of mental health symptoms.

To explore the potential mediating effect of psychoactive substance use on the relationship between violence victimization and UPF consumption, simple mediation models were employed. Nine models, three for each type of violence, were constructed. For instance, in the association between bullying and UPF consumption, separate analyses were conducted to examine mediation through alcohol, tobacco, and illicit drugs. Next, all three possible mediators were examined in the associations between physical aggression by parents and by others and the number of UPF consumed.

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

Results

Study Population

From the total initial population of 119,670 participants aged 13 to 17 years, we excluded those without complete information for socioeconomic condition ($n=19,257$), violence victimization ($n=929$), UPF consumption ($n=540$), alcohol, tobacco or illicit drug use ($n=170$) and others without information for any of the covariates included in the analyses ($n=2,378$) (Fig. 1). Thus, the final sample of the present analyses comprised 96,396 adolescents. Considering the proportion of excluded individuals (19.4%), the characteristics of the total original sample were compared with those of the analyzed sample (Supplementary material, Table S1). In general, no relevant differences were observed between the original and analyzed samples.

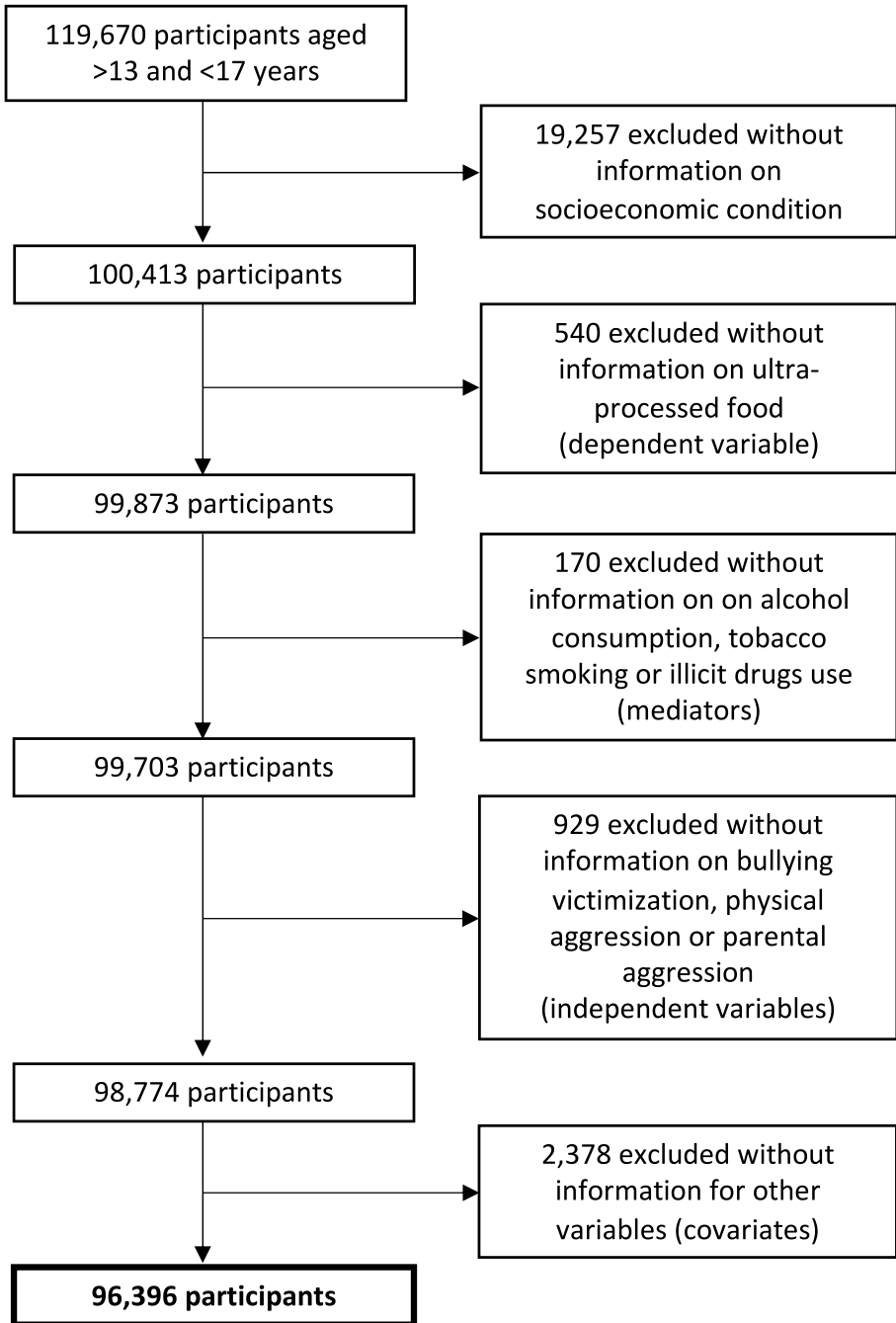


Fig. 1 Flow diagram for study participants

Table 1 Characteristics of Brazilian adolescent students

Characteristic	<i>n</i>	%
Total	96,396	100.0
Sex		
Male	46,158	47.8
Female	50,238	52.2
Age (years)		
13 to 15	62,044	66.5
16 to 17	34,352	33.5
Socioeconomic status (quartiles)		
1st	16,385	27.5
2nd	14,905	22.5
3rd	21,757	25.1
4th	43,349	24.9
Number of close friends		
None	3,042	3.8
1 or 2	5,232	5.9
3 or more	88,122	90.3
Daily consumption of fruits		
No	79,983	82.7
Yes	16,413	17.3
Daily consumption of other vegetables		
No	75,961	80.3
Yes	20,435	19.7
Sedentary behavior (hours/day)		
0 to 2	26,203	31.4
> 2 to 5	39,432	36.7
> 5	30,761	31.9
Total physical activity (hours/week)		
≤ 1	25,110	24.8
> 1 to 6	50,828	53.4
> 6	20,458	21.8
Alcohol consumption		
Never	34,934	36.7
Previously consumed, but not in the last month	35,460	35.7
Consumed in the last month	26,002	27.6
Tobacco smoking		
Never	77,084	77.9
Previously consumed, but not in the last month	13,977	15.6
Consumed in the last month	5,335	6.5
Illicit drugs use		
Never	84,838	87.5
Previously consumed, but not in the last month	7,150	7.7
Consumed in the last month	4,408	4.8
Bullying victimization in the last month		
None	58,221	60.2

Table 1 (continued)

Characteristic	<i>n</i>	%
Once	15,963	16.5
2 or more times	22,212	23.3
Physical aggression from parents or guardians in the last year		
None	74,887	77.6
Once	10,924	11.4
2 or more times	10,585	11.0
Physical aggression from others than parents or guardians the last year		
None	82,501	86.4
Once	7,914	8.3
2 or more times	5,981	5.3
Number of mental health symptoms (almost always/always)		
None	20,837	24.8
1 or 2	46,547	45.7
3 or more	29,012	29.5
Number of ultra-processed food consumed in the past 24 h		
0 to 2	20,377	19.8
3 or 4	34,250	34.1
5 or 6	27,494	29.7
7 and more	14,275	16.4

The characteristics of the studied population are depicted in Table 1. In summary, half (52.2%) were female, and most (90.3%) had three or more close friends. Most did not consume fruits (82.7%) or other vegetables (80.3%) on a daily basis. Almost one-third (31.9%) reported sedentary behavior for more than 5 h daily, and 21.8% engaged in physical activity for more than 6 h weekly. Regarding psychoactive substance use, more than half had either tried alcohol in their lifetime but did not consume it in the last month (35.7%) or had consumed it in the last month (27.6%) (Table 1). The reported use of tobacco in the last month was 6.5%, while 4.8% acknowledged using illicit drugs. The experience of violence victimization was mentioned by 39.8% for bullying, 22.4% for physical aggression from parents or guardians, and 13.6% for physical aggression from others than parents or guardians. Additionally, three-quarters of the adolescents (75.2%) reported at least one frequent mental health symptom. Last, the consumption of none to two UPFs was reported by 19.8%, 8%, while 16.4% reported having consumed seven or more UPFs in the last 24 h.

Associations Between Violence Victimization and UPF Consumption

As observed in Table 2, it was found that for all three types of violence, adolescents who reported experiencing victimization one or more times were more likely to report a higher number of UPFs consumed. These associations remained statistically significant when adjusted for sociodemographic, lifestyle, and mental health variables (Table 2). Specifically, in the complete adjusted models (Model 4), the number of UPF consumed was higher in those experiencing persistent (two or more times) bullying victimization ($\beta=0.18$; 95%

Table 2 Association between bullying victimization, physical aggression from parents and from others and the number of ultra-processed foods consumed in adolescent students

Exposure	Number of UPF consumed			
	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)
Bullying victimization				
None	Ref	Ref	Ref	Ref
Once	0.28 (0.19; 0.38)	0.28 (0.18; 0.37)	0.24 (0.15; 0.34)	0.25 (0.15; 0.34)
2 or more times	0.27 (0.18; 0.36)	0.23 (0.14; 0.32)	0.17 (0.08; 0.26)	0.18 (0.09; 0.27)
Aggression from parents				
None	Ref	Ref	Ref	Ref
Once	0.47 (0.36; 0.58)	0.42 (0.31; 0.53)	0.33 (0.22; 0.44)	0.33 (0.22; 0.44)
2 or more times	0.46 (0.35; 0.57)	0.38 (0.27; 0.49)	0.26 (0.15; 0.37)	0.27 (0.16; 0.38)
Aggression from others than parents or guardians				
None	Ref	Ref	Ref	Ref
Once	0.38 (0.23; 0.53)	0.35 (0.20; 0.50)	0.25 (0.10; 0.39)	0.24 (0.09; 0.38)
2 or more times	0.53 (0.36; 0.71)	0.43 (0.26; 0.60)	0.34 (0.16; 0.51)	0.31 (0.13; 0.49)

UPF: ultra-processed foods including soft drinks, industrialized fruit juice, powdered soft drinks, chocolate drinks, flavored yogurt, salty snacks, sweet snacks, industrialized desserts, meat products, industrialized bread, margarine, industrialized sauces, and industrialized ready meals

Model 1: Values indicate beta (β) coefficients (95% confidence interval) obtained through an unadjusted generalized linear model of the number of ultra-processed foods consumed in the last 24 h according to the frequency of each type of violence

Model 2: Model 1 adjusted for the following covariates: sex (male, female), age group (13 to 15, 16 to 17 years), socioeconomic status (categorical, in quartiles), number of close friends (none, 1 or 2, 3 or more), daily fruit consumption (no, yes), daily consumption of other vegetables (no, yes), sedentary behavior (0 to 2, > 2 to 5, > 5 h/day) and total physical activity (≤ 1 , > 1 to 6, > 6 h/week)

Model 3: Model 2 adjusted for the following covariates: alcohol consumption (never, previously consumed but not in the last month, consumed in the last month), tobacco smoking (never, previously consumed but not in the last month, consumed in the last month) and illicit drug use (never, previously consumed but not in the last month, consumed in the last month)

Model 4: Model 3 adjusted for the following covariate: number of frequent mental health symptoms (none, 1 or 2, 3 or more)

All results in the table were statistically significant ($p < 0.05$)

confidence interval, CI: 0.09, 0.27), aggression from parents ($\beta = 0.27$; 95% CI: 0.16, 0.38) and aggression from others ($\beta = 0.31$; 95% CI: 0.13, 0.49).

Mediation Analyses

In all the conducted mediation analyses, whose results are presented in Fig. 2, statistically significant direct and indirect effects were found. This consistently indicates that the increase in UPF consumption in violence-victimized adolescents could be partially attributed to mediation through the use of psychoactive substances. The highest indirect effects on UPF consumption were observed when evaluating the mediating role of alcohol consumption. Specifically, alcohol consumption could be attributed to a partial mediation (i.e., the proportion of the total association attributed to the indirect effect) of 11.7% in

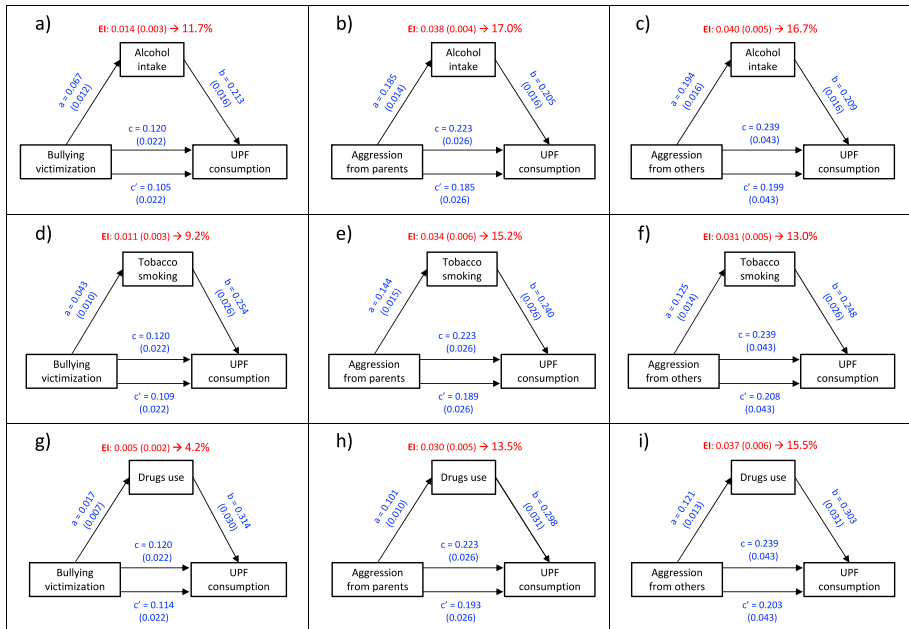


Fig. 2 Mediating role of alcohol consumption, tobacco smoking and illicit drug use on the associations between bullying victimization, physical aggression from parents and from others and the number of ultra-processed foods consumed by adolescent students. Values indicate beta (β) coefficients (95% confidence interval) obtained through generalized structural equation models for simple mediation analyses of the mediating role of psychoactive substance (alcohol, tobacco and illicit drug) use on the associations between different types of violence victimization (bullying, aggression from parents and aggression from others) and the number of ultra-processed foods consumed in the last 24 h. All models were adjusted for sex (male, female), age group (13 to 15, 16 to 17 years), socioeconomic status (categorical, in quartiles), number of close friends (none, 1 or 2, 3 or more), daily fruit consumption (no, yes), daily consumption of other vegetables (no, yes), sedentary behavior (0 to 2, > 2 to 5, > 5 h/day), total physical activity (≤ 1 , > 1 to 6, > 6 h/week), and the number of frequent mental health symptoms (none, 1 or 2, 3 or more). The letters in blue indicate a: path from the independent variable to the mediator, b: path from the mediator to the dependent variable; c: total effect; c': direct effect; EI: indirect effect (a*b); UPF: ultra-processed food. All results in the figure were statistically significant ($p < 0.05$)

the case of bullying victimization, 17.0% when the exposure was physical aggression from parents, and 16.7% for physical aggression from others than parents or guardians. Taking into account the type of violence, it was observed that bullying had the lowest direct and indirect effects (i.e., via psychoactive substances) on UPF consumption, while higher direct and total effects were observed for physical aggression perpetrated by others than parents or guardians (Fig. 2).

Discussion

The present findings reveal that adolescents who experience psychological or physical violence, whether at school, at home, or outside these spaces, are more susceptible to consuming more UPF. Additionally, the study provides evidence that alcohol, tobacco, and illicit drug use play a significant mediating role in these relationships. These associations were

observed regardless of confounding variables strongly associated with the aforementioned independent, dependent and mediating variables, such as sex, age, socioeconomic status, number of close friends, consumption of healthy foods such as fruits and other vegetables, sedentary behavior, physical activity, and the presence of mental health symptoms. In summary, our results suggest that the experience of violence may contribute to a pattern of behavior involving increased consumption of UPF, potentially influenced by the use of alcohol and other addictive substances. This interpretation is framed within the broader context of addiction, a chronic and recurrent disorder involving compulsive engagement in rewarding stimuli despite adverse consequences (Volkow et al., 2019).

After evaluating data from the 2015 edition of the PeNSE, a previous study found partially similar findings to ours (Marques et al., 2021). The authors highlighted the relationship between parental violence experienced by adolescents and poorer diet quality, characterized by low consumption of fruits and other vegetables and high consumption of UPF (Marques et al., 2021). While the strength of the association remained stable when comparing their results with ours, it is remarkable that the prevalence of parental violence victimization increased from 15.3% in 2015 to 22.4% in 2019. This finding underscores the importance of targeted interventions aimed at preventing domestic violence among Brazilian adolescents. Such efforts, as well as others, focused on other types of violence, demand a comprehensive approach planned and implemented by educational, health, and public safety professionals, along with parent associations and student representatives. Our study reinforces the need for these measures, highlighting the use of psychoactive substances and UPF as potential negative consequences of violence experienced by adolescents.

The indirect effect observed in the mediation analyses of our study cannot be compared with the available evidence thus far. However, the individual paths that constitute our mediation models can be discussed separately. First, the association between psychoactive substance consumption and violence (path “a”) has also been consistently reported in adolescents from different countries (Bye & Rossow, 2010; DuRant et al., 2000; Kobulsky et al., 2016; Madruga et al., 2012; Tharp-Taylor et al., 2009). For instance, in students aged 14 to 19 years included in the Brazilian National Alcohol Survey, smokers and those using illegal substances were more likely to report domestic violence (Madruga et al., 2012). Additionally, in a study with students aged 11 to 14 years from southern California, USA, youths who experienced mental or physical bullying separately or in combination were more likely to report the use of alcohol, cigarettes, marijuana and inhalants; their analyses adjusted for school attended, grade level, sex, and race/ethnicity (Tharp-Taylor et al., 2009). Apart from confirming these findings, our study extends the knowledge by showing that these associations are independent of lifestyle and mental health, in addition to the sociodemographic characteristics considered as adjustment variables in the aforementioned studies (Madruga et al., 2012; Tharp-Taylor et al., 2009).

Second, the cross-sectional relationship between the use of psychoactive substances and UPF consumption (path “b”) has also been reported in recent studies. In one of them, we analyzed the association in the opposite direction, i.e., UPF consumption as the exposure and substance use as the outcome, using data from PeNSE 2019 (Mesas et al., 2023). In addition to being associated with higher UPF consumption, we found that the frequency of alcohol, tobacco, and drug use increased as the frequency of consuming two specific UPFs, i.e., soft drinks and sweets, increased (Mesas et al., 2023). Similar findings considering the association between soft drinks and alcoholic beverages were reported for adolescents in Ghana (Atorkey et al., 2021), the United States (Terry-McElrath et al., 2014), and six Southeast Asian countries (Pengpid & Peltzer, 2019). Another study with Chinese adolescents found that cigarette smoking was associated with soft drinks and fast

food consumption (Wang et al., 2017). It is noteworthy that the direction of the association analyzed in previous studies (UPF – substance use) is opposite to the one investigated in the present study (substance use – UPF); however, all studies had a cross-sectional design and, therefore, do not support drawing conclusions about a causal relationship in either direction. Thus, prospective studies are needed to investigate whether the consumption of UPF and psychoactive substances is unidirectional and, if so, to determine the predominant direction or whether it involves a bidirectional relationship.

Among the possible mechanisms underlying the increase in UPF consumption in adolescents who are victims of violence, mediation through psychoactive substance use was the focus of our study. After experiencing psychological or physical violence, adolescents might turn to alcohol, tobacco or drugs to cope with stress and psychological and physical suffering by avoiding or numbing their feelings and memories related to violence (Begle et al., 2011; Brady et al., 2009; Ramos-Lira et al., 2006). Moreover, it is known that some victims of violence, such as bullying, might carry a sense of shame and guilt regarding their experience (Menesini & Camodeca, 2008). As a result, substance abuse might serve as a method of self-punishment regarding a violent experience while simultaneously providing a means of externalizing internal emotional distress (Asgeirsdottir et al., 2011; Beharie et al., 2019). In all cases, when initiating or increasing the consumption of these substances, it is reasonable to expect that the consumption of UPF would also rise. The evidence linking these consumptions is grounded in the fact that both psychoactive substances and UPF activate brain reward mechanisms and, as a result, share addictive potential (Schulte et al., 2015; Volkow et al., 2012). This additive nature of UPFs is supported by the fact that they meet the three scientific criteria used by the US Surgeon General in 1988 to identify tobacco products as addictive: cause highly controlled or compulsive use, have psychoactive effects via their action on the brain and are highly reinforcing (Gearhardt & DiFeliceantonio, 2023). Furthermore, considering the increase in addictive behaviors, including the use of psychoactive substances and the consumption of UPF, as part of the harmful consequences of experiencing violence extends beyond the individual level and encompasses social and public health concerns. Although evidence regarding the detrimental effects of UPF continues to accumulate (Monteiro et al., 2018), there are no regulatory rules for their sale and consumption, and young people are among the most frequent consumers of these products (Wang et al., 2021). Therefore, taking UPF consumption into account when investigating the intricate relationship between violence and addictive behaviors could provide a more comprehensive framework for developing public health strategies aimed at addressing not only the immediate health risks but also the broader societal impact of addictive consumptions.

Certain limitations must be acknowledged for the correct interpretation of the present findings. The most significant limitation is that this study employs a cross-sectional design, thus precluding the inference of causal relationships between violence victimization and UPF consumption. Furthermore, to expand our understanding of the complex relationships between violence, substance use, and UPF consumption, we assumed in our theoretical-conceptual model that some potentially bidirectional relationships are unidirectional (e.g., violence and alcohol consumption). Therefore, to overcome this limitation, prospective studies are needed to determine the most likely chronological order of influence on the causal relationship between violence and the consumption of psychoactive substances and UPF. Second, while we included three types of violence against adolescents and considered their frequency and context, the intensity and extent of mental and physical health impacts on these victims were not taken into account. In this regard, it is uncertain whether the associations between substance use and UPF

consumption only occur in severe cases of aggression or in milder instances. Similarly, the variables measuring substance use refer to frequency but do not specify the consumed dosage. Furthermore, whether it involves regular consumption in the past month or isolated episodes of excessive consumption was not assessed. It is known, for example, that binge drinking is prevalent among the young population (Kuntsche et al., 2017), and its relationship with both violence exposure and UPF consumption might differ compared to habitual alcohol consumption. Moreover, information about UPF consumption only considered the number of products consumed in the last 24 h, which may not reflect habitual consumption. Additionally, it does not account for the quantity consumed for each UPF, potentially leading to underestimated associations. Last, despite including a series of covariates in the adjustment analysis, the possibility of residual confounding due to unconsidered factors, such as violence rates in the adolescent's residential and school area, cannot be ruled out.

It is also worth highlighting some strengths of this study. First, the studied population includes a large representative sample of adolescent students from an entire country, providing it with broad external validity. Second, a novel approach (DAG) was used to explain the framework that supported the definition of the study variables and the direction of the associations among them, in addition to the selection of adjustment covariables. As a result, we considered the potential confounding effect of key variables for analyzing lifestyle patterns in adolescence, such as the number of close friends, the use of various types of psychoactive substances, and mental health symptoms. Last, while most studies on UPF consumption focus on specific foods, such as soft drinks or sweets, the current analyses considered the consumption of 13 different types of these foods, providing a more comprehensive picture of the presence of UPFs in the dietary patterns of the adolescents studied.

In conclusion, within a large population-based sample of adolescents, adolescents who have been victims of violence are more likely to consume UPF, which could be partially explained by higher psychoactive substance use. These cross-sectional findings need confirmation in future prospective studies that more accurately discern the severity and impact of aggression on the physical and psychological health of adolescents, the doses of ingested psychoactive substances, and the quantities of UPF consumed. Essentially, this study contributes a comprehensive understanding of the complex association between violence, psychoactive substances and UPF consumption in adolescents, offering valuable insights for designing programs that aim to contribute to reducing the consumption of unhealthy substances and foods after exposure to violence.

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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

Ethical Aspects 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. These institutions regulate and approve human health research, aiming to further protect ethical norms and the confidentiality of the adolescents interviewed.

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, SMA, FNM, JFL-G, NBR, VMV and EJ-L declare that they have no conflicts of interest.

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