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Availability and consumption of ultra-processed foods in schools in the municipality of São Paulo, Brazil: results of the SP-Proso

Disponibilidade e consumo de ultraprocessados em escolas do Município de São Paulo, Brasil: resultados do SP-Proso

Disponibilidad y consumo de ultraprocesados en escuelas del Municipio de São Paulo, Brasil: resultados del SP-Proso

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Abstract

Ultra-processed foods are markers of unhealthy eating patterns, and their consumption is high among adolescents. Characteristics of the school eating environment associate with student eating practices. This study aims to investigate the association between the presence of school canteens and the availability of ultra-processed foods in school canteens with the consumption of these foods, inside the school, among adolescents of the 9th grade (14 years) of the public and private schools of the city of São Paulo, Brazil. We conducted a cross-sectional study with SP-Proso data, in a sample of 2,680 adolescents. We elaborated multilevel linear regression models to evaluate associations between the exposures: presence of school canteens and availability of ultra-processed foods with outcomes of consumption frequency of ultra-processed foods in the school. We found an association between the presence of school canteens and the higher frequency of consumption of sausages (0.46; 95%CI: 0.24; 0.68), package snacks (0.50; 95%CI: 0.19; 0.80), goodies (0.82; 95%CI: 0.55; 1.09), and sugary drinks (0.34; 95%CI: 0.06; 0.62), as well as a score of consumption frequency of ultra-processed foods (2.37; 95%CI: 1.25; 3.48). The availability of package snacks, goodies, and sugary drinks in school canteens increased the frequency of consumption of these foods. We observed a dose-response effect between the diversity of ultra-processed foods in canteens and the frequency of consumption of these foods. A school food environment with greater availability of ultra-processed products is associated with their higher consumption in school, indicating the need to regulate the sale of food within these institutions.

School Feeding; Adolescent; Multilevel Analysis

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Introduction

Ultra-processed foods are typically ready-to-eat industrial formulations produced with numerous food-derived ingredients [1]. Compared with culinary preparations and processed foods, ultra-processed foods have, on average, a higher content of free sugar, fat, sodium, calories, flavorings, dyes, and texturizers, as well as a lower density of proteins, fibers and micronutrients [2,3,4]. They are products that can affect the control of satiety and glycemic responses of the body [5], and their excessive consumption is a risk factor for negative health outcomes in adolescents, such as metabolic syndrome [6], overweight [7] and asthma and wheezing [8]. According to data from the *Brazilian National Survey of School Health* (PeNSE), the frequent consumption of ultra-processed foods among Brazilian school adolescents increased between 2009 and 2015 [9], when it reached 60.6% [10].

Since adolescents stay for long periods in schools, consuming between a third and half of their daily meals there, it is recognized that the school food environment plays an important role in the quality of their nutrition [11,12]. According to the Food and Agriculture Organization of the United Nations (FAO), the food environment of schools comprises spaces, infrastructure, and conditions inside and outside school facilities where food is available, obtained or purchased and consumed. It also involves information on food and nutrition and the promotion and pricing of food and food products (advertisements, brands, food labels, packaging, promotional pricing, etc.). The food environment changes how accessible, desirable and convenient the food offered there is. A healthy school eating environment enables and encourages the school community – children, adolescents, families and school staff – to make choices that contribute to better eating standards [13]. In this sense, studies point out that the existence of commercial canteens in schools is associated with a greater consumption of ultra-processed foods by adolescents [14,15,16,17,18], making it necessary to better regulate the food available for sale and consumption in the school environment.

In Brazilian public schools, there is the Brazilian National School Feeding Program (PNAE) and the School Health Program (PSE), which, through the free provision of meals and educational strategies, protect to a certain extent the feeding of students [19,20]. On the other hand, in 2015, 45.2% of students in Brazil studied in schools with canteens that sell food [14] and, according to data from the 2013 and 2014 *Study on Cardiovascular Risks in Adolescents* (ERICA. http://www.erica.ufrj.br/), the sale of food in Brazilian schools occurred in 45% of public and 97.7% of private schools [21]. In Brazil, the sale of food in commercial canteens may or may not be regulated, according to each state, city, administrative dependency and internal standards of each school [22].

We do not know Brazilian studies that evaluated the possible effects of the presence of canteen and the quality of food sold in school canteens on the consumption of food by adolescents, specifically during the school period. Such explorations are necessary to defend the expansion, supervision or possible changes in Brazilian laws that regulate the sale of food in schools, in order to improve food practices, prevent obesity and promote the health of adolescents.

The aim of this study was to investigate the association between the presence of canteens and the availability of ultra-processed foods in canteens with the consumption of these foods, inside the school, among adolescents of the 9th grade of public and private networks in the municipality of São Paulo, Brazil.

Methods

The *São Paulo Project for the Social Development of Children and Adolescents* (SP-Proso) is a cross-sectional study conducted by the Department of Preventive Medicine, Medicine School, São Paulo University. It has a representative sample of adolescents attending the 9th grade from public and private schools in the city of São Paulo, capital of the state of São Paulo and the largest city in Brazil, with approximately 12 million inhabitants. In 2017, there were 99,179 adolescents attending the 9th grade [23].

The sample was stratified according to the type of school (municipal public, state public, and private) and the draw was by conglomerates, considering the school classes as primary sampling units (PSU). The sample size was estimated at 2,849 to allow estimates as low as 15% with an accuracy of 0.06 and design effect (deff) = 1.7 [24]. Among the 156 schools drawn, 119 schools (87 public and 32 pri-

vate) agreed to participate. A class from each school was randomly selected. The eligible adolescents were those who were present in the classroom on the day of data collection, whose parents did not express their opposition to their participation and who did not have serious impairment that limited the understanding of the questions or the possibility of responding to the survey anonymously.

In total, 2,816 students were present at the school on the day of data collection, out of which 96 refused to participate and 18 were excluded for having serious cognitive impairments that compromised their ability to understand or answer the questionnaire anonymously (n = 17) or serious disciplinary problem (n = 1) that prevented their stay in the classroom by decision of the school management. Another 22 students were excluded because they answered less than 20% of the questionnaire, resulting in a final sample of 2,680 students (94% of the estimated sample). More details about this study can be read in the report by Peres et al. [25].

Data were collected between August and November 2017, during school hours, with self-filled paper questionnaires. In each school visited, a research assistant collected data about the characteristics of the school and its canteen by an observation instrument.

The questionnaire applied to adolescents contained questions about sociodemographic aspects and about food. Questions about access to goods and services were extracted from the 2012 PeNSE questionnaire [26]. Questions about the frequency of food consumption were adapted from the 2015 PeNSE questionnaire [27]. The indicators of dietary practices used in PeNSE are validated [28].

The observation instrument contained items regarding the presence of canteens and an inventory of food sold in that space, adapted from the 2015 PeNSE questionnaire [26]. More details about the instruments used in the research can be seen in the SP-Proso [25].

Variables of interest

As exhibits, we used variables on the existence or not of commercial canteens in schools and a score of the sale of some ultra-processed foods, markers of unhealthy food consumption patterns. The food subgroups whose trade was used for the construction of this score were industrialized cookies and crackers, package snacks, goodies, sugar-sweetened beverages. The score could range from 0 to 5 points, where each subgroup available for sale on the day of data collection corresponded to one point (for example, cookies and crackers available for sale corresponded to one point). The score was divided into thirds, according to its distribution in the sample, so that adolescents in the first third were exposed to canteens with lower availability of ultra-processed foods and those in the last third to canteens with higher availability. Varieties, brands, or amounts of the food were not considered for the composition of the score.

As an outcome, we considered the frequency of consumption, within the school, of some ultra-processed foods. We questioned the weekly consumption frequency, on school days and inside the school (0 to 5 times), of five subgroups of ultra-processed foods: sausage-like (hamburgers, sausage, mortadella, salami, ham, or nuggets), cookies and crackers, package snacks (including package chips), goodies (sweets, candies, chocolates, gum, or lollipops), and sugar-sweetened beverages (soft drinks, powder juices, or juice boxes). The question was asked as follows: "In an ordinary week of classes (5 school days), on how many days do you eat or drink at school (include the foods you ate during break, even if it was outside the school)?", followed by the list of foods with the frequency options, from zero days to 5 days.

In our analyses, the weekly frequency of consumption of these subgroups of food was added to the construction of a second score, in which each day of consumption of each food corresponded to one point (for example, consuming treats once a week corresponded to one point), and could vary from 0 to 25 points. The outcomes were either the consumption of each subgroup, separately, or the score of the sum of the consumption frequencies.

As confounding variables, individual and school characteristics were included. The individual variables used were: age (in years), sex (male and female), maternal education (up to complete elementary school, incomplete or complete high school and incomplete or complete higher education), skin color (white, black and others), and socioeconomic status. The socioeconomic status of adolescents' families was assessed based on possession of consumer goods (landline telephone at home, car in the family, computer, and television in the bedroom and mobile phone), having a bathroom at home and

having a maid working in their homes. With this information, a continuous score was calculated, later categorized into thirds, according to the methodology proposed by Levy et al. [29]. The higher the prevalence of these items, the lower their weight in the creation of this score.

As variables of the school, we used: administrative dependence of the school (public or private), size of the school (from 200 to 500 students, from 500 to 1,000 students, and more than 1,000 students), class shift (full time, morning and afternoon), absence of structured cafeteria, presence of alternative point of sale of food inside the school, presence of street food seller in front of the school at the end of the classes, presence of ultra-processed food advertising inside the school (at least one food subgroup: industrialized cookies and crackers, package snacks, goodie, sugar-sweetened beverages).

Data analysis

Firstly, means and prevalence of the characteristics of adolescents and schools were described for the total sample and according to the condition of studying in schools with or without canteen.

Then, multilevel linear regression models were made, considering as levels: (i) the individual and (ii) the schools, to evaluate the relation between the presence of canteen in the school and the frequency of consumption of the subgroups of ultra-processed foods analyzed. We also made multilevel models to test the association between the sale of each subgroup of food in the canteen and its frequency of consumption. Then, we tested the association between the presence of canteens and the score of the frequency of ultra-processed food consumption. Finally, multilevel linear regressions were made to test the dose-response relationship between the amount of ultra-processed products sold in the canteen and the frequency score of consumption of these foods.

Multilevel analysis allows to simultaneously deal with the relations between exposure, outcome, and covariates both at the individual level, and at the group level or context to which they belong. Thus, the dependence of the subjects in relation to the group in which they are inserted was considered [30].

The multilevel models were made in two steps, as well as a first crude model. In the adjusted models, the individual sociodemographic variables, the administrative dependence of the school, its size and the shift of the classes were first inserted. Subsequently, in addition to these adjustment variables, other variables of characteristics of the school food environment were included (absence of a structured cafeteria, presence of an alternative point of sale of food, presence of a street vendor at the school door and presence of ultra-processed food advertising).

Multiple imputation by chained equations was used to assign numerical values to the educational level of the mother, which had 25.8% of missing values, according to the methodology described by other studies [15,31]. The imputed data showed satisfactory statistical reliability, according to the Monte Carlo error analysis [32].

The analyses were weighted according to the sample design and were made using Stata, version 14.0 (https://www.stata.com/).

Ethical aspects

According to the Helsinki Declaration, the project was approved by the Research Ethics Committee of the Medicine School, São Paulo University (CEP-FMUSP; opinion n. 1,719,856) and by the Brazilian National Research Ethics Committee (CONEP), linked to the Brazilian National Health Council (CNS; opinion n. 2,014,816). We only asked adolescents whose parents did not deny to their participation in the survey to answer the anonymous questionnaire. All adolescents signed the informed consent form.

Results

Table 1 shows the characteristics of the 2,680 adolescents and 119 schools, according to the presence or absence of canteen. Most students were male, regardless of whether or not there was a canteen (52.32% and 52.67%, respectively); students from schools without canteens were older (15.0 years versus 14.8 years) and most declared themselves as black (59.1%); among students from schools

Table 1

Characteristics of students and schools according to the existence of canteens. SP-Proso, 2017 (N = 2,680).

	Total		Students from schools without canteens (20.4%)		Students from schools with canteen (79.6%)	
	%	95%CI	%	95%CI	%	95%CI
Individual characteristic						
Age (years) [mean]	14.8	14.8; 14.9	15.0	15.0; 15.1	14.8	14.7; 14.8
Sex						
Female	47.4	45.7; 49.1	47.7	43.4; 52.0	47.3	45.5; 49.1
Male	52.6	50.9; 54.3	52.3	48.0; 56.6	52.7	50.8; 54.5
Maternal education						
Complete middle school	24.8	22.7; 27.0	34.2	31.2; 37.4	22.4	19.8; 25.2
Incomplete or complete high school	40.2	37.5; 42.9	44.1	40.0; 48.2	39.2	35.9; 42.5
Incomplete or complete higher education	35.0	32.1; 38.1	21.7	17.9; 26.0	38.4	34.5; 42.5
Score of goods and services						
Low	33.5	30.6; 36.6	43.9	38.2; 49.7	31.0	27.6; 34.6
Medium	40.0	37.0; 43.0	39.5	34.2; 45.1	40.1	36.6; 43.7
High	26.5	23.4; 29.9	16.6	13.8; 19.8	28.9	25.1; 33.1
Skin color						
White	44.2	41.7; 46.8	34.0	31.1; 37.0	46.8	43.6; 50.2
Black	49.1	46.3; 51.9	59.6	55.0; 64.1	46.3	42.7; 49.9
Others	6.7	5.5; 8.1	6.3	4.0; 10.0	6.8	5.5; 8.4
Mean frequency of consumption of ultra-processed foods at school (days) [minimum = 0; maximum = 5]						
Sausage-like	1.3	1.2; 1.4	1.0	0.9; 1.2	1.3	1.2; 1.4
Cookies and crackers	2.2	2.1; 2.3	2.1	1.9; 2.3	2.2	2.1; 2.0
Package snacks	1.5	1.4; 1.6	1.4	1,2; 1,5	1.6	1.4; 1.7
Goodies	2.2	2.1; 2.3	1.8	1.7; 2.0	2.3	2.2; 2.5
Sugar-sweetened beverages	1.9	1.8; 2.0	1.6	1.4; 1.8	1.9	1.8; 2.1
Score of ultra-processed consumption at school [minimum = 0; maximum = 25]	9.1	8.6; 9.5	7.8	7.1; 8.6	9.4	8.9; 9.8
School features						
Administrative dependency of the school						
Private	27.1	27.1; 27.1	0.0	-	100.0	-
Public	72.9	72.9; 72.9	36.1	33.0; 39.3	63.9	60.7; 67.0
School size (number of students)						
200-500	9.9	5.1; 18.5	8.8	2.1; 29.8	10.3	4.8; 20.8
500-1,000	47.7	36.7; 57.7	59.7	41.7; 75.4	42.6	30.4; 55.9
More than 1,000	43.0	32.8; 53.9	31.5	17.6; 49.6	47.0	34.4; 60.1
Class shift						
Full time	1.5	0.2; 9.9	0	-	1.9	0.3; 12.9
Morning	70.2	59.6; 78.9	70,7	52.8; 83.9	70.0	57.0; 80.4
Afternoon	28.4	19.8; 38.9	29.3	16.1; 47.2	28.1	18.0; 41.0
Mean score of ultra-processed foods sold in canteens [minimum = 0; maximum = 5] *						
First category (mean score = 2.30)	-	-	-	-	23.8	15.9; 34.2
Second category (mean score = 4.00)	-	-	-	-	28.6	18.4; 41.5
Third category (mean score = 5.00)	-	-	-	-	47.6	35.1; 60.4

(continues)

Table 1 (continued)

	Total		Students from schools without canteens (20.4%)		Students from schools with canteen (79.6%)	
	%	95%CI	%	95%CI	%	95%CI
Absence of structured cafeteria	14.7	8.5; 24.3	13.7	4.4; 35.1	15.0	7.9; 26.5
Presence of an alternative food selling point	3.7	1.5; 8.8	1.4	0.2; 9.5	4.5	1.7; 11.3
Presence of a street vendor in front of the school at the end of classes	22.3	15.3; 31.4	23.4	12.5; 39.6	21.9	13.6; 33.3
Presence of advertising of ultra-processed foods **	5.5	2.4; 11.9	2.7	0.6; 10.6	6.4	2.6; 15.1

95%CI: 95% confidence interval.

* Ultra-processed foods included in the score: industrialized cookies and crackers, packaged snacks, treats, soft drinks and other sugary drinks;

** At least one advertisement for the following foods: industrialized cookies and crackers, packaged snacks, treats, soft drinks and other sugary drinks.

with canteens, we found the same proportion between white and black people (46.8% and 46.3%, respectively) and observed higher maternal education and better socioeconomic status compared to students of schools without canteen. Notably, no private school students in a school without a canteen participated in this study (Table 1).

Regarding the characteristics of the school food environment, we observed that 14.7% of schools did not have a structured cafeteria, 3.7% of schools had an alternative point of sale of food; 22.3% had street vendors at the door of the schools; and 5.5% of schools had food advertising. There were no differences, for these characteristics, between schools with and without canteens.

In Table 2, we observed associations between the presence of schools canteens and the frequency of consumption of ultra-processed foods in school. In Model 1, which does not include the covariates in the food environment at school and in the cafeteria, we saw that having a canteen led to an average increase of 0.52 (95%CI: 0.30; 0.74) in the weekly frequency of consumption, in the school, of sausage-like foods; 0.31 (95%CI: 0.07; 0.55) for cookies and crackers; 0.59 (95%CI: 0.33; 0.86) for package snacks, 0.82 (95%CI: 0.58; 1.06) for goodies, and 0.39 (95%CI: 0.14; 0.64) for sugar-sweetened beverages. After adjusting for the other covariates (Model 2), the coefficients showed small reductions, and the consumption of cookies and crackers lost statistical significance. Thus, there was a mean increase of 0.46 (95%CI: 0.24; 0.68) for sausage-like foods, 0.50 (95%CI 0.19; 0.80) for packet snacks, 0.82 (95%CI 0.55; 1.09) for goodies, and 0.34 (95%CI 0.06; 0.62) for sugar-sweetened beverages (Table 2).

When we analyzed whether there was an association between the availability of each food in the canteen and the higher frequency of its consumption in school, we observed significant associations for all foods, except for cookies and crackers (Table 3). In models 1 and 2, the sale of package snacks increased the frequency of weekly consumption of the food in the school to 0.45 (95%CI: 0.23; 0.67) and 0.38 (95%CI: 0.13; 0.63), respectively; for goodies, the increase coefficients were 0.69 for the two models (in model 1 we have a 95%CI 0.55; 1.09, and in model 2 we have a 95% CI: 0.44; 0.94); for sugar-sweetened beverages, the increase coefficient was 0.38 (model 1 – 95%CI: 0.55; 1.09) and 0.35 (model 2 – 95%CI: 0.55; 1.09) (Table 3).

The presence of school canteens was associated with an increase in the mean frequency score of ultra-processed foods consumption in 2.37 (95%CI: 1.25; 3.48) in model 2. Furthermore, we observed a gradient in the association, in which the higher the availability of ultra-processed foods in canteens, the higher the score of frequency of consumption of these foods, regardless of the adjustment made (Table 4).

We could not associate the covariates of food environment absence of structured cafeteria, presence of alternative point of sale of food, presence of street vendor at the school door and presence of ultra-processed food advertisement with our outcomes (data not shown).

Table 2

Coefficients and 95% confidence intervals (95%CI) for the frequency of consumption of ultra-processed foods at school, according to the presence of a canteen. SP-Proso, 2017 (N = 2,680).

Frequency of consumption of ultra-processed foods at school	Crude models			Fitted models 1 *			Fitted models 2 **		
	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value
Sausage-like	0.28	0.11; 0.46	0.002	0.52	0.30; 0.74	< 0.001	0.46	0.24; 0.68	< 0.001
Cookies and crackers	0.15	-0.05; 0.35	0.149	0.31	0.07; 0.55	0.012	0.21	-0.06; 0.48	0.135
Package snacks	0.23	0.01; 0.45	0.037	0.59	0.33; 0.86	< 0.001	0.50	0.19; 0.80	0.001
Goodies	0.49	0.30; 0.69	< 0.001	0.82	0.58; 1.06	< 0.001	0.82	0.55; 1.09)	< 0.001
Sugar-sweetened beverages	0.36	0.16; 0.57	0.001	0.39	0.14; 0.64	0.003	0.34	0.06; 0.62	0.017

Note: Reference = absence of canteens.

* Models 1 = crude models + age, sex, maternal education, score for goods and services, skin color, administrative dependency at school, size of school and shift in classes;

** Models 2 = models 1 + absence of a structured cafeteria, presence of an alternative point of sale of food, presence of a street vendor in front of the school at the end of classes and presence of advertising for ultra-processed foods.

Table 3

Coefficients and 95% confidence intervals (95%CI) for the frequency of consumption of ultra-processed foods at school, according to the availability of these foods in the canteen. SP-Proso, 2017 (N = 2,680).

Frequency of consumption of ultra-processed foods at school	Crude models			Fitted models 1 *			Fitted models 2 **		
	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value
Cookies and crackers	0.06	-0.14; 0.26	0.556	0.09	-0.12; 0.31	0.386	0.08	-0.13; 0.30	0.441
Package snacks	0.35	0.14; 0.56	0.001	0.45	0.23; 0.67	< 0.001	0.38	0.13; 0.63	0.002
Goodies	0.51	0.32; 0.70	< 0.001	0.69	0.47; 0.91	< 0.001	0.69	0.44; 0.94	< 0.001
Sugar-sweetened beverages	0.37	0.16; 0.57	< 0.001	0.38	0.15; 0.61	0.001	0.35	0.10; 0.59	0.005

Note: Reference = absence of canteen or absence of food in the canteen.

* Models 1 = crude models + age, sex, maternal education, score for goods and services, skin color, administrative dependency at school, size of school and shift in classes;

** Models 2 = models 1 + absence of a structured cafeteria, presence of an alternative point of sale of food, presence of a street vendor in front of the school at the end of classes and presence of advertising for ultra-processed foods.

Table 4

Coefficients and 95% confidence intervals (95%CI) for the frequency score of consumption of ultra-processed foods at school, according to the presence of a canteen and the score of ultra-processed foods sold in the canteen. SP-Proso, 2017 (N = 2,680).

	Crude models			Fitted models 1 *			Fitted models 2 **		
	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value	Coefficient	95%CI	p-value
Exhibition: presence of canteens	1.50	0.69; 2.32	< 0.001	2.61	1.6; 3.61	< 0.001	2.37	1.25; 3.48	< 0.001
Exposure: score of ultra-processed products sold in canteens [minimum = 0; maximum = 5] ***									
First category (mean score = 2.30)	0.21	-0.90; 1.32	< 0.001	1.16	-0.35; 2.68	< 0.001	1.11	-0.39; 2.61	0.011 #
Second category (mean score = 4.00)	1.68	0.65; 2.72	< 0.001	2.37	1.24; 3.50	< 0.001	2.18	0.94; 3.41	0.011 #
Third category (mean score = 5.00)	2.23	1.30; 3.15	< 0.001	2.90	1.79; 4.02	< 0.001	2.72	1.47; 3.98	0.011 #

Note: Reference = absence of canteens.

* Models 1 = crude models + age, sex, maternal education, score for goods and services, skin color, administrative dependency at school, size of school and shift in classes;

** Models 2 = models 1 + absence of a structured cafeteria, presence of an alternative point of sale of food, presence of a street vendor in front of the school at the end of classes and presence of advertising for ultra-processed foods;

*** Ultra-processed foods included in the score: industrialized cookies and crackers, packaged snacks, sweets, soft drinks and other sugary drinks;

Trend p-value.

Discussion

In this study, conducted with a representative sample of students in one of the largest cities in Latin America, we observed that the presence of canteen in schools increases the frequency of ultra-processed foods consumption, measured by a score and by each subgroup of food evaluated individually (sausage-like, snacks, goodies, and sugar-sweetened beverages), except for the consumption of cookies and crackers. We also observed that the sale of each subgroup in canteens increases their consumption, except for cookies and crackers, and that the greater the variety of ultra-processed products available for sale in canteens, the higher the frequency of consumption of these foods by adolescents during the school period.

Other studies have already shown similar findings. Azeredo et al. [15], with 2012 PeNSE data, found that the presence of canteens selling unhealthy foods in Brazilian schools increased the students' consumption of soft drinks and fried savory foods. A study using 2015 PeNSE data found an association between the presence of commercial canteens in schools and a greater likelihood of consuming salty ultra-processed foods [14]. In Alberta and Ontario, Canada, buying a snack at school was associated with higher consumption of sugar-sweetened beverages [33]. Other studies have also found a relation between buying snacks in canteens and greater consumption of foods considered unhealthy [16,17,18].

The greater the supply of certain products, the greater their demand. This is what our data showed when we analyzed the dose-response effect between marketing and consumption of ultra-processed foods. In line with our findings, a recent study observed a 1.67% increase in the number of unhealthy foods purchased by Australian students in schools for every 1% increase in the availability of these foods in canteens [34]. These relations help to better understand how the environment can influence adolescents' food choices. We observed the role of the food environment in the modulation of consumption habits of adolescents, in which a greater availability of ultra-processed products will be a driver for their consumption.

The only foods that had no association, both with the presence of canteens and with the sale, were cookies and crackers. Cookies or crackers may be purchased elsewhere, such as in supermarkets and grocery stores, and may be taken from home to school. This would explain why the consumption of these foods was less related to the presence of the canteen and its availability for sale in relation to the other foods studied.

We found no association between the other covariates of food environment (absence of structured cafeteria, presence of alternative point of sale of food, presence of street vendor at the school door and presence of ultra-processed food advertising) and our outcomes, but we maintained them in the models because they allow the adjustment of the associations of the main items. The low prevalence of these variables in the schools evaluated may partly justify the lack of associations. Alternatively, they may actually be less significant when compared to the role played by the presence of the canteen and the foods marketed there, as modulators of the consumption of ultra-processed foods.

The school environment is considered a platform in which positive changes in behaviors can be implemented, since interventions can be easily delivered and evaluated, as schools maintain continuous, direct and intense contact with students, where it is possible to create a healthy and favorable environment for educational practices [35]. Changes in the school eating environment can positively affect eating behaviors and students' health by allowing them to make healthier choices [12], being more effective than punctual and/or individual awareness interventions.

A study, also conducted with PeNSE data from 2015, when estimating how much of the individual variation in the prevalence of health behaviors is attributable to the school level, showed the significance of the school context in adolescent's health and highlighted that interventions in the school environment can be effective to promote healthy behaviors [36]. Therefore, it seems plausible to say that regulating and restricting what is sold in schools can improve the adolescents' diet.

In the city of São Paulo, there are legal instruments that aim to promote healthy eating of school children and adolescents. In addition to the national programs PNAE and PSE, in the state of São Paulo, there is the *Joint Ordinance COGSP/CEI/DSE*, of March 23, 2005, which provides on which foods can be sold in the canteens of state public schools. However, this is not a mandatory regulatory instrument [37]. In the municipality of São Paulo, *Ordinance n. 11/2001*, of February 15, 2001, bans the existence of canteens in all schools of the municipal public network [38], which represents an advance, since there is no national regulation about food sold in schools, but some laws scattered among Brazilian cities [22]. Private schools of the municipality, on the other hand, are not covered by any type of regulation or policy regarding the food marketed in these spaces.

In 2012, the Brazilian National Education Development Fund (FNDE) demonstrated an effort to promote the sale of healthier food in canteens, through a technical note [39]. This, however, is a guiding instrument, also not mandatory, which may explain a probable low adherence.

Modifying the food environment by restricting the sale of some foods in institutional environments has the advantage of being a universal measure, since all students will be affected by that measure, unlike other motivational or educational strategies, which can reach individuals in different ways. Legal instruments are the possible tool to be applied in relation to the sale of food in school canteens. But only the implementation of local regulation does not seem to be effective. One study, which evaluated whether the presence of regulation prohibiting the sale of soft drinks in schools in Brazilian capitals would reduce their availability in these spaces, found that the existence of regulation is not always sufficient to restrict the sale, pointing to the need for a clear, unique and national law and that is accompanied by monitoring its compliance and constant evaluation [22].

The study, because it has a cross-sectional design, implies that the measures of effect extracted from it measure associations and not causal relations. Despite this possible limitation, we believe that reverse causality is unlikely, in the case of this study. It is plausible that the availability of food is early and determinant for the purchasing attitudes of adolescents. In addition, we estimated the consumption measures by an unvalidated indicator, which is a limitation. However, in general, self-reported frequency of food consumption questionnaires are the most common form of data collection in population surveys, which guarantees comparability with literature.

As positive aspects of the study, we highlight the evaluation of consumption only within the school (up to 5 days of the week), which allows us to better understand how the school food environment is associated with consumption metrics in the same space, different from other studies made with

PeNSE data [14,15], which evaluated total consumption (inside and outside the school, 7 days a week). In addition, trained researchers collected data from canteens in the field, rather than using data reported by school principals, as used in other studies [15,22], which could to some extent be influenced by social desirability bias. The external validity of the study is another positive point, since the study showed a high response rate in a representative sample of 9th grade students and, according to projections made from data from the *Continuous National Household Sample* (PNAD), 97.5% of children and adolescents, with compatible age, would be enrolled in elementary and middle school in the city of São Paulo in 2017 [40].

The novelty of this study is also relevant. Our study was the first to evaluate direct associations between the presence of canteens in the consumption of ultra-processed foods within the school and the dose-response effect between the commercialization of ultra-processed foods in canteens and their consumption in Brazil. We believe that these findings are of great use in the design of public policies aimed at regulating the sale of food in schools.

Conclusion

Our study demonstrated that the availability of unhealthy food in schools is significantly associated with the food consumption of adolescents in this environment. Understanding the school as a space of protection and education, it is important that the foods offered there are promoters of healthy eating patterns and health.

The evidence we found points to the need to regulate the food trade within schools, either through banning the existence of canteens or regulating the types of food marketed – without losing sight of the importance of the coexistence of programs and policies that offer or facilitate access to fresh and healthy food.

Contributors

M. A. Leite contributed to the design and execution of the research, data analysis and writing of the article. C. M. Azeredo collaborated in the design and execution of the research, data analysis and writing of the article. M. F. T. Peres participated in the design and execution of the research, data analysis and writing of the article. M. M. L. Escuder contributed to the research development process, study design, sample calculation, data analysis and review of the final version of the article. R. B. Levy collaborated in the design and execution of the research, data analysis and writing of the article.

Additional informations

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Resumo

Alimentos ultraprocessados são marcadores de padrões alimentares não saudáveis e seu consumo é elevado entre os adolescentes. Características do ambiente alimentar escolar se associam a práticas alimentares de estudantes. O objetivo do estudo foi investigar a associação entre a presença de cantinas e a disponibilidade de alimentos ultraprocessados nas cantinas com o consumo destes alimentos, dentro da escola, entre adolescentes do 9º ano do Ensino Fundamental das redes pública e particular do Município de São Paulo, Brasil. Foi realizado um estudo transversal com dados do SP-Proso, em amostra de 2.680 adolescentes. Foram feitos modelos de regressão linear multinível para avaliar as associações entre as exposições presença de cantinas nas escolas e disponibilidade de alimentos ultraprocessados com desfechos de frequência de consumo de ultraprocessados na escola. A presença de cantinas esteve associada à maior frequência de consumo de embutidos (0,46; IC95%: 0,24; 0,68), salgadinhos de pacote (0,50; IC95%: 0,19; 0,80), guloseimas (0,82; IC95%: 0,55; 1,09) e bebidas açucaradas (0,34; IC95%: 0,06; 0,62), bem como um escore de frequência de consumo de ultraprocessados (2,37; IC95%: 1,25; 3,48). A disponibilidade de salgadinhos de pacote, guloseimas e bebidas açucaradas nas cantinas aumentou a frequência de consumo desses alimentos. Foi observado um efeito dose/resposta entre a diversidade de ultraprocessados nas cantinas e a frequência de consumo destes alimentos. Um ambiente alimentar escolar com maior disponibilidade de ultraprocessados está associado ao maior consumo dos mesmos na escola, o que aponta para a necessidade de regulamentar o comércio de alimentos dentro destas instituições.

Alimentação Escolar; Adolescente; Análise Multinível

Resumen

Los alimentos ultraprocesados son marcadores de patrones alimentarios no saludables y su consumo es elevado entre los adolescentes. Características del entorno alimentario escolar se asocian a prácticas alimentarias de estudiantes. El objetivo del estudio fue investigar la asociación entre la presencia de cantinas, y la disponibilidad de alimentos ultraprocesados en las mismas, con el consumo de estos alimentos dentro de la escuela, entre adolescentes del 9º año de la enseñanza fundamental de las redes pública y privada del Municipio de São Paulo, Brasil. Se realizó un estudio transversal con datos del SP-Proso, en una muestra de 2.680 adolescentes. Se realizaron modelos de regresión lineal multinivel para evaluar las asociaciones entre las exposiciones presencia de cantinas en las escuelas y disponibilidad de alimentos ultraprocesados con resultados de frecuencia de consumo de ultraprocesados en la escuela. La presencia de cantinas estuvo asociada a una mayor frecuencia de consumo de embutidos (0,46; IC95%: 0,24; 0,68), aperitivos de bolsa (0,50; IC95%: 0,19; 0,80), golosinas (0,82; IC95%: 0,55; 1,09) y bebidas azucaradas (0,34; IC95%: 0,06; 0,62), así como un marcador de frecuencia de consumo de ultraprocesados (2,37; IC95%: 1,25; 3,48). La disponibilidad de aperitivos de bolsa, golosinas y bebidas azucaradas en las cantinas aumentó la frecuencia de consumo de esos alimentos. Se observó un efecto dosis/respuesta entre la diversidad de ultraprocesados en las cantinas y la frecuencia de consumo de estos alimentos. Un ambiente alimentario escolar con mayor disponibilidad de ultraprocesados está asociado a un mayor consumo de los mismos en la escuela, lo que apunta a la necesidad de regular el comercio de alimentos dentro de estas instituciones.

Alimentación Escolar; Adolescente; Análisis Multinivel

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