Consumption of differently processed food by public school adolescents

Consumo alimentar de adolescentes de escolas públicas segundo grau de processamento industrial dos alimentos

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A B S T R A C T

Objective

To characterize food consumption, considering the degree of industrial food processing by public schools' adolescents.

Methods

Cross-sectional study involving adolescents aged 14 to 19 years, of both genders, attending public schools in *Juiz de Fora*, MG. Food consumption was assessed using two 24-hour dietary recalls. Foods were classified into three groups according to the degree of industrial processing: (1) unprocessed foods or minimally processed foods, culinary ingredients and preparations based on these foods; (2) processed foods; (3) ultra-processed foods. In addition, weight and height information was collected, with subsequent calculation of body mass index/age to assess the individuals' nutritional

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status according to the gender. Pearson's chi-square, Mann-Whitney and Kruskal-Wallis tests were performed, adopting a value of *p*<0.05.

Results

The sample consisted of 804 adolescents, with a predominance of females (57.5%). In the sample, 29.9% and 26.1%, of girls and boys, respectively, were overweight. There was a difference in the daily consumption of ready-made sweet-tasting foods, being higher in females (26.2%) when compared to males (18.1%), whereas the consumption of soft drinks (one to four times a week) was 47.2% and 55.6% in girls and boys, respectively (*p*<0.05). Higher consumption of ultra-processed foods was observed in females (*p*=0.02) and processed foods in males (*p*=0.008).

Conclusion

There was a high contribution of ultra-processed foods in the diet of adolescents in public schools; a high prevalence of overweight was observed in both genders.

Keywords: Adolescent. Food consumption. Food processing. Nutritional status.

R E S U M O

Objetivo

Caracterizar o consumo alimentar através do grau de processamento industrial dos alimentos consumidos por adolescentes matriculados em escolas públicas.

Métodos

Estudo transversal com adolescentes de 14 a 19 anos de ambos os sexos matriculados em escolas públicas de Juiz de Fora, MG. O consumo alimentar foi avaliado através de dois recordatórios de 24h. Os alimentos foram classificados em três grupos de acordo com o grau de processamento industrial: (1) alimentos in natura ou minimamente processados, ingredientes culinários e preparações a base desses alimentos; (2) alimentos processados; (3) alimentos ultraprocessados. Ademais, foram coletadas informações de peso e altura dos estudantes, com posterior cálculo de índice de massa corporal/idade para avaliação do estado nutricional conforme o sexo. Foram realizados os testes Qui-quadrado de Pearson, Mann-Whitney e Kruskal-Wallis, adotando o valor de p<0,05.

Resultados

A amostra foi composta por 804 adolescentes, com predomínio do sexo feminino (57,5%). Entre os adolescentes, 29,9% das meninas e 26,1% dos meninos apresentaram excesso de peso. Observou-se diferença no consumo diário de alimentos prontos de sabor doce, sendo maior no sexo feminino (26,2%) quando comparado ao masculino (18,1%), ao passo que o consumo de refrigerantes de uma a quatro vezes na semana foi de 47,2% e 55,6% nas meninas e meninos, respectivamente (p<0,05). Maior consumo de alimentos ultraprocessados foi observado no sexo feminino (p=0,02) e de alimentos processados no sexo masculino (p=0,008).

Conclusão

Verificou-se elevada contribuição proveniente do grupo dos alimentos ultraprocessados na dieta dos adolescentes de escolas públicas, com altas prevalências de excesso de peso em ambos os sexos.

Palavras-chave: *Adolescente. Consumo alimentar. Processamento de alimentos. Estado nutricional.*

I N T R O D U C T I O N

Adolescence comprises the period between 10 and 19 years of age, and is the transition phase from childhood to adulthood, in which several biological, cognitive, emotional and social transformations occur [1]. Furthermore, it is the time of construction of autonomy and personality, with the consolidation of individual characteristics, affecting behavior, including food intake [2,3].

Studies show an excessive consumption in this age group [4-6] of ultra-processed foods, such as soft drinks and other sugary drinks, fast and ready-to-eat foods such as frozen pasta and pizza, nuggets and instant noodles, and low consumption of fruits and vegetables [4-6]. According to the NOVA classification,

ultra-processed foods are nutritionally unbalanced due to their high levels of sugar, fat and sodium and low amounts of fibers and protein [7,8].

Few studies have evaluated food consumption among adolescents by degree of industrial processing, according to the NOVA classification [5,6,9-11]. In Brazil, data from the National School Health Survey showed that approximately 40% of the students assessed reported daily consumption of at least one group of ultra-processed foods [2,12]. On the other hand, in a recently published systematic review, a high consumption of ultra-processed foods among adolescents was also verified, especially in Latin American countries [13].

Quality of food intake plays a key role in the nutritional and health status of adolescents, since during adolescence there is an increase in nutritional needs due to rapid growth and development [3,14]. However, an inadequate dietary profile, especially with high consumption of ultra-processed foods, is associated with inadequate intake of micronutrients and the emergence of several chronic Non-Communicable Diseases (NCDs) [5,9,15-17].

In recent decades, Brazil has gone through marked changes, and studies show a decrease in malnutrition and, in parallel, an increase in overweight and obesity of its population. Also in Brazil, in 2015, 23.7% of students aged between 13 and 17 years were overweight, with 7.3% of girls and 8.3% of boys being obese [2]. It is noteworthy that excess weight in childhood and adolescence is related to the emergence of dyslipidemia, diabetes mellitus, systemic arterial hypertension, among other NCDs in adulthood [18,19].

Thus, it is necessary to better understand adolescents' diet, since inadequate consumption is one of the main risk factors for the emergence of health disorders; nevertheless, such disorders may be modified through the adoption of actions to promote adequate nutrition, enabling the prevention of future complications. In addition, the study contributes to the assessment of the adolescents' eating habits, covering different Brazilian situations on account of the continental dimensions of Brazil. Thus, the aim of this study was to characterize differently processed food consumption by adolescents attending public schools.

METHODS

This study used data from the *Estudo do Estilo de Vida na Adolescência – Juiz de Fora, Brasil* – EVA-JF (Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study). This is a cross-sectional study, with a representative sample of public schools adolescents in the city of *Juiz de Fora, Minas Gerais*, Brazil.

Both genders adolescents between 14 and 19 years of age, regularly enrolled in public schools in the urban area of the municipality were evaluated. For the sample calculation, the following parameters were used: number of students enrolled in basic education in the years 2018 and 2019, in the morning classes of the 9th grade Elementary School and the 1st, 2nd and 3rd years of High School, with 8.0% prevalence of obesity, precision around the prevalence was 2.0%, standard error 1.0%, confidence interval 95.0% and 20% loss prediction [2,20]. For this study, the final sample of the EVA-JF study was used, which was composed of 835 adolescents; however, with the losses related to the absence of data on food consumption, 804 adolescents were assessed.

From a posteriori sample calculation, considering all adolescents evaluated in the EVA-JF study (804), the differences between the means of consumption of ultra-processed and processed foods; and 95% confidence level (α=5%), the sample had a power of 74.5% and 87.6%, respectively, in detecting significant differences between genders. Estimates were calculated using the OpenEpi program (version 3.01).

The selection of participants was performed at random, stratified and proportional to the government administrative regions, schools, academic years, classes and genders. The survey was carried out in the actual institutions, during the morning period between May 2018 and May 2019. Further information and details of the study can be found in Neves *et al*. [21].

In order to determine food consumption, two 24-hour food recalls (R24h) were applied, with an interval of approximately one week, on non-consecutive days and during the week (applied between Tuesday and Friday). Both recalls were obtained in person by trained nutritionists. The multiple-pass technique was used, which consists of five steps, aiming to reduce underreporting of food consumption [22]. Participants were instructed to inform the consumption of food and beverages (including water intake), the amount consumed, the day of the week, as well as the place and time of the meal. To help estimate the quantities of food ingested and standardize them, a photographic illustration record containing examples of serving sizes and serving utensils was used [23].

The total energy value (Kcal) and macronutrients (grams and kcal) were estimated using the Nutritional Composition Table of Foods Consumed in Brazil and the nutrition labels [24]. The foods were classified according to the extent and purpose of industrial processing, according to the NOVA classification: (1) unprocessed foods or minimally processed foods, culinary ingredients and preparations based on these processed foods (for example, rice, beans, fruits, milk, salt and oils); (2) processed foods (for example, processed breads and cheeses); (3) ultra-processed foods (for example, soft drinks, savory and stuffed cookies, sweets, frozen foods) [7,8]. It was decided to combine the culinary ingredients with unprocessed foods or minimally processed foods, since these are rarely used alone, being generally used in culinary preparations. In addition, all culinary preparations were broken down and the foods placed in their relevant food groups.

To estimate the usual intake of food, nutrients and energy, the data were fitted in the Multiple Source Method (version 1.0.1) program (Department of Epidemiology of Germany, Potsdam-Rehbrucke Institute of Human Nutrition, Germany), reducing the intra-individual variance. The average daily energy contribution of each food group was calculated later.

Through a structured questionnaire, the consumption frequency, during a normal week of ultra-processed foods, salt addition and processed seasonings, as well as the use of dietary sweeteners, purchase of food and/or beverages in locations close to the school setting and school meals were verified. The questionnaire was designed by two investigators from the EVA-JF study with questions adapted from the questionnaire applied PenSE 2015 survey in order to better extract the information answered in the 24-hour recall [2]. Subsequently, the structured questions were submitted to an evaluation panel composed of six experts in the field of epidemiology, four of them researchers in food and nutrition. Furthermore, two pre-tests were carried out in public schools in the city, both including adolescents of the same age group defined a priori (14-19 years). Three categories of consumption frequency were established, namely: C1: never/almost never (consumption at any time in the week or sporadically); C2: sometimes (consumption 1 to 4 times a week); and C3: frequently/always (consumption 5 to 7 times a week).

For the anthropometric assessments, body weight was measured using a Tanita Ironman™ Scale (model BC-553, Tanita Corp., Japan), and height was measured using a portable stadiometer (Alturexata®, Brazil). Subsequently, the calculation of the Body Mass Index (BMI) was performed, classified according to the BMI for age growth curves set by the World Health Organization, according to gender, expressed by the z-score, as follows: underweight when score $-z<-2$; eutrophy when z-score ≥-2 and $<+1$; overweight when z-score $\geq+1$ and $<+2$; and obesity when z-score $\geq+2$. Adolescents with excess weight were considered those with BMI/age, according to gender, classified as overweight and obese [25].

Information was collected to characterize the sample, such as gender, age, self-reported race/color and education. Socioeconomic status was verified using the Brazil Economic Classification Criteria, which defines economic classes as A1, A2, B1, B2, C1, C2, D and E, in descending order of purchasing power [26]. Average family income was classified according to economic classes, as follows: average/high family income: classes A and B1; average family income: classes B2, C1 and C2; low family income: class D-E. In addition, the stage of sexual maturation was evaluated using the illustrated Scale by Tanner, with layout and drawings adapted by the Ministry of Health [27,28].

Data were analyzed using the SPSS software (version 20.0), adopting a significance level of 5% ($p<0.05$). First, the normality of the variables was verified using the Kolmogorov-Smirnov test. For the description of the quantitative variables, measures of central tendency and dispersion were used, and for the qualitative ones, absolute and relative frequencies were used.

Pearson's Chi-square test was used to verify the difference between genders in the frequency of weekly consumption of foods and/or ultra-processed groups, school meals and consumption of foods purchased in the vicinity of the school. To evaluate the difference between the medians of caloric intake of each food group according to the degree of industrial processing and the difference between the contribution rates of macronutrients and fibers, according to the age group, the Kruskal-Wallis test was performed. In addition, the Mann-Whitney and Kruskal-Wallis tests were performed to assess the difference between the percentages of contribution of food groups, according to gender, BMI/age, self-reported skin color, economic class and stage of sexual maturation.

The investigation was approved by the Research Ethics Committee of the *Universidade Federal de Juiz de Fora*, under protocol number 3.412.539 (CAAE: 68601617.1.0000.5147) and was carried out in accordance with the principles of the Declaration of Helsinki. Adolescents participated in the survey on a voluntary basis, after signing together with their legal guardians the terms of consent and assent.

RESULTS

The sample consisted of 804 adolescents with females mean age of 16.1±1.2 years and males with 16.2±1.2 years. Table 1 shows the general characteristics of the sample according to gender. It was found that 64.0% of the girls defined themselves as black or brown, 75.8% had average family income and 29.9% were overweight (20.4% overweight and 9.5% obese). Among boys, 60.2% described themselves as black or brown skin, 75.4% had average family income and 26.1% were overweight (16.7% overweight and 9.4% obese).

Table 1 – General characteristics of public schools' adolescents – Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study, 2018-2019.

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Variables	Female*		Male**	
	%	n	%	n
Age (age group)				
14-15 years	33.3	154	27.5	94
16-17 years	53.5	247	61.1	209
18-19 years	13.2	61	11.4	39
Education				
9th year of elementary school	14.5	67	12.3	42
1st year of high school	34.2	158	37.4	128
2nd year of high school	29.7	137	25.7	88
3rd year of high school	21.6	100	24.6	84

Table 1 – General characteristics of public schools' adolescents – Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study, 2018-2019.

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Variables	Female[*]		Male[**]	
	%	n	%	n
Self-reported skin color				
White/Caucasian	32.5	150	38.0	130
Black	27.7	128	27.2	93
Brown/mulatto	35.3	163	33.0	113
Oriental yellow	2.6	12	1.5	5
Indigenous	0.4	2	0.3	1
Not informed	1.5	7	0.0	0
Economic Class[a]				
A and B1	20.6	95	22.8	78
B2. C1 and C2	75.7	350	75.4	258
D and E	3.7	17	1.8	6
Sexual maturity stage				
Prepubescent	0.2	1	7.0	24
Pubescent	36.2	167	13.7	47
Post-pubertal	63.4	293	79.0	270
Not informed	0.2	1	0.3	1
BMI by age				
Low weight (score-z <-2)	1.3	6	2.3	8
Eutrophy (score-z ≥-2 and <+1)	68.6	317	71.3	244
Overweight (score-z ≥+1 and <+2)	20.4	94	16.7	57
Obesity (score-z ≥+2)	9.5	44	9.4	32
Not informed (a)	0.2	1	0.3	1

Note: [*]n=462 (57.5%); [**]n=342 (42.5%). [a]Medium/high family income: classes A and B1; average family income: classes B2, C1 and C2; low family income: class D-E. BMI: Body Mass Index.

Table 2 describes food consumption according to the degree of industrial processing and the distribution of macronutrients and fibers, comparing the medians according to age group and gender. There was only a difference in consumption between age groups, in the percentage consumption of carbohydrates and proteins from processed foods, in females ($p<0.05$). It is noteworthy that the consumption of adolescents remained within the recommended ranges for macronutrients established for their age, according to the Acceptable Macronutrient Distribution Range, as well as for the consumption of monounsaturated and polyunsaturated fats [29]. However, the intake of fiber saturated and trans fat was inadequate in both genders and age groups evaluated.

Regarding the behavioral characteristics of food consumption (Table 3), it was observed that 55.8% of the girls and 57.3% of the boys reported consuming, from one to four times a week salty ready-to-eat foods, such as tortilla chips, instant noodles and frozen products. Every day soda consumption was featured by 16.9% of girls and 18.1% of boys, while the consumption of other processed beverages such as powdered soft drinks, box and/or can juices and chocolate drinks, was 38.1% and 33.0% among girls and boys, respectively.

Among adolescents, 31.1% of girls and 29.3% of boys reported purchasing some food and/or drink, from one to four times a week, in establishments close to the school. The most purchased foods were: fried or baked snacks, salty cookies and sugary drinks.

The frequent consumption (often/always category) of ready-to-eat seasonings, sweet-tasting ready-to-eat foods, other processed beverages and eating the food offered by the school were higher

Table 2 – Median percentage of food consumption by degree of industrial food processing, according to gender and age group, of public schools' adolescents – Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study, 2018-2019.

Variables	Female			p^*	Male			p^*
	14/15 years of age	16/17 years of age	18/19 years of age		14/15 years of age	16/17 years of age	18/19 years of age	
Unprocessed foods or minimally processed foods, culinary ingredients and preparations based on these foods								
Energy (Kcal)	849.0	845.7	834.5	0.944	979.1	936.6	905.9	0.231
Carbohydrates (%)	43.4	43.9	43.7	0.923	43.0	42.8	43.5	0.789
Protein (%)	22.8	22.4	22.5	0.783	22.9	23.3	22.5	0.178
Fat (%)	33.4	33.5	32.4	0.934	33.2	33.4	33.4	0.976
Processed foods								
Energy (Kcal)	202.7	212.4	219.7	0.350	232.3	254.1	274.1	0.270
Carbohydrates (%)	76.3**	77.6**	77.4**	0.021	76.7	77.2	77.3	0.322
Protein (%)	10.9**	10.1**	10.4**	0.001	10.9	10.4	10.4	0.082
Fat (%)	13.1	12.0	12.1	0.109	12.1	12.3	11.7	0.836
Ultraprocessed foods								
Energy (Kcal)	883.1	986.7	920.1	0.247	1021.3	986.1	958.2	0.685
Carbohydrates (%)	53.2	53.1	52.4	0.451	54.4	53.0	50.8	0.256
Protein (%)	9.8	9.3	9.1	0.091	9.5	9.1	8.7	0.246
Fat (%)	37.6	37.3	38.7	0.390	36.1	37.6	39.1	0.054
Total energy amount								
Energy (Kcal)	2000.8	2042.6	2006.5	0.320	2224.7	2178.5	2063.3	0.550
Carbohydrates (%)	51.7	52.2	52.2	0.214	52.0	52.0	51.8	0.901
Protein (%)	15.5	15.0	15.0	0.104	15.6	15.3	14.9	0.067
Total Fat (%)	33.6	32.9	33.4	0.526	33.1	32.8	34.0	0.117
Mono Fat[a] (%)	9.7	9.6	9.8	0.712	9.8	9.8	9.7	0.696
Poly Fat[b] (%)	6.0	6.0	5.9	0.680	6.2	6.1	6.2	0.643
Sat Fat[c] (%)	10.8	10.7	10.6	0.968	10.8	10.6	10.6	0.454
Trans Fat (%)	1.1	1.0	1.1	0.506	1.0	0.9	1.1	0.212
Fibers (g)	21.1	20.5	20.1	0.787	22.1	22.4	23.5	0.448

Note: *Kruskal-Wallis test, $p<0.05$; **Difference found between age groups. [a]Monounsaturated fat; [b]Polyunsaturated fat; [c]Saturated fat.

Table 3 – Frequency of weekly food consumption, by gender, in public schools' adolescents – Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study, 2018-2019.

Variables	C1 (%)		C2 (%)		C3 (%)		p^*
	Female	Male	Female	Male	Female	Male	
Salt added	72.3	75.5	11.7	14.0	16.0	10.5	0.066
Ready-made seasonings	67.3	71.3	17.5	20.5	15.2**	8.2**	0.010
Diet sweeteners	90.0	92.7	4.8	3.5	5.2	3.8	0.425
Diet/light/zero cal foods	86.1	82.7	10.2	13.5	3.7	3.8	0.350
Ready-made foods with a salty flavor[a]	34.4	36.0	55.8	57.3	9.8	6.7	0.313
Ready-made foods with a sweet taste[b]	28.8	29.5	45.0**	52.4**	26.2**	18.1**	0.020
Consumption in cafeterias and/or fast food chains	48.5	50.0	47.8	44.7	3.7	5.3	0.443
Soft drinks and carbonated drinks	35.9	26.3	47.2**	55.6**	16.9	18.1	0.014
Other processed beverages[c]	27.7	24.0	34.2**	43.0**	38.1**	33.0**	0.040
Purchase of food near school[d]	63.9	63.7	31.1	29.3	5.0	7.0	0.441
School meals[e]	40.0	48.7	26.5	30.8	33.5**	20.5**	<0.001

Note: *Pearson's Chi-square test, $p<0.05$; **Differences found between genders. [a]"packaged snacks" ("chips" type), powdered soups, mayonnaise and processed sauces, sausages, "instant" noodles, gnocchi or other refrigerated pasta, frozen lasagna, frozen pizzas, frozen cheese breads, frozen breaded chicken (nuggets type), box hamburgers, frozen meals (ready to warm up), *etc*; [b]ready-to-eat cakes, ready-made mixes for cakes and other processed desserts, breakfast cereals, frozen sweet pies, cereal bars, sweet biscuits or sweet cookies, sweets (ice cream, chocolate, candy, chewing gum, lollipop), *etc*; [c]boxed processed juices, sachets, flavored yoghurt, chocolate drink; [d]food and/or drinks sold close to the school, considering a maximum consumption of 5 days a week. [e]considering a maximum consumption of 5 days a week. C1: never/almost never (consumption at no time during the week or sporadically); C2: sometimes (consumption 1 to 4 times a week); and C3: frequently/always (consumption 5 to 7 times a week).

among females, while consumption from one to four times a week (category sometimes) of soft drinks, sweet-tasting ready-to-eat foods and other processed beverages were higher in males ($p<0.05$) (Table 3).

The median percentage of energy contribution of unprocessed foods or minimally processed foods observed was 42.1% for girls versus 43.0% for boys; for processed foods it was 10.2% and 11.2% for girls and boys, respectively, while that from ultra-processed foods corresponded to 46.7% in females versus 45.4% in males. However, no difference was found between the energy contribution rate of unprocessed foods when comparing genders. A difference was only observed between processed foods, that was higher in males ($p=0.008$) and in the case of ultra-processed foods, energy contribution rate were higher in females ($p=0.02$), as shown in Table 4. There were no differences with the other variables evaluated.

DISCUSSION

In the present study we found a high energy contribution from ultra-processed foods in public schools' adolescents' diet. The amount represented more than 40.0% of the daily calories, in females

Table 4 – Median rate of energy contribution by degree of industrial food processing in adolescents from public schools – Adolescence Lifestyle Study, *Juiz de Fora*, Brazil – EVA-JF Study, 2018-2019.

Variables	Unprocessed foods[a] (%)	Processed foods (%)	Ultraprocessed foods (%)
Gender			
Female	42.1	10.2	46.7
Male	43.0	11.2	45.4
p-value[*]	0.235	0.008	0.02
BMI/age			
Low Weight	40.3	8.9	51.2
Eutrophy	42.6	10.5	46.2
Overweight	42.7	10.6	45.5
p-value[**]	0.570	0.172	0.168
Economic Class[b]			
Upper/middle	41.4	10.9	48.1
Middle	43.0	10.5	45.4
Low	41.7	9.9	44.5
p-value[**]	0.290	0.850	0.241
Self-reported skin color			
Caucasian	42.8	10.9	45.7
Brown/Black	42.2	10.3	46.2
Other (yellow. indigenous)	40.8	9.7	47.8
p-value[**]	0.611	0.585	0.494
Age group			
14-15 years	43.4	10.1	45.2
16-17 years	41.7	10.6	46.5
18-19 years	41.7	11.3	46.2
p-value[**]	0.288	0.130	0.872
Sexual maturity			
Prepubescent	44.7	11.8	45.5
Pubescent	42.4	10.5	46.6
Post-pubertal	42.7	10.4	45.8
p-value[**]	0.390	0.328	0.226

Note: [*]Mann-Whitney Test, $p<0.05$; [**]Kruskal-Wallis Test, $p<0.05$. [a]Or minimally processed, culinary ingredients and culinary preparations based on these foods; [b]Medium/high family income: classes A and B1; average family income: classes B2, C1 and C2; low family income: class D-E

and males (46.8% and 44.7%, respectively). Other studies carried out in this same age group showed a contribution variation between 29.0% and 67.0% [5,9,10,30,31]. The significant participation of ultra-processed foods in the adolescents' eating framework is of concern, since those foods have unfavorable nutritional characteristics, being foods of low nutritional quality [8].

Adolescence is marked by biopsychosocial and behavioral changes, promoting greater autonomy. However, it becomes a period of greater vulnerability to the presence of risky behaviors that lead to negative impacts on health [2,4]. The peculiar characteristics of food consumption in this population, such as the increased consumption of processed foods at the expense of unprocessed foods, can already be observed in several countries [10,30-32].

More than 60% adolescents of both genders evaluated have the habit of consuming, at least once a week, ready-to-eat foods with a salty and/or sweet taste, and about 35% buy fried or baked snacks, savory cookies and sugary drinks in establishments close to the school setting at least one day a week; this habit was also observed by Santos *et al.* [33], with sweets being the most consumed foods by the sample of adolescents evaluated in the municipality of *Montes Claros, Minas Gerais*, Brazil. In our study, female adolescents exhibited a higher daily intake of sweet foods, similar to the findings of Zanini *et al.* [34] with adolescents from the city of *Caruaru, Pernambuco*, Brazil and by Braz *et al.* [35], in the city of *Campinas*, in *São Paulo*, Brazil. Furthermore, according to the 2009 PeNSE data, female adolescents exhibited higher regular consumption (≥5 days a week) of treats than male adolescents (58.3% versus 42.6%) and sweet cookies (35.8% versus 31.1%) [36].

It is noteworthy that the ease of access, the practicality in handling and consumption, in addition to the marketing strategies used by industries are factors pointed out as contributing to the increasing consumption of these foods, especially among young people, even among those with lower income [32,33,37,38]. Adolescence is a phase of greater vulnerability and susceptibility to food marketing strategies; however there are still few studies that assess the health impact on these individuals [39]. According to the PeNSE survey, carried out in 2015, more than half of the students assessed (54.0%) reported attending public schools that have canteens or points of sale nearby. Such points of sale, for the most part, are places that sell processed foods and beverages, which do not favor a healthy environment [2]. In addition, it is noteworthy that adolescents are more susceptible to socio-cultural influences, such as those of their peers and of the social media, tending to imitate habits and behaviors, including eating habits [3,39,40]. In a review carried out by Bittar and Soares [40], the authors emphasize that the media contributes to creating dysfunctional eating behaviors and that advertising exerts a strong influence on eating behavior, as it enhances an unattainable standard of beauty and this tends to have a negative effect on dietary behaviors.

Regarding the meals offered by the school, there was a difference in consumption between the genders on all days of the week. About 33.5% of girls and 20.5% of boys frequently consumed the school meal; these values are similar to those found by Locatelli *et al.* [41], which used the 2012 data of the PeNSE survey, where about 23.0% of adolescents reported consuming on a regular basis meals catered to school. Furthermore, the authors also found a positive association between the consumption of these meals and the intake of vegetables, fruits and beans, and a negative association with ultra-processed foods.

In a study by Noll *et al.* [42] with data from the PeNSE 2015 survey, it was also verified that the provision of meals in the school setting through the National School Feeding Program (PNAE) was associated with lower consumption of ultra-processed foods, such as processed snacks and soft drinks, among the adolescents surveyed. It is noteworthy that one of the PNAE guidelines, which covers Brazilian public schools, instituted the supply of healthy and adequate food, in which school meals are based, on unprocessed foods and culinary preparations based on these foods, contributing to the growth and adequate development, in

addition to allowing improved student learning and also playing an important role in the development of proper eating habits [43].

The consumption of sugary drinks was high in both genders, reaching more than 64% in at least one day a week. According to data from the Food and Nutritional Surveillance System, in 2019, the average consumption of sweetened beverages among adolescents was 65%, that is, about 2 out of 3 adolescents consumed these ultra-processed beverages [44]. Data from the Study of Cardiovascular Risks in Adolescents, with a sample of Brazilian adolescents, showed that the consumption of soft drinks was similar in both genders, about 45.0%, and this was the sixth most consumed food in this age group [4].

It is known that sugary drinks in general tend to increase caloric intake and may contribute to increased body fat and various health problems [45]. The wide dissemination of the harmful effects of soda consumption can help contributing to its replacement by other beverages that are not necessarily healthier, such as powdered soft drinks and boxed and/or canned juices. However, it cannot be said that the major consumption of other sugary drinks by girls in our study is due to this substitution. More investigations are needed.

When comparing the percentages of caloric contribution according to the degree of industrial processing, there was a greater contribution of ultra-processed foods in females. Other studies have also demonstrated greater consumption of ultra-processed foods among female adolescents, both in a national sample as well as in young people in the city of *Teresina, Piauí*, in the Northeastern region of Brazil and in *Montes Claros, Minas Gerais*, Brazil in the southeastern region [11,12,33]. One hypothesis that could explain this result is the range of ultra-processed foods available for purchase with fitness appeal, mainly aimed at female and younger audiences, as a result of the standard of beauty imposed by contemporary society. In general, industries develop food in these versions, which leads consumers to believe they are the best options and, consequently, healthier. Therefore, it is suggested that consumption increases due to the lack of knowledge about the harm that these products can cause. However, more investigations are needed.

Although it was observed that the consumption of macronutrients was within the limits established for the age groups and genders in general, the contribution rate of macronutrients observed in ultra-processed foods enhance their main characteristics: greater amounts of refined carbohydrates and fats in relation to the levels of proteins when compared to unprocessed foods, in addition to possibly contributing to a higher consumption of saturated and trans fats, as was observed in our sample. The average protein intake was higher among those adolescents aged between 14 and 15 years and lower in relation to carbohydrate intake, compared to other age groups. The difference may be due to the reduced intake of some processed foods, such as milk, cheese, bread, as also verified by Silva *et al.* [46] and Nogueira and Sichieri [47], and also due to the costs or to a diet that the adolescent may be on.

Several nutrients play important roles in adolescence, being responsible for proper body development and growth, such as vitamin A, minerals such as zinc and iron, and protein, and these are found in small amounts in ultra-processed foods [8,14]. It is known that this unbalanced composition, besides contributing to dietary inadequacy, is also strongly associated with the emergence of various health problems, such as overweight, lipid alterations in adolescents, as well as cardiovascular changes, respiratory problems and cancer [11,15,16,32,48-50].

In our study, there was a high prevalence of overweight in both sexes (29.9% among girls and 26.1% among boys), and these rates were higher than the average found in PeNSE [2]. It is known that excess weight is determined by several factors. However, it is also known that the increased consumption of ultra-processed foods is an avoidable factor and that it exerts a strong influence in causing excess weight, as demonstrated by the systematic review carried out by Costa *et al.* [51], where it was observed that most

studies show positive associations between the consumption of ultra-processed foods and the presence of body fat already during childhood and adolescence, thus being an extremely important aspect to be considered in public policies. The change in nutritional status due to the increasing consumption of ultra-processed foods also enhances the importance of adherence to healthy eating habits among these individuals as a way to prevent not only excess weight, but also other unfavorable health outcomes.

As for socioeconomic aspects, there were no differences in consumption between economic classes; however, most adolescents in the sample are from the middle classes (B2, C1 and C2), which can favor the purchase and consumption of ultra-processed foods. , as evaluated by Melo *et al.* [6], using data from the same study, verifying in adjusted linear regression models that the higher the socioeconomic level, the higher the consumption rate of ultra-processed foods. In other studies carried out with Brazilian and Chilean adolescents, a greater consumption of these foods by higher income young people living in urban areas was observed [52,53].

The study's strong point is the use of the NOVA classification of foods, taking into account industrial processing, since studies evaluating adolescents are still scarce. As a future perspective, it is considered essential that further studies assess the intake of salt and other food additives, such as sweeteners, as these can be highly consumed in adolescence and are widely present in ultra-processed foods. However, the study has some limitations, such as the application of only two R24h in the sample, both being performed on weekdays, which may not represent the usual intake of individuals. However, correction using the Multiple Source Method method was used in order to minimize the existing intrapersonal variation. Furthermore, the study cross-sectional design limits the inference on causality; however, it can help to generate hypotheses of potential health outcomes. Another existing limitation was that the students assessed attended only public schools, where lower income may have been an aspect limiting the inference to higher incomes, and for this reason, no associations were found between the consumption of ultra-processed foods and economic classes, as observed in other studies comparing adolescents attending public and private schools.

CONCLUSION

The present study found a high contribution from the group of ultra-processed foods in the diet of adolescents attending public schools, with a high prevalence of overweight in both sexes. Therefore, it is essential to adopt actions and strategies, with emphasis on food and nutrition education activities in the school setting, to foster healthy and sustainable eating habits, especially discouraging the consumption of ultra-processed foods and contributing to the reduction of the emergence of NCDs in this population.

CONTRIBUTORS

REFERENCES

1. World Health Organization. Young people´s health – a challenge for society: report of a who study group on young people and health for all. Technical Report Series 731. Geneva: Organization; 1986 [cited 2021 Jan 26]. Available from: https://apps.who.int/iris/handle/10665/41720

2. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde do Escolar – 2015. Rio de Janeiro: Instituto; 2016.

3. Das JK, Salam AR, Thornburg KL, Prentice AM, Campisi S, Lassi ZS, et al. Nutrition in adolescents: physiology, metabolism, and nutritional needs. Ann N Y Acad Sci. 2017;1393(1):21-33. https://doi.org/10.1111/nyas.13330

4. Souza AM, Barufaldi LA, Abreu GA, Giannini DT, Oliveira CL, Santos MM, et al. ERICA: intakeof macro and micro nutrients of Brazilian adolescents. Rev Saúde Pública. 2016;50(Suppl 1):S5. https://doi.org/10.1590/s01518-8787.2016050006698

5. Falcão RC, Lyra CO, Morais CM, Pinheiro LG, Pedrosa LF, Lima SC, et al. Processed and ultra-processed foods are associated with high prevalence of inadequate selenium intake and low prevalence of vitamin B1 and zinc inadequacy in adolescents from public schools in an urban area of northeastern Brazil. Plos One. 2019;14(12):e0224984. https://doi.org/10.1371/journal.pone.0224984

6. Melo AS, Neves FS, Batista AP, Machado-Coelho GL, Sartorelli DS, de Faria ER, et al. Percentage of energy contribution according to the degree of industrial food processing and associated factors in adolescents (EVA-JF study, Brazil). Public Health Nutr. 2021;24(13):1-10. https://doi.org/10.1017/S1368980021000100

7. Monteiro CA, Cannon G, Levy RB, Claro RM, Moubarac J-C, Martins AP, et al. The Food System. Ultra-processing. The big issue for nutrition, disease, health, well-being. World Nutr. 2012;3(12):527-69.

8. Monteiro CA, Cannon G, Levy RB, Moubarac J-C, Louzada ML, Rauber F, et al. Ultra-processed foods: what they are and how to identify them. Public Health Nutr. 2019;22(5):936-41. https://doi.org/10.1017/S1368980018003762

9. Vandevijvere S, Ridder K, Fiolet T, Bel S, Tafforeau J. Consumption of ultra-processed food products and diet quality among children, adolescents and adults in Belgium. Eur J Nutr. 2019;58(8):3267-78. https://doi.org/10.1007/s00394-018-1870-3

10. Rauber F, Martins CA, Azeredo CM, Leffa PS, Louzada ML, Levy RB. Eating context and ultra-processed food consumption among UK adolescentes. Br J Nutr. 2021;11:1-30. https://doi.org/10.1017/S0007114521000854

11. Lima LR, Nascimento LM, Gomes KR, Martins MC, Rodrigues MT, Frota KM. Association between ultra-processed food consumption and lipid parameters among adolescents. Cien Saude Colet. 2020;25(10)4055-64. https://doi.org/10.1590/1413-812320202510.24822018

12. Costa CD, Flores TR, Wendt A, Neves RG, Assunção MC, Santos IS. Sedentary behavior and consumption of ultra-processed foods by Brazilian adolescents: Brazilian National School Health Survey (PeNSE), 2015. Cad Saude Publica. 2018;34(3):e00021017. https://doi.org/10.1590/0102-311X00021017

13. Luiz-Roso MB, Padilha PC, Matilla-Escalante DC, Brun P, Ulloa N, Acevedo-Correa D, et al. Changes of physical activity and ultra-processed food consumption in adolescents from different countries during Covid-19 pandemic: an observational study. Nutrients. 2020;12(8):2289. https://doi.org/10.3390/nu12082289

14. Beal T, Morris SS, Tumilowicz A. Global patterns of adolescent fruit, vegetable, carbonated soft drink, and fast-food consumption: a meta-analysis of global school-based student health surveys. Food Nutr Bull. 2019;40(4):444-59. https://doi.org/10.1177/0379572119848287

15. Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. Br J Nutr. 2021;125(3):308-18. https://doi.org/10.1017/S0007114520002688

16. Srour B, Beslay M, Méjean C, Allès B, Fiolet T, Debras C, et al. Consumption of ultra-processed foods and the risk of overweight and obesity, and weight trajectories in the French cohort NutriNet-Santé. Proc Nutr Soc. 2020;79:e407. https://doi.org/10.1017/S0029665120003559

17. Liberali R, Kupek E, Assis MA. Dietary patterns and childhood obesity risk: a systematic review. Child Obes. 2020;16(2):70-85. https://doi.org/10.1089/chi.2019.0059

18. Deal BJ, Huffman MD, Binns H, Stone NJ. Perspective: childhood obesity requires new strategies for prevention. Adv Nutr. 2020;11(5):1071-78. https://doi.org/10.1093/advances/nmaa040

19. Enes CC, Silva JR. Association between excess weight and serum lipid alterations in adolescents. Cienc Saude Colet. 2018;23(12):4055-63. https://doi.org/10.1590/1413-812320182312.27882016

20. Bloch KV, Klein CH, Szklo M, Kuschnir MC, Abreu GA, Barufaldi LA, et al. ERICA: prevalences of hypertension and obesity in Brazilian adolescents. Rev Saude Publica. 2016;50S(Suppl 1):S9. https://doi.org/10.1590/s01518-8787.2016050006685

21. Neves FS, Fontes VS, Pereira PM, Lombelo-Campos AA, Batista AP, Machado-Coelho GL, et al. EVA-JF Study: methodological aspects, general sample characteristics and potentialities of a study on the lifestyle of Brazilian adolescents. Adolesc Saude. 2019;16(4):113-29.

22. Moshfegh AJ, Rhodes DG, Baer DJ, Muravi T, Clemesn JC, Rumpler WV, et al. The US department of agriculture automated multiple-pass method reduces bias in the collection of energy intakes. Am J Clin Nutr 2008;88(2):324-32. https://doi.org/10.1093/ajcn/88.2.324

23. Zaboto CB. Registro fotográfico para inquéritos dietéticos: utensílios e porções. Goiânia: Unicamp; 1996.

24. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009: tabela de composição nutricional dos alimentos consumidos no Brasil. Rio de Janeiro: Instituto; 2011.

25. Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007;85(9):660-7. https://doi.org/10.2471/blt.07.043497

26. Associação Brasileira de Empresas de Pesquisa. Critério de classificação econômica Brasil. São Paulo: Associação; 2018 [cited 2021 Jan 26]. Available from: http://www.abep.org/criterio-brasil

27. Tanner JM. Growth at adolescence: with a general consideration of the effects of hereditary and environmental factors upon growth and maturation from birth to maturity. 2nd ed. Oxford: Blackwell Scientific Publications; 1962.

28. Ministério da Saúde (Brasil). Proteger e cuidar da saúde de adolescentes na atenção básica. 2ed. Brasília: Ministério; 2017.

29. Padovani RM, Amaya-Farfán J, Colugnati FA, Domene SM. Dietary reference intakes: application of tables in nutritional studies. Rev Nutr. 2006;19(6):741-60. https://doi.org/10.1590/S1415-52732006000600010

30. Baraldi LG, Martinez Steele E, Canella DS, Monteiro CA. Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study. BMJ Open. 2018;8(3):e020574. https://doi.org/10.1136/bmjopen-2017-020574

31. Neri D, Martinez-Steele E, Monteiro CA, Levy RB. Consumption of ultra-processed foods and its association with added sugar content in the diets of US children, NHANES 2009-2014. Pediatr Obes. 2019;14(12):e12563. https://doi.org/10.1111/ijpo.12563

32. Organização Pan-Americana da Saúde. Alimentos e bebidas ultraprocessados na América Latina: tendências, efeito na obesidade e implicações para políticas públicas. Brasília: Organização; 2018.

33. Santos JC, Carvalho DM, Pinho L. Consumption of ultra-processed foods by adolescents. Adolesc Saude. 2019;16(2):56-63.

34. Zanini RV, Muniz LC, Schneider BC, Tassitano RM, Feitosa WC, González-Chica DA. Daily consumption of soft drinks, sweets and fried foods among adolescents in the Northeast of Brazil. Cienc Saude Colet. 2013;18(12):3739-50. https://doi.org/10.1590/S1413-81232013001200030

35. Braz M, Assumpção D, Barros MB, Filho AA. Added sugar intake by adolescents: a population-based study. Cienc Saude Colet. 2019;24(9):3237-46. https://doi.org/10.1590/1413-81232018249.24692017

36. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde do Escolar – 2009. Rio de Janeiro: Instituto; 2009.

37. Maia EG, Passos CM, Levy RB, Martins AP, Mais LA, Claro RM. What to expect from the price of healthy and unhealthy foods over time? The case from Brazil. Public Health Nutr. 2020;23(4):579-88. https://doi.org/10.1017/S1368980019003586

38. D'ávila HF, Kirsten VR. Energy intake from ultra-processed foods among adolescents. Rev Paul Pediatr. 2017;35(1):54-60. https://doi.org/10.1590/1984-0462/;2017;35;1;00001

39. Truman E, Elliot C. Identifying food marketing to teenagers: a scoping review. Int J Behav Nutr Phys Act. 2019;16:67. https://doi.org/10.1186/s12966-019-0833-2

40. Bittar C, Soares A. Media and eating behavior in adolescence. Braz J Occup Ther. 2020;28(1)291-308. https://doi.org/10.4322/2526-8910.ctoAR1920

41. Locatelli NT, Canella DS, Bandoni DH. Positive influence of school meals on food consumption in Brazil. Nutrition. 2018;53:140-4. https://doi.org/10.1016/j.nut.2018.02.011

42. Noll PR, Noll M, de Abreu LC, Baracat EC, Silveira EA, Sorpreso IC. Ultra-processed food consumption by Brazilian adolescents in cafeterias and school meals. Sci Rep. 2019;9(1)7162. https://doi.org/10.1038/s41598-019-43611-x

43. Ministério da Educação (Brasil). Resolução nº 6, de 8 de maio de 2020. Dispõe sobre o atendimento da alimentação escolar aos alunos da educação básica no âmbito do Programa Nacional de Alimentação Escolar – PNAE. Brasília: Ministério; 2020 [cited 2021 May 15]. Available from: https://www.in.gov.br/en/web/dou/-/resolucao-n-6-de-8-de-maio-de-2020-256309972

44. Sistema de Vigilância Alimentar e Nutricional (Brasil). Relatórios de Acesso Público. Brasília: Sistema; 2019 [cited 2021 Jan 26]. Available from: https://sisaps.saude.gov.br/sisvan/relatoriopublico/index

45. Yoshida Y, Simoes EJ. Sugar-Sweetened beverage, obesity, and Type 2 diabetes in children and adolescents: policies, taxation, and programs. Curr Diab Rep. 2018;18(6):31. https://doi.org/10.1007/s11892-018-1004-6

46. Silva JB, Elias BC, Mais LA, Warkentin S, Konstantyner T, Oliveira FL. Factors associated with inadequate milk consumption among adolescents: National School Health Survey – PeNSE 2012. Rev Paul Pediatr. 2020;38:e2018184. https://doi.org/10.1590/1984-0462/2020/38/2018184

47. Nogueira FA, Sichieri R. Association between consumption of soft drinks, fruit juice, and milk and body mass index among public school students in Niterói, Rio de Janeiro State, Brazil. Cad. Saude Publica, 2009;25(12):2715-24. https://doi.org/10.1590/S0102-311X2009001200018

48. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-processed foods and health outcomes: a narrative review. Nutrients. 2020;12(7):1955. https://doi.org/10.3390/nu12071955

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

50. Askari M, Heshmati J, Shahinfar H, Tripathi N, Daneshazad E. Ultraprocessed food and the risk of overweight and obesity: a systematic review and meta-analysis of observational studies. Int J Obes. 2020;44(10):2080-91. https://doi.org/10.1038/s41366-020-00650-z

51. Costa CS, Del-Ponte B, Assunção MC, Santos IS. Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. Public Health Nutr. 2018;21(1)148-59. https://doi.org/10.1017/S1368980017001331

52. Enes CC, Camargo CM, Justino MI. Ultra-processed food consumption and obesity in adolescents. Rev Nutr. 2019;32:e180170. https://doi.org/10.1590/1678-9865201932e180170

53. Cediel G, Reyes M, Louzada ML, Steele EM, Monteiro CA, Corvalán C, *et al.* Ultra-processed foods and added sugars in the Chilean diet (2010). Public Health Nutr. 2018;21(1):125-33. https://doi.org/10.1017/S1368980017001161