



Are the laws restricting the sale of food and beverages in school cafeterias associated with obesity in adolescents in Brazilian state capitals?

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ABSTRACT

Public policies that regulate the promotion or sale of unhealthy food and beverages in schools are relevant to prevent obesity in children and adolescents. However, the relationship between food and beverage laws within schools and obesity in Brazilian adolescents needs further study. Thus, this study aims to evaluate the association between laws that restrict the sale of food and beverages in school cafeterias and obesity in adolescents from public and private schools in Brazilian capitals. Data were provided by the ERICA study, which followed a cross-sectional school-based approach. The sample consisted of adolescents aged between 12 and 17 years ($n = 19,024$) from Brazilian capitals ($n = 27$) enrolled in schools that sell food and beverages in their dependence ($n = 486$). The dependent variable was the presence of obesity, and the main effect was the coverage of laws restricting the sale of food and beverages in school cafeterias. Data analysis was carried out using multilevel logistic regression models. Adolescents covered by laws restricting the sale of food and beverages in school cafeterias had an 11 % lower chance of obesity (adjusted OR = 0.89; 95 % CI 0.88 – 0.91). In conclusion, laws restricting the sale of food and beverages inside schools were associated with a decrease in the chance of obesity in adolescents in Brazilian state capitals.

1. Introduction

The school environment is where children and adolescents spend at least a third of their day (Reed et al., 2014) and may consume one to three meals corresponding to 40 % of their daily energy intake on average (Institute of Medicine, 2007). The foods and beverages that make up the meals consumed by students can be obtained through meals prepared at school, food brought from home, purchased from school cafeterias and nearby snack bars, or even from self-service machines (Story et al., 2009).

Regarding cafeterias, national data showed that 45.2 % of Brazilian students had a cafeteria at school in 2015 (Noll et al., 2019). According

to observational studies, cafeterias seem to expose students to the advertising of processed and ultra-processed foods (soft drinks, cookies, snacks, sandwiches, and pizzas) (Carmo et al., 2018), in addition to facilitating the consumption of these foods known as unhealthy (Leite et al., 2021).

On the other hand, a significant increase in obesity rates among Brazilian adolescents has been observed over the last five decades, according to the 2008–2009 Household Expenditure Survey (POF) (IBGE, 2011). In 2013–2014, the Study of Cardiovascular Risks in Adolescents (ERICA) found an overall prevalence of obesity 8.4 %, among boys it was 9.2 %, and for girls, it was 7.6 % (Bloch et al., 2016). In the face of rising obesity rates, interventions that contribute to a healthier eating

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environment at school become essential for obesity prevention (OPAS, 2018; Swinburn, 2008).

In developed countries, one can see a growing body of scientific evidence on the effectiveness of regulatory measures applied to the school environment to prevent obesity in the school environment (Chriqui et al., 2014; Sildén, 2018; Story et al., 2009). In Latin America, countries such as Chile (2016), Costa Rica (2012), and Mexico (2011), have mandatory legislation designed to restrict unhealthy foods and beverages sold in schools (Duran et al., 2021). In Brazil, there is no national mandatory legislation, but municipal and state instruments (Duran et al., 2021).

Previous studies that have characterized the food supply in cafeterias in Brazilian cities where laws exist have observed the persistent sale of foods that are not allowed (Gabriel et al., 2010; Gaetani and Ribeiro, 2015; Giacomelli et al., 2017; Machado and Höfelmann, 2019; Porto et al., 2015; Wognski et al., 2019). Another study found that laws restricting soft drinks in schools were associated with reduced sales in regions with better socioeconomic status (Azeredo et al., 2020).

Despite all this evidence, the association between laws restricting the sale of foods and beverages inside schools and the presence of obesity in Brazilian adolescents is yet to be determined. This study aims to contribute to this body of research by investigating the association between the presence of laws restricting sales of foods and beverages in school cafeterias and obesity in adolescents enrolled in public and private schools in Brazilian state capitals.

2. Methods

2.1. Study setting

In Brazil, in the scope of early childhood education, elementary school and high school, both public and private schools, are covered by the Interministerial Ordinance no. 1.010, of May 8, 2006, which establishes the guidelines for the Promotion of Healthy Eating at Schools (Ministério da Saúde; Ministério da Educação, 2006). However, only public schools are covered by the National School Meals Program (PNAE) (Henriques et al., 2021), which is responsible for ensuring mandatory subsidies for the consumption of healthy meals by students. In addition, the program provides for the supply of a minimum number of fruits and vegetables, prohibits some sugary drinks, and restricts the purchase of processed and ultra-processed foods to 20 % of federal funding (Duran et al., 2021). So far there is no Brazilian law at the federal level that regulates the sale of food in school cafeterias, but rather local initiatives by states and municipalities (Gabriel et al., 2012).

2.2. Study design and study population

Cross-sectional study based on data provided by *Estudo de Riscos Cardiovasculares em Adolescentes* (ERICA) - Study on Cardiovascular Risks in Adolescents. ERICA is a national school-based cross-sectional study carried out from March 2013 to December 2014, with 74,589 adolescents, in the age group 12 to 17 years, who study in public and private Brazilian schools. This is the most recent wave with available data. Detailed information about sample definition, sampling process, research protocol, participants' selection, and data collection from ERICA was previously published (Bloch et al., 2015; Vasconcellos et al., 2015).

Research sample included adolescents from 1,247 schools, who were enrolled in the last three years of elementary school or in the three high-school grades, in 124 counties divided into 32 geographic strata: 26 state capitals and the Federal District; and five strata that represented counties accounting for more than 100 thousand inhabitants in the country's macro-regions.

For this study, we selected the ERICA sample and only schools that sold food on their premises were eligible for the investigation ($n = 486$). Thus, the sample assessed included 29,024 adolescents from 486 schools

in the 27 Brazilian state capitals.

The study's complex sample included three selection levels. Schools were selected based on the number of students and on a probability inversely proportional to the distance between the state capital and the other counties. Three classes were selected in each school, at different school shifts (morning and afternoon) and grades (seventh, eighth, and ninth grades of elementary school; first, second and third grade of high school) at the same probability. All students from the selected classes were invited to participate in the study. Adolescents who were out of the determined age group (12 to 17 years), adolescents presenting some degree of disability – capable of impairing their anthropometric evaluation and questionnaire fulfillment – were not included in the study, as well as pregnant adolescents.

The study was approved by the Research Ethics Committee of the institution linked to the central coordination of the study (IESC/UFRJ) and of each Brazilian state. The study was also approved by the Research Ethics Committee of Federal University of Minas Gerais (CAAE: 61335316.5.0000.5149; Opinion 3.691.415 and CAAE: 38003220.4.0000.5149; Opinion 4.454.467). Adolescents who have agreed on participating in the study signed the consent form; the informed consent form was signed by their parents or legal guardians.

2.3. Data collection

Anthropometric measurements were taken from the full sample by trained researchers. Weight was measured based on single measurement taken in electronic scale Líder® (200 Kg capacity and 50 g variation), height was measured through the mean of two measurements taken in sequence in portable and detachable stadiometer (Altuxexata®), at millimeter resolution and field of use up to 213 cm.

Individual data were collected through questionnaire answered by adolescents, themselves, in electronic data collector Personal Digital Assistants (PDA). School data were collected through a questionnaire filled by the school principal (or the school's general manager) and by field research through direct observation.

In addition, data collection was performed to gather information about foods and beverages restricting sales in school cafeterias. Other regulation types, such as the ones that limit food advertisement, were not considered. The search for laws was carried out in duplicate by two researchers (L.H.A.G. and L.L.R.) who have consulted municipal and state government websites from the Brazilian state capitals. Data extracted from the selected laws included region, locality, publication year, provision, identification number, and coverage (only applied to public schools or to public and private ones). Only laws implemented up to 2014, corresponding to the final data collection at ERICA, were assessed.

2.4. Dependent variable

The presence of obesity was the dependent variable. Weight and height were the measurements used to calculate the body mass index (Bloch et al., 2015). Adolescents recording body mass index by age higher than the $Z + 2$ score were considered obese (de Onis et al., 2007).

2.5. Main effect

The coverage of laws restricting the sale of food and beverages in school cafeterias was considered the main effect. Two researchers read the laws' texts, in separate (M.M.A. and L.H.A.G.), and a third one was consulted in case of doubt (L.L.M.). After the texts were read, items that were addressed in the law were determined among the ones. Finally, the presence or absence of municipal and/or laws restricting the sale of food and beverages in school cafeterias was attributed to the adolescent (yes/no). Attribution considered the state capital the adolescent lived in, and the type of school (private/public). A detailed description of the laws can be accessed in [Supplementary Material 1](#).

The herein-approached regulations were law, ordinance, resolution, and decree. Briefly, to better understand the study, laws differ from each other due to force and function. From the hierarchical viewpoint, the law is more powerful, and it is followed by decree, resolution, and ordinance. Concerning function, the law is among the competencies of the Legislative Power; and it allows creating, extinguishing, or changing the rights and duties. A decree, in its turn, is issued by the Executive Power and mainly aims at regulating a law by providing details about its enforcement. Resolution is an internal legislative act that aims at explaining internal law. Finally, an ordinance is an administrative act aimed at disciplining the public administration (Oguisso and Schmidt, 1999).

2.6. Adjustment variables

The adjustment variables were sex (female/male), age (in years), socioeconomic status (SES) (low, middle, high), physical activity (inactive, insufficiently active, active), frequency of breakfast consumption (does not have it, has it every once in a while, almost every day, every day), and school meals (yes/no).

Socioeconomic status variable results from the sum of the score assigned to the possession of goods and comforts items considered in the 2013 version of the Brazil Economic Classification Criterion (CCEB) of the Brazilian Association of Research Companies (ABEP), as does the variable called wealth proxy proposed by Moura (2017). The use of the wealth proxy variable is due to the lack of information on some items required for the ABEP economic classification. Adolescents could respond to the student questionnaire by selecting “don’t know/don’t remember/don’t remember/prefer to answer” on at least one of the items essential for the classification. The exclusion of these items would represent a significant and heterogeneous loss of the sample, compromising the quality of the research (Moura et al., 2018; Moura, 2017).

The Adolescent Physical Activity Questionnaire (APAQ) validated was used by ERICA to assess whether adolescents exercised (de Farias Júnior et al., 2012). The ones who did not exercise (0 min) were considered inactive; those who used to exercise from 1 to 299 min a week were considered to be insufficiently active; and students who exercised for at least 300 min a week were considered active (WHO, 2018).

The frequency of breakfast consumption was included given its importance for the outcome, as shown by previous studies that have found an association between skipping breakfast and being overweight and obese in adolescents (Ma et al., 2020; Wicherski et al., 2021).

School meals refer to the provision of meals at school, a common practice in public schools compared to private schools because of the National School Meals Program (PNAE), which is aimed at public schools developed by the Brazilian federal government (FNDE, 2021).

2.7. Statistical analysis

First, the distribution of the proportions of all variables stratified according to being covered by law (yes/no) was assessed and compared through Chi-squared tests. The association between covered by law (main effect) and the presence of obesity (dependent variable) was estimated with logistic multilevel models including random intercepts at the school and capital levels. Variables such as sex, age, socioeconomic status, physical activity, frequency of breakfast consumption, school type (public/private) and provision of meals at the school were used for adjustment. Median Odds Ratios (MORs) and Intraclass Correlation Coefficients (ICCs) were computed for each level to quantify the proportion of obesity variation explained by each level across each model. The sequence of estimated models is as follows: first, we fit a “null” or “empty” model with just an overall mean and the random intercepts; afterward, we fit an “unadjusted” model further including the regulation exposure; and finally, we estimate an “adjusted” model further including the adjustment factors. In order to correct for possible confounding of

school-level covariates with unobserved capital characteristics (or “Level 3 endogeneity” in this case; see e.g., Castellano et al., 2014), we centered all adjustment variables on their capital means. A sensitive analysis was performed to assess whether results changed substantially without performing this group-mean centering of the adjustment variables (Supplement).

All analyses were conducted using STATA, version 17. Descriptive analyses and chi-square tests were performed with survey (svy) mode, which takes into consideration the sample structure. The package gllamm was used in the multilevel models since it allows the analysis of dependent data and inference for multilevel models within complex sampling designs. Significance level was set at 5 %.

3. Results

3.1. Sample description

The analyses in the present study included 29,024 adolescents from 486 schools in the 27 Brazilian state capitals. Obesity prevalence recorded in the samples reached 8.9 %. Adolescents in private schools presented higher obesity frequency than the ones in public schools (10.2 % vs 8.1 %, $p < 0.01$). The descriptive statistics of the samples stratified through the main effect are shown in Table 1.

3.2. Features of laws restricting sales of foods and beverages in school cafeterias

In total, 27 laws restricting food and beverage sales in school cafeterias in the Brazilian state capitals were published between 2001 (year when the first law was enacted) and 2014 (last years of data collection at ERICA). Most laws were state issued (63.0 %, $n = 17$) and covered public and private schools (77.8 %, $n = 21$). About regulating items in laws, 24 (88.9 %) laws mentioned forbidden-sales food, 17 (63.0 %) concerned allowed-sales food, 9 (33.3 %) regarded restrictions on the advertisement of unhealthy food, and 16 (59.3%) provisions mentioned some sort of food and nutrition education action (Tables A1 and A2,

Table 1

Features of adolescents enrolled in schools in Brazilian state capitals stratified by the coverage by laws restricting sales of foods and beverages in school cafeterias, 2013–2014, Brazil.

Variables	Total (%)	Covered by laws		p-value
		Yes (%)	No (%)	
<i>Sex (n = 29,024)</i>				
Male	50.3	50.2	50.4	0.826
Female	49.7	49.8	49.6	
<i>Age (n = 29,024)</i>				
< 15 years	49.2	49.3	49.2	0.986
≥ 15 years	50.8	50.7	50.8	
<i>Socioeconomic Status (n = 27,105)</i>				
High	32.1	31.2	34.1	0.060
Middle	66.3	67.5	63.5	
Low	1.6	1.3	2.4	
<i>Exercising (n = 29,024)</i>				
Inactive (0 min/week)	27.0	26.8	27.5	0.207
Insufficiently active (1–299 min/week)	27.8	28.4	26.3	
Active (≥ 300 min/week)	45.2	44.8	46.2	
<i>Frequency of breakfast consumption (n = 29,024)</i>				
Does not have it	22.1	23.5	19.2	0.047
Every once in a while	27.9	28.4	26.7	
Almost every day	13.1	13.3	12.7	
Every day	36.9	34.8	41.4	
<i>School meals (n = 29,024)</i>				
Yes	45.2	73.6	45.2	<0.001
No	54.8	26.4	54.8	
Rate of the weighed sample. Chi-square test. $p < 0.05$.				

Supplementary Material 1).

Of the 27 Brazilian state capitals, 11 (40.7 %) did not have any kind of restriction over the sales of foods and beverages in school cafeterias, which totaled 185 schools; this number corresponds to 31.6 % of adolescents in the sample (n = 9,163). On the other hand, 16 (59.3 %) state capitals have legal state and/or state laws, which totaled 301 schools covered by them; this number is equivalent to 68.4 % of adolescents in the sample (n = 18,861). Of the total of regulated state capitals, 4 (25.0 %) only covered public schools (two state networks, one municipal network, and one state, municipal and federal network), and 12 (75.0 %) covered public and private schools.

As shown in Table 2, there was a significant difference between the coverage of laws stratified by school type. The highest coverage rates of adolescents were observed in the ones at public schools; rather than those in private schools (76.8 % vs 55.5 %, p < 0.05).

3.3. Association between the coverage by laws restricting food and beverage sale in school cafeterias and the presence of obesity in adolescents

Table 3 contains the estimated associations between the coverage by laws restricting food and beverage sales in school cafeterias and the presence of obesity in adolescents. We found an inverse association between coverage by laws and obesity, with the presence of laws reducing the chance of obesity in adolescents in all schools by 11 % (adjusted OR = 0.89; 95 % CI 0.88 – 0.91). The complete estimates for these models (with the coefficients for the adjustment variables and random intercept variances), along with the main effect estimates without group-mean centering the adjustment variables are contained in the Supplement.

Throughout all estimated models, Median Odds Ratios (MORs) at the school level ranged from 1.66 to 1.78, and at the capital level, MORs ranged from 1.21 to 1.60. On the other hand, Intraclass Correlation Coefficients (ICCs) at the school level ranged from 0.08 to 0.10, and at the capital level, ICCs ranged from 0.01 to 0.07 for all schools. No qualitative changes in the results were found without group-mean centering the adjustment variables.

4. Discussion

The results showed that adolescents from public and private schools in Brazilian capitals covered by laws restricting the sale of food and beverages in school canteens had a lower chance of obesity.

Thus, it is suggested that the law restricting the sale of food and beverages in school canteens may be a protective factor against obesity. Previous studies observed that the law provided an increase in the availability and access to healthy foods, such as fruits and vegetables (Pineda et al., 2019), and the purchase of these foods in the school setting (Clinton-McHarg et al., 2018). In addition, the law appears to be a cost-effective measure in preventing obesity, enabling the generation of health savings (Gortmaker et al., 2015).

A systematic review that linked the law to body mass index (BMI) and weight observed mixed results (Chriqui et al., 2014), the authors attributed the results to a lack of rigorous study designs and very limited

Table 2
Distribution of adolescents enrolled in schools in Brazilian capitals covered by laws restricting sales of foods and beverages in school cafeterias, 2013–2014, Brazil (n = 29,024).

Type of school	Students attending schools	
	Covered by laws*	
	Yes	No
Public (%)	76.8 (72.1– 80.9)	23.2 (19.1 – 27.9)
Private (%)	55.5 (43.5 – 66.9)	44.5 (33.1 – 56.5)
Total (%)	68.4 (61.5 – 74.7)	31.6 (25.3 – 38.5)

Rate of the weighed sample. Chi-square test. *p < 0.001.

Table 3

Estimated associations between the coverage by laws restricting food and beverage sale in school cafeterias and the presence of obesity in adolescents enrolled in schools in Brazilian capitals, 2013–2014, Brazil.

Variables	Null Model		Unadjusted Model		Adjusted Model	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
All schools						
Global intercept	0.13	0.13 – 0.13	0.17	0.17 – 0.18	0.09	0.09 – 0.09
Coverage by laws restricting food and beverage sales in school cafeteria	–	–	0.55	0.54 – 0.56	0.89	0.88 – 0.91
ICC (schools)	0.10		0.09		0.08	
MOR (schools)	1.78		1.70		1.66	
ICC (capitals)	0.01		0.02		0.07	
MOR (capitals)	1.21		1.28		1.60	

p < 0.05; OR: Odds Ratio; 95 % CI: 95 % confidence interval; MOR: Median Odds Ratio; ICC: intraclass correlation coefficient. Associations were estimated using multilevel logistic regressions including random intercepts for each school and capital. The exposure (coverage by laws) has as its reference category the state/municipalities without any law. The null model includes only a global intercept, the unadjusted model further includes the coverage by laws, and the adjusted model further includes the adjustment factors (individual sex, age, socioeconomic status and physical activity and breakfast habits). In the model including all schools, the school type was adjusted for by a categorical variable indicating whether the school was private (reference = public schools).
The MOR for schools was computed as the exponential of 0.95 multiplied by the standard deviation of the school-level random intercept. The MOR for capitals was computed analogously.
The ICC for schools was computed as the ratio between the variance of the school-level random intercept and the sum between the same variance and 3.29. The ICC for capitals was computed analogously.

or no time intervals between the date of the policy and the outcomes examined (Chriqui et al., 2014). Another cross-sectional study, conducted with a representative sample of public school students in the United States, found that stronger state nutrition policies were associated with lower student BMI (Schwartz et al., 2020). The strengthening of state policy in this case came about through the introduction of a new federal policy, the Smart Snacks of 2013 that brings national guidelines for the sale of food and beverages in North American schools (Schwartz et al., 2020).

In Latin America, it is observed that countries such as Mexico and Costa Rica have mandatory laws valid in the country, unlike Brazil which has no national legislation (Duran et al., 2021). In Mexico and Costa Rica, prohibited foods were found in schools even after the implementation of the law (Duran et al., 2021; Jensen et al., 2021; Hugues et al., 2021; Jiménez-Aguilar et al., 2017). However, in Chile, a decrease in the availability of foods and beverages exceeding critical nutrient limits (sugar, saturated fats, total fats, trans fats) has been observed in schools (Silva et al., 2021).

In Brazil, previous studies show that there is also resistance to the creation and enforcement. And that although there are legal devices to regulate food sales in Brazilian schools, they still need to be more effective in improving the nutritional quality of food sold in school canteens (Gaetani and Ribeiro, 2015; Giacomelli et al., 2017; Machado and Höfelmann, 2019; Porto et al., 2015; Wognski et al., 2019). This is because there is resistance to the enforcement of the legislation, which generates ineffectiveness of legal devices in preventing the sale of ultra-processed foods, and industry interference in the development and approval of legal devices (Kurhayashi et al., 2022). In addition, the lack of enforcement and monitoring of the application of these laws reveals the need for strict control by responsible enforcement agencies.

As an alternative, we emphasize the need to study positive actions developed in the country, such as the prohibition of canteens in public schools (as is already done in the city of Belo Horizonte, Minas Gerais), or the reformulation of legal provisions on the sale of food and beverages

in schools to prohibit the sale of unhealthy foods and ensure the monitoring of its implementation. An excellent example to be followed to produce solid laws that promote healthy and adequate nutrition is the Model Law Project prepared by the Consumer Defense Institute (IDEC), which presents a proposal for a Model Law Project to transform public and private schools in Brazil into a school environment promoting adequate and healthy food (<https://idec.org.br/projeto-de-lei-para-escolas>). It is noteworthy that this model is aligned with the Food Guide for the Brazilian Population of the Ministry of Health and brings as a golden rule always to prefer fresh and minimally processed foods and avoid ultra-processed foods.

One of the main limitations of this study is how we assessed the laws, specifically regarding whether they already existed, and whether they were being implemented at the school level. Further, the very existence of school food policies does not necessarily mean that they are enforced. Another limitation is that, although in our case the exposure precedes the outcome, due to the cross-sectional design adopted we cannot infer causality. Since the possibility of endogeneity in our results (arising from school covariates that could have led to the existence of food policies and might therefore be confounded with unobserved capital characteristics) could not be completely ruled out, we implemented one of the corrections suggested by Castello et al. (2014) in order to consistently estimate associations, even in the presence of endogeneity.

As for the potential of this study, we highlight the pioneering profile of a study that associates the regulation of food and beverage trade in school cafeterias in Brazilian state capitals with obesity in adolescents using multilevel analysis. Furthermore, it reinforces the importance of regulatory measures targeting the school food environment as a strategy to address childhood obesity at the population level.

Finally, we can conclude that the coverage by laws restricting food and beverage sales in school cafeterias was associated with lower odds of obesity in adolescents in public and private schools in Brazilian state capitals. These results might help policymakers and decision-makers to adopt strategies focused on preventing child-adolescent obesity in the school setting.

4.1. Policy implications

Based on the results obtained in this study, it is possible to recommend the development of mandatory Federal Legislation that presents a minimum text capable of covering items considered important to promote a healthier school food environment, namely: a list of foods that are not allowed and allowed, restriction of advertising of foods that are not allowed, and food and nutrition education actions (IDEC, n.d.; OPAS, 2018). This legislation should also provide information about the school food environment in a broader sense, i.e., it should include all spaces, infrastructure, and conditions in and around school facilities where food is available for purchase or consumption (e.g.: school cafeterias, street food vendors, snack bars, kiosks, self-service machines, among others), all information should be available, such as that of food promotion (marketing, advertising, branding, food labels, packaging, and sales) and pricing, as recommended by the Food and Agriculture Organization of the United Nations (FAO, 2019). Furthermore, it is also relevant to identify the urgency of developing a single regulation that can be implemented nationwide and cover public and private schools, since all we can find are state and municipal decrees (IDEC, n.d.). Finally, we recommend further longitudinal research to reinforce these findings and even assess other outcomes, such as students' food consumption during their time at school.

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Maíra Macário de Assis: Conceptualization, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Milene Cristine Pessoa:** Conceptualization, Data curation. **Lucia Helena Almeida Gratão:** Investigation, Data curation, Writing – original draft. **Ariene Silva do Carmo:** Formal analysis, Data curation. **Mariana Zogbi Jardim:** Writing – review & editing. **Cristiane de Freitas Cunha:** Data curation. **Tatiana Resende Prado Rangel de Oliveira:** Data curation. **Luana Lara Rocha:** Investigation, Data curation, Writing – original draft. **Uriel Moreira Silva:** Formal analysis, Writing – review & editing. **Larissa Loures Mendes:** Conceptualization, Data curation, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodpol.2022.102402>.

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