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Adherence to school meals and co-occurrence of the healthy and unhealthy food markers among Brazilian adolescents

Adesão à alimentação escolar e coocorrência dos marcadores de alimentação saudável e não saudável entre adolescentes brasileiros

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Abstract *The aim of this study was to analyze the association between adherence to school meals and the co-occurrence of the regular consumption of healthy and unhealthy eating markers among Brazilian adolescents. Data from 67,881 adolescents in Brazilian public schools who participated in the 2015 National School Health Survey, were used. From the 7-day FFQ, the dependent variable was constructed, co-occurrence of regular consumption (≥ 5x/week) of healthy and unhealthy food markers, which was categorized as regular consumption of none, one or two, or three eating markers. We performed an ordinal logistic regression with adjustment for sociodemographic, eating habits outside of school, and school characteristics variables. The prevalence of the co-occurrence of the regular consumption of three healthy eating markers was 14.5%, and that of three unhealthy markers was 4.9%. High adherence to school meals (every day) was positively associated with regular consumption of healthy eating markers and inversely associated with regular consumption of unhealthy eating markers. The school meals provided by PNAE contribute to the promotion of healthy eating habits among Brazilian adolescents.*

Key words *School food, Adolescents, Food consumption, Healthy Surveys, Public Policy*

Resumo *Este estudo tem como objetivo analisar a associação entre a adesão à alimentação escolar e a coocorrência do consumo regular de marcadores de alimentação saudável e não saudável entre adolescentes brasileiros. Foram avaliados 67.881 adolescentes de escolas públicas brasileiras participantes da Pesquisa Nacional de Saúde do Escolar (PeNSE) de 2015. A partir do QFA de sete dias, construiu-se a variável dependente, coocorrência do consumo regular (≥ 5x/semana) de marcadores de alimentação saudável e não saudável, que foi categorizada em consumo regular de nenhum; um ou dois; ou três marcadores de alimentação. Realizou-se regressão logística ordinal com ajuste para variáveis sociodemográficas, hábitos alimentares fora da escola e características da escola. A prevalência da coocorrência do consumo regular de três marcadores de alimentação saudável foi de 14,5%, e de três marcadores de alimentação não saudável foi de 4,9%. A alta adesão à alimentação escolar (todos os dias) foi positivamente associada ao consumo regular de marcadores de alimentação saudável e inversamente associada ao consumo regular de marcadores de alimentação não saudável. A alimentação escolar fornecida pelo PNAE contribui para a promoção de hábitos alimentares saudáveis entre os adolescentes brasileiros.*

Palavras-chave *Alimentação escolar, Adolescentes, Consumo alimentar, Inquéritos epidemiológicos, Política Pública*

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Introduction

Adolescents are a nutritionally vulnerable population group due to the greater energy and nutrient requirements at this stage of life and their susceptibility to external influences, as school, media and friendships[1]. However, this group's eating habits are often unhealthy, characterized by low consumption of fruits and vegetables, and high consumption of ultra-processed foods (UPFs)[2,3] with their consumption is associated with several chronic diseases, as such obesity, cardiovascular and metabolic diseases, cancer, depression and gastrointestinal disorders[4].

Inadequate eating habits during adolescence are one of the main risk factors for the early development of chronic non-communicable diseases, with serious repercussions both in adolescence[1] (WHO, 2005) and adulthood[5]. On the other hand, healthy habits acquired and consolidated in adolescence can strongly perpetuate into adult life[5], and a school is a crucial place for the implementation of strategies and policies to promote healthy eating habits[6].

Several countries have implemented school food programs based on the hypothesis that it can be an effective intervention to improve the quality of students' diets, with positive effects seen in low- and middle-income countries[7]. In Brazil, the National School Food Program (PNAE, in the Portuguese acronym) aims to build healthy eating habits through food and nutrition education actions and the provision of free meals that meet all students' nutritional needs in the public primary and secondary education network throughout the school year. The menus prepared under the PNAE are planned based on fresh foods, sugar-sweetened beverages are forbidden, and the offer of ultra-processed foods rich in sodium or saturated fats is restricted. It is also mandatory to purchase at least 30% of food from family farming[8].

Studies have found an association between adherence to school meals and improved diet quality among Brazilian students[9-12]. However, none of them assessed the co-occurrence of the consumption of healthy and unhealthy markers associated with adherence to school meals among adolescents from Brazilian public schools.

Therefore, this study aims to analyze the association between the co-occurrence of the regular consumption of healthy and unhealthy eating markers and adherence to school meals among Brazilian students from public schools.

Methods

We used data from the third edition of the National School-based Health Survey (PeNSE) conducted in 2015, which is a cross-sectional study representative of Brazil, among ninth-graders enrolled at and attending public and private schools (102,072), covering the 27 federative units, including capitals and municipalities. Data were collected between April and September 2015 using a smartphone containing a structured and self-administered questionnaire divided into thematic modules. More detailed information on the sample size can be found in the survey publication[13].

This study evaluated only students from public schools offering school meals (67,881), considering that the independent variable of interest was students' adherence to school food of the National School Food Program (PNAE), which are all students enrolled in public schools[9].

Food consumption was assessed using a food frequency questionnaire (FFQ) in which adolescents could answer that they had not consumed any food or indicate the frequency from one to seven days, considering the last seven days before the interview. From a total of six food groups included in the FFQ, in this study, the following food groups were investigated: beans, vegetables, fruits, fried salted, soft drinks, and ultra-processed (*e.g.,* hamburger, ham, bologna, salami, sausages, packaged snacks, instant noodles, and crackers). The first three food groups were considered healthy eating markers, and the others were considered unhealthy eating markers, according to the classification adopted by IBGE[13].

From the responses for each food, food consumption was categorized as regular (≥ 5 x/week) and nonregular (< 5 x/week). Finally, two scores were created based on the simultaneity of foods consumed by each student, one for the consumption of healthy eating markers and another for the consumption of unhealthy eating markers, which were categorized into three categories: no consumption, regular consumption of one or two food groups or regular consumption of three eating markers.

The adherence to school meals was assessed by the question "Do you usually eat the meal (brunch/lunch) offered by the school?", with the categorized answers into (1) high adherence – considering the answer "Yes, every day"; (2) unsatisfactory adherence – considering the answers "Yes, 3 to 4 days a week"; "Yes, 1 to 2 days a week" and "rarely", and (3) nonadherence – considering

the answer "No". Sociodemographic, eating habits outside of school, and school characteristics variables were used to describe the sample and as covariates for adjusting the associations. Regarding school and sociodemographic characteristics, the variables included were the macroregion of the municipality (north, northeast, southeast, south, and midwest), school's geographic location (urban or rural), presence of canteen at school (yes or no), sex (male or female), age (groups: ≤ 13 years; 14 to 15 years; ≥ 16 years), paid work (yes or no), living with the parents (both of them, only mother, only father, neither of them), race/skin color (white, black, yellow, brown, and indigenous) and socioeconomic level (tertiles – low, medium, and high).

The socioeconomic level variable was built on the following reported items: owning a landline, mobile phone, computer, internet, car, motorcycle, bathroom with shower at home, and maid on three or more days a week. A weight was assigned to each item, which was the inverse of the frequency of ownership or presence in the total sample evaluated. Each adolescent's score was obtained by adding the individual items' weights, which were later divided into three tertiles[14]. Multiple imputation by chained equations (MICE) was performed for the variable maternal schooling, which showed a 25% loss of information, to assign numerical values to the variable[15]. Predictive variables for imputation were considered: gender, household assets (car, landline, cell phone, number of bathrooms at home), and services (housemaid and internet access at home).

The following variables were considered eating habits outside of school: having lunch or dinner with the parents or guardian, eating while watching television or studying, having breakfast, and having meals at fast-food restaurants. These variables were dichotomized: (1) Not regularly – considering the following answers: no; rarely; 1 to 2 days a week; and 3 to 4 days a week and (2) Regular – for the answers: 5-6 days a week; and every day.

The proportion of co-occurrence of the regular consumption of healthy and unhealthy eating markers was estimated using a Venn diagram. A descriptive analysis of the sociodemographic characteristics, eating habits outside of school, and school characteristics were performed for the general sample. Percentages of co-occurrence of the regular consumption of healthy and unhealthy eating markers and their respective 95% confidence intervals (CIs) were estimated according to adherence to school meals, and statistical significance was assessed by nonoverlapping confidence intervals. Multiple ordinal logistic regression models were used to test the association between the co-occurrence of the regular consumption of healthy and unhealthy eating markers (outcome) and adherence to school meals (exposure), adjusting for potential confounders. The variables included in the adjusted model were identified by constructing the directed acyclic graph (DAG) in the program daggity version 3.0[16]. The minimum adjustment identified included sex, age, socioeconomic level, living with parents, paid work, having breakfast, eating while studying or watching TV, having meals with parents or guardians, having meals at fast-food restaurants, macroregion of the municipality, school's geographic location, and presence of canteen (Figure 1).

Multiple models were developed for the co-occurrence of the regular consumption of healthy eating markers and the co-occurrence of the regular consumption of unhealthy eating markers, considering "not regularly consuming any health/unhealthy food" as the reference category.

The National Research Ethics Commission (CONEP) approved PeNSE on March 30, 2015 (registration no. 1.006.467). All analyses were performed using Stata version 14.2 for Windows, considering the complex design of the sample.

Results

Approximately 52% of the 67,881 adolescents attending public schools were female, most of them were aged between 14 and 15 years old, did not engage in paid work, lived with their parents, resided in urban areas and attended schools without canteen. Regarding adherence to school meals, 22.0% showed high adherence to school meals (every day), 47.3% showed unsatisfactory adherence, and 30.8% had nonadherence (Table 1).

The prevalence of the co-occurrence of the regular consumption (≥ 5x/week) of the three healthy and unhealthy eating markers was 14.5% and 4.9% among students, respectively. Slightly more than half of the adolescents (52.6%) reported not regularly consuming any of the unhealthy eating markers, and 21.7% reported not regularly consuming any of the healthy assessed eating markers (Figure 2).

A lower proportion of adolescents with high adherence to school meals reported not regularly consuming any of the healthy food markers as-

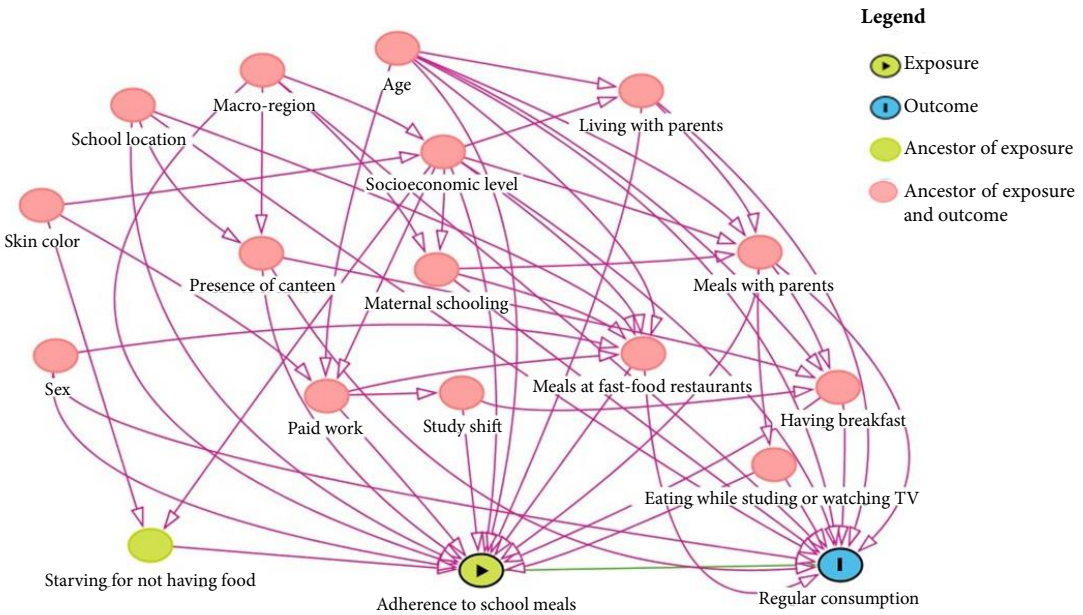

Figure 1. Directed acyclic graph (DAG) showing the association between the regular consumption of healthy and unhealthy eating markers with adherence to school meals.

Source: Authors.

sessed, and a higher proportion reported regularly consuming the three healthy eating markers when compared to adolescents with unsatisfactory adherence and nonadherence.

A higher proportion of adolescents with high and unsatisfactory adherence to school meals reported not consuming any unhealthy food markers regularly, and a lower proportion of adolescents reported regularly consuming three of those unhealthy food markers assessed when compared to adolescents who did not adhere to school meals. No statistically significant difference was found in the consumption of one or two healthy and unhealthy eating markers (Figure 3).

A positive association between high adherence to school meals and co-occurrence of the regular consumption of healthy eating markers was observed when compared with nonadherence (OR: 1.25; 95%CI: 1.15-1.36) in the adjusted ordinal logistic regression model. Regarding the co-occurrence of the regular consumption of unhealthy food markers, a negative association was observed with high (OR: 0.78; 95%CI: 0.72-0.84) and unsatisfactory (OR: 0.84; 95%CI: 0.79-0.90) adherence to school meals when compared with nonadherence (Table 2).

Discussion

The positive association between the co-occurrence of the regular consumption of healthy eating markers and adherence to school meals observed in this study suggest that PNAE are associated with healthy dietary habits among Brazilian students, similar to that found in Brazilian national surveys[9-12] and Belo Horizonte, Minas Gerais, Brazil. Data from other countries also showed that free school meals are positively associated with the quality of students' diet and food security[17]. A Brazilian study assessed 2,500 school meal menus by a quality index that was previously validated and found that only 20% presented low quality[18].

It is worth mentioning that in the year of the PENSE 2015 data collection, some rules to improve the school menus had already been implemented. Since 2009, it has been mandatory to provide at least three servings of fruits and vegetables per week (200 g/week), and there are limits on the amounts of sugar, sodium, and fats in the daily preparations for the school meal. Furthermore, low nutritional content drinks (soft drinks and artificial refreshments, drinks or

Table 1. Sociodemographic characteristics, eating habits outside of school, and school characteristics of adolescents from public schools. Brazil, 2015.

Variables	Total		
	n	%	95%CI
School meals			
High adherence (every day)	14,717	22.0	20.9-23.1
Unsatisfactory adherence (1-4x/week)	32,002	47.3	46.3-48.2
Nonadherence	21,124	30.8	29.4-32.2
Sex			
Female	36,031	52.4	51.7-53.2
Age group			
≥ 16 years	8,778	11.0	10.3-11.7
14-15 years	49,205	71.6	70.3-72.8
≤13 years	9,898	17.5	16.2-18.8
Socioeconomic level			
High – 3º tertile – (0-5.4 points)	18,996	28.8	27.7-29.8
Medium – 2º tertile - (5.5-7.3 points)	22,061	35.2	34.3-36.1
Low – 1º tertile – (11.9-19.2 points)	26,824	36.0	34.9-37.2
Race/skin color			
White	20,389	34.3	33.2-35.5
Black	9,123	13.9	13.3-14.5
Yellow	2,827	3.9	3.6-4.2
Brown	32,997	44.7	43.7-45.7
Indigenous	2,489	3.2	2.9-3.5
Living with parents			
Both of them	37,555	57.8	56.9-58.6
Only mother	22,100	31.7	3.1-3.2
Only father	3,437	4.5	4.2-4.8
Neither of them	4,711	6.0	5.7-6.4
Paid work			
Yes	8,629	13.0	12.4-13.6
Having breakfast			
Regularly (≥ 5x/week)	43,372	64.0	63.0-65.1
Meals with parents or guardian			
Regularly (≥ 5x/week)	50,268	75.2	74.5-75.8
Eating while studying or watching TV			
Regularly (≥ 5x/week)	32,508	49.2	48.3-50.1
Meals at fast-food restaurants			
Regularly (≥ 5x/week)	3,412	4.7	4.4-5.1
Presence of canteen			
Yes	22,143	34.2	30.3-38.3
School's geographic location			
Urban	61,709	91.3	89.9-926
Macroregion of the municipality			
North	16,563	9.3	8.6-10.0
Northeast	21,786	24.9	23.4-26.5
Southeast	12,447	44.9	42.5-47.4
South	7,298	13.4	12.4-14.6
Midwest	9,787	7.5	6.9-8.1

N: number of individuals (unweighted sample). 95%CI: 95% confidence interval.

Source: Authors.

concentrates based on guarana or currant syrup, ready-to-drink teas, and other similar drinks) are prohibited, and ultra-processed foods (canned food, sweets, compound foods, semi-ready or ready-made preparations consumption, or concentrated foods) are restricted[8].

Additionally, aiming to encourage the voluntary adoption of healthy food practices and

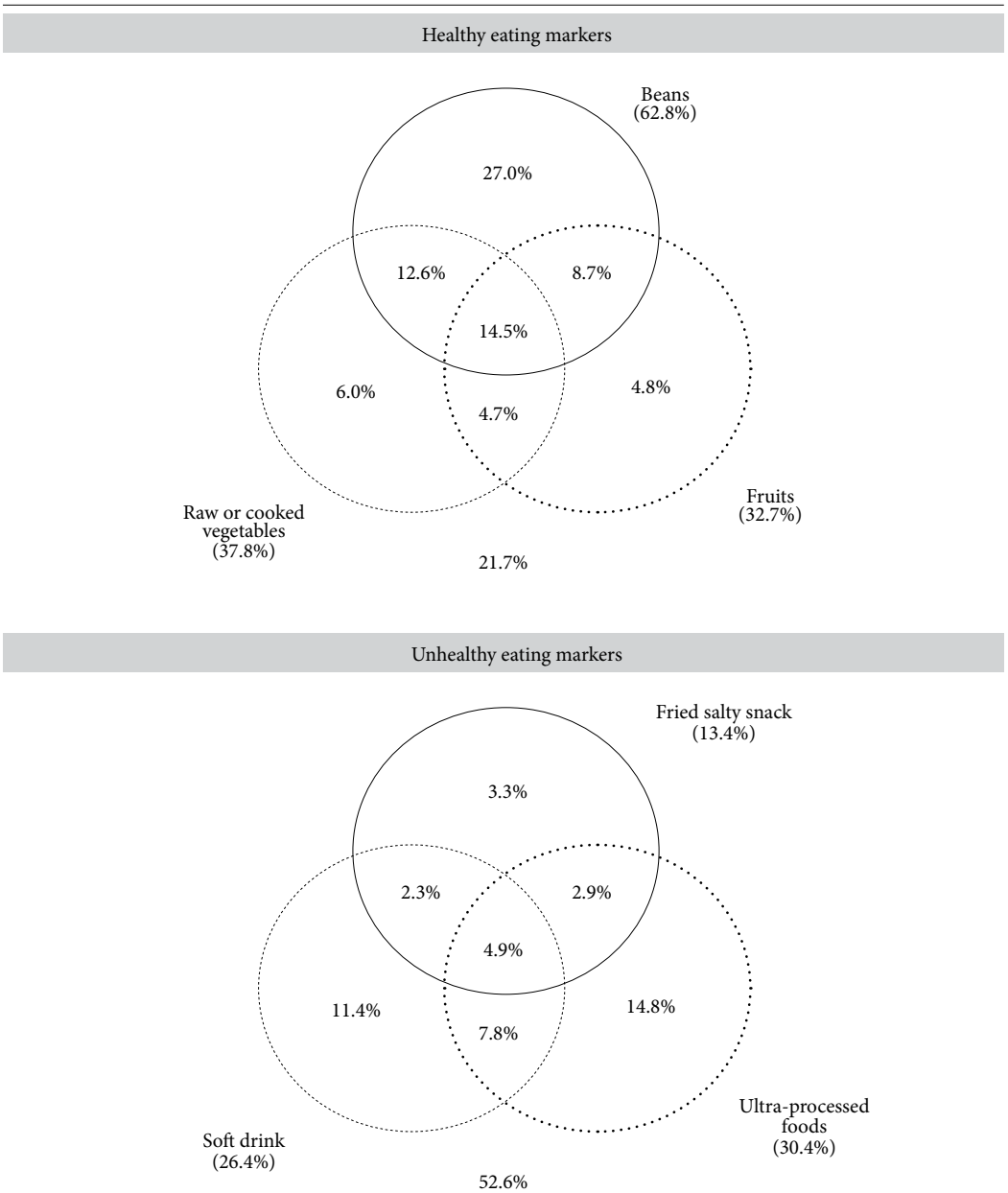

Figure 2. Venn Diagram of the co-occurrence of the regular consumption of healthy and unhealthy eating markers among adolescents from public schools (Brazil, 2015).

Source: Authors.

students' choices, the legislation provides the inclusion of Food and Nutrition Education actions in the school environment. Another rule implemented to improve the quality of school menus was to destinate 30% of the PNAE budget for purchasing fresh and minimally processed foods from family farming[19], supporting the sustainable food systems. Thus, the study findings are in line with PNAE legislation in force in the year of data collection and suggest that the aims of PNAE to promote healthy habits among schoolchildren are being achieved.

Recently, the rules for the planning of school menus were updated, making progress more rig-

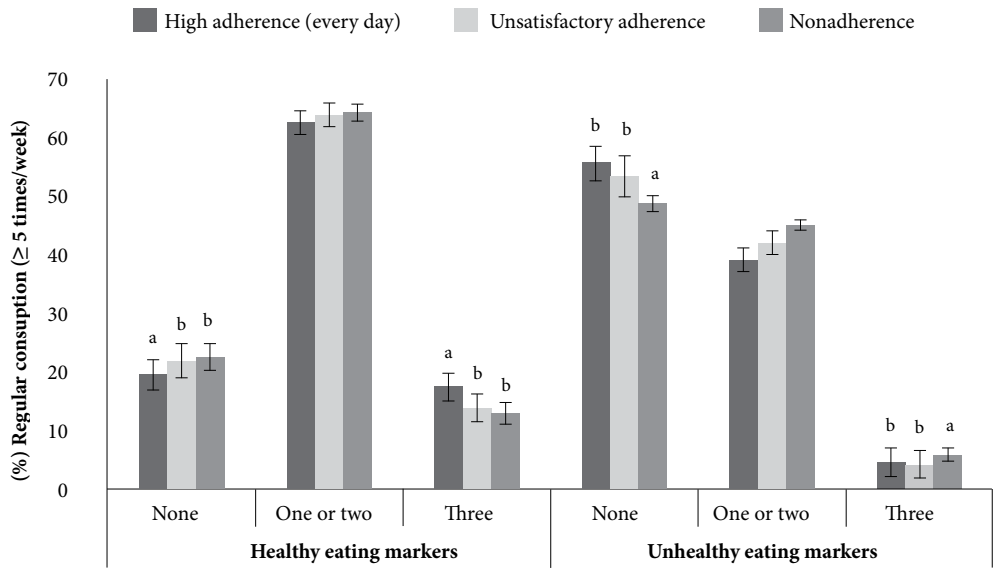

Figure 3. Co-occurrence of the regular consumption of healthy and unhealthy eating markers, according to adherence to school meals among adolescents from public schools (Brazil, 2015).

Different letters represent statistical differences ($p < 0.05$).

Source: Authors.

Table 2. Multiple ordinal logistic regression model for the association between co-occurrence of the regular consumption of healthy and unhealthy eating markers with adherence to school meals among students from public schools, adjusted for covariates (Brazil, 2015).

Variable	Healthy eating markers			Unhealthy eating markers		
	OR	95%CI	p-valor	OR	95%CI	p-valor
School meals						
High adherence	1.25	1.15-1.36	< 0.01	0.78	0.72-0.84	< 0.01
Unsatisfactory adherence	1.03	0.96-1.03	0.42	0.84	0.79-0.90	< 0.01
Nonadherence	1.00			1.00		

OR: Odds ratio. 95%CI: 95% confidence interval. Reference category: consumption of no healthy marker regularly and no unhealthy marker regularly. Adjusted for sociodemographic variables (sex, age, socioeconomic level, paid work, and living with parents), eating habits outside of school (having breakfast, eating while studying or watching TV, meals with parents or guardians, and meals at fast-food restaurants), and school characteristics (macroregion of the municipality, school's geographic location and presence of canteen).

Source: Authors.

orous. It was established that the PNAE resources should be spent according to criteria based on food processing, restricting even more purchases of ultra-processed foods[19], based on the Dietary Guideline for the Brazilian Population[20]. This is important progress to improve the school meals offered by PNAE and could result in an even better positive impact on adolescents' eating habits.

In this context, we highlighted that the update of the acquisition food by PNAE and the results of this study show the important role of PNAE to mitigate the global syndemic of obesity, malnutrition and climate change and to reach the Sustainable Development Goals for 2030, which outlines strategies such as the promotion of healthier eating behaviors and the adoption of sustainable food systems[21], since the school meals' guideline encourages the consumption of fresh or minimally processed foods from sustainable agriculture and the disincentive to the consumption of ultra-processed foods.

Despite the positive findings of this study and the fact that the school meals in Brazil are free of charge, it is important to highlight that the proportion of adolescents who consume school meals five times/week is low (22.0%), similar to other Brazilian studies that also observed a low consumption of school meals[10,22-24].

One of those main factors associated with the consumption of school meals is socioeconomic conditions, with higher consumption of school meals among students with worse socioeconomic conditions[24]. Even though school meals are offered to all students, the idea that the consumption of school meals is related to the condition of poverty still persists in the daily life of schools among the entire school community (students, teachers, directors, lunch ladies and nutritionists). In this way, a stigmatized image is attributed to students who consume the meals offered by school[25].

Other issues involving the food preferences of students and the presence of competitive food inside the school are also considered main factors for low adherence to school meals[24]. In Brazil, public schools may have canteens, which may be regulated or not by local governments[26]. Additionally, it is common to find alternative food outlets around schools[9,13,27]. The presence of canteens[28] and alternative sale outlets[13] in the school environment is associated with higher consumption of ultra-processed foods in Brazilian adolescents and lower consumption of school meals provided by PNAE[21,23,24]. The ultra-processed foods commercialized by canteens and alternative outlets in the school environment[9,27] are known as "competitive foods", as they compete with school meals and are a barrier to healthy eating habits.

Currently, it has been observed that the diet quality of Brazilian adolescents is worsening[2,3], which was exacerbated by suspension of classes in schools due COVID-19[29]. Multiple challenges were faced related to execution of the PNAE during pandemic period, resulting in worsened health and nutrition indicators and advanced dietary inequalities[30,31]. Therefore, it emphasizes the need for governments to plan strategies and direct financial resources that aim to change this scenario. Another point that should be highlighted is the role of the PNAE in reducing possible disparities in access to and consumption of healthy foods, such as fruits and vegetables[11]. This becomes even more important in a context where healthy foods are becoming more expensive[32].

School meals offered by the PNAE can be a great ally to improve adolescents' health since the findings of this study demonstrate its potential in the formation of healthy habits. However, the modification of the school food environment, such as limiting access to competitive foods by effective regulations and using strategies to enhance the palatability of the meals offered by PNAE, could result in a positive impact on eating practices in Brazilian students, as was already observed in other countries[33]. It is also necessary to eliminate the stigma associated with school meals offered by the PNAE by recognizing it as a policy based on the human right to adequate food for everyone in the school community.

The PeNSE 2015 questionnaire did not assess quantities and the place where food was consumed, which can be considered a limitation of this study, as it cannot be ascertained that the consumption of healthy or unhealthy foods comes from school meals. Despite this, the school food environment is capable of influencing consumption outside of schoo[l6,19], and it was appointed that food consumption on school days is associated with healthier eating habits[34]. Furthermore, there is no information on the survey instrument about food purchased in canteens and other places around the schools by adolescents, which would be relevant for this study. As PeNSE is carried out periodically, we believe it would be important to investigate further details about the school food environment in the next edition.

As a strength, the novelty of this study stands out when evaluating the association between the

co-occurrence of the regular consumption of healthy and unhealthy eating markers and adherence to school meals in a representative sample of Brazilian school adolescents. The construction of the directed acyclic graph to identify potential confounders is a strength of the study as well.

In conclusion, the results of this study showed that high adherence was positively associated with regular consumption of healthy eating makers and inversely associated with regular consumption of unhealthy eating makers, reinforcing the crucial role of PNAE in encouraging healthy habits among Brazilian adolescents and its potential to mitigate the global syndemic. These data could be useful in decision-making regarding the direction of financial resources aimed at improving adolescent health and chronic disease prevention by public managers.

Collaborations

M Froelich, AP Muraro e ACS Andrade participated in the study design, analysis and interpretation of data; writing or critical review. BSN Souza, PRM Rodrigues and DB Cunha participated in the analysis and interpretation of data; critical review of the article. All authors were responsible for the final review of the article and its approval

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