ORIGINAL ARTICLE

School Food Environment and Adherence to School Meals of Brazilian Adolescents: A Multilevel Analysis

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Highlights:
1. The school food environment influences adherence to school meals;
2. Geographic variables were associated with adherence to school meals;
3. Actions aiming to promote a healthy school environment are needed.

ABSTRACT

Objective: This study aimed to assess school food environment factors associated with adherence to school meals among adolescents from Brazilian public schools. *Methods*: This is a cross-sectional study with data of 67,881 adolescents aged 11 to 19 years, students from public schools who participated in the 2015 National Adolescent School-based Health Survey (PeNSE). The dependent variable was the frequency of school meals consumption, classified as adherence (≥3x/week), unsatisfactory adherence (1-2x/week), and non-adherence (no day). Multilevel ordinal proportional odds regression was used to estimate the effect of individual variables and the school environment on school meals adherence. *Results*: Among the students evaluated, 31.3% adhered to school meals, 37.9% adhered to it unsatisfactorily, and 30.8% did not adhere to it. After adjusting for individual variables, greater adherence was observed among those who attended schools without a canteen (OR: 1.46; 95% CI: 1.35-1.57), without an alternative food sale outlet (OR: 1.29; 95% CI: 1.20-1.39), from the South (OR: 1.38; 95% CI: 1.22-1.56), Southeast (OR: 1.30; 95% CI: 1.16-1.46), and the Midwest (OR: 1.95; 95% CI: 1.75- 2.18), non-capitals (OR: 1.42; 95% CI: 1.33-1.52) and rural areas (OR: 1.41; 95% CI: 1.26-1.57). *Conclusion*: The students who attended schools without canteen and alternative food sale outlet show 46% and 29% greater chances to adhere to school meals, respectively. These results highlighted the need for interventions that promote a healthier school food environment and strengthen Food and Nutrition Education actions in Brazilian public schools.

Keywords: school feeding; students; school health services; public policy; healthy surveys.

AMBIENTE ALIMENTAR E ADESÃO À ALIMENTAÇÃO ESCOLAR DE ADOLESCENTES BRASILEIROS: ANÁLISE MULTINÍVEL

RESUMO

Objetivo: Este estudo teve como objetivo avaliar os fatores do ambiente alimentar escolar associados à adesão à alimentação escolar entre adolescentes de escolas públicas brasileiras. *Métodos:* Trata-se de um estudo transversal com dados de 67.881 adolescentes de 11 a 19 anos, estudantes de escolas públicas que participaram da Pesquisa Nacional de Saúde do Escolar (PeNSE) 2015. A variável dependente foi a frequência de consumo da alimentação escolar, classificada em adesão (≥3x/semana), adesão insatisfatória (1-2x/semana) e não adesão (nenhum dia). Utilizou-se regressão multinível ordinal para estimar o efeito das variáveis individuais e do ambiente escolar na adesão à alimentação escolar. *Resultados:* Dentre os estudantes avaliados, 31,3% aderiram à alimentação escolar, 37,9% aderiram insatisfatoriamente e 30,8% não aderiram. Após ajuste para variáveis individuais, observou-se maior adesão entre os que frequentavam escolas sem cantina (OR: 1,46; IC 95%: 1,35-1,57), sem ponto alternativo de venda de alimentos (OR: 1,29; IC 95%: 1,20-1,39), do Sul (OR: 1,38; IC 95%: 1,22-1,56), Sudeste (OR: 1,30; IC 95%: 1,16-1,46) e Centro-Oeste (OR: 1,95; IC 95%: 1,75-2,18), não capitais (OR: 1,42; IC 95%: 1,33-1,52) e áreas rurais (OR: 1,41; IC 95%: 1,26-1,57). *Conclusão:* Os estudantes que frequentam escolas sem cantina e ponto alternativo de venda apresentaram 46% e 29% maiores chances de adesão à alimentação escolar, respectivamente. Esses resultados destacam a necessidade de intervenções que promovam um ambiente alimentar escolar mais saudável e fortaleçam as ações de Educação Alimentar e Nutricional nas escolas públicas brasileiras.

Palavras-chave: alimentação escolar; estudantes; serviços de saúde escolar; políticas públicas; inquéritos de saúde.

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INTRODUCTION

The National School Food Program (PNAE) was created in the 1950s, evolved through the years, and has become nationally and internationally recognized as a main strategy to promote Food and Nutrition Security (FNS) in the country[1,2]. It aims to contribute to biopsychosocial growth and development, learning, school performance, and the establishment of healthy eating habits through food and nutrition education actions and free school meals that meet the student's daily nutritional needs. In Brazil, all students from pre-school to upper secondary level of public schools can benefit from one or up to three meals a day, depending on their age and how long they stay in school[3]. The menus are planned by nutritionist professionals and are based on fresh foods, sugar-sweetened beverages are forbidden, and the offer of ultra-processed foods rich in sodium or saturated fats is restricted[4,5]. Thus, it is an important strategy to improve eating habits.

Previous studies have shown a positive association between school meal consumption and healthy eating habits among Brazilian adolescents[6-8], which highlights the potential of school meals to improve the habits of adolescents, who often have a high consumption of ultra-processed foods and low consumption of fruits and vegetables[9]. However, although the PNAE provides school meals for all students in public schools, adherence to the food offered is low among adolescents, ranging from approximately 20% to 60%[2,10-15]. These results are very far from the universal care advocated by the program[3], thus reflecting the achievement of its objective.

In this sense, identifying determinants for low adherence to school meals is essential to support actions that contribute to PNAE's improvement and effectiveness. Some studies observed an association between adherence to school meals and individual factors among adolescents, such as age group[2,11,13], sex[2,12,14,16], ethnicity/skin color[2,12,13], maternal schooling[12,16], socioeconomic conditions [2,11,13,14,16], maternal occupation, consumption of competing foods (competing with school meals) at school[14,16], regularly buying food at the canteen, and having paid work[13].

Most of the studies that evaluate the school meals adherence, considering only the individual factors[2,11-14,16], but literature evidenced an association between adherence to school meals and some characteristics of the school food environment, such as the presence of a canteen[11], alternative food sale outlets[15], the student's perception of the cafeteria's physical structure[14]. The school food environment, defined as available spaces and infrastructure where food can be obtained, purchased, or consumed in and around schools [17], has contributed to unhealthy food choices among adolescents[20]. Understanding the influence of the food environment on food choice could provide a basis for interventions aimed at enhancing healthy eating, which can contribute to reaching the Sustainable Development Goals for 2030[18].

Therefore, this study evaluated school food environment factors associated with adherence to school meals among Brazilian adolescents from public schools, adjusting for factors in individual level.

METHODS

In this study, we used data from the 2015 National Adolescent School-based Health Survey (PeNSE), obtained through a survey carried out with ninth-graders enrolled and regularly attending public and private schools located in urban and rural areas throughout the national territory in 2015 (n=102,072). This sample adequately represents Brazilian adolescents, covering the 27 federative units, including capitals and inland cities. However, considering the objective the objective of this study, only the data of students from public schools that offered school meals (n= 67,881) were evaluated. Data were collected between April and September 2015 using a smartphone provided by interviewers containing a structured and self-administered questionnaire. The data are available at

https://www.ibge.gov.br/estatisticas/sociais/saude/9134-pesquisa-nacional-de-saude-do-escolar.html?edicao=9135&t=microdados. More detailed information on sample design and data collection is available in the survey publication[19].

The dependent variable was adherence to school meals, assessed from the question "do you usually eat the food (snack/lunch) offered by the school?" and with the answers categorized as: (1) adherence – considering the answers: "yes, every day"; and "yes, 3 to 4 days a week", (2) unsatisfactory adherence – considering the answers "yes, 1 to 2 days a week" and "rarely" and (3) non-adherence considering the answer – "no"[15].

The independent variables refer to the individual and school levels. The following variables were considered for the school level: the presence of canteen and alternative food sale outlet at school (yes and no), macro-region of the municipality (North, Northeast, South, Southeast, and Midwest), municipality location (capital and non-capital) and the school's geographic location (rural and urban).

The individual-level variables were sex (female and male); ethnicity/skin color (White, Black, Yellow, Brown, and Indigenous); age group (≤13 years, 14-15 years, and ≥ 16 years); paid work (yes and no); study shift (afternoon, morning, intermediate or full-time); maternal schooling (complete higher education, complete secondary education/incomplete higher education, complete primary education/incomplete secondary education, incomplete primary education and no education); living with parents (both parents, neither of them, lives only with the mother, lives only with the father); socioeconomic level (tertiles – low, medium, and high); and starving for not having food at home (never, rarely and sometimes/most of the time/always).

The economic level variable was constructed and based on the following reported items: owning a landline telephone, cell phone, computer, internet, car, motorcycle, bathroom with shower in the house, and presence of a maid three or more days a week. A weight was assigned to each item equivalent to the inverse of the frequency of ownership or presence in the total sample evaluated. The score of each adolescent was obtained by adding the weights of the respective items, later divided into tertiles[20]. For the variable maternal schooling, which had 25% of information loss, we performed Multiple Imputation by Chained Equations (MICE) to assign numerical values to the variable[21]. We considered predictive variables for imputation sex, family assets (car, landline telephone, cell phone, number of bathrooms at home), and services (maid and internet access at home), as per a previous study[22].

We calculated the proportion and the respective 95% confidence interval of adherence to school meals (dependent variable) by individual and independent school variables, considering the complex sample design. We estimated ordinal multilevel proportional odds models that generated crude and adjusted odds ratios, besides the respective 95% CI, to verify the bivariate and multivariate association of school level and individual variables with adherence to school meals.

We built the multilevel models in sequential steps. First, we estimated the null model and verified the variability of adherence between schools using the Likelihood Ratio Test. Then, we analyzed the associations between each variable and adherence to school meals. Subsequently, we examined the association of school-level variables: the presence of a canteen and alternative food sale outlets (model 1). In the construction of model 2, we included variables related to the location of schools (macro-region of the municipality, municipality location and the school's geographic location). Finally, in model 3 (complete), we examined the associations between all independent variables (at school and individual level) and adherence to school meals simultaneously, with the individual variables employed solely as confounders. The variables with p<0.20 in the bivariate analysis were included in the multiple model. Furthermore, we calculated the intraclass correlation coefficient (ICC) using the latent variable method[23]. We employed the Akaike information criterion (AIC) to compare

the models, and the best model was the one with the lowest AIC value. The models were adjusted with the sample weights.

PeNSE was approved by the National Research Ethics Committee (Conep) on March 30, 2015 (registration no. 1.006.467). All analyses were performed using Stata version 14.2.

RESULTS

Of the 67,881 adolescents from public schools evaluated, 34.2% attended schools with a canteen and 29.7% with an alternative sale outlet, 44.9% were from the Southeast region, 80.2% from non-capitals, 91.3% from the urban area, 52.4% were girls, 44.7% were Brown, 71.6% were aged 14-15 years, 87.0% did not engage in paid work, 61.1% studied in the morning shift, 31.1 % had mothers with complete secondary education or incomplete higher education, 57.8% lived with their parents, and 10.9% reported starving sometimes/most of the time/always (Tables 1 and 2). We found that 31.3% (95% CI: 30.0;32.7) adhered to school meals (≥ 3x/week), 37.9% (95%CI: 37.1;38.7) had unsatisfactory adherence, and 30.8% (95%CI: 29.4;32.2) did not adhere (Table 1).

Table 1 – Adherence to school meals according to the characteristics of the school environment. Brazil 2015

Variables	Total			Adherence		Unsatisfactory adherence		Non-adherence	
	n[a]	%	95% CI[b]	%	95% CI[b]	%	95% CI[b]	%	95% CI[b]
Total									
School meals				31.3	30.0-32.7	37.9	37.1-38.7	30.8	29.4-32.2
Presence of canteen									
Yes	22143	34.2	30.3- 38.3	27.2	24.6- 29.9	37.6	36.0- 39.2	35.2	32.4- 38.1
No	45656	65.8	61.7- 69.7	33.5	32.0- 35.0	38.0	37.1- 39.0	28.5	27.1- 29.9
Presence of alternative food sale outlet									
Yes	24005	29.7	26.7- 33.0	28.1	26.1- 30.1	37.9	36.4- 39.5	34.0	31.8- 36.3
No	43794	70.3	67.0- 73.3	32.7	31.0- 34.5	37.9	36.9- 38.8	29.4	27.7- 31.2
Macro-region of the municipality									
North	16563	9.3	8.6- 10.0	27.4	25.3- 29.7	37.1	35.4- 38.8	35.5	32.9- 38.2
Northeast	21786	24.9	23.4- 26.5	29.7	27.9- 31.6	37.5	36.2- 38.8	32.8	31.0- 34.7
Southeast	12447	44.9	42.5- 47.4	30.2	27.7- 32.9	37.9	36.4- 39.4	31.9	29.2- 34.7
South	7298	13.4	12.4- 14.6	35.7	33.0- 38.6	38.7	36.7- 40.6	25.6	23.0- 28.4
Midwest	9787	7.5	6.9- 8.1	40.4	38.3- 42.5	39.2	37.7- 40.7	20.4	18.9- 22.1
Municipality location									
Capital	30738	19.8	18.3- 21.3	23.8	22.1- 25.5	39.4	36.6- 38.5	36.8	34.4-39.2
Non-capital	37143	80.2	78.7-81.7	33.2	31.6- 34.9	37.5	38.0- 40.9	29.3	27.7-30.9
School's geographic location									
Rural	6172	8.7	7.4- 10.1	42.4	39.0- 45.8	35.5	33.2- 37.8	22.2	19.4- 25.3
Urban	61709	91.3	89.9- 926	30.3	28.9- 31.7	38.1	37.3- 39.01	31.6	30.1- 33.1

[a]N: number of individuals (unweighted sample).
[b]95%CI: 95% confidence interval.

Table 2 – Adherence to school meals. According to individual characteristics. Brazil 2015

Variables	Total			Adherence		Unsatisfactory adherence		Non-adherence	
	n[a]	%	95% CI[b]	%	95% CI[b]	%	95% CI[b]	%	95% CI[b]
Sex									
Female	36031	52.4	51.7-53.2	29.6	28.1- 31.1	38.2	37.1- 39.3	32.2	30.6- 33.9
Male	31850	47.6	46.8- 48.3	33.2	31.6- 34.8	37.6	36.5- 38.7	29.2	27.7- 30.7
Ethnicity/skin color									
White	20389	34.3	33.2- 35.5	30.6	28.8- 32.4	37.4	36.3- 38.6	32.0	30.0- 34.0
Black	9123	13.9	13.3- 14.5	35.6	33.2- 38.1	35.8	34.1- 37.5	28.6	26.4- 30.9
Yellow	2827	3.9	3.6- 4.2	29.9	26.9- 33.1	37.7	34.6- 40.9	32.4	29.1- 35.9
Brown	32997	44.7	43.7- 45.7	30.5	29.0- 32.0	39.0	37.9- 40.2	30.5	29.0- 32.0
Indigenous	2489	3.2	2.9- 3.5	34.4	30.9- 38.0	36.7	33.2- 40.3	28.9	25.3- 32.9
Age group									
≥ 16 years	8778	11.0	10.3- 11.7	32.8	30.8- 34.9	33.0	31.3- 34.7	34.2	32.2- 36.2
14 – 15 years	49205	71.6	70.3- 72.8	31.9	30.5- 33.3	38.4	37.5- 39.3	29.8	28.4- 31.1
≤13 years	9898	17.5	16.2- 18.8	28.2	25.7- 30.8	39.1	37.4- 40.8	32.8	30.0- 35.7
Paid work									
Yes	8629	13.0	12.4- 13.6	35.7	33.7- 37.7	36.5	34.6- 38.5	27.8	25.8- 29.8
No	59240	87.0	86.4- 87.6	30.7	29.3- 32.1	38.1	37.2- 39.0	31.2	29.8- 32.7
Study shift									
Afternoon	27654	37.2	33.8- 40.8	29.4	27.5- 31.4	38.0	36.9- 39.1	32.6	30.6- 34.7
Morning	38867	61.6	58.0- 65.0	31.8	30.1- 33.6	38.2	37.0- 39.3	30.0	28.3- 31.9
Intermediate or full-time	1301	1.1	0.7- 1.6	66.3	58.6- 73.2	23.0	17.7- 29.2	10.8	6.7- 16.8
Maternal schooling									
Complete higher education	9736	13.6	13.0- 14.2	28.6	26.6- 30.7	37.7	35.6- 39.9	33.7	31.2- 36.2
Complete secondary education/ incomplete higher education	20789	31.1	30.4- 31.8	29.9	28.2- 31.7	38.7	37.4- 40.1	31.3	29.6- 33.2
Complete primary education/incomplete secondary education.	12218	18.3	17.7- 18.8	30.6	28.9- 32.3	37.7	36.3- 39.1	31.8	29.9- 33.6
Incomplete primary education	19388	29.2	28.4- 29.9	33.5	31.8- 35.4	38.4	36.8; 40.0	28.1	26.5- 29.8
No education	5672	7.9	7.5- 8.3	35.3	33.1- 37.6	33.8	31.4- 36.2	30.9	28.6- 33.2
Living with parents									
Neither of them	4711	6.0	5.7- 6.4	30.4	27.8- 33.2	37.0	34.5- 39.6	32.6	30.0- 35.2
Both of them	37555	57.8	56.9- 58.6	31.4	29.9- 32.9	38.1	37.1- 39.1	30.5	29.0- 32.1
Only mother	22100	31.7	3.1- 3.2	31.0	29.5- 32.5	37.8	36.6- 39.0	31.2	29.6- 32.8
Only father	3437	4.5	4.2- 4.8	33.9	31.0- 37.0	37.6	34.6- 40.6	28.5	25.8- 31.4
Socioeconomic level									
High – 3º tertile (0- 5.3 points)	18996	28.8	27.7- 29.8	28.9	27.3- 30.7	38.0	36.7- 39.4	33.1	31.1- 35.1
Medium – 2º tertile (5.4 – 7.9 points)	22061	35.2	34.3- 36.1	30.1	28.4- 31.9	38.8	37.4- 40.2	31.1	29.4- 32.8
Low – 1º tertile (8.0 – 22.1 points)	26824	36.0	34.9- 37.2	34.4	32.9- 35.9	37.0	35.9- 38.1	28.6	27.3- 30.0

Starving for not having food at home

Never	53045	79.3	78.7- 79.8	30.6	29.2- 32.0	37.9	37.0- 38.8	31.5	30.1- 33.0
Rarely	7066	9.9	9.5- 10.3	31.5	29.2- 33.8	41.7	39.6- 43.8	26.9	25.0- 28.9
Sometimes/ most of the time/ always	7697	10.9	10.5- 11.3	36.4	33.9- 39.0	34.6	32.5- 36.7	29.0	26.5- 31.6

ªN: number of individuals (unweighted sample). ᵇ95%CI: 95% confidence interval.

In the bivariate analysis, we observed a higher likelihood of increased adherence to school meals by students who attended schools without a canteen (OR: 1.51; 95% CI: 1.39-1.63), without an alternative food sale outlet (OR: 1.36; 95 % CI: 1.26-1.47), from the South (OR: 1.30; 95% CI: 1.14-1.49), Southeast (OR: 1.20; 95% CI: 1.07-1.36) and Midwest (OR: 1.75; 95% CI: 1.54-1.99), non-capitals (OR: 1.47; 95% CI: 1.36-1.59), and rural areas (OR: 1.52; 95% CI: 1.36-1.70). As for the individual-level variables, we observed a likelihood of greater adherence among male, Black and Indigenous students, who engaged in paid work, did not study in the afternoon shift, with less educated mothers, who lived with one or both parents, were from the lowest socioeconomic strata, and who reported starving. There was no statistically significant difference concerning age (Table 3).

Model 1 introduced explanatory variables referring to the school's food environment (presence of canteen and alternative sale outlet), which remained significant in the adjusted model. Model 2 was obtained by introducing variables macro-region of the municipality, municipality location, and school's geographic location, and all variables remained significant at the 5% level. We included all independent variables (individual and school level) in Model 3. The model showed that students with the highest likelihood to adhere to school meals attended schools without a canteen and an alternative food sale outlet, from the South, Southeast, and Midwest regions, non-capitals, rural areas, male, Black and Indigenous, younger, who were engaged in paid work, who did not study in the afternoon shift, with less educated mothers, who lived with both parents, were classified in the lowest socioeconomic strata, and reported starving (Table 3).

A reduction in the variance and the Akaike criterion was observed in the models with the addition of variables, and Model 3 was the one that best explained adherence to school meals. Regarding the variability of adherence to school meals, 18.27% can be attributed to the difference between schools, and 3.06% was explained by variables at the school level (model 2) and 1.22% at the individual level (Model 3) (Table 3).

Table 3 – Odds Ratio (OR) for the association between school context and individual variables with adherence to school meals by multilevel model. Brazil. 2015

Adherence to school meals (≥ 3x/week)					
	Unadjusted model	Null model	Model 1ᶜ	Model 2ᵈ	Modelo 3ᵉ
Variables	ORª (95% ICᵇ)	ORª (95% ICᵇ)	ORª (95% ICᵇ)	ORª (95% ICᵇ)	ORª (95% ICᵇ)
School-level					
Presence of canteen					
Yes	1		1	1	1
No	1.51 (1.39-1.63)		1.51 (1.39-1.63)	1.53 (1.42-1.65)	1.46 (1.35-1.57)
Presence of alternative food sale outlet					
Yes	1		1	1	1
No	1.36 (1.26-1.47)		1.36 (1.26-1.47)	1.30 (1.21-1.40)	1.29 (1.20-1.39)

Macro-region of the municipality

North	1	1	1
Northeast	0.99 (0.90-1.10)	0.95 (0.86- 1.05)	0.97 (0.89-1.07)
Southeast	**1.20 (1.07-1.36)**	**1.25 (1.14- 1.41)**	**1.29 (1.15-1.45)**
South	**1.30 (1.14-1.49)**	**1.26 (1.12- 1.43)**	**1.38 (1.22-1.56)**
Midwest	**1.75 (1.54-1.99)**	**1.90 (1.69- 2.13)**	**1.95 (1.75-2.18)**

Municipality location

Capital	1	**1**	**1**
Non -capital	**1.47 (1.36-1.59)**	**1.38 (1.29- 1.49)**	**1.42 (1.33- 1.52)**

School's geographic location

Urban	1	1	1
Rural	**1.52 (1.36-1.70)**	**1.42 (1.27- 1.59)**	**1.41 (1.26-1.57)**

Individual-level

Sex

Female	1		1
Male	**1.28 (1.33;1.23)**		**1.29 (1.24-1.34)**

Ethnicity/skin color

White	1		1
Black	**1.24 (1.18-1.30)**		**1.19 (1.14-1.26)**
Yellow	1.00 (0.93-1.09)		1.01 (0.93-1.09)
Brown	**1.11 (1.07-1.15)**		**1.11 (1.07-1.15)**
Indigenous	**1.24 (1.14-1.35)**		**1.20 (1.10-1.31)**

Age group

≥ 16 years	1		1
14 – 15 years	1.00 (0.95-1.05)		**1.06 (1.01-1.12)**
≤13 years	0.98 (0.92-1.04)		**1.09 (1.03-1.17)**

Paid work

No	1		1
Yes	**1.22 (1.16-1.27)**		**1.17 (1.12-1.23)**

Study shift

Afternoon	1		1
Morning	**1.18 (1.10-1.26)**		**1.18 (1.11-1.26)**
Intermediate or full-time	**3.66 (2.72-4.93)**		**4.18 (3.10-5.65)**

Maternal schooling

Complete higher education	1		1
Complete secondary education/ incomplete higher education	**1.10 (1.05;1.15)**		**1.07 (1.02-1.12)**

Complete primary education/incomplete secondary education.	**1.16 (1.10;1.22)**			**1.10 (1.04-1.16)**
Incomplete primary education	**1.21 (1.16;1.28)**			**1.14 (1.08-1.20)**
No education	**1.20 (1.13;1.29)**			**1.10 (1.03-1.18)**
Living with parents				
Neither of them	1			1
Both of them	**1.09 (1.03-1.16)**			**1.09 (1.03-1.16)**
Only mother	**1.10 (1.03-1.17)**			1.07 (1.00-1.14)
Only father	**1.12 (1.02-1.21)**			1.10 (1.00- 1.20)
Socioeconomic level				
High – 3º tertile (0- 5.4 points)	1			1
Medium – 2º tertile (5.5 – 7.3 points)	**1.10 (1.06-1.15)**			**1.11 (1.07-1.15)**
Low – 1º tertile (11.9 – 19.2 points)	**1.32 (1.26-1.37)**			**1.32 (1.26-1.37)**
Starving for not having food at home				
Never	1			1
Rarely	**1.31 (1.25-1.38)**			**1.28 (1.23-1.35)**
Sometimes/most of the time/always	**1.24 (1.18-1.30)**			**1.21 (1.16-1.28)**
School-level variance	0.74	0.68	0.59	0.54
Standard error	0.03	0.03	0.03	0.02
Intraclass correlation coefficient	18.27	17.11	15.21	13.99
AIC	140761.1	140447.8	140187.8	138489.1

Bold data reflect statistical significance (p < 0.05).

[a]OR: Odds Ratio

[b]95%CI: 95% confidence interval.

[c]Model 1: adjusted for food environment variables;

[d]Model 2: adjusted by the variables of the food environment and school characteristics;

[e]Model 3: adjusted for food environment variables, school and individual characteristics.

DISCUSSION

This study was the first to analyze the nationally representative sample of ninth-graders of PeNSE 2015, and it was observed that the absence of a canteen and alternative food sale outlet, schools in the Midwest, Southeast, and South regions, in non-capitals and rural areas, were associated with greater adherence to school meals, showing the importance of school context factors, even adjusted for individual factors. Adherence was higher among male adolescents, black and indigenous, with paid work, who did not study in the afternoon shift, with lower maternal schooling, who lived with both parents, who were in the lowest socioeconomic strata, and who reported starving.

Corroborating the results found in this study, the national literature that investigated the association of the characteristics of the school environment in the adherence to the food offered at school[11,13,15,16,24] pointed to an inverse association with the presence of a canteen.

The sale of competing foods in the school environment and adolescent preference for foods with low nutritional value and high energy density[9] can contribute to the low adherence to school meals[2,10–14], besides favoring adolescent consumption of ultra-processed foods [7,24,25].

One of the strategies contributing to the increased consumption of school meals is to limit students' access to competing foods[26]. Brazil has no federal legislation on the sale of food and beverages in schools[27]. However, some cities and states have regulations restricting the sale of specific unhealthy foods[27,28], although several school canteens have already reported failure to comply with these rules[10,29]. Therefore, there is a need to implement a federal policy that prohibits the sale of unhealthy foods and beverages in and around schools and constant monitoring and inspection to ensure compliance.

In this study, we observed that the adherence to school meals was higher among students from the Midwest region, non-capitals, and rural areas, as identified by Locatelli et al.[12], Hoffman[2], and Froelich et al.[15] When evaluating the food environment of Brazilian public schools, Carmo et al.[28] did not identify difference in the prevalence of school meals between the country's regions. However, they identified that the North had the most obesogenic food environment, which have a higher proportion of street vendors at the school door or in its surroundings when compared to the Southeast, South, and Midwest regions.

Among the possible explanations for the greater effective adherence (4-5x/week) to school meals among students in rural areas, nationally representative studies have shown that families in rural areas have greater availability and consumption of fresh or minimally processed foods, while ultra-processed foods have low availability and consumption compared to residents of urban areas[30,31]. Cezar et al.[16] point to the longer home-school commuting time, which can increase the interval between meals, besides the fact that menus provided by the PNAE meet the eating habits of these students since they are primarily composed of fresh foods. Moreover, the rural area probably has a lower availability of retail food establishments than the urban area.

Among the individual factors considered as adjustment variables in this study, we found a greater adherence to school meals among adolescents who reported starving when compared to those who reported that they had never been starving. Evaluating schoolchildren from ten Brazilian municipalities, Sturion et al.[11] found a negative association between the number of home meals and participation in the PNAE. From this perspective, we highlight the relevance of the PNAE as a public policy to guarantee Food and Nutrition Security. However, we should consider that the food offered by the PNAE aims to meet the nutritional needs of all students in the public network during the school year, regardless of socioeconomic conditions.

Although the PNAE is no longer a welfare program, the idea that school meals are related to the condition of poverty persists in the daily life of schools. As a result, a stigmatized image is attributed to students who consume the food offered, while buying food in the canteen may represent a better social position for adolescents[24]. Such factors may contribute to low adherence, especially among adolescents, since this is a phase in which peer opinions exert a significant influence on decision--making[32].

The lack of data regarding the composition and timetable of school meals and the consumption of competing foods in the school environment may be a limitation in this study. Despite this, the PeNSE data have internal and external validity because the sample of adolescents adequately represents Brazil.

CONCLUSIONS

Adherence to school meals among adolescents was associated with the school food environment, with students who attended schools without canteen and alternative food sale outlet show 46% and 29% greater chances to adhere to school meals, respectively, even after adjusting for individual factors already explored in the literature as associated with this adherence. These results points to the need for interventions that promote a healthier school food environment and strengthen Food and Nutrition Education actions in Brazilian public schools. Beyond that, our findings can support the devolvement of the school food environment policies in Brazil and other countries that face the same scenario, aiming to reach the Sustainable Development Goals (SDGs). Finally, this study provides significant results to improve the effectiveness of the PNAE since they can help in reformulations that aim to reach the universality recommended by the legislation.

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