

Food environment as an aggravating factor of food insecurity among Brazilian public school students: ESANP study

Ambiente alimentar como fator agravante da insegurança alimentar entre estudantes de escolas públicas brasileiras

El entorno alimentario como factor agravante de la inseguridad alimentaria entre estudiantes de escuelas públicas brasileñas

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Abstract The social restriction measures of the COVID-19 pandemic have impacted the families' access to food. This study aims to describe the relationship between perception of access to fruits and vegetables (FV) and ultra-processed foods (UPF) sold in the neighborhood of municipal public school students, and the prevalence of food insecurity (FI) during suspension of classes in two Brazilian municipalities. A cross-sectional study with a representative sample was conducted through telephone interviews. FI was assessed using the Brazilian Scale of Food Insecurity (EBIA) and the food environment through questions about the perception of access to FV and UPF. Among the 475 households investigated, 69.7% were experiencing FI. The majority demonstrated a positive perception regarding the ease of acquisition (64.0%), quality (67.6%), and variety (57.9%) of FV sold in the neighborhood. Regarding cost, 73.1% disagreed that FV were cheap, with this prevalence being higher in households with FI and lower income. In contrast, the majority agreed that it is easy to buy UPF (85.9%) and that those are available in a wide variety (78.9%).

Keywords Food insecurity, COVID-19, Access to healthy food, Environment and Public Health

Resumo As medidas de restrição social da pandemia de Covid-19 impactaram o acesso das famílias aos alimentos. Este estudo tem como objetivo descrever a relação entre a percepção do acesso a frutas e verduras (FV) e alimentos ultraprocessados (AUP) vendidos na vizinhança dos alunos de escolas públicas municipais e a prevalência de insegurança alimentar durante a suspensão das aulas em dois municípios brasileiros. Um estudo transversal com uma amostra representativa foi realizado por meio de entrevistas telefônicas. A insegurança alimentar foi avaliada utilizando a Escala Brasileira de Insegurança Alimentar (EBIA) e o ambiente alimentar por meio de perguntas sobre a percepção do acesso a FV e AUP. Entre os 475 domicílios investigados, 69,7% estavam vivenciando insegurança alimentar. A maioria demonstrou uma percepção positiva em relação à facilidade de aquisição (64,0%), qualidade (67,6%) e variedade (57,9%) das FV vendidas na vizinhança. Em relação ao custo, 73,1% discordaram que as FV eram baratas, com essa prevalência sendo maior em domicílios com insegurança alimentar e renda mais baixa. Em contraste, a maioria concordou que é fácil comprar AUP (85,9%) e que esses estão disponíveis em grande variedade (78,9%).

Palavras-chave Insegurança alimentar, Covid-19, Acesso a alimentos saudáveis, Meio ambiente e Saúde Pública

Resumen Las medidas de restricción social de la pandemia de COVID-19 afectaron el acceso de las familias a los alimentos. Este estudio tuvo como objetivo describir la relación entre la percepción de acceso a frutas y verduras (FV) y alimentos ultraprocessados (AUP) vendidos en el barrio de estudiantes de escuelas públicas municipales y la prevalencia de inseguridad alimentaria durante la suspensión de clases en dos municipios brasileños. Se realizó un estudio transversal con una muestra representativa mediante entrevistas telefónicas. La inseguridad alimentaria se evaluó mediante la Escala Brasileña de Inseguridad Alimentaria (EBIA) y el entorno alimentario mediante preguntas sobre la percepción del acceso a frutas y verduras y a alimentos ultraprocessados. Entre los 475 hogares investigados, el 69,7% padecía inseguridad alimentaria. La mayoría demostró una percepción positiva respecto a la facilidad de adquisición (64,0%), calidad (67,6%) y variedad (57,9%) de las FV comercializadas en el barrio. Respecto al costo, el 73,1% no estuvo de acuerdo en que los alimentos básicos fueran baratos, siendo esta prevalencia mayor en los hogares con inseguridad alimentaria y menores ingresos. Por el contrario, la mayoría estuvo de acuerdo en que es fácil comprar AUP (85,9%) y que están disponibles en una amplia variedad (78,9%).

Palabras clave Inseguridad alimentaria, COVID-19, Acceso a alimentos saludables, Medio ambiente y salud pública

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Introduction

According to the Food and Agriculture Organization (FAO) there has been a significant global increase in food insecurity (FI), particularly since 2020. It is estimated that approximately 828 million people experienced hunger in 2021 (an increase of 150 million since 2019)¹. In Brazil, national surveys had already revealed a significant setback with the decline in food security since 2013²⁻⁵ and, especially in the context of the COVID-19 pandemic, when more than half of the Brazilian population was living with FI to some degree^{3,4}.

FI is recognized as the absence of regular and permanent access to quality food in sufficient quantities for sustaining a healthy life². Associated with this context, it is hypothesized that households experiencing FI have a less favorable perception of the food environment in their neighborhood, especially regarding the accessibility, quality, and variety of Fruits and Vegetables (FV)⁶. In Brazil, the consumption of ultra-processed foods (UPF) has continued to rise over the past decades (Increase of 0.4% per year between 2002-2009, and 0.2% between 2008-2018)⁷⁻¹⁰, particularly among children and adolescents nationwide^{8,9,11,12}. This trend aligns with a notable reduction in the availability of staple foods such as rice and beans along with a low availability of FV in Brazilian households⁷⁻¹³.

With the COVID-19 pandemic, measures were implemented to contain viral spread. Isolation and social distancing became essential and had a major impact on the lives of the population^{14,15}. Businesses, schools, and institutions were closed, and there were restrictions on public transportation^{15,16}. These pandemic-imposed restrictions affected the economy, resulting in reduced household incomes and an increase in poverty^{16,17}, and impacted the entire food supply chain from production to food access^{14,18-20}. Such impact contributed to rising prices, particularly in Latin America, exacerbating a scenario of high food inflation^{1,22}.

Such changes, in addition to affecting the purchasing power of families, encompass alterations in the food environment, influencing various dimensions of food access and how individuals interact with food systems. Consequently, there were difficulties in accessing healthy foods, especially for families already in a situation of vulnerability, affecting healthy eating practices and the assurance of the Human

Right to Adequate Food (HRAF)^{17,20,22}.

For families of public school students, the situation can be even more serious, as the closing of schools affected the full execution of the National School Feeding Program (PNAE), which may have increase the risk of public school student families experiencing some degree of FI. Considering the role the program plays as a social protection policy and guarantee of food security, it is crucial to ensuring the HRAF for millions of Brazilian public school students^{23,25}.

The interruption of school meals not only impairs the quality and quantity of students' meals but also affects families' income as the household spending on food increases. Furthermore, the actions taken (distribution of basic food baskets, meal kits or food vouchers) in an attempt to mitigate the effects of the suspension of school meals may have been insufficient to guarantee access to enough food for families' needs^{23,25,26}.

Thus, the COVID-19 pandemic deepened numerous social issues and impacted food systems, including dimensions of the food environment, which, in turn, may have compromised access to food and dietary practices, increasing the risk of families experiencing FI. Despite the wealth of research on various aspects of food security, there is a conspicuous dearth of investigations delving into the nuanced connections and influences that the food environment exerts on food security outcomes. In this regard, the aim of this study is to describe the relationship between the prevalence of food insecurity and the perception of access to FV and UPF in the vicinity of the households of students from municipal schools in two medium-sized municipalities in the state of Minas Gerais during the suspension of classes.

Methods

Design and location

This is a cross-sectional study using data obtained through the Longitudinal Study of Food and Nutritional Security in the COVID-19 Pandemic (ESANP), in two medium-sized Brazilian municipalities (Ouro Preto and Mariana) located in the state of Minas Gerais²⁵.

Ouro Preto is a municipality with approximately 74,558 inhabitants, a Human Development Index (HDI) of 0.741, a school enrollment

rate (6 to 14 years of age) of 98.8%, and the average monthly salary for formal workers is equivalent to 3.1 minimum wages (US\$ 632,07 - IPEA exchange rate²⁷). Mariana has an estimated population of 61,830 inhabitants, a HDI of 0.742, a school enrollment rate (6 to 14 years of age) of 98%, and the average monthly salary for formal workers is equivalent to 2.5 minimum wages (US\$ 509,73 - IPEA exchange rate²⁷)²⁸.

Sample and data collection

The calculation to determine the number of participating students was carried out through a proportional stratification representative of the modalities of basic education in the municipal network, including daycare centers, kindergartens, and elementary schools²⁵. This study was approved by the Ethics Committee of the Federal University of Ouro Preto (CAAE: 32005120.6.0000.5150) and informed verbal consent was obtained from all participants. The consent was recorded in mp4 format by an interviewer.

Mariana and Ouro Preto are neighboring municipalities, and according to school census data in 2020, they had 13,219 students enrolled in public municipal schools in both cities, aged between 6 months and 17 years, all eligible for the study sample. Thus, considering a margin of error of 5% and a 95% reliability for the calculation, a minimum sample size of 374 individuals was obtained, allocated proportionally to their strata by education level (nursery, infant, and elementary schools). A percentage of recomposition (60%) was added to the sample size, considering the anticipated losses arising from refusals throughout the longitudinal study²⁵.

The data were collected through telephone interviews with the adults in charge of purchasing and/or preparing food in the students' households. The education departments of the municipalities provided contact information, such as the students' and their respective responsible adults' names, and contact telephone numbers. In general, the interviews lasted approximately 20 to 25 minutes and were conducted by trained interviewers. They were available to conduct interviews from Monday to Saturday (on alternate days), during business hours or by appointment. Phone lines that were consistently busy or unavailable after five unsuccessful contact attempts were excluded from the study²⁵. For the present study, the data used referred to the first segment, collection occurred between

March and May 2021, the period when children and adolescents were at home due to the suspension of classes. A rejection rate of 22.4% was applied concerning the baseline, ensuring the sample's representativeness (n=475).

Variables

To measure FI, we used the Brazilian Food Insecurity Scale (EBIA), which is a validated instrument for the Brazilian population, widely recommended and used in national studies^{2,29,32}. The EBIA is a psychometric scale that assesses the intra-family perception of food access over the previous 3 months. The analysis is conducted through a scoring gradient resulting from the sum of the final scores of the 14 closed questions (yes/no answers) that compose the scale when there is a resident under 18 years old in the household. The questions encompass the perception of concern regarding food scarcity, the quality of the diet, and the quantitative reduction in food. Each affirmative answer (yes) corresponds to 1 point and each negative answer (no) is graded zero³⁰.

According to this scoring, the EBIA allows for the identification of degrees of FI: food security: 0; mild food insecurity: 1 to 5; moderate food insecurity: 6 to 9; severe food insecurity: 10 to 14 points².

Regarding family income, we considered the total monthly family income, i.e., the sum of the earnings of all household residents, by minimum wage bracket for the year 2021 (up to half a minimum wage [US\$ 102.00], 1 to 2 minimum wages [US\$ 203,89 to \$407,78], 3 minimum wages or more [$>$ US\$ 611,68] based on IPEA exchange rate²⁷). It was also considered whether there was a reduction in family income during the pandemic (yes/no) and the perceived impact of such reduction in income (no impact/very large/large, medium, small/very small) over the past nine months (since the last baseline questionnaire).

The perceived food environment, especially in relation to the accessibility/variety of fresh foods (fruits and vegetables) and UPF (soft drinks, cookies, packaged snacks, candies, and other foods)³³, was assessed through the perception of access to food purchases in the neighborhoods of the students' households. A questionnaire adapted from the National Study of Child Feeding and Nutrition (ENANI), a nation-wide scientific survey that assesses children in households in all regions of Brazil, including rural

and urban areas, was used³⁴. The following statements were assessed using a Likert scale of agreement, ranging from strongly disagree to strongly agree: 1) *"It is easy to buy fruits and vegetables in your neighborhood"*; 2) *"Fruits and vegetables are of good quality in your neighborhood"*; 3) *"There is a wide variety of fruits and vegetables in your neighborhood"*; 4) *"Fruits and vegetables are cheap in your neighborhood"*; 5) *"It is easy to buy soft drinks, cookies, packaged snacks, sweets, and other treats in your neighborhood"*; 6) *"There is a wide variety of soft drinks, cookies, packaged snacks, sweets and other treats in your neighborhood"*.

To describe the sociodemographic characteristics of the sample, variables related to the students' households were considered, such as receiving social program benefits (yes/no) and receiving government emergency financial aid in the last month prior to the survey (yes/no). The total number of individuals in the household (2/3/4/5 individuals or more) was also considered, as well as the number of adults in the household (1/2/3/4 adults or more) and the number of children in the household (1/2/3 children or more).

Regarding the information about the head of the family, i.e., the person with the highest income in the household, the following was included: sex (female/male), skin color (yellow/white/brown/black), age (categorized based on national surveys: between 18-24 years/25-34 years/35-44 years/45-54 years/55-64 years/65 years or older)², marital status (married/single/divorced/widowed), and education level (Illiterate /Incomplete elementary education/Complete elementary education/Incomplete middle school education/Complete middle school education/Incomplete high school education/Complete high school education/Incomplete higher education/Completed higher education).

Data analysis

After the data were obtained, they were organized in Excel spreadsheets and then imported into Stata 14.2 software. Relative frequency (%) and a 95% confidence interval (CI) were used to describe the data. The descriptive analysis of the perception of the food environment was stratified according to the level of household FI (food security/mild food insecurity/moderate and severe food insecurity) and by family income (up to half the minimum wage/1 to 2 minimum wages/3 minimum wages or more).

In the present study, the EBIA responses were categorized in two distinct ways. To characterize the sample in addition to describing all the degrees of FI, we also considered the grouping of households in a situation of food security vs. FI (mild/moderate/severe). Subsequently, when analyzing perceptions of the food environment in relation to food security and insecurity, the EBIA responses were grouped into three categories: food security, mild FI, and moderate/severe FI. Additionally, the Likert scale responses were grouped into three categories: agree, disagree, and no opinion (neither agree nor disagree).

Results

A total of 475 households were assessed, with 275 from the municipality of Ouro Preto and 200 from the municipality of Mariana. Overall, the majority of families had a monthly family income between 1 and 2 minimum wages (63.1%), were not beneficiaries of social assistance programs (54.6%), and did not receive emergency financial aid from the federal government in the month prior to the interview (72.2%).

Regarding income, 62.3% of the households reported a decrease in family income during the pandemic, with 36.6% of them considering the impact of the income decline as very large or large.

In relation to the head of the family, 50.1% were men, and 52.6% self-identified as black/brown. The majority were between 35 and 44 years old (40.5%), were married (61.7%), and had completed high school and/or limited college education (43.6%) (Table 1).

In relation to the FI situation (Figure 1), 69.7% of the households presented some degree of FI (n = 331), with mild FI observed in 55.2% of them (n=262).

Table 2 displays the perception of the food environment in both municipalities, categorized by family income. Overall, it can be observed that regarding the purchase of FV in the neighborhood, the majority agrees that they experience ease in purchasing such foods (64.0%), that they have good quality (67.6%), and that they are available in a wide variety for purchase (57.9%) across all income strata; however, it is noteworthy that as family income increases, a higher proportion of individuals agree about the ease of access. Conversely, concerning the cost of FV, we observe the opposite

Table 1. Distribution of sociodemographic characteristics according to the total sample (n=475) - ESANP, 2021.

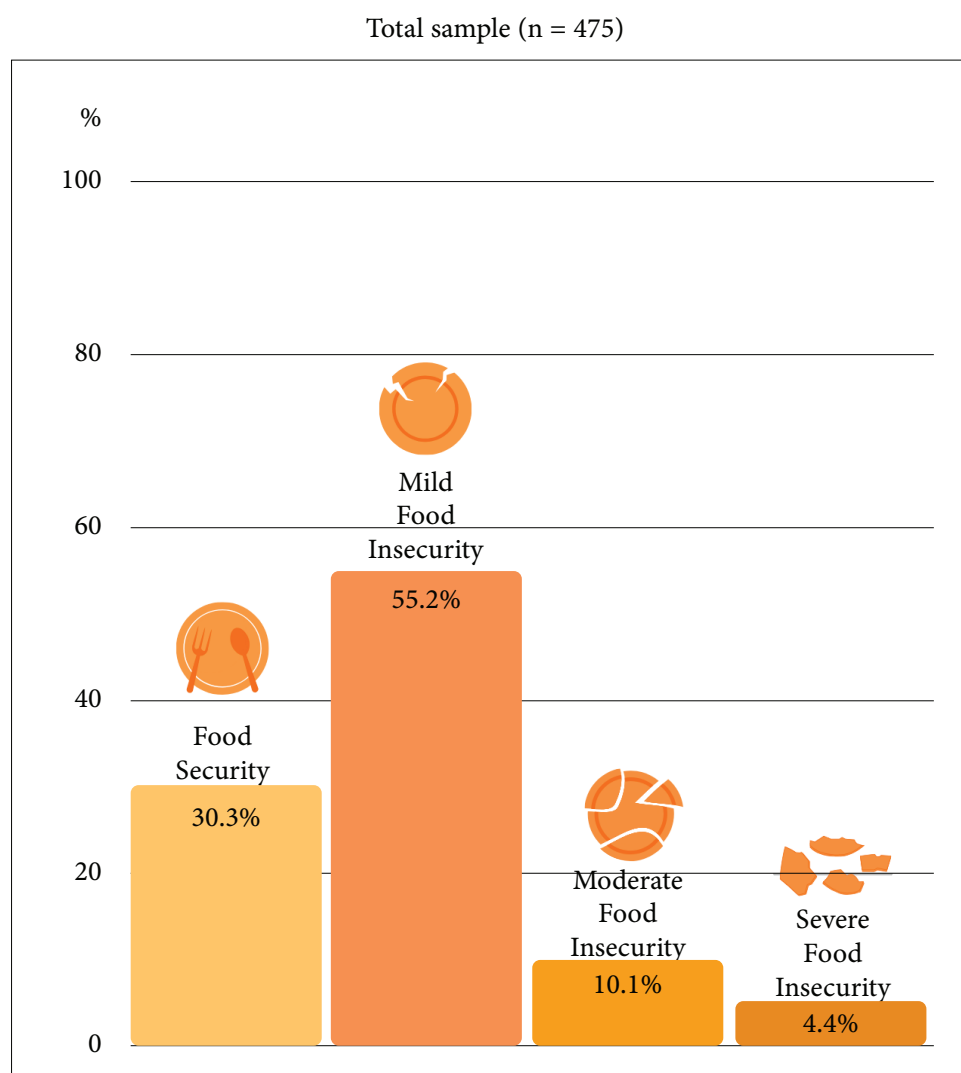
Variable	All (n=475)
Household	% (95%CI)
Food security status	
Food security	30,3 (26,3-34,6)
Food insecurity	69,7 (65,3-73,6)
Monthly family income	
Up to half the minimum wage	19,6 (16,2-23,4)
1 to 2 minimum wage	63,1 (58,7-67,3)
3 minimum wages or more	17,3 (14,1-20,9)
Reduction in household income during the pandemic	
Yes	62,3 (57,8-66,5)
No	37,7 (33,4-42,1)
Impact of the reduction in household income	
Large or very large	36,4 (32,1-40,8)
Medium	21,5 (17,9-25,4)
Small or very small	4,4 (2,8-6,6)
No impact	37,7 (33,4-42,1)
Beneficiary of social programs	
Yes	45,4 (40,9-49,8)
No	54,6 (50,1-59,0)
Received government emergency financial aid in the last month	
Yes	27,8 (23,9-32,0)
No	72,2 (67,9-76,0)
Total number of individuals in the household	
2 individuals	5,7 (3,9-8,1)
3 individuals	27,6 (23,7-31,7)
4 individuals	36,6 (32,4-41,0)
5 individuals or more	30,1 (26,1-34,3)
Number of adults in the household	
1 Adult	15,8 (12,7-19,3)
2 Adults	55,8 (51,2-60,2)
3 Adults	15,8 (12,7-19,3)
4 Adults or more	12,6 (9,9-15,9)
Number of children in the household	
1 Child	41,5 (37,1-45,9)
2 Children	41,7 (37,3-46,1)
3 Children or more	16,8 (13,7-20,4)
Head of household	
Sex	
Male	50,1 (45,6-54,6)
Female	49,9 (45,3-54,3)
Referred skin color	
Yellow	3,8 (2,3-5,9)
White	18,5 (15,2-22,2)
Brown/black	77,7 (73,7-81,2)
Age	
Between 18 and 24 years	3,4 (2,0-5,4)
Between 25 and 34 years	26,8 (22,9-30,9)
Between 35 and 44 years	40,5 (36,1-45,0)
Between 45 and 54 years	20,2 (16,8-24,1)
Between 55 and 64 years	3,8 (2,4-5,9)
65 years and over	5,3 (3,5-7,6)

continued

Table 1. Distribution of sociodemographic characteristics according to the total sample (n=475) - ESANP, 2021.

Variable	All (n=475)
Household	% (95%CI)
Head of household	
Marital status	
Single/Divorced	33,3 (29,1-37,6)
Married/Common-law marriage	61,7 (57,2-65,9)
Widowed	5,0 (3,4-7,4)
Educational level	
Illiterate /Incomplete elementary education	6,8 (4,8-9,4)
Complete elementary education/Incomplete middle school education	22,5 (18,9-26,4)
Complete middle school education/Incomplete high school education	16,7 (13,6-20,3)
Complete high school education/Incomplete college education	43,6 (39,2-48,1)
Completed college education	10,4 (7,9-13,4)

Note: The minimum wage at the time of the survey was US\$ 204,10.

**Figura 1.** Prevalence of food insecurity by degrees of severity (n=475) - ESANP, 2021.

trend; 73.1% of individuals disagree that such foods are cheap in their neighborhood, regardless of income strata. Furthermore, the lower the family income, the higher the percentage of disagreement regarding such foods being inexpensive. Moreover, the vast majority agrees that UPF are easily accessible for purchase (85.9%) and are available in a wide variety in the neighborhood (78.9%) across all income brackets.

When evaluating the perception of the food environment according to FI status, we can observe from Table 3 that regardless of FI status, the majority of respondents agree with the ease of purchase, the good quality, and the wide variety of FV available in the neighborhood (64.0%, 67.6%, and 57.9%, respectively).

However, households experiencing food security showed the highest proportions of positive responses regarding ease of purchase (71.5%), good quality (75.0%), and wide variety of FV in the neighborhood (65.3%). In contrast, households experiencing moderate or severe FI

had a higher level of disagreement regarding the variety of FV in the neighborhood (44.9%) and such foods being cheap (88.4%).

Regardless of the FI status, the majority of individuals disagree that FV are inexpensive in their neighborhood (73.1%). On the other hand, the majority agrees that UPF are easily accessible for purchase (85.9%) and that such foods are available in a wide variety in the neighborhoods (78.9%).

Table 2. Perception of the food environment according to the total sample (n=475) and family income - ESANP, 2021.

Variables		All (n=475)	Up to half minimum wage (n= 93)	1 to 2 minimum wages (n=300)	3 minimum wages or more (n=82)
		% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
It is easy to buy FV in the neighborhood	Agree	64,0 (59,5-68,2)	55,9 (45,6-65,7)	63,7 (58,0-68,9)	74,4 (63,7-82,7)
	Disagree	32,2 (28,1-36,5)	39,8 (30,3-50,1)	32,0 (26,9-37,5)	24,4 (16,2-34,9)
	No opinion	3,8 (2,3-5,9)	4,3 (1,6-10,9)	4,3 (2,5-7,3)	1,2 (0,1-8,2)
FV are of good quality in the neighborhood	Agree	67,6 (63,2-71,6)	58,1 (47,7-67,7)	67,0 (61,4-72,1)	80,5 (70,3-87,7)
	Disagree	25,3 (21,5-29,3)	34,4 (25,4-44,6)	25,3 (20,7-30,5)	14,6 (8,4-24,1)
	No opinion	7,1 (5,1-9,8)	7,5 (3,6-15,0)	7,7 (5,1-11,2)	4,9 (1,8-12,3)
There is a wide variety of FV in the neighborhood	Agree	57,9 (53,3-62,2)	47,3 (37,3-57,5)	57,7 (51,9-63,1)	70,7 (59,9-79,6)
	Disagree	38,3 (34,0-42,7)	47,3 (37,3-57,5)	38,7 (33,2-44,3)	26,8 (18,3-37,5)
	No opinion	3,8 (2,3-5,9)	5,4 (2,2-12,3)	3,6 (2,0-6,5)	2,5 (0,6-9,3)
FV are cheap in the neighborhood	Agree	18,9 (15,6-22,7)	11,8 (6,6-20,1)	20,0 (15,8-24,9)	23,2 (15,2-33,5)
	Disagree	73,1 (68,8-76,8)	79,6 (70,0-86,6)	71,7 (66,2-76,4)	70,7 (59,9-79,6)
	No opinion	8,0 (5,8-10,8)	8,6 (4,3-16,3)	8,3 (5,6-12,0)	6,1 (2,5-13,9)
It is easy to buy UPF in the neighborhood	Agree	85,9 (82,4-88,7)	79,6 (70,0-86,6)	87,7 (83,4-90,9)	86,6 (77,2-92,4)
	Disagree	12,4 (9,7-15,7)	18,3 (11,6-27,5)	11,0 (7,9-15,0)	11,0 (5,7-19,8)
	No opinion	1,7 (0,8-3,3)	2,1 (5,3-8,2)	1,3 (0,4-3,5)	2,4 (6,0-9,3)
There is a wide variety of UPF in the neighborhood	Agree	78,9 (75,0-82,3)	76,3 (66,5-83,9)	79,3 (74,3-83,5)	80,5 (70,3-87,7)
	Disagree	19,6 (16,2-23,4)	23,7 (16,0-33,4)	19,3 (15,2-24,2)	15,8 (9,3-25,5)
	No opinion	1,5 (0,7-3,0)	0	1,4 (0,4-3,5)	3,7 (1,1-10,8)

Note: The minimum wage at the time of the survey was US\$ 203,89. FV: fruits and vegetables; UPF: ultra-processed foods. 95%CI: 95% confidence interval.

Table 3. Perception of the food environment according to the total sample (n=475) and household food insecurity level - ESANP, 2021.

Variables		All (n=475)	Food security (n=144)	Mild food insecurity (n=262)	Moderate and severe food insecurity (n=69)
		% (95%IC)	% (95%IC)	% (95%IC)	% (95%IC)
It is easy to buy FV in the neighborhood	Agree	64,0 (59,5-68,2)	71,5 (63,5-78,3)	59,9 (53,8-65,7)	63,8 (51,7-74,2)
	Disagree	32,2 (28,1-36,5)	25,7 (19,1-33,4)	35,1 (29,5-41,1)	34,8 (24,4-46,7)
	No opinion	3,8 (2,3-5,9)	2,8 (1,0-7,2)	5,0 (2,8-8,3)	1,4 (0,1-9,7)
FV are of good quality in the neighborhood	Agree	67,6 (63,2-71,6)	75,0 (67,2-81,4)	65,3 (59,2-70,8)	60,9 (48,8-71,7)
	Disagree	25,3 (21,5-29,3)	18,1 (12,5-25,5)	28,6 (23,4-34,4)	27,5 (18,2-39,3)
	No opinion	7,1 (5,1-9,8)	6,9 (3,7-12,4)	6,1 (3,7-9,7)	11,6 (5,8-21,6)
There is a wide variety of FV in the neighborhood	Agree	57,9 (53,3-62,2)	65,3 (57,1-72,6)	55,4 (49,2-61,2)	52,2 (40,3-63,7)
	Disagree	38,3 (34,0-42,7)	30,5 (23,5-38,5)	40,8 (35,0-46,9)	44,9 (33,5-56,8)
	No opinion	3,8 (2,3-5,9)	4,2 (1,8-9,0)	3,8 (2,0-6,9)	2,9 (0,7-10,9)
FV are cheap in the neighborhood	Agree	18,9 (15,6-22,7)	23,6 (17,3-31,2)	19,1 (14,7-24,3)	8,7 (3,9-18,1)
	Disagree	73,1 (68,8-76,8)	66,7 (58,5-73,9)	72,5 (66,7-77,6)	88,4 (78,3-94,1)
	No opinion	8,0 (5,8-10,8)	9,7 (5,8-15,7)	8,4 (5,5-12,4)	2,9 (0,7-10,9)
It is easy to buy UPF in the neighborhood	Agree	85,9 (82,4-88,7)	89,6 (83,3-93,6)	84,3 (79,4-88,2)	84,1 (73,3-90,9)
	Disagree	12,4 (9,7-15,7)	10,4 (8,3-13,6)	12,6 (9,0-17,2)	15,9 (9,0-26,6)
	No opinion	1,7 (0,8-3,3)	0	3,1 (1,5-6,0)	0
There is a wide variety of UPF in the neighborhood	Agree	78,9 (75,0-82,3)	79,2 (71,7-85,0)	79,8 (74,4-84,2)	75,4 (63,7-84,1)
	Disagree	19,6 (16,2-23,4)	20,1 (14,3-27,5)	18,7 (14,4-23,9)	21,7 (13,4-33,1)
	No opinion	1,5 (0,7-3,0)	0,7 (0,5-4,0)	1,5 (0,5-4,0)	2,9 (0,7-10,9)

FV: fruits and vegetables; UPF: ultra-processed foods. 95%CI: 95% confidence interval.

Discussion

The results indicate a high prevalence of FI in the households of the students assessed in the two Brazilian municipalities during the COVID-19 pandemic. Additionally, households that expressed a more negative perception of the food environment, especially regarding the access to FV, were those experiencing moderate/severe FI, and concomitantly, those with lower income levels.

As we can observe in the study, the literature indicates that in recent years, the prevalence of FI has been increasing in Brazil and around the world^{1,5,35}. National surveys have shown a significant rise in FI in Brazil, especially mild FI, compared to previous studies³⁻⁵, particularly during the COVID-19 pandemic^{3,4}.

In general, it is observed that families experiencing FI are situated in a food environment with limited availability and variety of healthy foods options for purchase and high prices³⁶⁻³⁸.

However, there is a lack of national studies that elucidate the relationship between food environment characteristics and FI. To our knowledge, this is the first epidemiological study to assess such relationship in households of public school students in two municipalities.

In the present study, for both socioeconomic strata and degrees of FI, the majority of households demonstrated a positive perception regarding the ease of purchase, quality, and variety of FV available in the neighborhood. However, the percentages of disagreement are significant and should not be overlooked. These findings may suggest the importance of other factors, such as financial accessibility to food, considering that even with proximity to healthy and quality food, families may not have the means to purchase these items^{1,21,22,39}.

In line with this hypothesis, the results herein clearly demonstrate that the vast majority of households, especially those in severe FI and with lower income, disagree that FV are cheap.

Therefore, we can infer that family income and food prices are extremely relevant factors for these families' access to healthy foods, particularly for vulnerable families^{39,40}.

These results align with studies that highlight economic factors as one of the main determinants of food choice, especially for individuals with low income³⁹⁻⁴⁴. In this context, higher food prices can exacerbate the severity of FI among the most vulnerable families. Moreover, rising food inflation has a significant impact on the purchasing power of households, especially lower-income families, who need to allocate a larger portion of their budget to food^{4,24,45,46}. In the Brazilian scenario, according to the National Broad Consumer Price Index (IPCA), the year-end inflation rate in 2021 was 10.6%, the highest annual accumulated rate since 2015⁴⁷. In this context, as per a report by FAO et al. (2021), the elevated cost of nutritious diets, combined with high levels of income inequality, results in healthy diets being inaccessible to around 3 billion people worldwide, especially the poorest³⁵.

Another aggravating factor for FI, which we can associate with the results herein, is the higher cost of fresh foods compared to highly processed foods, especially considering a food environment increasingly abundant and dominated by the latter^{10,24,43,48-51}. When comparing the agreement percentages for fresh foods assessed in the survey, we can infer that highly processed foods are more accessible, and, especially, they are available in great variety in the neighborhoods of the analyzed households, for both income strata and FI levels. This potential scenario is a consequence of a food production, processing, and distribution system that is increasingly focused on highly processed foods⁵²⁻⁵⁴, to the detriment of unprocessed and minimally processed foods⁵⁵⁻⁵⁸.

In addition, the literature is clear in demonstrating that socioeconomically disadvantaged areas may have lower densities of establishments selling food in general, particularly those that predominantly offer fresh and minimally processed foods, contributing to health disparities⁵⁹⁻⁶³. Moreover, the agreement rates regarding the variety and ease of purchase of UPF increase especially with income in our study - a trend also observed in other research - it is important to note a trend towards national standardization for higher consumption of UPF⁶⁴. This is also propelled by the characteristics of these products, such as the use of cheap ingredients, long shelf life, ease transportation, low cost, hyper-

palatability, and aggressive marketing^{50,58,59}.

It highlights the concerning rise in exposure to a wide variety of UPF available among children and adolescents, as evidenced in recent studies^{65,66,67} and within socially vulnerable groups⁶⁴. The escalation in the consumption of UPF has been linked, along with other risk factors, to the rise in childhood obesity among schoolchildren. It is also a risk factor for the development of chronic non-communicable diseases and other adverse health outcomes⁶⁸.

The results of this study should be interpreted in the broader context experienced on the global and Brazilian stage. Brazil had already faced high rates of unemployment and informal labor, and with the outbreak of the pandemic, a larger number of families suffered from job loss, reduced salaries, and low income^{18,69,70}.

Furthermore, in response to the suspension of classes, state and municipal governments, through the PNAE, distributed kits or basic food baskets to the families of the students, aiming to maintain the right to food for these public school students. Despite the importance of these actions, they may have been insufficient to guarantee access to enough food to meet the needs of those families, as they were unable to reduce FI indicators^{3,24,25}. Moreover, for those states and municipalities that opted for transferring financial resources to families, ensuring the nutritional quality of the purchased food becomes even more challenging, potentially favoring the purchase of UPF based on the results observed here²⁶.

Such factors can lead families to reduce both the quality and quantity of the food they consume, which directly contributes to an increase in FI. In addition to these factors, Brazil has experienced a scenario marked by political instability and the dismantling of social protection policies, especially those aimed at promoting food and nutritional security and a sustainable, healthy food system^{24,71-73}.

This study has limitations, such as the use of telephone interviews, potentially leading to participation bias. Additionally, the questionnaire lacked options for households with incomes between half a minimum wage and 1 minimum wage or between 2 and 3 minimum wages. Lastly, the study focused exclusively on families of students in public schools, limiting the generalizability of the results to all students in the municipalities.

As strengths of the study, it is worth highlighting the utilization of the full version of

EBIA, a validated instrument for the Brazilian population and employed in national surveys^{2,29}. The random stratified sampling process is representative of the population of students in public schools in the two municipalities. Besides, the study contributes to understanding the food environment in medium-sized Brazilian municipalities, given that most studies are conducted in large cities⁷⁴, and it aids in comprehending the effects of the COVID-19 pandemic as an exacerbating factor in the food crisis experienced in Brazil.

Given the significant prevalence of FI in households of students within an environment highly conducive to UPF, it is imperative to investigate extensively how these factors interact and influence disparities in access to healthy foods. There is a clear demand for comprehensive longitudinal research that explores this relationship comprehensively.

Furthermore, there is a clear need for policies that provide support to the most vulnerable populations, guaranteeing food environments that promote the HRAF, in particular ensuring access (at all levels) to healthy food, as an essential measure to prevent the elimination of hunger. It is essential to develop and implement policies and interventions through a multisectoral approach that specifically targets poverty and addresses the obstacles to accessing healthy diets.

Additionally, a strategic plan is essential to ensure the continued provision of school meals by the PNAE during interruptions to classes, both in emergency and non-emergency scenarios.

Conclusion

A high prevalence of FI was observed in the households of students, along with a highly abundant food environment that promotes UPF. It is noteworthy that the most vulnerable families have less financial access to healthy food, highlighting the importance of the economic situation in nutrition.

The COVID-19 pandemic has exacerbated social and food inequalities, deepening the food crisis in Brazil. This context contributes to the expansion of a food environment that obstructs access to basic and healthy foods, while facilitating access to UPF. This has an undeniable impact on the population's food insecurity, contributing to malnutrition in all its forms, particularly among children and adolescents.

Collaborators

All authors met the authorship criteria and also reviewed the final version of the manuscript, which was approved for publication.

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