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Consumer food environment assessment and its association with socioeconomic factors in a midsize city in Brazil

Avaliação do ambiente alimentar do consumidor e suas associações com fatores socioeconômicos em uma cidade brasileira de médio porte

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ABSTRACT

Objective
To assess the consumer food environment and its associations with socioeconomic factors in a midsize Brazilian city.

Methods
An ecological study that assessed the consumer food environment through audits in a stratified and proportional sample of food stores. The ESAO-S and the ESAO-R instruments were used. Access to healthy food was assessed using the Healthy Food Store Index and the Healthy Meal Restaurant Index. Socioeconomic and demographic characteristics and the Health Vulnerability Index were obtained from the 2010 Demographic Census. Statistical analyses were performed using the IBM®SPSS® software.

Result
A total of 280 food stores were assessed. Only 47.1% of food stores for home consumption had fruits, vegetables, or legumes. High availability of ultra-processed food was identified, such as sugar-sweetened beverages (85.0%) and chocolate sandwich cookies (77.8%). The prices of some unprocessed foods and the availability of snacks were different according to socioeconomic characteristics. In food stores for immediate consumption, low availability of healthy options was identified, and, in most of them, natural juices had higher prices than sugar-sweetened

beverages (87.1%). The mean Healthy Food Store Index score was 5.1 (SD=3.6), and the Healthy Meal Restaurant Index was 2.4 (SD=1.2).

Conclusion
These findings allow us to expand the knowledge about the consumer food environment, helping to implement public policies related to food supply.

Keywords: Environment; Food; Socioeconomic factors.

RESUMO

Objetivo
Avaliar o ambiente alimentar do consumidor e suas associações com fatores socioeconômicos em uma cidade brasileira de médio porte.

Métodos
Estudo ecológico, no qual avaliou-se o ambiente alimentar do consumidor por meio de auditorias em uma amostra estratificada e proporcional de estabelecimentos que comercializam alimentos. Utilizaram-se os instrumentos ESAO-S e ESAO-R. O acesso a alimentos saudáveis foi avaliado por meio do Healthy Food Store Index e do Healthy Meal Restaurant Index. As características socioeconômicas, demográficas e o índice de vulnerabilidade da saúde foram obtidos a partir do Censo Demográfico de 2010. As análises estatísticas foram realizadas no software IBM®SPSS®.

Resultados
Avaliaram-se 280 estabelecimentos, onde apenas 47,1% dos comércios de alimentos para consumo em domicílio possuíam frutas, verduras ou legumes. Foi identificada uma elevada disponibilidade de alimentos ultraprocessados, como refrigerantes (85,0%) e biscoitos (77,8%). Os preços de alguns alimentos in natura e a disponibilidade de salgadinhos foram diferentes segundo as características socioeconômicas. Nos comércios de alimentos para consumo imediato, foi identificada baixa disponibilidade de opções saudáveis e, na maioria deles, os sucos naturais apresentaram preços superiores a refrigerantes (87,1%). A pontuação média do Healthy Food Store Index foi 5,1 (DP=3,6) e do Healthy Meal Restaurant Index de 2,4 (DP=1,2).

Conclusão
Os resultados permitem ampliar o conhecimento sobre o ambiente alimentar do consumidor, auxiliando na implantação de políticas públicas relacionadas ao abastecimento alimentar.

Palavras-chave: *Meio ambiente. Alimentos. Fatores socioeconômicos.*

INTRODUCTION

The food environment is composed of physical (availability, quality, and promotion), economic (prices), political, and socio-cultural (norms and behavior) dimensions that influence access to healthy and unhealthy foods and, consequently, food consumption and health [1-3]. It can be divided into community food environment, characterized by the distribution of food stores based on type, location, density, and accessibility [4,5], and consumer food environment, which comprises quality, price, advertising, availability, and variety of food offered in these stores [5,6].

Consumer food environment studies are necessary, as they allow us to analyze the characteristics of foods found in food stores, avoiding a reductionist view of these stores, considering only their type, without necessarily knowing the products offered [7-9]. It is recognized that different types of food, with different availability, variety, and prices, can be found between two food stores of the same type, depending on the socioeconomic level of the region where they are located [10-13]. Research conducted in developed and developing countries indicates that healthy foods, such as fruits, vegetables, and unprocessed foods, are less available in low-income neighborhoods or more inhabited by minorities (blacks, browns, and indigenous) [14-16]. In contrast, unhealthy

foods such as sugar-sweetened beverages, chips, and fast food are widely found in low-income neighborhoods [17,18].

Although the volume of evidence about the food environment is increasing in the literature, they mainly assess the metropolises of developed countries. Hence, studies addressing the consumer food environment in Latin America and countries with low or middle income, such as Brazil, are still scarce [19-25]. Therefore, studies assessing the consumer food environment in different economic contexts are necessary to plan public fiscal and regulatory policies to expand access to healthy food [26-29].

This study aimed to assess the consumer food environment and its associations with socioeconomic factors in a midsize Brazilian city.

METHODS

This ecological study assessed the consumer food environment in Juiz de Fora, Minas Gerais, Brazil. The city, located in the southeast of Minas Gerais, has an area of 1,435,749 km^2 and an estimated population of approximately 573,285 inhabitants in 2019 [30]. It is classified as a midsize city due to its economic and administrative function and population volume [31,32]. The Municipal Human Development Index in 2010 was 0.778, and the Gross Domestic Product per capita in 2017 was R$ 28,355.07 (last available data), equivalent to US$ 5,186.78. It is divided into seven administrative regions (North, South, East, West, Centre, Northeast, and Southeast) and 81 urban regions [31].

The Taxpayer Registration spreadsheet for June 2019 was obtained by contacting the State Finance Department of Minas Gerais to assess the food environment, which provided the registration data [legal name, trade name, full address, and code of the *Classificação Nacional de Atividades Econômicas* (CNAE, Brazilian National Classification of Economic Activities) of commercial establishments in the city.

Audits were conducted in a sample of food stores to assess the consumer food environment. Sample calculation was performed using the Epi Info software, adopting: a total of 4,788 food stores in the city; hypothetical frequency of the outcome factor in the unknown population (50%); 5% confidence limit; design effect of 1 and 95% confidence interval, totaling a sample of 356 food stores. Subsequently, a random, stratified, and proportional selection was conducted, considering the grouping according to the CNAE and the city's administrative regions.

Audits were performed using the instruments proposed by the *Estudo do Ambiente Obesogênico em São Paulo* (ESAO-SP, Study of the Obesogenic Environment of São Paulo, which are validated for Brazil. The ESAO-S was implemented to assess the following types of food stores: convenience stores, public-owned specialized Fruits and Vegetable (FV) markets, privately-owned specialized FV markets/stores, open-air food markets, corner stores, locally owned grocery stores/corner stores, large chain grocery stores, large chain supermarkets, and delis. The variables investigated were the availability, variety, and price of unprocessed foods (FV) and ultra-processed foods (sugar-sweetened beverages, chocolate sandwich cookies, and snacks) [21]. The ESAO-R was used to assess the following types of food stores: snack places, teahouses, juice bars, and corresponding stores; bakeries and retail trade of dairy products and cold cuts; restaurants and corresponding stores. The availability and price of healthy products (fruits and salads) and unhealthy foods (sugar-sweetened beverages and fries) were assessed. Facilitators and barriers to healthy eating are the presence of combos, the price of sugar-sweetened beverages, chips, and fruit, and food marketing [21]. Food

prices were assessed in Brazilian currency (R$) and converted to US Dollars (US$) – the price in Reais was multiplied by 0.25 (considering December 2019, US$ 1.00 = R$ 4,03).

Audits were conducted from October to December 2019 by experienced researchers properly trained in applying the instruments.

Two indexes were calculated to assess the access to healthy foods in food stores for home consumption and immediate consumption: Healthy Food Store Index (HFSI) and Healthy Meal Restaurant Index (HMRI), respectively. The HFSI is used to score the ESAO-S, and its score ranges from 1 to 16; it measures the availability, variety, and advertising or promotion of healthy foods (FV) and ultra-processed products considered unhealthy markers (sugar-sweetened beverages, chocolate sandwich cookies, and corn chips). In the index, healthy foods have a positive score, and unhealthy foods have a negative score. Availability is determined by the existence of at least one variety of the assessed foods. The variety of FV is assessed using a score that ranges from 0 (absence), 1 (from 1 to 14 varieties available), and 2 (15 or more varieties available). Higher HFSI scores mean better access to healthy foods. The HMRI is used to score the ESAO-R; its score ranges from 0 to 8 and encompasses data on the availability and promotion of fresh vegetables, fruits, and juices and advertising data for highly processed foods. It also encompasses data on the presence of nutritional information and barriers to healthy choices, such as fixed-price services. Items related to healthy consumption are positively coded, and those related to unhealthy behavior are not scored [21].

Socioeconomic and demographic characteristics of Urban Regions (UR), such as estimated population, proportion of older adults, illiteracy rate, proportion of black, brown, and/or indigenous races and ethnicities, proportion of households without treated water and proportion of people with per capita household income below two minimum wages, were obtained from the 2010 Demographic Census [31]. Additionally, the Health Vulnerability Index (HVI) was assessed, which encompasses eight indicators calculated from the 2010 Demographic Census variables and grouped into two dimensions (sanitation and socioeconomic), and enables to analyze the socio-environmental characteristics of resident population groups in some geographic regions [32]. The HVI was stratified into three categories: low vulnerability [UR with an HVI score more than half a Standard Deviation (SD) below the mean: 0.0843-0.2356]; medium vulnerability (UR with HVI score with half an SD around the mean: 0.252-0.3857); and high vulnerability (UR with an HVI score of more than half an SD above the mean: above 0.3923) [33].

Statistical analyses were performed using the IBM®SPSS® software (version 17.0, IBM Corp., USA), with a significance level set at 5%. Initially, exploratory analyses were performed to verify data integrity and coherence. Quantitative variables were assessed for the presence of outliers and type of distribution using the Kolmogorov-Smirnov test. Categorical variables were presented as absolute and relative frequencies and compared, according to the HVI, using Pearson's chi-square test, followed by Bonferroni's post hoc test, in cases where F-test was significant. The ANOVA test was performed, with a Games-Howell post hoc test, in cases where the F-test was significant. Quantitative variables with asymmetric distribution were described according to medians and Interquartile Range (IQR) to compare the HFSI and HMRI scores of each type of commercial establishment. The Kruskal-Wallis test was used, followed by the Bonferroni post hoc test, in cases where the F-test was significant, to test for differences in food availability, variety, and prices, according to the HVI. Spearman's correlation was performed between the socioeconomic variables of the regions (population; proportions of older adults; dependency ratio; proportions of households without treated water; proportions of illiterates; proportions of black, brown, and indigenous races and ethnicities; proportions of families with income below two minimum wages and HVI) and the HFSI and HMRI scores or the prices of unprocessed and ultra-processed foods.

RESULTS

A total of 280 food stores were assessed, 105 (37.5%) of which were food stores for home consumption and 175 (62.5%) for immediate consumption, arranged in a stratified manner, according to the type of food store, and proportionally across the different areas of the city.

The sample included was inferior to the sample size calculation due to the beginning of the COVID-19 pandemic, which resulted in the adoption of measures to restrict the circulation of people during the period in which the audits were conducted. Thus, one of the city's regions could not be assessed (South region). This region has low, medium, and high-vulnerability neighborhoods, and the estimated population was 62,730 individuals in 2020 (corresponding to approximately 10.95% of the city's population). However, the audited sample was adequate in other regions of the city.

Considering the food stores for home consumption, it was observed that 47.1% used to sell fruits, vegetables, or legumes. Amid these, the most available fruits were banana (100%), lemon (95.8%), and orange (93.8%), and vegetables/legumes were onion (100%), tomato (87.2 %), and chayote (83.3%). The high availability of ultra-processed foods in these establishments stands out: 85.0% used to sell sugar-sweetened beverages; 81.2% used to sell juice or industrialized nectar; 73.1% used to sell powdered juices; 77.8% used to sell chocolate sandwich cookies; and 69.6% used to sell corn chips.

The median score of the HFSI was 5.1 (SD=3.6 points), with hypermarkets and supermarkets [9.5 (SD=0.8)] and FV retail shops [9.1 (SD=2.1)] having higher scores than sweets stores [1.4 (SD=0.7)], butchers and fishmongers [3.1 (SD=1.2)] and minimarkets [4.4 (SD=3.2)]. Minimarkets and butchers had higher scores than sweets stores (Table 1).

Amid the specifications for selling foods for immediate consumption, only 25.7% used to have a catering of salads, vegetables, or legumes available, and only 13.5% used to offer fresh fruit or fruit salad on the menu/catering. Natural juices were available for purchase in 53.4%; however, 87.1% were more expensive than sugar-sweetened beverages.

The HMRI had a mean score of 2.4 (SD=1.2). The highest scores were found in restaurants [2.9 (SD=1.2)] compared to snack places [2.2 (SD=0.9)] (Table 1).

Table 1 – Access to healthy foods in food stores for home consumption and immediate consumption according to the HFSI and HMRI indexes, respectively, is classified according to the *Classificação Nacional de Atividades Econômicas*. Juiz de For a (MG) Brazil, 2020.

Types of food stores	n	%	Mean (SD)	*p*
Home consumption			Healthy Food Store Index	
Hypermarkets and supermarkets	10	9.5	9.5 (0.8)	
Sweets stores, convenience stores	11	10.5	1.4 (0.7)	
Fruit and vegetable retail shops	12	11.4	9.1 (2.1)	<0.001†
Butchers and fishmongers	15	14.3	3.1 (1.2)	
Minimarkets, grocery stores, warehouses	57	14.3	4.4 (3.2)	
Total	105	100	5.1 (3.6)	
Immediate consumption			Healthy Meal Restaurant Index	
Snack places	95	54.3	2.2 (0.9)	
Restaurants	56	32.0	2.9 (1.2)	0,001‡
Bakeries	24	13.7	2.1 (1.7)	
Total	175	100	2.4 (1.2)	

Note: †Difference between the groups: hypermarkets/supermarkets and sweets stores (p<0.001); hypermarkets/supermarkets and butchers/fishmongers (p<0.001); hypermarkets/supermarkets and minimarkets (p<0.001); sweets stores and fruit and vegetable retail shops (p<0.001); sweets stores and butchers/fishmongers (p=0.001); sweets stores and minimarkets (p<0.001); fruit and vegetable retail shops and butchers/fishmongers (p<0.001); fruit and vegetable retail shops and minimarkets (p<0.001). ‡ Difference between the groups: snack places and restaurants (p<0.001). SD: Standard Deviation.

Food availability and variety in food stores for home consumption did not show significant variations according to the HVI (Table 2). The prices of some unprocessed foods showed differences according to the HVI, namely: bananas had a higher price in regions with a low HVI (median of R$ 2,99) compared to medium ones (median of R$ 2,49) and high HVI (median of R$ 1,99); papaya and apple had higher prices in regions with low HVI (medians of R$ 2,99 and R$ 7,34, respectively) compared to those with high HVI (medians of R$ 1,80 and R$ 5,99, respectively); onion was more expensive in regions with a high HVI (median of R$ 3,99) compared to those of medium HVI (median of R$ 2,99) (Table 3).

Table 2 – Availability and variety of unprocessed and ultra-processed foods and HFSI in food stores for home consumption according to the Health Vulnerability Index. Juiz de Fora (MG) Brazil, 2020.

Availability and variety	Health Vulnerability Index			Total	*p*
	Low	Medium	High		
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	
Availability of fruits	9.0 (6.0-9.0)	7.5 (6.0-8.0)	3.5 (4.5-7.0)	8.0 (6.0-9.0)	0.060
Variety of fruits	14.5 (9.0-18.0)	10.5 (6.0-13.0)	4.5 (4.0-10.0)	11.5 (8.0-16.0)	0.136
Availability of vegetables	9.0 (6.0-10.0)	9.0 (5.0-10.0)	4.5 (4.0-7.5)	9.0 (5.0-10.0)	0.260
Variety of vegetables	12.5 (9.0-15.0)	10.5 (6.0-13.0)	4.5 (4.0-10.5)	11 (5.0-13.0)	0.052
Variety of sugar-sweetened beverages (flavors and brands)	10.5 (5.0-15.0)	5.5 (4.0-11.5)	4.5 (4.0-10.5)	6.0 (4.0-14.0)	0.885
Variety of juices or Tetra Pak nectars (brands)	4.5 (1.0-7.0)	4.0 (2.5-5.0)	3.0 (2.0-5.5)	4.0 (2.0-5.0)	0.755
Variety of powdered juice (brands)	4.5 (2.0-5.0)	4.0 (2.5-5.5)	5.0 (3.5-6.5)	4.0 (3.0-5.0)	0.640
Variety of chocolate sandwich cookies	6.5 (3.0-8.0)	7.5 (5.5-11.5)	4.5 (3.0-6.5)	6.5 (4.0-9.0)	0.084
Variety of corn chips (30 a 66 g)	3.0 (0.0-5.0)	3.0 (0.5-4.0)	3.0 (1.5-5.5)	3.0 (0.0-5.0)	0.395
Variety of corn chips (100 to 170 g)	2.0 (0.0-6.0)	3.5 (1.0- 5.0)	4.0 (3.5-7.0)	3.5 (0.0-5.0)	0.078
	Mean (SD)	Mean (SD)	Mean (SD	Mean (SD)	*p*
Healthy Food Store Index score	4.9 (3.9)	5.5 (3.5)	4.2 (3.2)	5.1 (3.6)	0.403

Note: IQR: Interquartile Range; SD: Standard Deviation.

Table 3 – Prices of unprocessed and ultra-processed foods in food stores for home consumption according to the Health Vulnerability Index. Juiz de Fora (MG) Brazil, 2020.

Food, lowest price found (Brazilian Real, R$)[¶]	Health Vulnerability Index			Total	*p*
	Low	Medium	High		
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	
Orange	2.79 (2.59-2.99)	2.99 (2.19-3.49)	2.59 (2.54-2.79)	2.94 (2.49-3.24)	0.528
Banana	2.99 (2.99-3.95)	2.49 (1.99-2.69)	1.99 (1.99-2.49)	2.40 (1.99-2.99)	<0.001[†]
Papaya	2.99 (2.69-3.99)	2.49 (1.99-2.99)	1.80 (1.65-2.25)	2.69 (1.99-2.99)	0.027[‡]
Apple	7.34 (5.99-8.99)	4.24 (2.79-5.99)	5.99 (5.49-5.99)	5.74 (3.99-6.99)	0.012[§]
Tomato	5.99 (3.99-6.25)	4.50 (3.49-5.99)	4.99 (4.99-5.99)	4.99 (3.99-5.99)	0.620
Onion	3.99 (2.99-4.74)	2.99 (2.49-3.99)	3.99 (3.75-4.19)	3.59 (2.89-3.99)	0.050[‖]
Carrot	3.99 (3.97-4.99)	3.24 (2.62-3.99)	3.99 (3.74-4.25)	3.99 (2.99-4.25)	0.051
Lettuce	1.75 (1.29-1.99)	1.50 (1.39-2.00)	1.44 (1.19-1.50)	1.50 (1.35-1.99)	0.620
Cola sugar-sweetened beverages (can of 350 ml)	3.42 (2.74-3.50)	3.05 (2.77-3.74)	2.90 (2.25-3.25)	3.10 (2.69-3.50)	0.164
Tetra Pak juice or nectar	2.63 (1.55-3.60)	2.24 (1.49-3.10)	2.99 (1.79-3.90)	2.49 (1.49-3.59)	0.461
Powdered juice	0.82 (0.69-1.00)	0.84 (0.69-1.00)	0.79 (0.65-1.00)	0.79 (0.69-1.00)	0.904
Chocolate cookie (70-165 g)	1.55 (1.35-2.00)	1.39 (1.29-1.99)	1.50 (1.39-1.60)	1.49 (1.29-1.95)	0.471
Corn chips (30-66 g)	1.29 (1.00-1.50)	1.00 (0.99-1.49)	1.20 (1.00-1.49)	1.19 (0.99-1.50)	0.516
Corn chips (100-170 g)	2.00 (1.59-3.10)	1.90 (1.50-2.35)	1.95 (1.50-2.00)	1.99 (1.50-2.99)	0.632

Note: [†]Difference between low and medium (p=0.007) and low and high (p=0.014) groups; [‡]Difference between low and high groups (p=0.015); [§]Difference between low and high groups (p=0.004); [‖]Difference between medium and high groups (p=0.041); [¶]To convert to US Dollars (US$), multiply the price in Brazilian Real (R$) by 0.25 (considering December 2019, US$ 1.00 = R$ 4.03). IQR: Interquartile Range.

No associations have been observed between access to healthy foods in food stores for home consumption, according to the HFSI score, and the socioeconomic characteristics of the URs in which the establishments were located.

Regions with higher proportions of individuals who earn less than two minimum wages had negative correlations with the price of unprocessed food such as banana (r^2=0.241; p<0.001), papaya (r^2=0.111; p=0.042) and apple (r^2=0.178; p = 0.005), in addition to greater availability of corn chips brands (r^2=0.043; p=0.014). A similar result was found in regions with higher proportions of black, brown, and indigenous races and ethnicities, which presented a negative correlation with the price of unprocessed foods such as banana (r^2=0.234; p=0.001), papaya (r^2=0.105; p=0.047) and apples (r^2=0.226; p=0.001), and greater availability of corn chips brands (r^2=0.070; p=0.029).

Regarding stores that sell food for immediate consumption, it was observed that the price of a glass of natural juice was higher than that of sugar-sweetened beverages in 92.1% of food stores in low HVI regions and 57.1% in high HVI regions. (Table 4).

Access to healthy foods in stores that sell food for immediate consumption, assessed by the HMRI, was not influenced by the socioeconomic characteristics of the regions where the establishments were located.

Table 4 – Characteristics of stores that sell food for immediate consumption and HMRI according to Health Vulnerability Index. Juiz de Fora (MG) Brazil, 2020.

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Characteristics	Health Vulnerability Index			Total	*p*
	Low	Medium	High		
	n (%)	n (%)	n (%)	n (%)	
Catering of salads/vegetables/legumes available or these options in the catering					
No	74 (69.2)	45 (80.4)	11 (91.7)	130 (74.3)	0.108
Yes	33 (30.8)	11 (19.6)	1 (8.3)	45 (25.7)	
Food store offers only a fixed-price self-service or all-you-can-eat					
No	75 (7.,3)	47 (83.9)	11 (91.7)	133 (78.7)	0.191
Yes	26 (25.7)	9 (16.1)	1 (8.3)	36 (21.3)	
Existence of nutritional information next to the food					
No	100	54	12	166	0.698
Yes	2 (2.0)	2 (3.6)	0 (0)	4 (2.4)	
Availability of salads as main dishes, side orders, or dishes exclusively made of vegetables and legumes					
No	69 (67.6)	45 (80.4)	11 (91.7)	125 (73.5)	0.075
Yes	33 (32.4)	11 (19.6)	1 (8.3)	45 (26.5)	
Availability of fresh fruits or fruit salad as dessert					
No	90 (87.4)	46 (83.6)	11 (91.7)	147 (86.5)	0.695
Yes	13 (12.6)	9 (16.4)	1 (8.3)	23 (13.5)	
Availability of fresh, natural juice or prepared from the frozen pulp					
No	44 (41.1)	33 (58.9)	4 (36.4)	81 (46.6)	0.075
Yes	63 (58.9)	23 (41.1)	7 (63.6)	93 (53.4)	
Price of one glass of 300 mL of natural juice superior to a can (350 mL) or one glass (300 mL) of light/diet/zero or regular sugar-sweetened beverages					
No	2 (3.2)	2 (8.7)	0 (0)	4 (4.3)	0.011[1]
Yes	58 (92.1)	19 (82.6)	4 (57.1)	81 (87.1)	
Equal	3 (4.8)	2 (8.7)	3 (42.9)	8 (8.6)	
Possibility of replacing the sugar-sweetened beverages in combos/ promotions for natural juices or water, with no additional cost					
No	13 (76.5)	12 (80.0)	3 (37.5)	28 (70.0)	0.079
Yes	4 (23.5)	3 (20.0)	5 (62.5)	12 (30.0)	
Existence of advertising for sugar-sweetened beverages, chips, desserts and ice cream					
No	66 (61.7)	31 (55.4)	6 (50.0)	103 (58.9)	0.599
Yes	41 (38.3)	25 (44.6)	6 (50.0)	72 (41.1)	

Table 4 – Characteristics of stores that sell food for immediate consumption and HMRI according to Health Vulnerability Index. Juiz de Fora (MG) Brazil, 2020.

Characteristics	Health Vulnerability Index			Total	*p*
	Low	Medium	High		
	n (%)	n (%)	n (%)	n (%)	
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	*p*
Price of the cheapest regular soft sugar-sweetened beverages (1 can of 350 mL or 1 glass of 300 mL) [§]	4.0 (3.5-4.5)	4.0 (3.5-4.6)	4.0 (3.5-5.0)	4.0 (3.5-4.5)	0.819
Price of the smallest serving of seasonal or day fruit or the cheapest serving of fruit salad [§]	6.5 (5.3-12.4)	3.0 (3.0-5.2)	2.5 (2.0-3.0)	5.4 (3.0-7.5)	0.023[‡]
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*
Healthy Meal Restaurant Index	2.5 (1.2)	2.2 (1.2)	2.3 (0.8)	2.4 (1.2)	0.312

Note: [†]Difference between low and high HVI groups (p=0,003); [‡]Difference between low and medium HVI groups (p=0,047), low and high (p=0,030); [§]To convert to US Dollars (US$), multiply the price in Brazilian Real (R$) by 0.25 (considering December 2019, US$ 1.00 = R$ 4.03) IQR: Interquartile Range; SD: Standard Deviation.

DISCUSSION

Best access to healthy food, according to the HFSI score, was found in supermarkets and FV retail shops, similar to the literature, as these establishments offer healthier foods compared to local markets, small grocery stores, and convenience stores [34]. Studies show that greater access to supermarkets is associated with healthy diets [28,35]; however, it is important to emphasize that supermarkets offer healthy and ultra-processed products. Thus, food choices will be influenced by different issues such as eating behavior, marketing, price, family, and culture [36,37].

The lower HFSI scores in convenience stores and local markets can be explained by the fact that they predominantly have ready-to-eat food options, which are easier to store, attractive to consumers, and easier to sell. These factors are consistent with the sale of ultra-processed foods – snacks, cookies and crackers, corn chips, and sugar-sweetened beverages [19,38-40].

A similar study was conducted by Duran, in which the same questionnaire (ESAO-S) was applied, and the HFSI index was also calculated for a sample of supermarkets, FV retail shops, local markets, delis, and convenience stores located in the Brazilian metropolis of São Paulo. Mean HFSI scores of 10.33 (SD=2.87) for supermarkets, 13.13 (SD=2.69) for FV markets, 3.07 (SD=2.50) for local grocery stores and 2.53 (SD=1.46) for delis and convenience stores were found. These scores are higher than those found in this study for supermarkets [9.5 (SD=0.8)], FV markets [9.1 (SD=2.1)], and convenience stores [1.4 (SD=0.7)]. The scores found in local grocery stores were lower [4.4 (SD=3.2)]. Contrary to the present study, the author identified that the availability, variety, and amount of advertising or promotion of healthy items increased as socioeconomic conditions in the environment were improved [22]. Another survey also conducted in Juiz de For a (MG), assessed supermarkets and similar establishments, and found a similar score: the HFSI mean was 8.91 (SD=1.51), and regions with low HVI had a higher score in the index [9.93 (SD=0.96)] in comparison with the regions of medium [8.08 (SD=1.38)] and high and very high HVI [8.00 (SD=1.41)] (p=0.010) [41].

Studies conducted in developed and developing countries, such as Brazil, indicate that food availability, variety, and price may differ in areas of varied socioeconomic status and that regions of low socioeconomic status have limited variety, lower quality, and higher prices of healthy foods [14,22,34,42-44]. Additionally, it has been shown that individuals with favorable socioeconomic status have greater access to healthy foods such as fruits, vegetables, and legumes [21,24,45,46]. However, in the present study, no difference was observed in food availability and variety HFSI scores according to socioeconomic characteristics. A similar outcome was observed by Costa et

al. [47], who assessed access to food (through the HSFI index) in a Brazilian city and found out that this index was only influenced by the type of food store.

Lower prices for unprocessed foods such as bananas, papaya, and apples were identified in regions with greater vulnerability, regions with higher proportions of individuals who earn less than two minimum wages, and higher proportions of black, brown, and indigenous races and ethnicities. This outcome can be explained by the fact that regions with higher proportions of black, brown, and indigenous races and ethnicities showed a strong correlation with income lower than two minimum wages ($r=0.974$, $p<0.001$). This finding can be considered positive since, amid the various factors that determine food acquisition and consumption, as the importance of prices stands out [48]. According to the most recent Consumer Expenditure Survey, from 2017 to 2019, families with up to two minimum wages allocate a more significant share of their income to food expenses [49]. Thus, food prices can be decisive in healthy food consumption [50], especially in impoverished families. Leite et al. [41] when assessing supermarkets in the same city as the present study, found that more vulnerable neighborhoods had lower prices for FV; however, the food had worse quality, affecting the perceived value of these products and discouraging their purchase. However, other researchers [51-53] found that areas with lower socioeconomic status have higher spending on food.

There was a greater availability of corn chip brands in regions with higher proportions of individuals who earn less than two minimum wages and with higher proportions of black, brown, and indigenous races and ethnicities. Other studies also indicate that unhealthy foods are widely found in low-income neighborhoods [17,18]. This finding reinforces that the current dynamic of commercial food stores favors ultra-processed food consumption, leading to the deterioration of traditional cultures [24,36]. In Brazil, ultra-processed foods are relatively more expensive than unprocessed or minimally processed foods [54,55]. However, Maia et al. [56] analyzing the temporal variation of food prices in Brazil (1994-2030), predicted that, from 2026 onwards, healthy diets would become more expensive than unhealthy diets.

Some limitations can be identified regarding the present study: food store assessment was conducted over a short period, which may influence the availability and variety of some unprocessed foods. Nevertheless, since all food stores were audited simultaneously, the results are comparable. Additionally, due to the beginning of the COVID-19 pandemic and the adoption of measures to restrict the circulation of people, the audits were interrupted, and consequently, the sample calculated for the southern region of the city (n=99) could not be assessed; however, we emphasized that in other regions the audits were properly conducted. We also highlighted that the South region has neighborhoods with different HVI, and regions with similar characteristics were represented in the sample.

Although it has limitations, this study is relevant, as data collection through direct observation led to a better understanding of the access and quality of the consumer food environment. Additionally, few studies assessed the consumer food environment in Brazil using a specific questionnaire developed for our reality (ESAO-S and ESAO-R) and calculated an index of access to food such as the HFSI and HMRI [19,22,41]. More ecological studies are imperative to assess access to healthy foods, especially in Latin American countries, where such studies are scarce, and most of these are conducted in large cities, with a need for more data in smaller cities.

CONCLUSION

In the present study, it was identified that less than half of the food stores for home consumption used to sell fruits, vegetables, or legumes and that there is a high availability of ultra-processed

foods in these places. Some unprocessed foods, such as bananas, papaya, and apples, had higher prices in regions of low social vulnerability and lower prices in regions with higher proportions of individuals who earn less than two minimum wages and with higher proportions of black, brown, and indigenous races and ethnicities. When assessing stores that sell food for immediate consumption, low availability of healthy options (salads, vegetables, legumes, and fruits) was observed.

The results allow for expanding the knowledge about the availability, variety, price, and access to unprocessed and ultra-processed foods in small and in midsize cities, which can help to identify areas with a greater need for implementation and reinforcement of public policies related to food supply that prioritize areas of difficult access and aim to improve access, availability, and consumption of healthy and sustainable food, contributing to overcoming inequality in access.

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CONTRIBUTORS

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