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Food deserts and swamps in major Brazilian cities: an analysis of inequities of race, income, and territory

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Abstract

Background

Food deserts and swamps describe food environments characterized by limited access to healthy foods or by an overabundance of ultraprocessed foods. This study examines food deserts and swamps in Brazilian municipalities and their association with race, income and regional inequalities.

Methods

An ecological study analyzed 220,576 census tracts from 319 Brazilian cities (> 100,000 inhabitants). Food establishments were identified using Brazilian Annual Social Information Report (RAIS) data and classified according to Locais-NOVA methodology. Food deserts were defined by a density of establishments selling fresh or minimally processed foods below the 25th percentile, and food swamps by a density of establishments selling ultra-processed foods above the 75th percentile. Socioeconomic variables included the percentage of Black population and income. Poisson regression with robust variance estimated associations between socioeconomic variables and food deserts and swamps prevalence, stratified by macro-regions.

Results

Overall, 77% of census tracts were food deserts and 25% as food swamps. Census tracts in the highest tertile of Black residents had 24% higher food desert prevalence compared to the lowest tertile, while food swamp prevalence was 54% lower. Higher income was associated with lower prevalence of food deserts (South:PR:0.69; 95%CI: 0.66–0.71) but higher prevalence of food swamps (North:PR: 3.55; 95%CI: 3.17–3.98). Associations evidencing inequality were strongest in the North and Northeast regions.

Conclusions

Food deserts are highly prevalent in major Brazilian cities and are strongly associated with socioeconomic and racial inequalities. These findings highlight regional disparities and support geographically targeted policies to improve access to healthy foods.

Background

The community food environment represents and encompasses the physical, economic, political and sociocultural environment, which is defined by the number, type, place and accessibility of the establishments that sell food [1]. Some metaphors have been proposed to describe the presence or absence of food outlets, and therefore characterize different food environments. The term food deserts refers to places with limited access to nutritious and affordable food, given the reduced number of outlets that sell healthy food [2]. In contrast, the spatial metaphor of food swamps refers to areas where a large supply of high-energy-density foods overwhelms the availability of healthy foods [3].

The prevalence of food deserts in Brazil has been investigated at different geographic scales, with studies mainly demonstrating variability across urban contexts. At a municipal level, investigations in several state capitals reveal that food deserts affect a large proportion of census tracts, ranging from a quarter of these districts in some cities to almost half of them in another city [4–6]. At the same time, fewer studies have investigated the prevalence of food swamps in Brazil. These studies demonstrated a high prevalence of food swamps that increased in the last decade [5].

The configuration of the food environment is closely associated with other forms of inequities. Studies have shown that areas with lower socioeconomic status are more likely to be labeled as food deserts, having impaired access to healthy food [4, 7, 8]. According to a systematic review and meta-analysis, there is a worrying scenario of ethnic-racial inequalities in the community and consumer food environments worldwide, especially regarding Black, Latinos and Indigenous populations who are disproportionately more likely to live in unhealthy food environments [9].

In Brazil, studies have shown how these socioeconomic and racial inequalities are expressed. Evidence from capital cities indicates that socially vulnerable areas, with lower income and higher proportions of Black, Brown and Indigenous populations, are more likely to be food deserts [5, 6, 10]. Nevertheless, the association between food swamps and socioeconomic status remains heterogeneous, while important methodological challenges, such as the operationalization of food swamps and potential residential selection bias, persist in the literature [11].

The studies of the community food environment in Brazil have mostly been restricted to a municipal scale or have focused on a specific aspect of the food environment. More recently, a nationwide study described the spatial distribution of food deserts and food swamps in Brazil [12]. However, these analyses were conducted at the municipal level and did not investigate within-city socioeconomic and racial inequalities in the distribution of food deserts and food swamps. Therefore, this study aims to analyze the prevalence of food swamps and food deserts in Brazilian cities with more than 100,000 inhabitants and their relationship with racial, income and regional inequalities.

Methods

Study design and sample

This is an ecological study based on publicly available secondary data. The primary unit of analysis was the urban census tracts (n = 220,576) of municipalities with more than 100,000 inhabitants in Brazil in 2022 (n = 319). Municipalities with more than 100,000 inhabitants, were selected because smaller municipalities often have a limited number of ZIP codes, reducing the spatial specificity required for georeferencing food establishments and characterizing the food environment at the census tract level. This inclusion criterion therefore aimed to ensure sufficient spatial detail and greater reliability in the identification of food deserts and swamps. Brazil is a federative republic divided into five official macro-regions: North, Northeast, Southeast, South, and Central-West, which group the states according to geographic, cultural, and socioeconomic characteristics. The country is also composed of 26 states and one Federal District, which together encompass 5,570 municipalities, and approximately 50% of its inhabitants (115 million) live in cities with more than 100,000 inhabitants [13].

Variables and data collection

Community food environment: food deserts and swamps

The community food environment variables were created from data on food establishments with active registrations extracted from the Annual Social Information Report (RAIS) for the year 2022. This database provides data on the type of establishment and its location based on the postal address code.

In order to identify food deserts and swamps, the census tracts were analyzed for the availability of establishments within their territory. Two geoprocessing stages were conducted to obtain geographic coordinates for food establishments, using ZIP code centroids of the census tracts as the inclusion criterion. To identify food access points, establishments that sell food in the 220,576 census tracts of the 319 municipalities studied were georeferenced to obtain their geographic coordinates. First, 447,781 establishments were georeferenced using the geocodebr R package, based on their ZIP codes. Subsequently, records that were not identified were reprocessed using the Google Maps API via Awesome Table. After cleaning and excluding establishments that only returned in the centroids of the municipalities or with invalid information, a total of 470,405 food establishments (97.2%) were georeferenced and included in the analysis. These losses were likely random, since no differences were found when analyzing them according to macro-regions.

The Locais-Nova methodology was used to classify food establishments into different groups [14]. The methodology is based on the NOVA classification, a widely recognized system that categorizes foods according to the extent and purpose of their processing [15]. The Locais-Nova includes four groups: (G1) fresh or minimally processed foods, such as fruits, vegetables, grains, milk and eggs, all of which maintain their natural characteristics; (G2) processed culinary ingredients, such as oils, sugar, and salt, used in cooking; (G3) processed foods, such as canned vegetables and cheeses, created when culinary ingredients are added to whole foods; and (G4) ultraprocessed foods, which are industrial products made mostly from food-derived substances and additives, such as soft drinks, packaged snacks, and instant meals. In this methodology, fresh or minimally processed foods and processed culinary ingredients were evaluated as a single food group (G1 + G2). In order to categorize types of establishments according to household food acquisition profiles, the Locais-Nova methodology used data from the 2017–2018 Brazilian Household Budget Survey. For this categorization, cut-off points were established based on the average percentage contribution of each food group to the total grams purchased in each macro-region of the country, and these average percentages of contribution of each food group at each place of acquisition were compared. When the average percentage contribution of a food group in a given place of acquisition was equal to or greater than the mean contribution of the macro-region in question, that place was classified as a source of acquisition for that food group [14].

Food deserts were defined as those census tracts that had a density of healthy food establishments (source of fresh/minimally processed foods — G1 + G2) lower than the 25th percentile in the census tracts in the total sample, considering the number of fresh/minimally processed food establishments per 10,000 inhabitants [4]. Food swamps were defined as those census tracts that had a density of food establishments that were sources of ultra-processed foods (G4) per 10,000 inhabitants higher than the 75th percentile in the total sample.

Socioeconomic variables

Socioeconomic data were obtained from the 2022 Brazilian Census, conducted by the Brazilian Institute of Geography and Statistics (IBGE). The variables included the proportion of residents who self-identified as Black or Brown (*preto* or *pardo*, respectively), collectively classified as Black in the Brazilian context, and the mean income of household heads. Both variables were measured at the census-tract level and categorized into tertiles.

Data analysis

The analyses were conducted using R (version 4.5) and Stata (version 14.0) software. Numerical variables were described using measures of central tendency and dispersion (mean, standard deviation, minimum and maximum values), and categorical variables using absolute (n) and relative (%) frequencies. The Kruskal-Wallis test was used to compare the densities of each group of food outlets (Fresh/minimally processed; Processed; Ultra-processed) across tertiles of the percentage of Black population and income of the head of household in census tracts. Poisson regression analysis with robust variance was employed to estimate the association between the percentage of the Black population and income of the head of household and food deserts and swamps, estimating prevalence ratios (PR) and respective 95% confidence intervals (95% CI). Analyses were stratified by the five Brazilian macro-regions to capture regional differences. A significance level of 5% was considered for all analyses.

Results

Among the 225,909 urban census tracts initially identified, 3,315 contained no residents and 2,018 had missing information on race/skin color, leaving 220,576 tracts eligible for analysis. The average number of establishments classified as sources of fresh/minimally processed, processed, and ultra-processed foods was 0.69 (SD: 2.46), 0.20 (SD: 0.67), and 1.36 (SD: 4.22), respectively. When stratified by Brazilian macro-regions, the South (1.99, SD: 4.67) and Central-West (1.95, SD: 4.04) regions showed the highest averages of establishments that are sources of ultra-processed foods, while the North region showed the lowest averages for both fresh/minimally processed establishments (0.49, SD: 1.89) and establishments that are sources of ultra-processed foods (1.11, SD: 3.31) (Supplementary Table 1). Among the types of establishments, the most frequent were restaurants (0.45, SD: 1.86), snack bars (0.40, SD: 1.84), and mini-markets (0.29, SD: 1.00), while hypermarkets (0.01; SD: 0.11), canteens (0.01, SD: 0.12), fish markets (0.01, SD: 0.16), and street vendors (0.02, SD: 0,15) showed the lowest averages (Supplementary Table 1).

Regarding food availability according to socioeconomic characteristics, census tracts with the highest percentage of Black population showed lower availability of all groups of food establishments (27,55, min: 0, max: 50625). Conversely, the higher income of the head of household was associated with greater availability of all groups of food establishments (103, min: 0, max: 88889) (Table 1). When the analysis was stratified by macro-region, the same overall pattern was observed. The gradient of food establishment availability according to the percentage of Black population was more pronounced in the North and Northeast regions, where the differences between the tertiles were more accentuated. In contrast, the increase in the average number of establishments across income tertiles was particularly evident in the South and Southeast regions (Table 2).

Table 1
Density of establishments that sell food (per 10,000 inhabitants) in relation to the sociodemographic characteristics of census tracts (n = 220,576) in Brazilian municipalities with more than 100,000 inhabitants (n = 319) in 2022.

Variable	n	Total		Fresh/Minimally processed		Processed		Ultra-processed	
		Mean (min-max)	p-value[a]	Mean (min-max)	p-value[a]	Mean (min-max)	p-value[a]	Mean (min-max)	p-value[a]
Total	220576	58.55 (0.00-88889.00)		20.55 (0.00-28889.00)		4.93 (0.00-5588.00)		38.67 (0.00-61111.00)	
Black/brown (%)			< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	73526	96.15 (0.00–88889.00)		34.54 (0.00–28889.00)		6.88 (0.00–3333.00)		63.45 (0.00–61111.00)	
2nd tertile	73525	51.96 (0.00–66618.00)		18.07 (0.00–22059.00)		4.84 (0.00–5588.00)		34.33 (0.00–48677.00)	
3rd tertile	73525	27.55 (0.00–50625.00)		9.03 (0.00–18750.00)		3.08 (0.00–3429.00)		18.23 (0.00–35000.00)	
Income of the head of household (mean)			< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	73518	27.76 (0.00–66618.00)		8.87 (0.00–22059.00)		2.63 (0.00–5588.00)		18.80 (0.00–48677.00)	
2nd tertile	73517	44.79 (0.00–23816.00)		14.95 (0.00–8636.00)		4.67 (0.00–2500.00)		30.79 (0.00–18947.00)	
3rd tertile	73517	103.12 (0.00–88889.00)		37.83 (0.00–28889.00)		7.50 (0.00–3333.00)		66.43 (0.00–61111.00)	

[a] Kruskal–Wallis test.

Table 2
Density of food establishments (per 10,000 inhabitants) in relation to the sociodemographic characteristics of census tracts (n = 22,0576) in Brazilian municipalities with more than 100,000 inhabitants (n = 319) in 2022, by macroregion of Brazil.

Total									
Variable	**n**	**North**		**Northeast**		**Southeast**		**South**		**Center-West**	
		Mean (min-max)	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**
Total	12574	35.11 (0-21600.00)		44.78 (0-33142.86)		61.14 (0-88888.89)		71.62 (0-54000.00)		68.89 (0-16734.69)	
Black/brown (%)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	68.60 (0–21600.00)		77.10 (0–17600.00)		104.00 (0–88888.89)		118.97 (0–53571.43)		119.22 (0–16734.69)	
2nd tertile	4191	18.84 (0–2196.19)		28.62 (0–13636.36)		53.05 (0–66617.65)		62.17 (0–54000.00)		54.38 (0–12500.00)	
3rd tertile	4191	17.88 (0–13870.97)		28.61 (0–33142.86)		26.34 (0–50625.00)		33.72 (0–29000.00)		33.07 (0–6153.85)	
Income of the head of household (mean)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	13.85 (0–13870.97)		17.39 (0–12000.00)		30.00 (0–66617.65)		38.60 (0–54000.00)		29.61 (0–8214.29)	
2nd tertile	4191	24.83 (0–3666.67)		39.79 (0–33142.86)		46.73 (0–15238.10)		52.24 (0–15384.62)		57.54 (0–14090.91)	
3rd tertile	4191	66.66 (0–21600.00)		77.16 (0–11578.95)		106.69 (0–88888.89)		124.03 (0–53571.43)		119.53 (0–16734.69)	
Fresh/Minimally Processed									
Variable	**n**	**North**		**Northeast**		**Southeast**		**South**		**Center-West**	
		Mean (min-max)	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**
Total	12574	11.88 (0-9200.00)		15.65 (0-10142.86)		21.15 (0-28888.89)		26.15 (0-22000.00)		25.51 (0-8636.36)	
Black/brown (%)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	25.29 (0–21600.00)		28.33 (0–5853.66)		36.58 (0–28888.89)		46.90 (0–20000.00)		46.30 (0–8636.36)	
2nd tertile	4191	5.39 (0–575.54)		9.41 (0–5454.55)		18.26 (0–22058.82)		21.73 (0–22000.00)		19.08 (0–6551.72)	
3rd tertile	4191	4.95 (0–4516.13)		9.21 (0–10142.86)		8.60 (0–18750.00)		9.82 (0–5000.00)		11.14 (0–3846.15)	
Income of the head of household (mean)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	3.83 (0–4516.13)		5.46 (0–7764.71)		9.89 (0–22058.82)		11.80 (0–22000.00)		10.15 (0–4642.86)	
2nd tertile	4191	7.08 (0–1333.33)		12.49 (0–10142.86)		15.62 (0–4761.91)		17.82 (0–3846.15)		20.72 (0–8636.36)	
3rd tertile	4191	24.72 (0–9200.00)		29.00 (0–5853.66)		37.93 (0–28888.89)		48.84 (0–20000.00)		45.66 (0–6551.72)	
Processed									
Variable	**n**	**North**		**Northeast**		**Southeast**		**South**		**Center-West**	
		Mean (min-max)	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**
Total	12574	3.28 (0-2000.00)		4.69 (0-3428.57)		4.76 (0-5588.24)		5.48 (0-895.52)		7.30 (0-1134.02)	
Black/brown (%)			< 0.001		<0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	6.09 (0–2000.00)		7.36 (0–1666.67)		6.97 (0–3333.33)		8.38 (0–895.52)		11.72 (0–1071.43)	
2nd tertile	4191	2.15 (0–292.83)		3.46 (0–1363.64)		4.51 (0–5588.24)		4.94 (0–586.73)		6.24 (0–833.33)	
3rd tertile	4191	1.61 (0–1774.19)		3.26 (0–3428.57)		2.82 (0–2500.00)		3.12 (0–714.29)		3.92 (0–1134.02)	
Income of the head of household (mean)			< 0.001		< 0.001		< 0.001		<0.001		< 0.001
1st tertile	4192	1.35 (0–1774.19)		1.93 (0–878.05)		2.73 (0–5588.24)		2.78 (0–895.52)		3.57 (0–1134.02)	
2nd tertile	4191	2.47 (0–434.78)		4.79 (0–3428.57)		4.57 (0–1463.42)		5.23 (0–769.23)		6.77 (0–606.06)	

Total											
Variable	**n**	**North**		**Northeast**		**Southeast**		**South**		**Center-West**	
		Mean (min-max)	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**
3rd tertile	4191	6.03 (0–2000.00)		7.35 (0–1032.86)		6.99 (0–3333.33)		8.44 (0–750.00)		11.55 (0–882.35)	
Ultra-Processed											
Variable	**n**	**North**		**Northeast**		**Southeast**		**South**		**Center-West**	
		Mean (min-max)	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**	**Mean (min-max)**	**p-value[a]**
Total	12574	24.83 (0.00-12800.00)		24.98 (0.00-33142.86)		41.39 (0.00-61111.11)		42.90 (0.00-35000.00)		46.30 (0.00-10000)	
Black/brown (%)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	46.01 (0.00–12800.00)		42.42 (0.00–11600)		69.13 (0.00–61111.11)		75.64 (0.00–35000.00)		75.74 (0.00–10000.00)	
2nd tertile	4191	14.54 (0.00–1771.60)		16.10 (0.00–6818.18)		36.43 (0.00–48676.47)		42.67 (0.00–32000.00)		38.52 (0.00–10000.00)	
3rd tertile	4191	13.94 (0.00–10161.29)		16.42 (0.00–19714.29)		18.60 (0.00–35000.00)		25.38 (0.00–24000.00)		24.66 (0.00–4020.62)	
Income of the head of household (mean)			< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
1st tertile	4192	10.81 (0.00–10161.29)		10.23 (0.00–5243.90)		21.26 (0.00–48676.47)		28.58 (0.00–32000.00)		22.14 (0.00–4020.62)	
2nd tertile	4191	19.14 (0.00–2333.33)		22.94 (0.00–19714.29)		32.65 (0.00–11851.85)		36.86 (0.00–11538.46)		39.92 (0.00–5454.55)	
3rd tertile	4191	44.55 (0.00–12800.00)		41.76 (0.00–8947.37)		70.26 (0.00–61111.11)		78.27 (0.00–35000.00)		76.87 (0.00–10000.00)	
[a] Kruskal-Wallis test.											

Of the total of census tracts, 77% were classified as food deserts and 25% as food swamps. The percentage of the Black population in the census tract was significantly associated with both food deserts and food swamps. The prevalence of food deserts was 24% higher in the 3rd tertile of Black population percentage when compared to the 1st tertile, whereas the prevalence of food swamps was 54% lower in the 3rd tertile of the Black population percentage when compared to the 1st tertile. Regarding the income of the head of household, it was observed that the higher the income tertile, the lower the prevalence of food deserts, whereas the higher the income, the higher the prevalence of food swamps (Table 3).

Table 3
Proportion of food deserts and swamps in relation to the sociodemographic characteristics of census tracts (n = 220,576) in Brazilian municipalities with more than 100,000 inhabitants (n = 319) in 2022.

Variable	**n**	**Food Desert**			**Food Swamp**		
		n (%)	**PR (95% CI)**	**p-value**	**n (%)**	**PR (95% CI)**	**p-value**
Total	220576	169738 (76.95)			57065 (25.87)		
Black/Brown (%)				< 0.001			< 0.001
1st tertile	73526	50626 (68.85)	Ref.		25846 (35,15)	Ref.	
2nd tertile	73525	56399 (76.71)	1.11 (1.10–1.13)		19237 (26.16)	0.74 (0.73–0.76)	
3rd tertile	73525	62713 (85.29)	1.24 (1.22–1.25)		11982 (16.30)	0.46 (0.45–0.47)	
Income of the head of household (mean)				< 0.001			< 0.001
1st tertile	73518	64943 (88.34)	Ref.		10171 (13.84)	Ref.	
2nd tertile	73517	55454 (75.43)	0.85 (0.84–0.86)		20802 (28.30)	2.05 (2.00-2.09)	
3rd tertile	73517	49320 (67.09)	0.76 (0.75–0.77)		26088 (35.49)	2.56 (2.51–2.62)	
Legend: PR, prevalence ratio; 95% CI, 95% confidence interval.							

The associations observed in the overall sample remained consistent across all five macro-regions, although with differences in their magnitude. In all regions, a higher percentage of Black population was also associated with a higher prevalence of deserts and a lower prevalence of food swamps, with the magnitude of these associations being greater in the North (Deserts - PR 3rd tertile: 1.32; 95% CI: 1.25–1.38. Swamps: PR 3rd tertile: 0.37, 95% CI: 0.33–0.41) and Northeast (Deserts - PR 3rd tertile: 1.33; 95% CI: 1.30–1.37. Swamps: PR 3rd tertile: 0.43; 95% CI: (0.41–0.45) when compared to the other regions. The magnitude of the associations between income of the head of household and food deserts was greater in the Northeast (PR 3rd tertile: 0.71; 95% CI: 0.69–0.73) and South (PR 3rd tertile: 0.69; 95% CI: 0.66–0.71) regions; while in the relationship between income of the head of household and food swamps, the North and Northeast regions showed greater measures of association (North: PR 3rd tertile: 3.55; 95% CI: 3.17–3.98; Northeast: PR 3rd tertile: 3.28; 95% CI: 3.07–3.49) when compared to the other regions, respectively (Table 4).

Table 4
Proportion of food deserts and swamps in relation to the sociodemographic characteristics of census tracts (n = 220,576) in Brazilian municipalities with more than 100,000 inhabitants (n = 319) in 2022, by macroregion of Brazil.

Food Desert										
Variable		**North**		**Northeast**		**South**		**Southeast**		**Centre-West**
	n (%)	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**
Total	10194 (81.0)	-	30565 (79.0)	-	100628 (78.7)	-	17759 (69.9)	-	10592 (66.0)	-
Black/Brown (%)										
1st tertile	2885 (68.8)	Ref.	8557 (66.3)	Ref.	29892 (70.2)	Ref.	4995 (59.0)	Ref.	3099 (57.9)	Ref.
2nd tertile	3516 (83.9)	1.22 (1.16–1.28)	10586 (82.0)	1.24 (1.20–1.27)	33365 (78.3)	1.12 (1.10–1.13)	5948 (70.2)	1.19 (1.15–1.24)	3509 (65.5)	1.13 (1.08–1.19)
3rd tertile	3793 (90.6)	1.32 (1.25–1.38)	11422 (88.4)	1.33 (1.30–1.37)	37371 (87.7)	1.25 (1.23–1.27)	6816 (80.5)	1.37 (1.32–1.42)	3984 (74.4)	1.29 (1.23–1.35)
Income of the head of household (mean)										
1st tertile	3850 (91.8)	Ref.	11806 (91.4)	Ref.	37834 (88.8)	Ref.	6992 (82.5)	Ref.	4045 (75.6)	Ref.
2nd tertile	3492 (83.3)	0.91 (0.87–0.95)	10327 (80.0)	0.87 (0.85–0.90)	32485 (76.3)	0.86 (0.85–0.87)	5961 (70.4)	0.85 (0.82–0.88)	3407 (63.7)	0.84 (0.80–0.88)
3rd tertile	2852 (68.1)	0.74 (0.71–0.78)	8426 (65.3)	0.71 (0.69–0.73)	30295 (71.1)	0.80 (0.79–0.81)	4806 (56.7)	0.69 (0.66–0.71)	3139 (58.6)	0.78 (0.74–0.81)
Food Swamp										
Variable		**North**		**Northeast**		**South**		**Southeast**		**Centre-West**
	n (%)	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**
Total	2558 (20.3)	-	7857 (20.3)	-	32138 (25.2)	-	8542 (33.6)	-	5970 (37.2)	-
Black/Brown (%)										
1st tertile	1354 (32.3)	Ref.	3965 (30.7)	Ref.	14687 (34.5)	Ref.	3685 (43.5)	Ref.	2449 (45.7)	Ref.
2nd tertile	708 (16.9)	0.52 (0.48–0.57)	2191 (17.0)	0.55 (0.52–0.58)	11059 (25.9)	0.75 (0.73–0.77)	2826 (33.3)	0.77 (0.73–0.81)	2054 (38.4)	0.84 (0.79–0.89)
3rd tertile	496 (11.8)	0.37 (0.33–0.41)	1701 (13.2)	0.43 (0.41–0.45)	6392 (15.0)	0.44 (0.42–0.45)	2031 (24.0)	0.55 (0.52–0.58)	1467 (27.4)	0.60 (0.56–0.64)
Income of the head of household (mean)										
1st tertile	383 (9.1)	Ref.	1241 (9.6)	Ref.	6091 (14.3)	Ref.	1954 (23.1)	Ref.	1423 (26.6)	Ref.
2nd tertile	815 (19.4)	2.13 (1.89–2.40)	2551 (19.8)	2.06 (1.92–2.20)	12040 (28.3)	1.98 (1.92–2.04)	2844 (33.6)	1.46 (1.37–1.54)	2141 (40.0)	1.50 (1.41–1.61)
3rd tertile	1360 (32.5)	3.55 (3.17–3.98)	4064 (31.5)	3.28 (3.07–3.49)	14004 (32.9)	2.30 (2.23–2.37)	3744 (44.2)	1.92 (1.81–2.02)	2406 (45.0)	1.69 (1.58–1.81)

Legend: PR, prevalence ratio; 95% CI, 95% confidence interval.

Discussion

This study comprehensively investigates the prevalence of food deserts and swamps in Brazil. Nearly eight in ten census tracts were classified as food deserts, whereas one in four were classified as food swamps. Regional differences were observed, with food deserts predominating in the North and

Northeast and food swamps in the South and Central-West.

Considering that 50% of the Brazilian population lives in the cities we analyzed, about 78 million Brazilians were living in food deserts, while 25.3 million were living in food swamps. Other studies have also found an alarming prevalence of food deserts, especially in the Global North, even if at a smaller proportion compared to this study. In the United States of America, about 13.5 million people have limited access to fresh and healthy food, and 13% of the census tracts in the USA have low-access to these foods [16]. Additionally, 13.8 million people in the United Kingdom have limited access to store and online groceries, the equivalent to 19.9% of the country's population [17]. Other smaller-scale studies also reported food desert prevalences: in Winnipeg, Canada, up to 14.5% of the population was living in food deserts [18]. When investigating food swamps, we see the studies are even scarcer. In the region of Flanders, in Belgium, 77.7% of the area was considered a severe food swamp [19].

In Brazil, three state capitals were analyzed according to the prevalence of food deserts: Belo Horizonte has 37.80% of food deserts, Recife has 28.50%, and Porto Alegre has 48.30% (4–6). There are also a few studies in Brazil that have analyzed food swamps at a municipal level. In a Northeastern Brazilian state capital, almost three-fourths of the city's census tracts were identified as food swamps [5], and in a Southeastern Brazilian state capital, the prevalence of food swamps increased from 2008 to 2020 [10]. Also, 5 out of the 18 administrative regions in Campinas are considered food swamps [20]. At a national level, but with a smaller sample compared to our study, the recent Mapping of Food Deserts and Swamps, for the group of 91 Brazilian municipalities with over 300,000 inhabitants, identified that 32.3% of the population live in food deserts, while 19.0% of the population live in food swamps [21]. Differences between these findings and those of the present study should be interpreted considering important methodological differences, including the unit of analysis, the operational definition of food deserts and food swamps, the inclusion criteria for municipalities, and the classification methods used to characterize food environments.

It is worth noting that methods for analyzing food environments in Brazil and countries in the Northern hemisphere vary: in the USA, for example, grocery stores and supermarkets are considered the healthier food retailers, while fast food restaurants and convenience stores mark the less healthy food retailers [22, 23]. In contrast, the methods of classifying the food environment in Brazil encompass a broader range of types of food establishments, such as fruit and vegetable vendors, butcher shops, street food vendors, fishmongers, restaurants, dairy and cold cuts retailers, mini-markets and grocery stores, snack bars, candy stores, and others [14]. This approach enables a more comprehensive characterization of the food environment and is aligned with the *'Guia Alimentar para a População Brasileira'*, which underpins the classification adopted in the present study [24].

The sizeable food desert and swamp prevalence in Brazil, shown both in our study and in other literature, brings about health concerns, given that higher exposure to unhealthy food outlets, as well as great food swamp presence, has been associated with increased type 2 diabetes prevalence and hospitalizations [25–28]. Additionally, reduced access to healthy foods is linked to higher CVD, myocardial infarction, and ischemic heart disease mortality, and the relationship between food deserts and cardiovascular outcomes is seen to be partially mediated by socioeconomic status [29, 30].

Racial and social differences in the prevalence of food deserts and swamps observed in our study may reflect historical inequities across Brazilian macroregions. Our findings show that the North and Northeast regions have more food deserts, while the South and Central-West regions have more food swamps and a higher overall density of food establishments. It is no coincidence, given that the North and Northeast regions have long presented worse socioeconomic indicators, such as higher poverty rates and lower access to services, whereas other regions in Brazil have higher socioeconomic status and access to the same services [31]. National statistics also indicate that poverty and infrastructure deficits remain concentrated in the North and Northeast regions, reinforcing persistent regional inequalities in Brazil [13].

In the present study, census tracts with a higher percentage of the Black population showed a higher prevalence of food deserts, a pattern maintained in all five macro-regions, albeit with different intensities. A systematic review with meta-analysis of 105 articles identified that food deserts had 3.63% more ethnic-racial minorities than non-food deserts, as well as 2.02% more ethnic-racial minorities in food swamps compared to non-food swamps [9]. Studies in South, Southeast, and Northeast Brazilian cities demonstrated that the greater the health vulnerability, the percentage of Black, Brown and Indigenous residents, and the lower the income of people residing in the sectors, the greater the probability of the sector being a food desert [5, 6, 10].

On the other hand, census tracts with a higher percentage of the Black population were consistent with a lower prevalence of food swamps in our study. This finding should not be interpreted as evidence of healthier food environments. Instead, it likely reflects a lower overall density of commercial establishments, resulting in reduced access to both healthy and unhealthy food retailers. This disparity is in agreement with the findings of other Brazilian studies, which indicate that less socioeconomically vulnerable municipalities and neighborhoods had higher access to all types of food establishments [4, 20, 32]. Even so, the relationship between food swamps and the socioeconomic characteristics of their food environment remains unclear. A recent study has identified that, in a Brazilian state capital, food swamps were more prevalent in less vulnerable neighborhoods, which were characterized by higher percentages of literate residents and whites, greater purchasing power and better basic sanitation [5], while another study in a different state capital identified that food swamps were more prevalent in neighborhoods with lowest income, high deprivation, and high segregation [33].

In Brazil, even without any institutionalized segregation regime, persistent informal and extralegal forms of racism have contributed to the systematic exclusion of the Black population from central urban areas with greater access to infrastructure, services and opportunities [34]. Regarding the ethnic-racial inequalities evidenced through the results of our study, the inadequate access to nutrient-rich, affordable and culturally significant foods, marked by the occurrence of food deserts, can be considered a manifestation of structural racism [5, 35]. Racial discrimination is linked to unhealthy food environments, and as pointed out by a study done in a southern Brazilian state, food insecurity is higher in the Brown population, and Black race/skin color is positively associated with a less healthy food environment [36].

Food deserts were more prevalent in census tracts with lower income in major Brazilian cities. In convergence with these findings, the Interministerial Chamber for Food and Nutritional Security (CAISAN) went through the process of mapping food deserts in Brazil in 2018, studying the food access in state

capitals by subdistricts, and concluding that in 12 of the 21 capitals analyzed, the group of subdistricts with the lowest density of food deserts is also the group with the lowest income [37]. In the city of Rio de Janeiro, the community food environments around schools had economic disparities, where food deserts were more present in the school's neighborhoods of lower income and higher deprivation [33]. Also, both in Porto Alegre and in Recife, census tracts with greater socioeconomic vulnerability were more likely to be classified as food deserts [5, 6]. Still, our study identified that the magnitude of disparities of income and food desert prevalence was stronger in the North and Northeast regions, both of which are known to suffer from the highest rates of poverty amongst the macroregions of Brazil, with 39.4% and 35.9%, respectively [38].

Our results point out that areas classified as food swamps were more prevalent where income was higher. These patterns reflect broader spatial inequalities in urban food environments, in which areas with higher income attract greater commercial investment and a larger diversity of food establishments, while economically disadvantaged areas often face reduced access to food establishments overall. Nevertheless, findings in the broader literature still do not have a cohesive agreement regarding income and food swamps. In Belo Horizonte, for example, food swamps increased over time in census tracts with greater social vulnerability [10]. However, food swamps in Recife were more prevalent in less vulnerable neighborhoods characterized by greater purchasing power [5].

Limitations and strengths

This study has some methodological limitations. The secondary data collected from the RAIS database, used to characterize the food environment according to the presence of food establishments, only includes formal establishments, but does not encompass the informal markets that are a part of food access. Also, since RAIS uses ZIP codes to identify the location of these establishments, the use of ZIP code centroids for geocoding may have resulted in location inaccuracies, given the lower specificity of the measurement compared to addresses. Additionally, this study used food retailers' availability as a measure of the food environment, but that does not necessarily reflect accessibility to food, given that proximity to these establishments does not guarantee that surrounding residents will purchase food from them. Also, even if the Locais-NOVA methodology provides a more context- specific classification of food retailers, it still is not able to capture the full diversity of foods available within each establishment. As a consequence, retailers may offer both healthy and unhealthy ultraprocessed foods, despite being classified according to their predominant food acquisition profile.

This study also has relevant strengths. First, the data used has a national scope, considering it includes 319 large cities from all regions of Brazil, which account for approximately 50% of the Brazilian population. Second, it is the first to comprehensively analyze income disparities at an inter-city and within-city level, at a broad national scope in Brazil. Third, the food establishments were classified according to a recent and contextually validated classification of food retail [14], which is consistent with the Food Guide for the Brazilian Population [24].

Conclusions

This study provides national scale evidence on the distribution of food deserts and swamps in large Brazilian cities, revealing a high prevalence of both environments with noticeable regional, socioeconomic and racial inequities. The high prevalence of food deserts in lower-income and predominantly Black census tracts reflects persistent patterns of social and spatial exclusion. At the same time, there is a higher concentration of food swamps in higher-income areas, which are also areas with overall greater food retail density, demonstrating that Black people and those with lower incomes face difficulties in accessing any type of food in Brazil.

There are also marked regional differences in the distribution of food deserts and swamps across Brazil, with greater concentration of food deserts in the North and Northeast, alongside the higher prevalence of food swamps in the South and Central-West, reflecting long-lasting regional disparities such as unequal distribution of income, infrastructure and investment. Addressing these inequities requires public policies that consider both regional contexts and social inequalities to promote equitable access to healthy foods. Strategies to improve community food environments should prioritize socioeconomically and racially disadvantaged and underserved areas through measures such as expanding public food markets and farmers' markets, providing incentives for retailers of fresh and minimally processed foods, strengthening public food procurement and distribution programs, and improving public transportation to food retail locations.

Abbreviations

API
Application programming interface
CAISAN
Interministerial Chamber for Food and Nutritional Security
CI
Confidence interval
CVD
Cardiovascular disease
IBGE
Brazilian Institute of Geography and Statistics
NOVA
Food classification according to the extent and purpose of processing
PR
Prevalence ratio

RAIS
Annual Social Information Report
SD
Standard deviation
ZIP
Zone Improvement Plan (postal code).

Declarations

Ethics approval and consent to participate

This ecological study used publicly available secondary data aggregated at the census-tract level, with no personally identifiable information. Therefore, ethics committee approval and informed consent were not required.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

Conceptualization: all authors. Methodology e formal analysis: Lauren Yurgel da Silva, Elma Izze da Silva Magalhães, Raquel Canuto, Giovani Longo Rosa. Writing - review and editing: All authors. Supervision: Raquel Canuto. All authors read and approved the final manuscript

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Data Availability

The study used public secondary data from the 2022 Annual Social Information Report (RAIS) and the 2022 Brazilian Census. The dataset supporting the conclusions of this study is publicly available in the Zenodo repository: https://doi.org/10.5281/zenodo.15392071.

References

1. Glanz K, Sallis JF, Saelens BE, Frank LD. Healthy Nutrition Environments: Concepts and Measures. Am J Health Promot. 2005;19(5):330–3. https://doi.org/10.4278/0890-1171-19.5.330.
2. Cummins S. Food deserts'—evidence and assumption in health policy making. BMJ. 2002;325(7361):436–8. https://doi.org/10.1136/bmj.325.7361.436.
3. Rose D, Bodor JN, Swalm CM, Rice JC, Farley TA, Hutchinson PL. DESERTS IN NEW ORLEANS? ILLUSTRATIONS OF URBAN FOOD ACCESS AND IMPLICATIONS FOR POLICY. 2009.
4. Honório OS, Pessoa MC, Gratão LHA, Rocha LL, De Castro IRR, Canella DS, et al. Social inequalities in the surrounding areas of food deserts and food swamps in a Brazilian metropolis. Int J Equity Health. 2021;20(1):168. https://doi.org/10.1186/s12939-021-01501-7.
5. Silva JMLD, Oliveira JS, Casagrande Borges D, Honório OS, Mendes LL, Canuto R. Social inequities in food deserts and food swamps in a northeastern Brazilian capital. J Biosoc Sci. 2024;56(3):493–503. https://doi.org/10.1017/S0021932024000087.
6. Borges DC, Vargas JCB, Honório OS, Mendes LL, Canuto R. Social and ethnic-racial inequities in the occurrence of food deserts in a Brazilian state capital. Food Sec. 2024;16(3):595–606. https://doi.org/10.1007/s12571-024-01450-3.
7. Powell LM, Slater S, Mirtcheva D, Bao Y, Chaloupka FJ. Food store availability and neighborhood characteristics in the United States. Prev Med. 2007;44(3):189–95. https://doi.org/10.1016/j.ypmed.2006.08.008.

8. Sharkey JR, Horel S, Dean WR. Neighborhood deprivation, vehicle ownership, and potential spatial access to a variety of fruits and vegetables in a large rural area in Texas. Int J Health Geogr. 2010;9(1):26. https://doi.org/10.1186/1476-072X-9-26.
9. da Silva Magalhães EI, Schattschneider DP, de Vargas EB, da Silva LY, Borges DC, da Conceição WL, et al. Ethnic-Racial Disparities in Food Environments: A Systematic Review and Meta-analyses of Inequities in Food Access and Availability. J Racial Ethnic Health Disparities. 2025. https://doi.org/10.1007/s40615-025-02728-8.
10. Honório OS, Mendes LL, Moreira CC, Araújo MLD, Pessoa MC. Evolution of food deserts and food swamps in a Brazilian metropolis between 2008 and 2020. Ciência & Saúde Coletiva. 2024;29(10):e09582023. https://doi.org/10.1590/1413-812320242910.09582023
11. Cooksey-Stowers K, Schwartz M, Brownell K. Food Swamps Predict Obesity Rates Better Than Food Deserts in the United States. IJERPH. 2017;14(11):1366. https://doi.org/10.3390/ijerph14111366.
12. Gianetti GW, Giannotti M, Caldeira G, Takahashi N, Santos CRB, Carmo ASD, et al. Ambiente alimentar no Brasil: desertos e pântanos em grandes cidades urbanas. Rev saúde pública. 2026;60:e252193. https://doi.org/10.11606/s1518-8787.2026060007379.
13. IBGE, Dados censos. IBGE 2024 https://www.ibge.gov.br/estatisticas/sociais/trabalho/22827-censo-demografico-2022.html Accessed 18 Jun 2024.
14. da Silva MAL, Mendes LL, Leite MA, Rocha LL, Borges CA, Levy RB, et al. Food purchasing places classification system based on the Dietary Guidelines for the Brazilian Population: Locais-Nova. Epidemiol Serv Saude. 2025;34:e20240361. https://doi.org/10.1590/S2237-96222025v34.20240361.en.
15. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018;21(1):5–17. https://doi.org/10.1017/S1368980017000234.
16. Odoms-Young A, Brown AGM, Agurs-Collins T, Glanz K, Food Insecurity. Neighborhood Food Environment, and Health Disparities: State of the Science, Research Gaps and Opportunities. Am J Clin Nutr. 2024;119(3):850–61. https://doi.org/10.1016/j.ajcnut.2023.12.019.
17. Janatabadi F, Newing A, Ermagun A. Social and spatial inequalities of contemporary food deserts: A compound of store and online access to food in the United Kingdom. Appl Geogr. 2024;163:103184. https://doi.org/10.1016/j.apgeog.2023.103184.
18. Slater J, Epp-Koop S, Jakilazek M, Green C. Food deserts in Winnipeg, Canada: a novel method for measuring a complex and contested construct. Health Promotion Chronic Disease Prev Can. 2017;37(10):350–6. https://doi.org/10.24095/hpcdp.37.10.05.
19. Smets V, Cant J, Vandevijvere S. The Changing Landscape of Food Deserts and Swamps over More than a Decade in Flanders, Belgium. Int J Environ Res Public Health. 2022;19(21):13854. https://doi.org/10.3390/ijerph192113854.
20. Grilo MF, Menezes CD, Duran AC. Food swamps in Campinas, Brazil. Ciência. Saúde Coletiva. 2022;27(7):2717–28. https://doi.org/10.1590/1413-81232022277.17772021en.
21. Brasil. Mapeamento dos Desertos e Pântanos Alimentares: principais achados. MDS; 2024.
22. Glover B, Mao L, Hu Y, Zhang J. Enhancing the Retail Food Environment Index (RFEI) with Neighborhood Commuting Patterns: A Hybrid Human–Environment Measure. IJERPH. 2022;19(17):10798. https://doi.org/10.3390/ijerph191710798.
23. Carmo ASD, Mendes LL, Cardoso LDO, Caiaffa WT, Santos LCD. The influence of neighborhood safety and built environment on childhood obesity: isolated and combined effect of contextual factors. Cad Saúde Pública. 2023;39(8):e00104822. https://doi.org/10.1590/0102-311xen104822.
24. Brasil. Ministério da Saúde. Guia Alimentar para a População Brasileira Brasília: Ministério da Saúde. 2014. https://bvsms.saude.gov.br/bvs/publicacoes/guia_alimentar_populacao_brasileira_2ed.pdf
25. Den Braver NR, Lakerveld J, Rutters F, Penninx BW, Generaal E, Visser M Neighborhood Retail Food Environment, et al. editors. Diet Quality and Type 2 Diabetes Incidence in 4 Dutch Cohorts. The Journal of Nutrition. 2025;155(7):2367–75. https://doi.org/10.1016/j.tjnut.2025.04.022
26. Ntarladima AM, Karssenberg D, Poelman M, Grobbee DE, Lu M, Schmitz O, et al. Associations between the fast-food environment and diabetes prevalence in the Netherlands: a cross-sectional study. Lancet Planet Health. 2022;6(1):e29–39. https://doi.org/10.1016/S2542-5196(21)00298-9.
27. Sheehan CM, Gotlieb EE, Ayers SL, Tong D, Oesterle S, Vega-López S, et al. Neighborhood Conditions and Type 2 Diabetes Risk among Latino Adolescents with Obesity in Phoenix. IJERPH. 2022;19(13):7920. https://doi.org/10.3390/ijerph19137920.
28. Kusuma D, Atanasova P, Pineda E, Anjana RM, De Silva L, Hanif AA et al. Food environment and diabetes mellitus in South Asia: A geospatial analysis of health outcome data. Popkin BM, editor. PLoS Med. 2022;19(4):e1003970. https://doi.org/10.1371/journal.pmed.1003970
29. Victor A, Silva RDCR, Silva NDJ, Ferreira A, Barreto ML, Campello T. Influence of Unhealthy Food Environment on Premature Cardiovascular Disease Mortality in Brazil: An Ecologic Approach. Am J Prev Med. 2023;64(2):285–92. https://doi.org/10.1016/j.amepre.2022.09.018.
30. Testa A, Jackson DB, Semenza DC, Vaughn MG. Food deserts and cardiovascular health among young adults. Public Health Nutr. 2021;24(1):117–24. https://doi.org/10.1017/S1368980020001536.
31. Szwarcwald CL, Souza Júnior PRBD, Marques AP, Almeida WDSD, Montilla DER. Inequalities in healthy life expectancy by Brazilian geographic regions: findings from the National Health Survey, 2013. Int J Equity Health. 2016;15(1):141. https://doi.org/10.1186/s12939-016-0432-7.
32. Schattschneider DP, Da Silva Magalhães EI, Do Carmo AS, Da Silva LY, Colucci CM, Vargas JCB, et al. Social inequities in the community food environment: temporal analysis of food retail availability in the state of Rio Grande do Sul, Brazil (2010–2022). Public Health Nutr. 2025;28(1):e179. https://doi.org/10.1017/S1368980025101286.
33. Andretti B, Cardoso LO, Honório OS, De Castro Junior PCP, Tavares LF et al. Da Costa Gaspar Da Silva I,. Ecological study of the association between socioeconomic inequality and food deserts and swamps around schools in Rio de Janeiro, Brazil. BMC Public Health. 2023;23(1):120. https://doi.org/10.1186/s12889-023-14990-8
34. Panta M. População negra e o direito à cidade: interfaces sobre raça e espaço urbano no Brasil. Acervo. 2019;33(1):79–100. https://doi.org/10.64729/an.acervo.v33i1.1521.

35. Gripper AB, Nethery R, Cowger TL, White M, Kawachi I, Adamkiewicz G. Community solutions to food apartheid: A spatial analysis of community food-growing spaces and neighborhood demographics in Philadelphia. Soc Sci Med. 2022;310:115221. https://doi.org/10.1016/j.socscimed.2022.115221.
36. De Vargas EB, Da Silva Dias M, Schuch I, Rosa PBZ, Fanton M, Canuto R. The community food environment as an effect modifier of the relationship between racial discrimination and food insecurity among adults in Southern Brazil. Int J Equity Health. 2024;23(1):224. https://doi.org/10.1186/s12939-024-02311-3.
37. CAISAN. Mapeamento dos Desertos Alimentares no Brasil CAISAN. 2018 https://aplicacoes.mds.gov.br/sagirmps/noticias/arquivos/files/Estudo_T%C3%A9cnico_Mapeamento_Desertos_Alimentares_Final_30_10_2019(1).pdf Accessed 18 Aug 2024.
38. IBGE, Síntese. de Indicadores Sociais: Uma análise das condições de vida da população brasileira 2024. 2026 https://www.ibge.gov.br/estatisticas/sociais/populacao/9221-sintese-de-indicadores-sociais.html Accessed 8 Sep 2026.

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