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Physical access to municipal organic food fairs in favelas in Belo Horizonte, Minas Gerais

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Abstract

Introduction: Favelas are usually in regions forgotten by public policies, and it reflects on their residents' food environment, as well as on their tough time accessing food, mainly produced through sustainable ways. **Objective:** Featuring the physical access to municipal organic-food fairs in Belo Horizonte City, Minas Gerais State, based on identifying food deserts and swamps and comparing food availability to distance and displacement time from shops that sell conventional food in these places. **Methods:** The distribution of organic food municipal fairs, as well as of both food security and nutrition public equipment, and shops selling food that was registered at Minas Gerais State Treasury Secretariat in 2019, located in the 192 census sectors set in Belo Horizonte favelas. The closest facility and displacement distance analyses were based on the 500m buffer network. Displacement time linked to public transportation usage was also analyzed. **Results:** The number of organic food municipal fairs in favelas is smaller, and favelas are located farther from fairs' centroids. The distance to be crossed to get to fairs on foot in favelas is also longer, and getting to them by public transportation often demands longer displacements. **Conclusions:** Public programs and policies are needed to encourage new organic fairs and other establishment types capable of providing fresh and minimally processed food in favela areas based on sustainable production models. It must be done to reduce inequities in access to healthy and sustainable food in these territories.

Keywords: Healthy Food Access. Built Environment. Organic Food. Poverty areas.

Resumo

Introdução: Favelas são regiões que não foram priorizadas pelas políticas públicas, e isso se reflete no ambiente alimentar e, consequentemente, na dificuldade de acesso aos alimentos, sobretudo aqueles produzidos de forma sustentável. **Objetivo:** Caracterizar o acesso físico às feiras de orgânicos municipais em favelas de Belo Horizonte, Minas Gerais, identificando desertos e pântanos alimentares e realizando uma comparação com a disponibilidade, distância e tempo de deslocamento de estabelecimentos que ofertam alimentos convencionais nessas áreas. **Métodos:** Foi analisada a distribuição das feiras de orgânicos municipais, dos equipamentos públicos de segurança alimentar e nutricional e dos estabelecimentos que ofertam alimentos cadastrados na Secretaria da Fazenda do Estado de Minas Gerais para o ano de 2019, nos 192 setores censitários localizados em favelas de Belo Horizonte. Para as análises *closest facility* e distância de deslocamento, foi utilizado o *buffer network* de 500 metros. Também foi realizada a análise do tempo de

deslocamento utilizando transporte público. **Resultados:** As feiras de orgânicos municipais estão em menor número e mais distantes dos centroides das favelas. E, além da maior distância para acessar as feiras caminhando, acessá-las por meio de transporte público leva, em geral, um tempo maior de deslocamento. **Conclusões:** São necessários programas e políticas públicas que incentivem a abertura de feiras de orgânicos e outros tipos de estabelecimentos que ofertam alimentos *in natura* e minimamente processados que adotem modelos de produção sustentáveis em áreas de favelas, a fim de reduzir as iniquidades de acesso aos alimentos saudáveis e sustentáveis nesse território.

Palavras-chave: Acesso a Alimentos Saudáveis. Ambiente Construído. Alimentos Orgânicos. Áreas de pobreza.

INTRODUCTION

The Brazilian Institute of Geography and Statistics (IBGE, Portuguese acronym) has defined favelas as areas subjected to irregular land and property occupation for housing purposes in urban zones.¹ Their irregular urbanistic standards, lack of essential public services, and location in areas presenting occupation limitations can feature them¹. Iniquities are easily observed in favelas when it comes to basic sanitation and health and education services, which also reflect on favela residents' food environment and access to food.²

Evidence has pointed out that residents in the most vulnerable regions and those with the lowest income rates suffer from lower availability of and physical access to healthy food.^{3,4} According to the Food Guideline for the Brazilian Population,⁵ healthy food focuses on fresh and minimally processed food as the basis of eating habits.⁵ Besides, it is necessary to include sustainability issues in the food security concept because food choices and intake have environmental and social consequences.⁵⁻⁷

Adopting more sustainable production models, such as organic agriculture, is one of the solutions to mitigate likely environmental consequences.⁸ Law n. 10.831/2003 regulates organic agriculture in Brazil. It defines organic food as that resulting from organic agricultural and livestock production or sustainable extraction processes that do not pose a risk to local ecosystems.⁹ In addition, Suszek¹⁰ shows that these food types must be grown without chemical fertilizers to respect the environment and social relationships. However, although consumers understand the relevance of consuming organic food to have healthy and sustainable eating habits, the main barrier to the intake of these products lies in their high prices in the market.¹¹⁻¹⁴ This finding highlights the relevance of public policies to subsidizing organic food availability in cities, mainly in regions accounting for high vulnerability.

In 2010, the Municipal Food and Nutrition Security Policy set for Belo Horizonte City – Minas Gerais State capital – implemented public food and nutrition security equipment, or EPSAN (Portuguese acronym), to provide low-cost healthy food to socially vulnerable citizens. This public policy included organic food fairs in its main items.^{15,16} However, EPSAN distribution over the city is uneven, and they are concentrated in the wealthiest parts of town, where one finds more circulation of people.^{3,4} Thus, access to organic food fairs can be impaired for the most vulnerable populations living in favelas. The literature does not have studies focused on assessing physical access to places selling healthy and sustainable food in the herein-assessed municipality.

Accordingly, the present study aimed to feature physical access to municipal organic food fairs in favelas in Belo Horizonte, Minas Gerais - Brazil, by identifying food deserts and swamps, as well as by comparing organic food availability to distance and displacement time from shops selling conventional food types in these locations. The herein-advocated hypothesis is that there is no availability of establishments selling organic food and food based on ecological production in favelas.

METHODS

Study design

An ecological design study was conducted in Belo Horizonte, the capital of Minas Gerais, Southeastern Brazil. This city is the sixth most populous one in the country, with 2,375,151 inhabitants and a territory covering 331,401 km². Its Human Development Index reaches 0.81.¹⁷ Census sectors were adopted as analysis units, forming territorial units set by IBGE to organize data collection during household surveys. Only sectors located in favelas were taken into account. In total, 192 favelas were mapped in Belo Horizonte City by the Belo Horizonte Metropolitan Region Development Agency in 2020.¹⁸ Supplementary material 1 provides this map and the location of formal census sectors and favelas in Belo Horizonte City, Minas Gerais State.

Study variables

Municipal organicfood fairs

Municipal organic food fairs are part of EPSAN items. They are installations belonging to the Belo Horizonte Municipal Food and Nutrition Security Policy, and they focus on the sales of healthy, economically accessible food to the population, mainly to citizens living under social vulnerability conditions.^{15,16} The Municipal Sub-Secretariat of Food and Nutrition Security manages and regulates the implementation of these equipment types. In 2019, 124 EPSANs in Belo Horizonte were ABasteCer Fresh Food Shops, Straight from the Countryside shops, Organic Food Fairs, Free Fairs, and Municipal food markets.¹⁶ Supplementary Material 2 provides the chart with the features of these equipment types...

The present study aimed to assess the physical access to organic food fairs included in EPSAN in Belo Horizonte favelas. There are other ways to sell organic food in the city; however, the present study only addresses those found in Belo Horizonte Municipal Food and Nutrition Security. The first organic food fairs came up in 2001, and they emerged from a partnership among the Municipal Supply Secretariat, Minas Gerais Technical Assistance and Rural Extension Company (EMATER-MG, Portuguese acronym), and entities in charge of assessing conformity to organic production.¹⁹ It is necessary to have organic producers participating in bidding processes capable of defining fairs' location, days, and functioning times, as well as the food to be sold and the price rates, so organic food producers can have a place to sell their products.¹⁹ Only producers with an organic production certificate – credited by bureaus acknowledged by the Collegiate of the Ministry of Agriculture and Supply (Minas Orgânica is the certifying institution in Minas Gerais State) - can participate. This certificate ensures consumers acquire a high-quality product, chemicals, and agro-toxic fertilizers-free product.

Belo Horizonte counted on eight organic food fairs in 2019, which were distributed around the city. Fairs' addresses and functioning schedules are shown in Supplementary Material 3. Supplementary Material 4 shows a map of organic food fair locations. The days and functioning schedules set for the other EPSANs can be found on the Belo Horizonte City Hall website.¹⁶

Conventional food selling establishments

The database on establishments selling conventional food types comprises 23,384 shops registered in the Superintendence of Collection and Fiscal Information of the Finance Department of Minas Gerais State back in 2019.

The 2019 list of shops selling these food types was requested to the Superintendence of Tax Collection and Information. Address information and the National Classification of Economic Activities (CNAE, Portuguese acronym) applied to 12 establishment types were collected (Chart 1). CNAE is the national standard instrument that provides the code of each economic activity and the framing criteria to be used by several bureaus linked to Treasury Management in the country.²⁰

Chart 1. The database on establishments selling conventional food types comprises 23,384 shops registered in the Superintendence of Collection and Fiscal Information of the Finance Department of Minas Gerais State back in 2019.

Establishments that sell fresh and minimally processed food	Establishments that sell mixed foods	Establishments that offer ultra-processed food
Fish stores, Fruit and vegetable stores, Butchers and meat trade	Hypermarkets, Supermarkets Minimarkets and grocery stores, Restaurants, Bakeries, Dairy and cold-cut stores	Snack bars, Bars, Sweet shops and delicatessen

According to CNAE, establishments are categorized into shops that mainly sell fresh or minimally processed products (50% or more of products for sale), shops that make mixed food available (fresh, minimally processed food, and ultra-processed food), and establishments that primarily sell ultra-processed food (50% of the total, or more) (Chart 1), based on recommendations by the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN).²¹ Supplementary Material 5 provides the map locating establishments that sell products based on CAISAN's classification.

Food deserts and swamps

In total, 132 favela census sectors were subjected to the food desert and swamp classification. These sectors had information about the number of inhabitants in the geographic area based on the IBGE 2010 census. Food deserts are socioeconomically vulnerable neighborhoods where access to healthy food and its availability are limited.²¹ In their turn, food swamps are defined as neighborhoods presenting high concentrations of establishments selling unhealthy food (with high marketing appeal) compared to healthy food.²²

The Brazilian methodology adopted to assess food deserts was suggested by CAISAN, and it is based on using census sectors as an analysis unit. It was developed based on the 2011 methodology by the Centers for Disease Control and Prevention (CDC). Food deserts were identified by calculating the density of shops selling fresh and minimally processed products (including EPSAN) and establishments selling mixed food per 10,000 inhabitants.²¹

Census sectors where the density of shops selling fresh and minimally processed products and of establishments selling mixed products was below distribution percentile 25 in all Belo Horizonte City sectors were considered food deserts.²¹ Food swamps were identified by calculating the density of establishments selling ultra-processed food, divided by 10,000 inhabitants.²¹ The cut-off point was the same one used by Honório et al.²³ Thus, census sectors where the density of shops selling ultra-processed food was higher than distribution percentile 25 in all census sectors in Belo Horizonte City were taken as food swamps.²³ This methodology was suggested by CAISAN, and it was developed based on the methodology proposed by CDC in 2011.

Census sectors could be simultaneously classified as desert and swamp because they had limited access to establishments selling fresh and minimally processed food and to those selling mixed food, as well as easy physical access to shops selling ultra-processed food.

Data analysis

Descriptive analyses were conducted based on frequency, mean, and 95% confidence interval presentation. The lack of overlap between confidence intervals was taken as a significant difference.

The Closest Facility analysis was conducted to calculate the distance from the census sector centroid to the closest shops selling healthy food. It was done by considering the maximum distance of 1-thousand-meter radius around the centroid (calculated through a buffer network). The Closest Facility analysis sets the closest routes between two locations, and it considers street maps to generate the number of routes available to go from one point to another, as well as the distance to be crossed. The Buffer network considers street connections to calculate the perimeter around a given point.²⁴ A 500-meter buffer around the favelas' centroid was calculated, just as observed in previous studies focused on assessing the community environment.²⁵⁻²⁸ The number of municipal organic food fairs and establishments that sell food within these perimeters was counted.

Displacement analysis based on public transportation used to get to the establishments was carried out to estimate the shortest mean time spent to get to establishments in the sector's centroid by public transportation on working days, at rush time (06:00 am to 09:30 am) and at times without traffic jam (09:45 am to 03:45 pm) – it was calculated based on 15 min-intervals, by taking into account the roads and transportation means available. Data on the existing bus lines, as well as their schedules and displacement times, were provided by BHTrans, which is the collective transport company in Belo Horizonte. This analysis

was conducted in the r5r package of R software, which was developed by the Institute of Applied Economic Research (IPEA).²⁹

Spatial analyses were conducted using ArcGIS software version 10.8 and QGIS software version 3.22. Descriptive statistical analyses were conducted in Stata software, version 14.0, and RStudio software, at a 5% significance level.

RESULTS

In total, 192 census sectors located in favelas were herein assessed. The analyzed 500m radius around the favelas' centroid showed that the mean number of organic food fairs in these areas is smaller than that of other EPSANs, as well as provided the number of establishments selling fresh and minimally processed food, mixed food, and ultra-processed food (Table 1)

Table 1. Physical availability of municipal organic food fairs and establishments selling foods in favelas in Belo Horizonte, Minas Gerais - Brazil (n=192, 2019).

<i>Buffer Network 500m</i>			
Establishment type	Number of establishments in the buffer	Largest number of establishments in the buffer	Mean (CI)
Municipal organic food fairs	0	1	0.04 (0.01 – 0.06)
Conventional Public Food and Nutritional Safety Equipment*	0	4	0.67 (0.49 – 0.85)
Establishments that sell fresh and minimally processed foods ¹	0	42	15.74 (14.49 – 16.99)
Establishments that sell mixed foods ²	0	193	61.63 (57.10 – 66.15)
Establishments that sell ultra-processed foods ³	0	210	62.07 (57.37 – 66.78)

CI: Confidence interval. Note: The *buffer network* was calculated by taking into account the census sector centroid located in the favelas. *ABasteCer Fresh Food Shops, Straight from the Countryside shops, Organic Food Fairs, Free Fairs, and Municipal food markets; ¹The establishments included in the program based on the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN) were fish stores, fruit and vegetable stores, butchers and meat trade; ²The establishments included in the program based on CAISAN were hypermarkets, supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores; ³The establishments included in the program based on CAISAN were snack bars, bars and sweet shops and delicatessen.

The food desert and swamp classification encompassed 132 sectors; 41.67% were food deserts, and 63.64% were food swamps, yet 18.94% were food deserts and swamps.

Concerning municipal organic food fairs and grocery shops' availability, based on the analysis of the 500-m radius around the centroids of favelas featured as food deserts and swamps, one can say that the mean number of organic food fairs in these areas is smaller than the means recorded for other EPSANs and of shops selling fresh and minimally processed food, mixed food and ultra-processed food (Table 2). Furthermore, food desert areas do not have municipal organic food fairs within the 500m buffer compared to food swamp areas and simultaneous food desert and swamp areas, where some census sectors have fairs within the buffer mentioned above

Table 2. Physical availability of municipal organic food fairs and establishments that sell food in favelas in Belo Horizonte, Minas Gerais - Brazil, based on the food swamp and desert classification (n=132, 2019).

Establishment type	Food deserts			Food swamps			Simultaneous food deserts and swamps		
	Fewer establishments in the buffer *	Larger number of establishments in the buffer *	Number of establishments* Mean (CI)	Fewer establishments in the buffer*	Larger number of establishments in the buffer *	Number of establishments* Mean (CI)	Fewer establishments in the buffer *	Larger number of establishments in the buffer *	Number of establishments* Mean (CI)
Municipal Organic Fairs	0	0	0 (0 - 0)	0	1	0.02 (-0.02 – 0.05)	0	1	0.04 (-0.04 – 0.12)
Conventional Public Food and Nutritional Safety Equipment **	0	4	0.60 (0.17 – 1.03)	0	3	0.68 (0.42 – 0.93)	0	3	0.80 (0.35 – 1.25)
Establishments that sell fresh and minimally processed foods ¹	0	30	13.57 (10.57 – 16.56)	0	31	16.92 (14.77 – 19.06)	0	30	15.84 (12.56 – 19.12)
Establishments that sell mixed foods ²	5	140	57.93 (46.28 – 69.59)	1	130	67.66 (61.46 – 73.86)	2	189	66.16 (51.09 – 81.23)
Establishments that sell ultra-processed foods ³	1	127	59.43 (47.46 – 71.41)	1	144	68.98 (61.85 – 76.12)	3	210	66.40 (49.89 – 82.91)

CI: Confidence interval. *A 500m buffernetwork was taken into consideration, calculated based on census sector centroid located in favelas. **ABasteCer Fresh Food Shops, Straight from the Countryside shops, Organic Food Fairs, Free Fairs, and Municipal food markets; ¹The establishments included in the program based on the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN) were fish stores, fruit and vegetable stores, butchers and meat trade; ²The establishments included in the program based on CAISAN were hypermarkets, supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores; ³The establishments included in the program based on CAISAN were snack bars, bars and sweet shops and delicatessen.

Table 3 shows the distance from favelas' centroid to municipal organic food fairs and grocery shops. Fairs account for fewer routes and longer minimum distances to favelas' centroids. Besides, municipal organic food fairs recorded a mean distance to favelas' centroid longer than grocery shops selling fresh, minimally processed, mixed, and ultra-processed food (Table 3).

Table 3. Municipal organic fairs and establishments selling foods closer to favelas in Belo Horizonte, Minas Gerais - Brazil (n = 192, 2019).

Establishment type	Number of routes for walk	Shortest distance	Longest distance	Mean (CI)
Municipal organic food fairs	9	196.54	812.03	542.77 (388.10 – 697.44)
Conventional Public Food and Nutritional Safety Equipment *	56	134.19	982.70	562.01 (499.77 – 624.24)
Establishments that sell fresh and minimally processed foods ¹	184	5.08	938.99	313.78 (286.88 – 340.67)
Establishments that sell mixed foods ²	192	0.16	801.13	158.84 (141.10 – 176.57)
Establishments that sell ultra-processed foods ³	190	0.55	728.74	156.50 (139.62 – 173.39)

CI: Confidence interval. Note: Establishments closest to the census sector centroids located in favelas within a 1,000 meter buffer network surrounding the sector centroid. *ABasteCer Fresh Food Shops, Straight from the Countryside shops, Organic Food Fairs, Free Fairs, and Municipal food markets; ¹The establishments included in the program based on the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN) were fish stores, fruit and vegetable stores, butchers and meat trade; ²The establishments included in the program based on CAISAN were supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores; ³The establishments included in the program based on CAISAN were snack bars, bars and sweet shops and delicatessen.

When it comes to the time spent in public transport to get to municipal organic food fairs and other EPSANs, starting from favelas' centroids, at rush hours, the mean time needed to get to fairs is longer than the mean time spent to get to any other existing EPSAN type in Belo Horizonte City and shops selling fresh and minimally processed food, mixed food and ultra-processed food (Table 4). However, more than 90 % of favela residents need up to 15 minutes in public transport to get to shops selling fresh, minimally processed, mixed, and ultra-processed food. 73.86% of residents in favelas need up to 30 minutes in public transport to get to any other EPSAN. However, only 2.12% of favela residents need up to 15 minutes to get to municipal organic food fairs, and 11.11% of them need 30 minutes in public transport to get to these fairs (Table 4). Results recorded for rush time are shown in Supplementary Material 6.

Table 4. Physical access classification based on public transportation from favelas to municipal organic food fairs and to establishments that sell food in Belo Horizonte, Minas Gerais
- Brazil, out of rush time (n=192, 2019)

Establishment type	Time out of the rush							
	Minutes		Mean (CI)	Classification (%)				
	Shortest time	longest time		Up to 15 min	15 to 30 min	30 to 45 min	45 to 60 min	More than 60 min
Municipal organic food fairs	8	87	49,01 (46,70 - 51,33)	2,12	11,11	26,46	34,39	25,93
Conventional Public Food and Nutritional Safety Equipment *	3	56	23,70 (22,00 - 25,39)	25,93	47,93	21,69	4,76	0
Establishments that sell fresh and minimally processed foods ¹	0	24	6,33 (5,54 - 7,12)	92,54	6,72	0	0	0,75
Establishments that sell mixed foods ²	0	14	2,34 (1,98 - 2,70)	97,01	0	0	0	2,99
Establishments that sell ultra-processed foods ³	0	16	2,24 (1,81 - 2,66)	95,52	0,75	0	0	3,73

CI: Confidence Interval. Note: The calculation was carried out by taking into consideration census sector centroids located in favelas in Belo Horizonte/MG. *ABasteCer Fresh Food Shops, Straight from the Countryside shops, Organic Food Fairs, Free Fairs, and Municipal food markets; ¹The establishments included in the program based on the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN) were fish stores, fruit and vegetable stores, butchers and meat trade; ²The establishments included in the program based on CAISAN were hypermarkets, supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores; ³The establishments included in the program based on CAISAN were snack bars, bars and sweet shops and delicatessen

DISCUSSION

The present study described the physical access to municipal organic food fairs in favelas in Belo Horizonte City and compared it to physical access to other establishments selling conventional food in these locations. The number of municipal organic food fairs is smaller in favelas, and the distance from favelas' centroids to them is longer. Despite the longer distance to get to fairs on foot, accessing them by public transport takes longer displacements. Finally, the number of shops selling mixed and ultra-processed food in favelas is often larger.

Organic food has been gaining room in food production and in Brazilians' food consumption due to growing interest in and demand for food free of chemical fertilizers and chemicals to promote health and quality of life.³⁰ However, the high prices of organic food are significant economic barriers to its consumption by low-income families.¹¹⁻¹⁴

It is important to highlight that access to and availability of EPSAN to favela residents are essential to ensure the Human Right to Adequate Food and Food and Nutrition Security, as provided in the Municipal Food and Nutrition Security Policy.^{15,16} However, municipal organic food fairs have low physical availability in favela regions, leading to longer displacements to locations where fairs are installed. Besides, fairs only work once a week in each location, only in the morning shift,¹⁶ and it impairs the physical access of people who work on commercial days and schedules.

Another essential element regards favelas' features as food deserts and swamps, which can worsen these territories' vulnerability situations. Honório and collaborators²³ assessed inequities in food deserts and swamps in Belo Horizonte City and found out that census sectors featured as food deserts recorded the worse availability of essential services, such as access to water and sewage pipelines, lower income per capita and smaller mean number of literate individuals, besides exposure to food that does not favor healthy eating.

The great availability of shops selling mixed and ultra-processed food is also concerning if one assesses physical access to food. Therefore, it can influence the population's food consumption. The abundance of establishments selling unhealthy food in each environment is associated with a higher intake of these food types,³¹⁻³⁴ and it can lead to adverse health outcomes, such as the development of non-transmissible chronic diseases, obesity, high blood pressure, and diabetes.³⁵⁻⁴⁰

Accordingly, broadening the EPSANs, mainly organic fairs in favelas, is important to increase the availability of and access to healthy food types produced based on ecological procedures. It must be done to influence their intake by vulnerable populations.⁴¹ However, one of the barriers to implementing new EPSANs in high-vulnerability regions lies in violence and sellers' lack of interest in it; therefore, these factors are other challenges to be overcome to broaden access to healthy and sustainable food in favelas.⁴²⁻⁴⁵ Thus, it is necessary to make communities engage in political commitment to improve favelas' food environment by decreasing inequities and ensuring an environment capable of promoting healthy eating and food and nutrition security.

Encouraging local production and short supply chains is important for food and nutrition security. It makes access to healthy, high-quality food easier and increases access to food diversity at amounts good enough to meet families' demands. This process would lead to proper and healthy eating and favor the local economy.^{46,47} Organic food fairs and other EPSANs are good examples of elements to encourage this production type because they help food flow, mainly in

the current scenario, where agro-food systems are centered on large retail chains, which strongly influence agribusiness.⁴⁶ Thus, the state must keep investing in and expanding this policy to ensure equal access to healthy, sustainable, and low-cost food. It is important to highlight the leading role played by civil society in spreading information about healthy food availability in each environment, such as the work done by the Consumer Protection Institute, also known as IDEC, which created the Organic Food Fairs Map. This map is an online search tool to help find the existing organic food fairs in the country (<https://feirasorganicas.org.br/sobre-nos/>).

The present study has some limitations. First, secondary databases were used, which did not make it possible to assess informal commerce in Belo Horizonte favelas. Census sectors were used, and they may not represent the real dynamics of favela residents when it comes to buying food. However, because census sectors are small areas, they can reflect the neighborhood's environment where individuals are inserted in.⁴⁸ The adopted data were recorded in 2019, so changes after the COVID-19 pandemic were not analyzed.⁴⁹ Finally, assessing the physical distance between food-selling shops and census-sector centroids did not consider the existing barriers, such as slopes, lighting, sidewalks, and security issues.

The strengths of the current study regard the assessment of organic food physical availability in favelas, which are regions accounting for poor studies in the literature. Using a buffer network is another study highlight because it considers street maps to draw areas around the centroids and the unique accessibility analysis based on public transportation. This method allows studies on physical accessibility to food-selling shops in Belo Horizonte favelas. It is necessary to observe favela areas to go on with these studies, which must focus on identifying existing establishments and spaces capable of encouraging healthy and sustainable eating and identifying gaps in need of necessary support for public policies and State actions.

CONCLUSION

Municipal organic food fairs have low physical availability in favela areas in Belo Horizonte. This finding highlights the need for public programs and policies to encourage the launching and maintaining of municipal organic food fairs or other establishment types that adopt production systems based on ecological principles in favela areas. It must be done to reduce inequities regarding access to healthy and sustainable food in this territory.

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Contributors

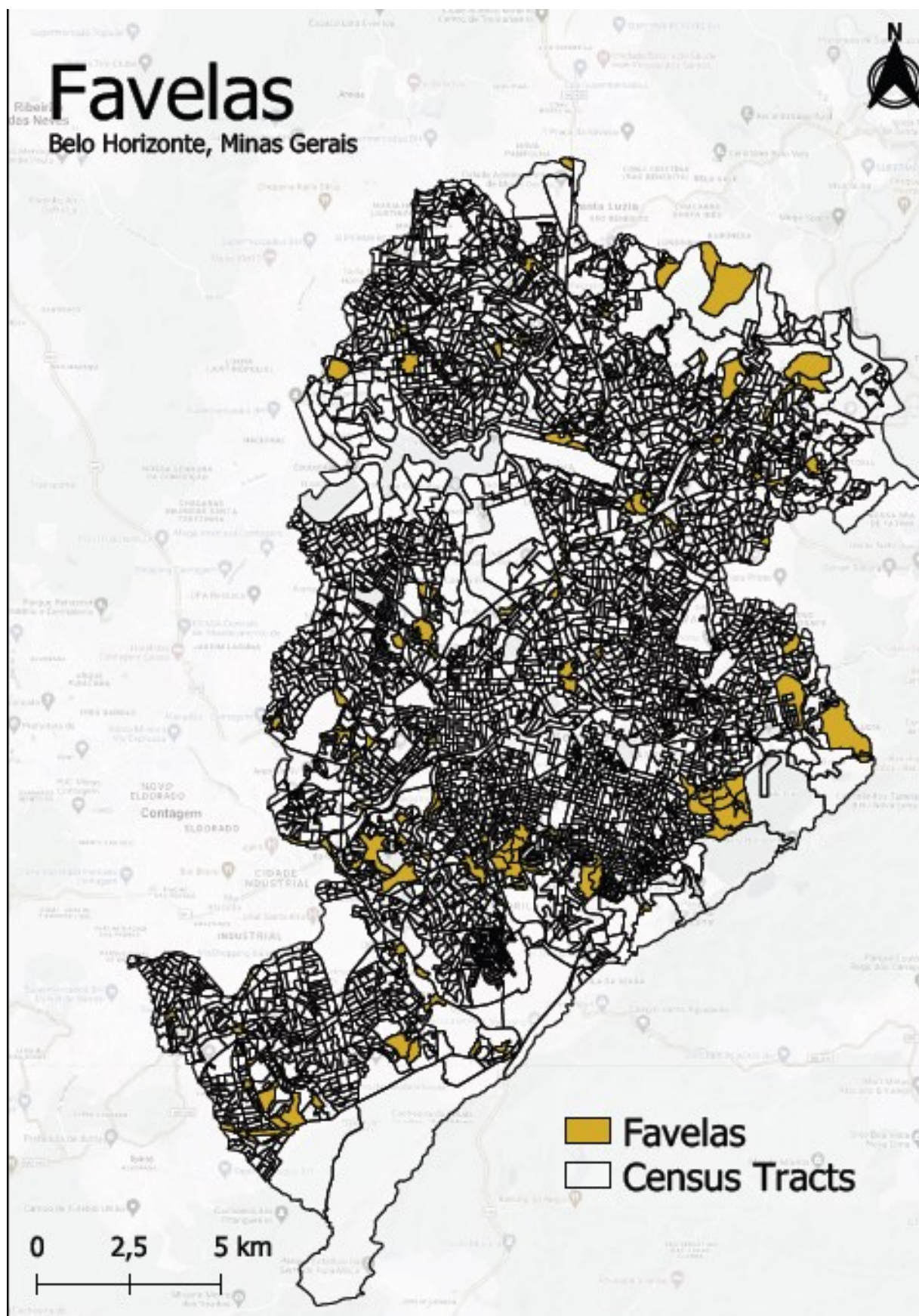
Rocha LL, Bulhões FM, Friche AAL and Mendes LL participated in the design of the study; Rocha LL, Jardim MZ, Melo GBV and Honório OS participated in the collection, analysis and interpretation of the data; Rocha LL, Jardim MZ participated in the writing of the study; All authors participated in the final review and approval of the manuscript for submission.

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Supplementary Material 1. Map identifying census tracts located, Minas Gerais, 2019.



Supplementary Material 2. Characterization of Public Equipment for Food and Nutrition Security in Belo Horizonte, Minas Gerais.

Public Equipment for Food and Nutrition Security	Number of Installations	Characterization	Business Hours
ABasteCer Fresh Food Shops	20	Fixed locations that sell food at low cost and must offer at least 20 items, such as fruits and vegetables, costing up to R\$ 1.19 per kilo ^a .	Monday through Saturday: 7:00 AM to 6:00 PM Sunday: 7:00 AM to 1:00 PM
Straight from the Countryside shops	39	Mobile locations in which there are direct sales from family farmers in the metropolitan area to consumers ^b .	Days open depending on location. Times: 9:00 AM to 3:00 PM
Organic Food Fairs	8	Mobile locations where producers sell their organic products at below cost, without intermediaries ^c .	Days open depend on location. Times: 7:00 AM to 1:00 PM
Free Fairs	54	Mobile locations where producers sell their products at below cost, without intermediaries ^d .	Days open depend on location. Times: 7:00 AM to 1:00 PM
Municipal food markets	3	Fixed locations where Municipal Markets 3 sell various types of food and non-food items, preserving typical local activities and creating conditions for expanding economic activity ^e .	Days open depend on location.

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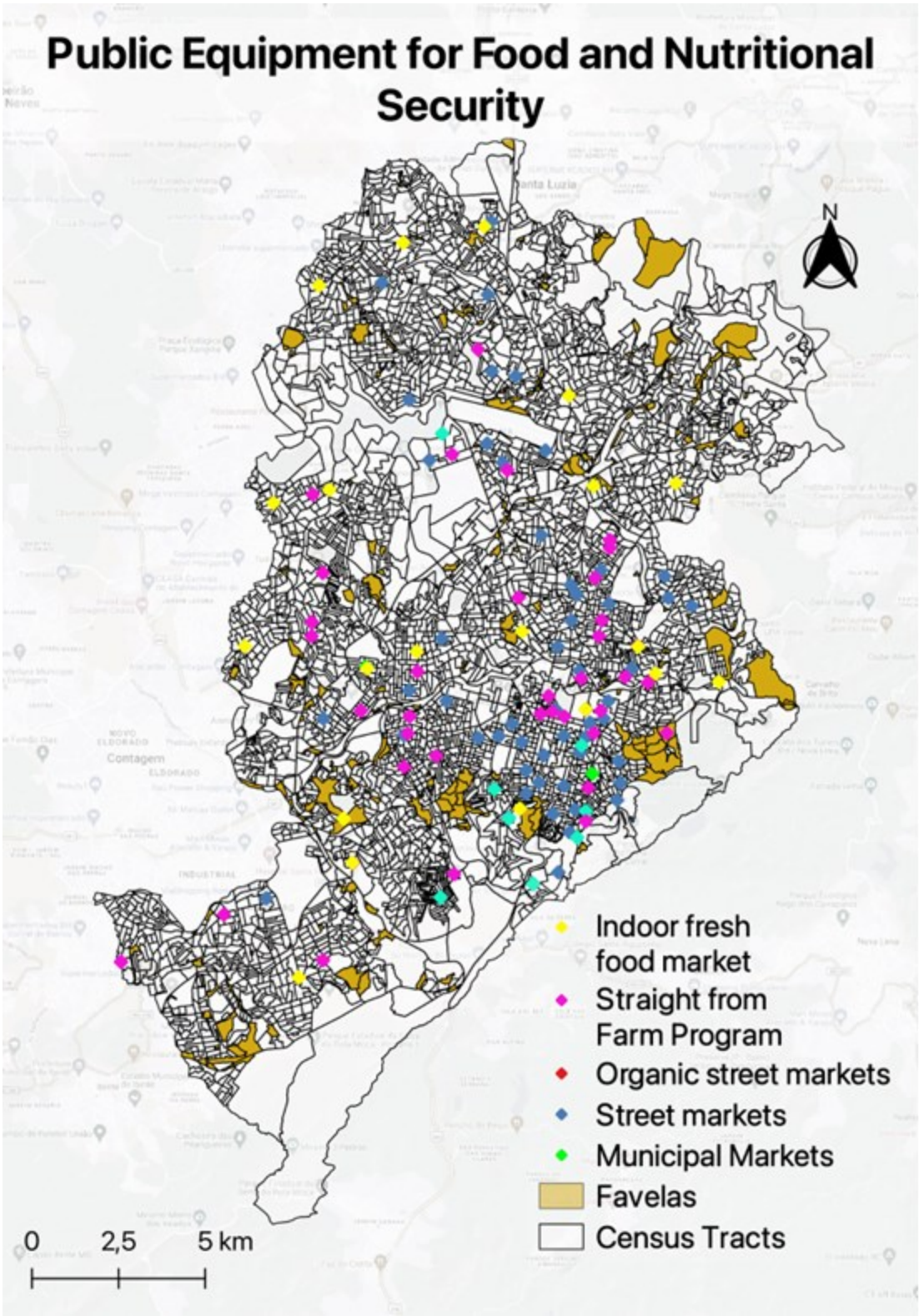
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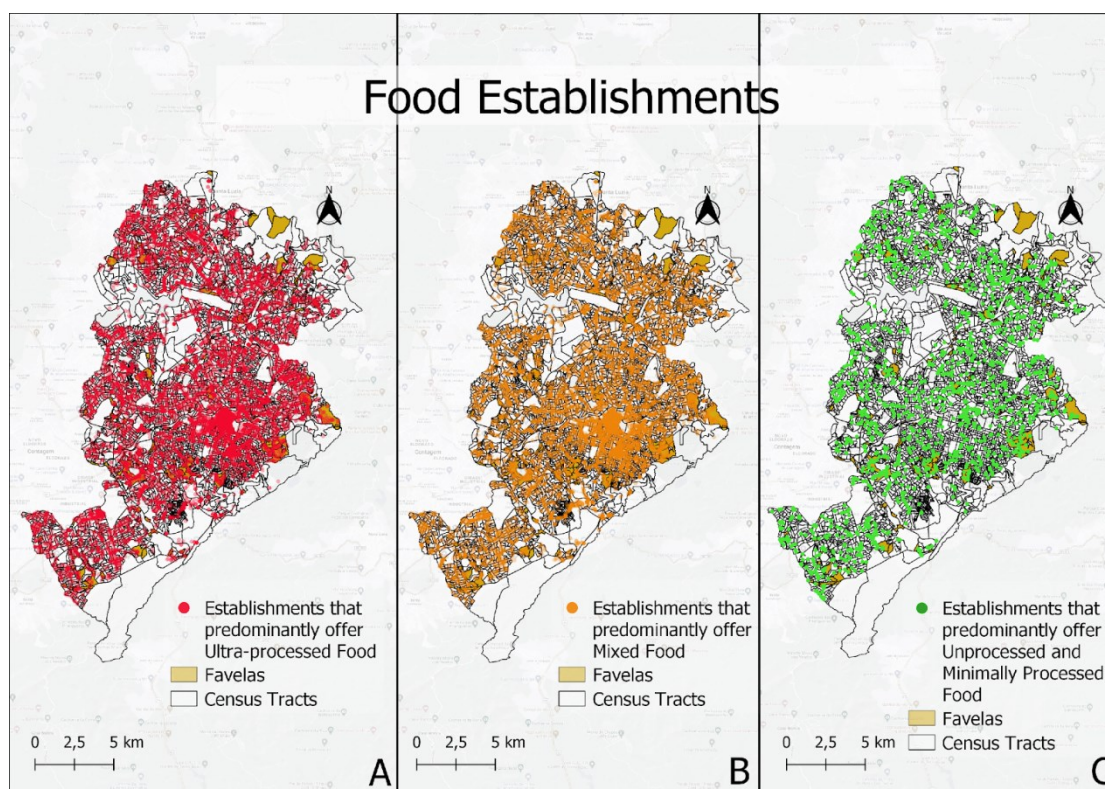
Supplementary Material 3. Operation of Municipal Organic Fairs in 2019 in Belo Horizonte, Minas Gerais.

Regional	Neighborhood	Opening Day	Opening Hours
Center-South	Anchieta	Tuesday	7h - 13h
	Belvedere	Tuesday	
	Funcionários	Tuesday	
	São Bento	Tuesday	
	Mangabeiras	Tuesday	
	Luxemburgo	Wednesday	
Pampulha	São Luiz	Saturday	
West	Buritis	Friday	

Supplementary Material 4. Map of Public Equipment for Food and Nutrition Security in Belo Horizonte, Minas Gerais.



Supplementary Material 5. Map of food establishments in 2019 in the city of Belo Horizonte, Minas Gerais, classified according to the Interministerial Chamber of Food and Nutritional Security.



A: geographical location of establishments offering ultra-processed foods (snack bars, bars and sweet shops and delicatessen). B: geographical location of establishments offering mixed foods (hypermarkets, supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores). C: geographical location of establishments offering fresh and minimally processed foods (fish stores, fruit and vegetable stores, butchers and meat trade).

Supplementary Material 6.. Classification of physical access using public transport from favelas to Municipal Organic Fairs and establishments that offer food in Belo Horizonte, Minas Gerais at peak times. (n=192, 2019)

Peak Times								
Minutes				Classification (%)				
Establishment type	Shortest time	Longest time	Mean (CI)	Up to 15 min	15 to 30 min	30 to 45 min	45 to 60 min	More than 60 min
Municipal organic food fairs	8	78	5,20 (43,04 - 47,36)	2,12	15,87	31,75	33,86	16,4
Conventional Public Food and Nutritional Safety Equipment *	3	52	89 (20,35 - 23,43)	29,63	48,15	17,99	4,23	0
Establishments that sell fresh and minimally processed foods ¹	0	24	6,33 (5,54 – 7,12)	92,54	6,72	0	0	0,75
Establishments that sell mixed foods ²	0	16	2,44 (2,03 – 2,86)	97,01	0,75	0	0	2,24
Establishments that sell ultra-processed foods ³	0	15	2,24 (1,81 – 2,67)	95,52	0,75	0	0	3,73

CI: Confidence Interval. Note: The calculation was carried out by taking into consideration census sector centroids located in favelas in Belo Horizonte/MG. *ABasteCer Fresh Food Shops, Straight from the Countryside shops, Free Fairs and Municipal Food Markets; ¹ The establishments included in the program based on the Inter-Ministry Chamber of Food and Nutritional Security (CAISAN) were fish stores, fruit and vegetable stores, butchers and meat trade; ² The establishments included in the program based on CAISAN were hypermarkets, supermarkets, mini-markets and grocery stores, restaurants, bakeries and dairy and cold cuts stores; ³ The establishments included in the program based on CAISAN were snack bars, bars and sweet shops and delicatessen.