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Food and nutrition public establishments: assessment of the food environment

Equipamentos públicos de segurança alimentar e nutricional: avaliação do ambiente alimentar

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Abstract *This article aims to assess the community food environment around areas with and without Food and Nutrition Public Establishments (FNPE). Cross-sectional study carried out in Belo Horizonte, Brazil. The unit of analysis was the buffer (500m) around the FNPE and the census tracts without FNPE. The investigated establishments should market food for consumption at home and be located within the buffer of the areas with and without FNPE. Data collection performed by direct observation (active search) in August to October 2019. Data collected were location and type of commercial establishments, the density of the establishments was calculated. Descriptive analysis, spatial distribution (Kernel estimator) and Nearest Neighbor analysis were performed. Of the evaluated establishments, 60.5% were in the areas without FNPE and 39.6% in the areas with FNPE, showing a random distribution pattern. Of these, 24.2% were convenience stores and bakeries, 21.0% butcher stores, and 19.0% street markets. Seven FNPE were close to commercial establishments. There were fewer establishments around the FNPE, with convenience stores and bakeries predominating.*

Key words *Food environment, Food and nutrition security, Public health*

Resumo *O objetivo deste artigo é avaliar o ambiente alimentar comunitário de áreas com e sem estabelecimentos públicos de segurança alimentar e nutricional (EPSAN). Estudo transversal realizado em Belo Horizonte, Brasil. Unidade de análise foi o buffer (500m) no entorno dos EPSAN e dos setores censitários sem EPSAN. Os estabelecimentos investigados deveriam comercializar alimentos para consumo no domicílio e localizar-se dentro do buffer das áreas com e sem EPSAN. Coleta de dados realizada por observação direta (busca ativa) de agosto a outubro de 2019. Os dados coletados foram localização e tipo dos estabelecimentos comerciais, e também foi calculada a densidade dos estabelecimentos. Foram feitas análise descritiva, distribuição espacial (estimador de Kernel) e análise do vizinho mais próximo. Dos estabelecimentos avaliados, 60,5% estavam nas áreas sem EPSAN, e 39,6% nas áreas com EPSAN, apresentando padrão de distribuição aleatório. Desses, 24,2% eram lojas de conveniência e padarias, 21,0% açougues e 19,0% feiras-livres. Sete EPSAN encontravam-se próximos aos estabelecimentos comerciais. Havia menor número de estabelecimentos no entorno dos EPSAN, com predominância de lojas de conveniência e padaria.*

Palavras-chave *Ambiente alimentar, Segurança alimentar e nutricional, Saúde pública*

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Introduction

Food and nutrition security (SAN, acronym in Portuguese) means the right of all to regular and permanent access to good quality food, in enough quantity, without compromising access to other essential needs[1]. It involves issues related to access, availability, quality, and distribution of nutritious food while tackling the need for a cross-sectorial approach to ensure the human right to adequate food and nutrition (HRAF)[1]. In this context, cross-sectorial programs that respect, protect and promote HRAF were articulated, leading to the implementation of Food and Nutrition Public Establishments (FNPE)[2]. These are public establishments located in vulnerable areas aimed at ensuring availability and access to healthy and affordable food for the population, with governmental support[1].

FNPE as Public greengrocers, Open-air food markets, Organic Farmers' Market, Farmers' markets, and City Markets sets a space that brings together actions from both political and social stakeholders[3-6], allowing the population to interact with different subjects, such as local trade, health care services, popular movements, non-governmental organizations, and the State[7,8]. FNPE is subject to each implementation context, as it interacts with local conditions, highlighting the views, concerns, and expectations of the local population[3]. However, the presence of the FNPE in vulnerable areas also influences its surroundings (in a continuous feedback loop) which affects the food environment in a complex way. However, such effects are often overlooked in surveys on the effectiveness of FNPE[9,10].

Consequently, by studying the FNPE surroundings, we will be able to understand the influence of FNPE on local particularities, especially on the access to food retailers, which depends on the interaction between the built-up environment and individuals[11,12]. For example, by principles of competition, FNPE can attract establishments with greater availability and access to healthy food in its surroundings, thus improving local access to healthy food. However, the opposite can also occur that is, the presence of FNPE can repel potential competitors, leading to negative impacts on access to healthy foods[12].

Thus, assessing the food environment in the context of FNPE will provide crucial information for the design of public policies and health strategies as it will allow us to learn about the different types of food retailers, the creation of partnerships, and the influence to create healthy environments. Hence, the objective of this paper is to assess the community food environment around areas with and without Food and Nutrition Public Establishments.

Methods

Design and sampling

This is an observational, cross-sectional study carried out in the city of Belo Horizonte, Brazil. Belo Horizonte is the sixth most populous city in Brazil, with a Municipal Human Development Index (MHDI) of 0.840[13].

To further investigate the hypothesis, two samples were drawn independently: the first being areas in which FNPE are available in the city; and the second sample being areas with no presence of FNPE. The later sample was designed to respect the vulnerability of FNPE areas. By pairing the samples, we can achieve the proper balance between both areas (with and without FNPE).

Buffering was our analysis unit for both areas with Food and Nutrition Public Establishments (FNPE) and areas without any FNPE.

Sample of areas with food and nutrition public establishments

The inclusion criteria established for FNPE were: to trade food products for home consumption (public greengrocers, open-air food markets, organic farmers' markets, farmers' markets, and the city markets) and to have run operations in the city of Belo Horizonte until May 2019. The sample size was calculated from the number of FNPE. A total of 116 FNPE contained in the 3,830 census tracts were eligible for the study. All FNPE had information on the Health Vulnerability Index (HVI) from the census sectors in which they were inserted, and were distributed throughout the nine regions of the city[14]. The HVI was developed by the Municipal Health Secretary of Belo Horizonte to guide the planning of health actions. It is a composite indicator that aims to correlate variables of sanitation, housing, education, income, and health of the population in a given geographic area to synthesize socioeconomic and environmental variables into a single quantifiable value. Therefore, it has an important discriminatory power of the municipality's spatial inequalities[14].

The list with the FNPE´s addresses was received by e-mail, from the Belo Horizonte City

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Hall and the georeferencing process was based on information retrieved from Google Maps.

The sample size had a confidence level of 95% and a margin of error of less than 3%. However, the number of FNPEs is higher in less vulnerable areas[9,15]. Therefore, to ensure sample proportionality, two FNPEs located in regions 2 and 3 were selected, totaling 10 units. Due to the low representativeness, all City Market (n = 3) were included in the sample. The food environment surrounding the selected FNPE was defined within a buffer zone with 500 meters radius.

Sample of areas without food and nutrition public establishments

The criteria to be included among the census tracts without FNPE: are being in the same administrative region as the corresponding FNPE; being distant at least 1000 meters from the corresponding FNPE; and, having the same HVI classification as the corresponding FNPE. The minimum distance of 1000 meters was adopted to prevent potential influences of environments that included FNPE[16,17].

Draws were then conducted within strata (simple random sampling) and ten census sectors with no FNPE were selected. To ensure sample equivalence and proportionality between administrative regions, two census sectors located were selected (regions 2 and 3). The food environment in areas with no FNPE was defined within a buffer zone with 500 meters radius surrounding the centroid of the selected census sector. The centroid is the point that minimizes the distance to all edges of the geometry[18].

Food stores

Commercial establishments selling food were then investigated within the selected buffer (with and without FNPE) by direct observation (active search). The criteria to be included among food stores participating in the study were: selling food for home consumption; to be located inside the 500 meters radius buffer around the FNPE, and inside the 500 meters radius buffer around the centroid of the census tract without any FNPE. Commercial establishments selling food for immediate consumption such as full-service restaurants, fast-food restaurants, snack bars, bars, and candy bars were not included. This study adopted a 500 meters buffer because it is a short[19], easily accessible distance[20-22], used in studies that correlate a built-up environment with the presence or absence of commercial establishments in the same ring[23].

Data collection and analysis

Data were collected from food stores from August 2019 to October 2019, from Monday to Friday, both in the morning and in the afternoon, by two researchers. In total the team consisted of ten volunteer researchers, who were followed by a field supervisor and the research coordinator.

Research instruments used were the Observation Tools for Food Retailers and the Farmers' Market Audit Tool, from the Obesogenic Environment Study, São Paulo – ESAO[24,25].

Data collected from food retailers concerned their location and type. Subsequently, the density of food stores was determined by the overall number of commercial establishments around the FNPE and the census tracts without FNPE. As for the type of establishment, they were ranked according to their CNAE (Economic Activities National Classification): butcher, organic markets, open-air food markets, hypermarkets, dairy stores, local or small food markets, bakeries, fishmongers, city markets, greengrocers, supermarkets and wholesalers[26,27]. Next, to compare the studies, those establishments were ranked into six categories: butcher; dairy store; large chain supermarkets; open-air food markets; local grocery store; convenience stores, and bakeries[15,26-28].

Initially, food stores (absolute number, relative number, and 95% confidence interval – 95%CI) were distributed as having or not having any FNPE according to the nine administrative regions and type of establishment. To compare the distribution of food retailers around the FNPE and the census tracts without FNPE, we used the comparative proportion test (95%CI). When 95%CI did not overlap, we assumed a statistically significant difference.

To represent the spatial distribution of food retailers and indicate concentrations in areas with and without any FNPE, we used the Kernel estimator, due to its ability to assess the distribution of specific events according to the proximity or density of a central point[29,30], through color intensity in an area of interest. The Kernel estimation can analyze the dispersion and agglomeration of events, or, in this case, the distribution of food retailers[30]. In this study, the cell size adopted was 2. This estimation is obtained by dividing the buffer (500m) by 250. The ring area was 500m, which establishes the food environment around the FNPE and the census tracts without any FNPE[30].

To analyze the distribution pattern among food retailers in areas with and without FNPE and to determine whether they followed a random

spatial pattern or not, we used the Nearest Neighbor Method. This is a spatial dependency method that considers the spatial distance relationship between observations in a pattern of points. It is, therefore, a method to assess the degree of spatial dependence that observes the cumulative distribution of distances between points[29,31]. Spatial analyzes were performed using the QGIS Software 2.10.1 and 2.18.0 and ArcGIS 10.5 and statistical analysis used STATA, version 14.0.

Results

The ten FNPE included in the sample were farmers' markets (n = 2), open-air food markets (n = 3), organic farmers' market (n = 1), city market (n = 3) and public greengrocers (n = 1).

Three hundred and twelve (312) food retailers in areas with and without FNPE were investigated. Of these, 24 (7.7%) food retailers were outside the unit of analysis (observed after the collection of the address and georeferencing) and three (0.9%) had incorrect addresses (the georeferencing was not possible) and, therefore, were excluded from the sample. Thus, 285 (91.3%) food retailers were included in the study sample.

It was found that 39.6% (n = 113) were located in areas with FNPE, while 60.5% (n = 172) were located in areas without any FNPE – a significantly different proportion. The assessment of the ratio of food stores between areas with FNPE and without any FNPE, according to each administrative region showed a difference ($p < 0.05$). The highest ratio of food stores was observed in the surroundings of the areas with FNPE in the 5A and 6A regions and around the areas without any FNPE in the 2B and 3B regions (Table 1).

As for the type of food store, the majority was composed of convenience stores and bakeries (24.2%), butcher (21.0%), greengrocers, and open-air food markets (19.0%). In the assessment of the distribution of types of food stores, according to the presence of FNPE, we observed a higher ratio of convenience stores and bakeries (32.7%), followed by the butcher (23.0%), greengrocers and open-air food markets (19.5%). in areas without any fnpe, we found higher ratios of butcher (19.8%), dairy stores (19.2%), followed by convenience stores and bakeries, and greengrocers and open-air food markets with the same percentage (18.6%). There was a significant difference in the proportion of dairy stores among areas with and without FNPE, the latter presenting a higher proportion (Table 2).

The Nearest Neighbor analysis method showed that most areas with and without FNPE (45.0%) presented a random distribution pattern of food stores. A cluster was observed in six locations (30.0%) – in FNPE areas in the 5, 6, and 7 regions and areas without FNPE in the 1B, 2B, 3B, 9A, and 9B regions. The other areas (25.0%) showed a diffuse pattern for food stores (Table 3).

The Kernel analysis offers a view of areas with a higher concentration of food stores, called hot spots (Figure 1). Of all FNPE participating in the study, 7 were located in the darkest spots of the map (hot spot), showing proximity to local food stores: 1A, 3A, 4A, 5A, 8A, 9A, and 10A. As for the areas without any FNPE, regions 2B and 5B also concentrated food stores in the hot spot of the map, without any food stores in other areas.

Clustering among food stores was observed in areas with FNPE in the 5A, 6A, and 7A regions, and in FNPE-free areas in the 1B, 3B, and 9B regions (Figure 1).

FNPE-free areas in the 2B, 3B, and 5B regions had large areas without any food stores. The analysis showed that these empty areas comprise parks, squares, and bridges in the 2B and 3B regions and a subway station in the 5B (Figure 1).

Discussion

We observed that most food stores included in the study were located in areas without any Food and Nutrition Public Establishments (FNPE) and they were mostly convenience stores and bakeries, butchers, followed by greengrocers and street food markets. In general, food stores had a random distribution pattern, regardless of the presence of any FNPE, and about only one-third of the sample food stores showed a clustering pattern.

The higher ratio of food stores in areas without any FNPE is due to the presence of the Belo Horizonte Central Food Market, which represented almost 50% of all food stores in FNPE-free areas. And the higher proportion of food stores in areas with an FNPE in the 5A and 6A regions, when compared to FNPE-free areas in the same regions, can be explained by the presence of city markets.

These food markets concentrate food stores that sell traditional food items, mainly fresh or minimally processed foods such as fruits, vegetables, meat, and dairy products, which is why these food markets are an important asset in the strategy to diversify food sources, strengthen

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Table 1. Distribution (absolute and relative number, and 95% confidence interval) of commercial establishments by administrative region and areas with and without food and nutrition public establishments. Belo Horizonte, 2019.

	Commercial establishments						
	Community food environment						
	With FNPE*				Without FNPE*		
Administrative Regions	FNPE	N	%	CI95%**	N	%	CI95%**
1	Farmers' markets	8	7.1	[0.023-0.119]	22	12.8	[0.077-0.178]
2 and 3	Open-air food markets	23	20.4	**[0.128-0.279]**	85	49.4	**[0.419-0.570]**
	City markets						
4	Farmers' markets	9	8.0	[0.029-0.130]	7	4.1	[0.011-0.071]
5	City markets	14	12.4	**[0.062-0.186]**	5	2.9	**[0.004-0.054]**
6	City markets	26	23.0	**[0.151-0.309]**	12	7.0	**[0.031-0.108]**
7	Open-air food markets	14	12.4	0.062-0.186]	10	5.8	[0.023-0.093]
8	Open-air food markets	9	8.0	[0.029-0.130]	4	2.3	[0.001-0.046]
9	Organic farmers' market	2	1.8	[0.007-0.042]	14	8.1	[0.040-0.123]
10	Public greengrocer	8	7.1	[0.023-0.119]	13	7.6	[0.036-0.115]
Total	**10**	**113**	**100**	**[0.338-0.452]**	**172**	**100**	**[0.548-0.662]**

* FNPE: Food and Nutrition Public Establishments. ** The absence of overlap between the CI95% was assumed as a statistically significant difference.

Source: Authors.

Table 2. Distribution (absolute and relative number, and 95% confidence interval) by type of commercial establishments, according to areas with and without food and nutrition public establishments. Belo Horizonte, 2019.

Types of establishments	Community food environment							
	Total		With FNPE*			Without FNPE*		
	N	%	N	%	CI95%**	n	%	CI95%**
Butcher	60	21.0	26	23.0	[0.151-0.309]	34	19.8	[0.138-0.258]
Dairy store	36	12.6	3	2.7	**[0.004-0.057]**	33	19.2	**[0.132-0.251]**
Large chain supermarkets	34	11.9	12	10.6	[0.049-0.164]	22	12.8	[0.077-0.178]
Greengrocers and open-air food markets	54	19.0	22	19.5	[0.121-0.269]	32	18.6	[0.127-0.245]
Local grocery store	32	11.2	13	11.5	[0.055-0.175]	19	11.0	[0.063-0.158]
Convenience stores and bakeries	69	24.2	37	32.7	**[0.240-0.415]**	32	18.6	**[0.127-0.245]**
Total	**285**	**100**	**113**	**100**	**[0.338-0.452]**	**172**	**100**	**[0.548-0.662]**

* FNPE: Food and nutrition public establishments. ** The absence of overlap between the CI95% was assumed as a statistically significant difference.

Source: Authors.

local development and contribute to the population's nutrition safety[32]. Food trading activities within these food markets gather independent grocery stores, and local food sellers, with potential competition between traders, which has an impact on the quality, variety, and price of products and the local economy[32,33]. The strengthening of economic activities contributes to keeping part of the money locally and improves the community's infrastructure, generating social welfare34. Creating new food markets should be the focus of public policies, to make fresh food more affordable and accessible[35,36].

The economy, in turn, impacted by the food trade, also influences the type of product available and determines food accessibility[32]. In this study, existing food markets ensured a greater presence of convenience stores and bakeries, butcher and dairy stores, and a limited presence of greengrocers or open-air food markets. Governmental zoning and urbanization laws need to encourage the trade of healthy food[37]. For the expansion and/or opening of healthy food stores, the relevance of the role of open-air food markets should be highlighted, as it is a positive element for the community food environment[33,38,39].

Table 3. Distribution pattern (absolute number, index and z-score) of commercial establishments according to administrative region and areas with and without food and nutrition public establishments. Belo Horizonte, 2019.

Administrative regions	Type*	N	Index	Z-score	Spatial distribution
1	A	8	1.4267	2.3089	Diffuse
	B	22	0.6200	-3.4102	*Cluster*
2 and 3	A	16	0.9302	-0.5170	Random
	B	5	1.8945	3.8265	Diffuse
4	A	7	1.0693	0.4193	Random
	B	80	0.3182	-11.6661	*Cluster*
5	A	9	1.3139	1.8991	Random
	B	7	1.1545	0.7819	Random
6	A	14	0.7199	-2.0751	*Cluster*
	B	5	2.1775	4.5051	Diffuse
7	A	26	0.1884	-8.0681	*Cluster*
	B	12	0.8132	-1.2883	Random
8	A	14	0.5297	-3.4844	*Cluster*
	B	10	1.0696	0.4212	Random
9	A	9	0.8582	-0.8135	Random
	B	4	1.8804	3.7663	Diffuse
10	A	2	2.8001	5.9646	Diffuse
	B	14	0.6603	-2.4319	*Cluster*
	A	8	1.0717	0.4116	Random
	B	13	1.0421	0.2905	Random

* Type A: regions with food and nutrition public establishments; b: regions without food and nutrition public establishments.

Source: Authors.

Open-air food markets are often sought after for the purchase of food products, such as fruits and vegetables, as they usually offer better prices, quality, and variety, in addition to freshness and flavor, a friendly atmosphere, and support for local farmers[33,34]. In this sense, studies show that living close to open-air food markets and greengrocers can increase the consumption of healthy foods[40,41].

A study carried out in Ashington, England, showed that incentives such as the reduction or abolition of financial and logistical burdens and government support for the open-air food markets are important to increase the availability of healthy food stores, thus increasing access for the population[42]. In the United States, a study on low-income individuals demonstrated that although there are initiatives aimed at increasing the consumption of healthy food, one of the biggest barriers is the high cost of healthy food[43].

Local economic activity planning policies can also promote and foster the opening and sustainability of healthy food stores[37,44]. In this sense, Brazil's public policies on Food and Nutritional Security, include the implementation of FNPE in the context of food trading activities and encourage the consumption of high-quality, varied, and affordable healthy food products, through cross-sector initiatives aimed to respect the right to adequate and healthy food[2]. However, contrary to expectations, the presence of an FNPE did not mean an increase in the availability of healthy food stores in its surroundings either because the FNPE met the local demand or because it inhibited the presence of other stores. For this reason, implementing new FNPE, such as open-air food markets, greengrocers, and city markets, which aim to expand access to adequate and healthy food in the community food environment, is a crucial strategy for such policies[39].

In this sense, increasing the availability of healthy and affordable food stores, as seen in the context of FNPE, is a viable strategy. It is noteworthy that the location of FNPE is also important since the clustering of food stores was observed in wealthier areas, where the purchasing power of individuals is greater, suggesting that the higher the income of a location, the greater the number of food stores[15,45].

The zoning of economic activities in high-income areas is twice as likely to allow open-air food markets and three times as likely to allow urban farming initiatives when compared to low-income areas[37]. Therefore, there should be more incentive programs for establishments such as FNPE, open-air food markets, and greengrocers, particularly in lower-income areas, through tax credits, financial subsidies, and loan programs. Also, healthy food stores should be opened in locations close to public transport centers. As public transportation is used by a large number of people, it also serves the purpose of increasing access to healthy food in the community food environment, while enhancing the turnover for these establishments[10].

One of the strengths of this work was the sample design, which was used to compare areas with and without FNPE through an effective and low-cost methodology. Another strength was the on-site assessment of the food environment as part of a public policy for the Promotion of Health and Food and Nutritional Security, which can provide data for the implementation of public policies capable of influencing the food environment to reach vulnerable populations.

However, this study has some limitations. We used information from the Health Vulnerability

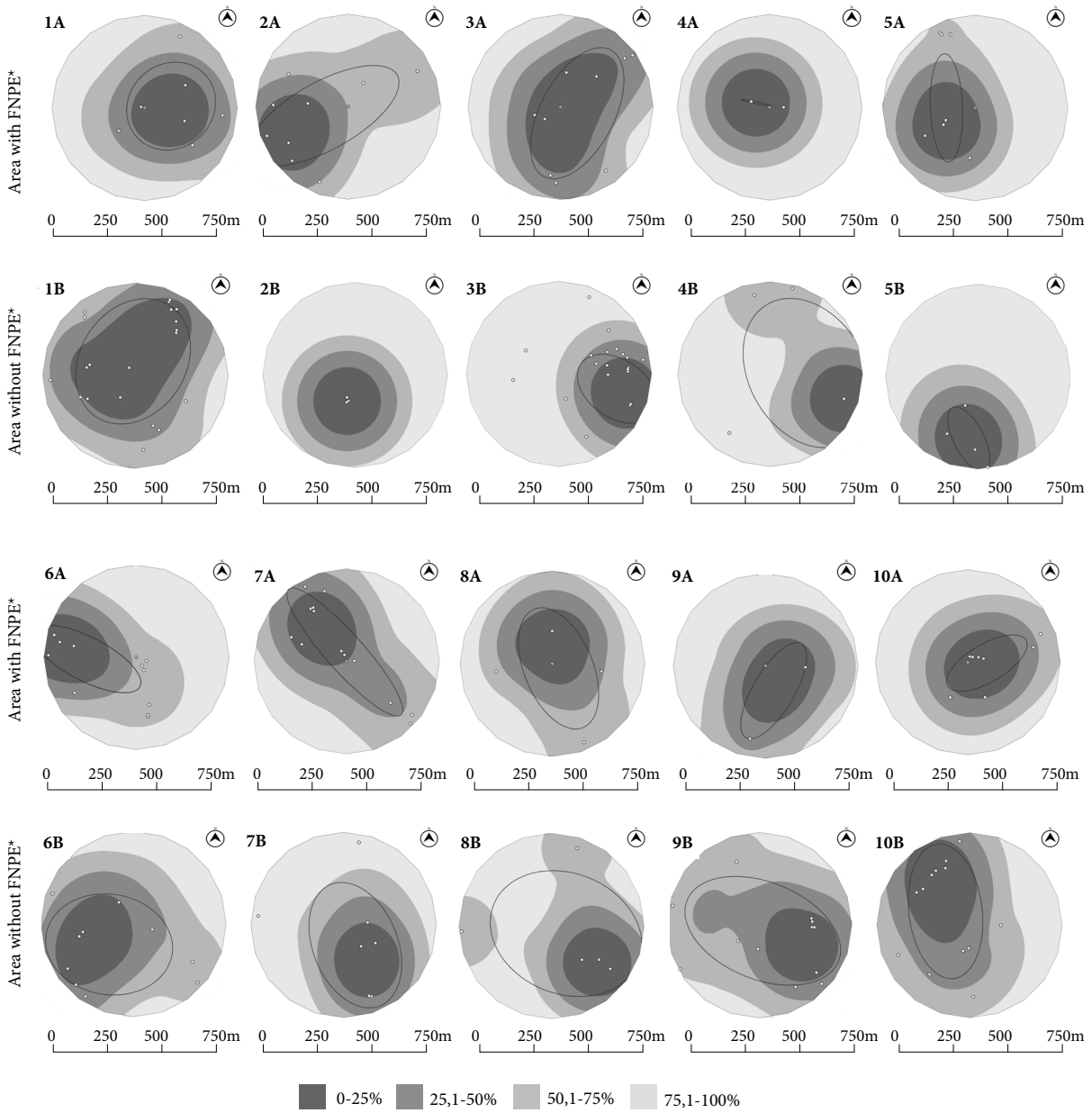

Figure 1. Kernel Analysis of Areas with Food and Nutrition Public Establishments (FNPE) and areas without any FNPE.

* FNPE: Food and Nutrition Public Establishments; A: area with FNPE; B: area without FNPE.

Source: Authors.

Index (HVI) taken from the census tracts of the Municipality, published in 2012, and due to the time gap, some census tracts that currently have socioeconomic and environmental information may have been left out. It should be noted that the HVI data used were retrieved from the last publication of the Municipality. Another point to be highlighted is the use of the circular buffer for the definition and assessment of the food environment in locations with or without an FNPE, which implies defining borders that may not be restricted to this geographical limit, as well as

in the use of the 1000m buffer, because this area may or may not express influence in areas without FNPE, and, therefore, locations may be smaller or greater than set out by this arbitrary border.

Our suggestion for upcoming assessments of the food environment in the context of FNPE is to understand who are the people who have access to FNPE, who buys from them and why they do it. Therefore, the investigation of the consumers' food environment and the perceived environment becomes relevant to assess access to FNPE and move forward with the study.

Conclusion

The assessment of the community food environment around food and nutrition public establishments showed a smaller number of food retailers in areas with FNPE. The majority of convenience stores and bakeries, butcher and dairy stores, and open-air food markets show mostly a random distribution pattern. With that in mind, strengthening policies and programs to encourage the implantation of a larger number of healthy food stores (such as FNPE, open-air food markets, and greengrocers), especially in vulnerable areas, is a significant strategy to change and create healthy food environments.

Collaborations

MZ Jardim contributed to the data collection, analysis and interpretation of the data, and elaboration of the article; NG Cordeiro participated in the data collection and revision of the article; LL Mendes, RM Claro, MC Pessoa participated the interpretation of the data and revision of the article; ACS Andrade participated in the analysis and interpretation of the data; and BVL Costa worked on the conception and design, fundraising, analysis and interpretation of the data, and revision of the article.

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