Sources of food ready to consume around the Health Academy Program units: an analysis according to inequality

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Abstract *The aim of this study was to spatially examine the distribution of establishments for the acquisition of food that is ready to consume around the Health Academy Program (PAS) in Belo Horizonte, Minas Gerais, Brazil, according to the Municipal Human Development Index (IDH-M). This is an ecological study with the PAS as the unit of analysis. The establishments contained in a circular buffer with a radius of 900 meters from the 77 units of the PAS in operation were evaluated. Address and type of establishment data were obtained from a public list and verified in a virtual audit. Thematic kernel maps were used. A total of 3,050 establishments were identified around the PAS units. Higher densities were observed around units located in the city's south-central region and in areas with high and very high IDH-M. There was a high density of establishments selling ready-to-consume foods around the PAS units, especially in the wealthier parts of the city. These results are useful in supporting the planning of actions aimed at strengthening the PAS as a promoter of healthy eating environments. Further, it reinforces the need for equitable public policies for supply and regulation, aiming to promote access to adequate and healthy food for all.*

Key words *Food environment, Business, Ultra-processed foods, Health programs, Geographic mapping*

Introduction

The expansion of urban centers has led to changes in the population's lifestyle, such as a reduction in time devoted to eating at home and the consequent search for convenience in preparing meals and consuming food[1]. In this sense, the food environment plays an important role in the food choices of individuals and families, and the predominance of establishments selling ready-to-consume foods in a given region may favor the intake of these foods[2-5]. Among these establishments, restaurants and snack bars stand out for selling mostly ultra-processed foods (UPFs) such as soft drinks, snacks, and fast food[6].

UPFs are formulated from ingredients extracted from other foods (sugars, oils, proteins, starch, and fibers) and are often added with industrial additives, such as dyes and flavoring, to make them hyperpalatable and increase their consumption[7,8]. Excessive intake of these foods is associated with poorer diet quality, excessive weight gain, the development of obesity, and other chronic non-communicable diseases (NCDs)[8-12].

Despite evidence presented by international studies, national research that describes the distribution of establishments that primarily sell UPFs is scarce, especially in the vicinity of health services[13]. In the realm of public health promotion services, such as the Health Academy Program (PAS), no studies have been identified. However, PAS is usually located in areas with health and economic vulnerability, which lack studies on the food environment.

PAS is a point of attention in the Unified Health System (SUS), which seeks to promote health and control of NCDs based on changes in people's lifestyles and the development of healthy territories[14]. To this end, it is guided by the principles of integrality, intersectoriality, popular participation, interdisciplinarity, intergenerationality, and territoriality[15]. In Belo Horizonte-MG, the municipality in which this work was carried out, and the activities offered by the program, include bodily and physical activities, the production of care, and healthy ways of living. Adequate and healthy food, integrative and complementary practices, education in health, artistic and cultural practices, and social mobilization are promoted among other initiatives[14,16,17].

The influence of the food environment on food choices and its repercussions for the health of the population, as well as the importance of environments favorable to health, underscore the need to characterize the food environment, especially in the surroundings of health services, such as the PAS, aiming to attain the intersectoriality of policies. In this sense, this study aimed to spatially analyze the distribution of establishments selling ready-to-consume foods in the surroundings of the PAS in Belo Horizonte, Minas Gerais, Brazil, according to the Municipal Human Development Index (IDH-M).

Methods

Design and location of the study

An ecological study was developed from data on establishments selling ready-to-consume foods in the city of Belo Horizonte, Minas Gerais. This metropolis is the sixth most populous city in Brazil, with a population projection for 2018[18] of more than 2.5 million inhabitants in a 331 km² area subdivided into nine administrative regions[19] and 277 Human Development Units (HDUs).

HDUs are units of analysis with fairly homogeneous socioeconomic characteristics, resulting from the aggregation of census sectors with similar characteristics. They have a maximum area value of 19.91 km² and a minimum of 0.01 km², with an average value of 1.19 km². The features and spatial distribution of these areas are not homogeneous, and respect the junction of limits of census sectors selected for each unit. HDUs were created for AtlasBR in a partnership between the United Nations Development Program (UNDP), the João Pinheiro Foundation (FJP), and the Institute for Applied Economic Research (IPEA)[20]. For the city of Belo Horizonte, the data were gathered from the 2000 and 2010 demographic censuses by the Brazilian Institute of Geography and Statistics (IBGE) and include demographic and socioeconomic indicators. In this study, only data from 2010 were used, as they are closer to the year in which the data were collected.

Among the data provided by HDUs, the IDH-M was also calculated for 2010. The components of IDH-M are longevity, education and income. The index ranges from 0 to 1, and the closer to 1, the greater the human development[20]. According to the AtlasBR criteria for the composition and classification of the index, Belo Horizonte has an IDH-M ranging from medium (0.617-0.699) to high (0.700-0.799) and very high (0.800-0.955)[20].

Study sample and database

Establishments selling ready-to-consume foods located in a 900-meter radius around the 77 PAS units, operating in the municipality in January 2018, were investigated. These PAS units serve approximately 19,000 users and are distributed throughout the municipality's nine administrative regions[16].

Information on establishments that sell ready-to-consume foods in the municipality was obtained from the register of the Municipal Secretary of Social Assistance, Food Security and Citizenship (SMASAC). The following were considered establishments that sell ready-to-consume foods: bakeries and confectioneries; convenience stores; restaurants and equivalents; bars; snack bars; and tea, juice houses, and equivalents. The complete list of subclasses of establishments classified as places that sell ready-to-consume foods can be found in Chart 1.

All establishments in the database were georeferenced in a semi-automated way by a trained team through a Google Maps Application Programming Interface (API) in which the addresses of establishments were entered to obtain their respective geographic coordinates in latitude and longitude format. Non-processed establishments were manually georeferenced using Google Maps. In the event of the impossibility of georeferencing due to inconsistencies in the addresses, an additional search was carried out in Open Street Map[21] to obtain the latitude and longitude. Establishments not located after this stage were classified as impossible to georeference and excluded from the study.

Google Maps offers geographic coordinates in latitude and longitude format, decimal degrees, and in the WGS84 datum, requiring their conversion to the UTM projection in SIRGAS 2000 datum. This conversion was made using the geographic calculator from the National Institute for Space Research (INPE)[22], and the location given in the UTM projection was compared to the original address from a Google Maps link produced by the geographic calculator.

The location of the PAS units, as well as other databases with data related to the urban fabric of the municipality, was accessed through the geoportal available on the Belo Horizonte City Hall website[23].

From the georeferencing of the PAS units, circular *buffers* were built with a 900-meter radius around each one, a distance corresponding to approximately ten minutes of walking; that is, a distance considered walkable. Establishments selling ready-to-consume foods within these buffers (n=6,467) were selected for the next stages of the study.

After selecting the establishments, a virtual audit was carried out to confirm the existence of the establishment and whether it was intended for selling ready-to-consume foods. Other eligible establishments appear in the search areas but are not listed in the database; these were also identified (n=244). To perform a virtual audit, the addresses of the establishments were entered into the tool, which enabled us to obtain a panoramic view of the environment with a range of 360° horizontally and 290° vertically. The existence and type of establishment and the year of image capture by Street View were checked, prioritizing images captured in 2018, the same year as the database. To classify the establishments that sell ready-to-consume foods as existing, the façade, signs, and characteristics of the interior of the stores (when possible) that identified them as belonging to this category were analyzed. This entire process was carried out by a trained team using the Street View tool on Google Maps (Google Inc. 2019).

The existence of establishments located inside shopping malls, galleries and district/municipal/central markets was verified by checking the list of establishments available on the website of the relevant location. In the event that this information was unavailable, the establishment was considered non-existent. Places with no indication of becoming a commercial establishment (e.g., residences and vacant lots), as well as establishments whose virtual audit was impossible due to location (e.g., streets without Street View image capture), were deemed non-existent. Also, establishments inside private institutions do not have images registered on Street View and street food services due to the absence of a fixed sales address.

After the virtual audit of 6,467 establishments, those considered non-existent (n=2,932; 43.3%) and those that were not considered establishments that sell ready-to-consume foods (n=729; 10.8%) were excluded (Figure 1).

Data analysis

The distribution frequencies of the PAS units and establishments that sell ready-to-consume foods by IDH-M category were shown as a percentage with 95% confidence intervals (95%CI). Differences were examined from 95%CI analysis.

Chart 1. Investigated subclasses of establishments selling ready-to-consume foods according to the Brazilian Institute of Geography and Statistics.

Section	Division	Group	Class	Subclass	Description
Section G: trade; repair of motor vehicles and motorcycles	47 - Retail trade	47.2 - Retail trade of food, beverages, and tobacco products	47.21-1 - Retail trade in bakery products, dairy, sweets, candies, and equivalents	4721-1/02 - Bakeries and confectioneries with a predominance of resale	Retail trade of breads and bagels, cakes, pies, and other bakery products when the resale of other products is predominant
			47.29-6 - Retail trade of food products in general, or specialized in food products not previously specified; tobacco products	4729-6/02 - Retail trade of goods in convenience stores	Commercial establishments with predominant sales of industrialized food products, in addition to other non-food products usually associated with another activity (24 hours a day)
Section I: accommodations and food	56 - Food	56.1 - Restaurants and other food and beverage services	56.11-2 - Restaurants and other establishments with food and beverage service	5611-2/01 - Restaurants and similar businesses	Establishments that sell and serve prepared food, with or without alcoholic beverages to the general public, with full service
				5611-2/02 - Bars and other establishments specialized in serving drinks	Activities of serving alcoholic beverages, with or without entertainment, to the general public, with full service
				5611-2/03 - Snack bars, tea houses, juices, and similar businesses	Food service for on-site consumption, whether or not drinks are sold, in establishments that do not offer full service: - Snack bars, fast food, pastry shops, tea houses, juice houses, and similar businesses - Ice cream parlors with consumption on site

Source: Authors.

In parallel, a kernel density map and thematic map were created, representing the distribution of the number of establishments by HDU and their respective IDH-M to guide the spatial analysis. The kernel density map considers the distribution of georeferenced addresses by interpolating points from a nucleus, enabling the identification of hotspots; that is, areas of greater concentration in the analyzed territory. Classes were created to identify the strata of the IDH-M in the thematic map according to the data used by the Atlas of Human Development in Brazil, segmented into three classes[24]. The classification method adopted for dividing the intervals of the kernel density map analysis categories, and for dividing the class intervals by the number of establishments, was the natural breaks segmented into five classes. This method is useful for mapping data values that are not evenly distributed. Classes established by natural breaks are rooted in natural groupings inherent in the data, and limits are set where there are fairly large differences in data values[25].

Georeferencing, treatment, the spatialization of data, and the elaboration of maps were performed using Microsoft Excel, ArcGis 10.5 and Quantum Gis 3.10.9 software. The statistical analyses were performed in the program STATA/SE, version 14.0 (Stata Corp, College Station, TX, USA).

Results

Among the 77 PAS units analyzed, 41.6% [95%CI: 30.9-53.1] were in areas with a high

IDH-M, 37.7% [95%CI: 27.4-49.2], very high, and a 20.8% [95%CI: 13.0–31.5] medium, with no significant differences between the frequency of PAS units and the IDH-M categories (Table 1).

A total of 3,050 establishments that sell ready-to-consume foods in the surroundings of the PAS were analyzed. Stratifying them by the IDH-M category revealed that the highest prevalence of these establishments was in areas with very high (58.8 [95%CI: 57.1-60.6]) and high (32.7 [95%CI]: 31.1-34.4]) IDH-M compared to areas with medium IDH-M (8.4 [95%CI: 7.5-9.4]) (Table 2).

Figure 2 shows the Kernel Density Map with the spatial distribution of the establishments. Darker shades represent zones with the highest concentration of establishments that sell ready-to-consume foods; this intensity diminishes as the density of establishments decreases. The South-Central region is an area with the highest concentration of establishments, but areas with a high density of establishments have also been observed between the North and Venda Nova, West, Northeast, and Barreiro regions.

Areas with the highest density of establishments selling ready-to-consume foods were those with very high IDH-M and an emphasis on the South-Central, Northwest, East, West and Pampulha regions. In the Venda Nova and

Table 1. Frequency of units of the Health Academy Program (PAS) by category, based on the Municipal Human Development Index (IDH-M). Belo Horizonte, 2018.

IDH-M	PAS units	
	No.	%, 95%CI
Medium	16	20.8 [13.0-31.5]
High	32	41.6 [30.9-53.1]
Very high	29	37.7 [27.4-49.2]

Note: CI=confidence interval; PAS=Health Academy Program; IDH-M=Municipal Human Development Index (IDH-M); IDH-M categories=medium (0.617-0.699), high (0.700-0.799) and very high (0.800-0.955).
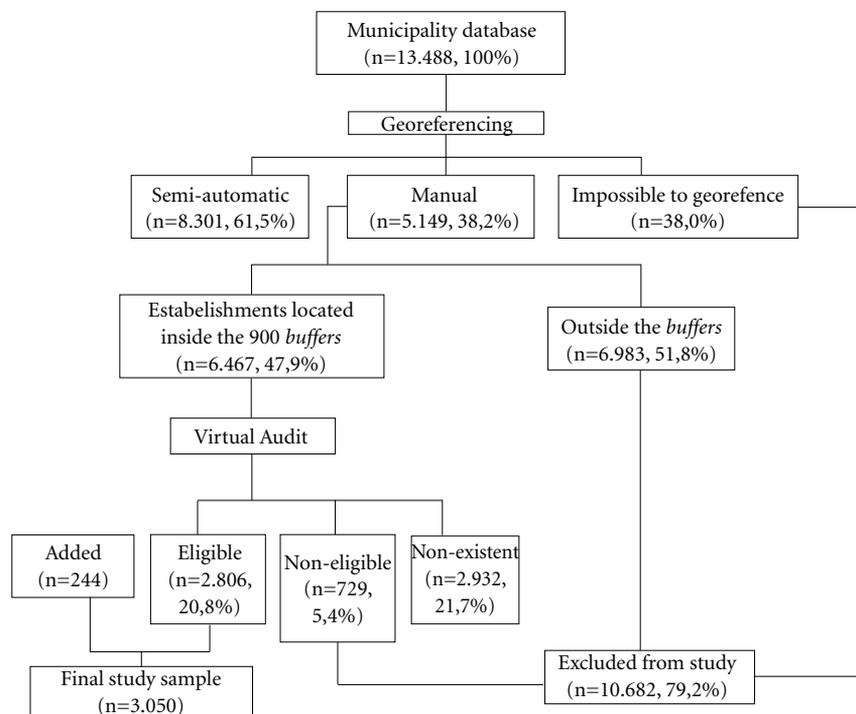
Source: Authors.

Figure 1. Study flowchart.

Source: Authors.

Barreiro regions, the highest density of establishments was concentrated in regions with a high IDH-M (Figure 3).

Table 2. Frequency of establishments selling ready-to-eat foods by category, based on the Municipal Human Development Index (IDH-M). Belo Horizonte, 2018.

IDH-M	Establishments selling ready-to-eat foods	
	n	%, 95%CI
Medium	256	8.4 [7.5-9.4]
High	995	32.7 [31.1-34.4]
Very high	1,788	58.8[57.1-60.6]

Note: CI=confidence interval; PAS=Health Academy Program; IDH-M=Municipal Human Development Index (IDH-M); IDH-M categories=medium (0.617-0.699), high (0.700-0.799) and very high (0.800-0.955).

Source: Authors.

Figure 2. Kernel Density Map of establishments selling ready-to-consume foods. Belo Horizonte, 2018.

Source: Authors.

Discussion

Establishments selling ready-to-consume foods were not distributed in a similar way around the PAS units in Belo Horizonte-MG, with a greater density of establishments in the central and richest parts of the city; that is, those with the highest IDH-M. However, concentrations of these establishments have also been seen in less affluent regions.

As expected, a greater concentration of establishments that sell ready-to-consume foods was identified, with the predominant sale of ready-to-eat foods in the south-central region. This is the main region for commerce, leisure, and services in the city, with a higher concentration of offices, companies, diversified markets, bus stations, cultural spaces, and the movement of people. In addition, it is the wealthiest and most densely populated region in terms of municipalities[16].

The concentrated distribution of food acquisition establishments in central and more affluent parts of cities has been described in other studies, with peculiarities between high- and middle-income countries[26-28]. In the US, a high-income country, the concentration of establishments seems associated with the type of establishment and the healthiness of the foods sold. For example, establishments selling predominantly healthy foods, such as supermarkets, are mostly located in the richest neighborhoods when compared to the most vulnerable, racially, or economically segregated residents. The opposite seems to happen with unhealthy establishments, such as fast food or convenience stores, which tend to be more prevalent in the most vulnerable areas[29-33].

However, in Brazil, there seems to be a greater availability of commercial establishments in more affluent areas, regardless of type[28,34]. Thus, wealthier parts of cities have a greater number of establishments that sell food, whether healthy or not, as suggested by studies carried out in three cities in the country's Southeast macroregion.

The first, an ecological study that characterized the community food environment according to the socioeconomic status of the census sectors in Viçosa-MG, showed that the average number of food outlets, regardless of type, increased according to the income of the census sector[28], with agglomeration in the central part of the city. Studies conducted in Jundiaí-SP and Belo Horizonte-MG also indicated such inequality in the distribution of establishments. The study carried out in Jundiai, for example, revealed that in areas with better sociodemographic indicators, there
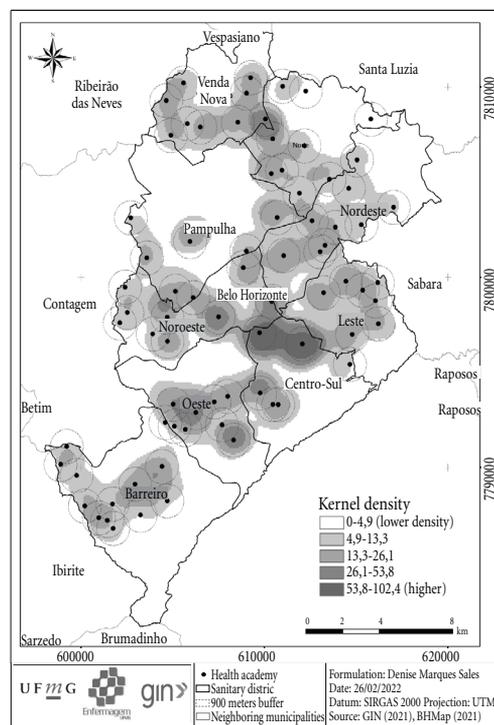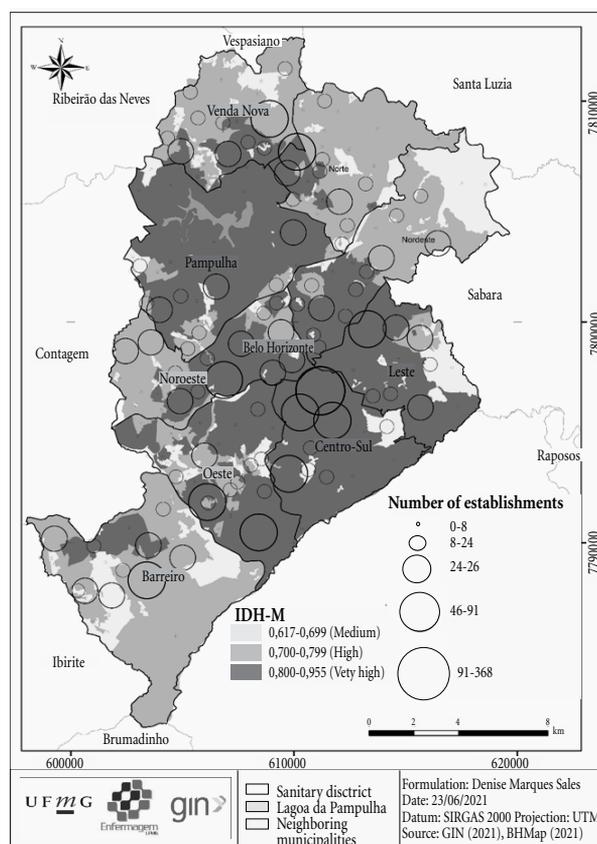
Figure 3. Location of establishments according to Municipal Human Development Index (IDH-M). Belo Horizonte, 2018.

Source: Authors.

were higher concentrations of establishments, such as bakeries[26,34].

It is hypothesized that the diversity of activities in the central and wealthier areas of Brazilian municipalities, and the addition of better connected streets, favor the sale of ready-to-eat foods, thus being an alternative for workers who seek quick meals and live close to their workplace, as well as those who use services and trades in the region. It is believed that the same could happen with users of PAS units located in these regions. However, on the other hand, this hypothesis might not be confirmed in countries such as the US, not only because of their peculiarities and the planning of cities but also because of cultural aspects that affect the population's food consumption. Another aspect that may contribute to the difference in the outcomes between these countries is the classification of establishments as

healthy and unhealthy. For example, while in the US, supermarkets are considered healthy food establishments; in Brazil, in many regions, they are considered to be mixed[26].

Additionally, in Brazil, it is necessary to underline that the consumption of food outside the home has been growing, accounting for a rising share of food costs[35]. Changes in the job market, with a greater number of family members outside their homes throughout the day and more time spent commuting, are important factors that drive this process[6].

A study carried out with data from the 2008-2009 Family Budget Survey concluded that restaurants and snack bars are the most frequent places to purchase ready-to-consume foods, with snack bars being predominantly places to buy UPFs[6,8]. In these establishments, the most consumed foods are beer (51.0%), distilled beverag-

es (44.1%), fried and baked snacks (40.1%), and other non-alcoholic beverages (40.1%), followed by ice cream/popsicles (37.2%), chips (32.7%), stuffed cakes (32.6%), and soft drinks (31.1%)[37]. However, the consumption of these foods may vary according to income, and a higher income is related to greater consumption of vegetables and soft drinks. On the other hand, a lower income is associated with the predominant consumption of UPFs like ham, yogurt, chips, and pizza[36].

This scenario is far from the primary objectives of the PAS, since the program is one of the main health promotion strategies proposed by the Plan to Tackle NCDs and the National Policy for Health Promotion[36]. Furthermore, avoiding UPF consumption is recommended by the Dietary Guidelines for the Brazilian Population as part of the golden rule for an adequate and healthy diet, one of the guidelines of the National Food and Nutrition Policy[1]. The high density of UPF-purchasing establishments can make it difficult for PAS users and the population residing in their territories to adhere to an adequate and healthy diet. This leads to a negative impact on food choices and favoring the replacement of traditional eating habits by the excessive consumption of UPFs[37,38], which is associated with the development of obesity and other NCDs[8,39,40].

Notwithstanding, restaurants – also categorized as establishments that sell ready-to-consume foods – can offer both healthy and unhealthy foods. Restaurants that provide a wide variety of culinary preparations are considered good alternatives for individuals who cannot routinely eat at home[1]. However, meals eaten in commercial restaurants can also result in higher consumption of sugars, sweets, oils and fats[41].

Although in smaller concentrations, in this study, we observed a high density of establishments that sell ready-to-consume foods in peripheral parts of the city, such as in the West, Venda Nova, and Northwest regions. This may indicate the expansion of new commercial centers, driven by the process of organization and population growth. In addition, the location of PAS units, as recommended by Ordinance 2684/2013, should favor regions with greater health vulnerability and that concentrate a large number of people in order to help build healthy environments that serve more individuals[42,43].

In this context, intersectoral policies are indispensable. That said, the main policies observed in different countries are related to the provision of nutritional information on menus, which are important but insufficient[44]. According to the World Health Organization (WHO), governments need to engage in proactive measures to encourage the sectors responsible for the food supply to recognize issues and to act responsibly to contribute to better consumer choices[45]. Strategies include regulating advertising, subsidizing healthy foods, and increasing the supply of healthier foods in establishments that sell ready-to-consume foods.

Previous evidence that indicates limited access to establishments that sell fruits, vegetables, food, and nutritional security equipment[28,31,46] in PAS territory – in addition to the high availability of establishments that sell ready-to-eat food, as shown in this study – points to a double health risk for the population. In addition to the low number of establishments that sell healthy foods in PAS areas, the low variety of fruits and vegetables hinders the consumption of these foods, in addition to being associated with the monotony of food consumption and being overweight[42,43,47].

One limitation of this study is the information bias imposed by the use of secondary data and the failure to conduct an on-site audit of the establishments. Virtual audits are a good alternative to reduce the risk of such bias given the difficulties in carrying out an on-site validation due to the municipality's large territorial extension. In addition, the virtual audit has a lower cost, a relevant aspect in the national scenario of a lack of funding for research[48,49]. The choice of not including informal food services such as street vendors and food trucks, and establishments located on private property, serving as potential food stores for immediate consumption, may have limited the characterization of the community environment of the investigated territories.

Another limitation refers to the Street View capture tool, which can record the environmental image on a certain date that is not necessarily the same as the date in the database. Notwithstanding, in this study, the analysis of images captured in 2018 was prioritized, the same period of data registration in the municipality's database. Finally, the lack of information on the type of food sold within commercial establishments and other information on the consumer's food environment restricted some conclusions, highlighting the need to carry out future surveys with this objective. Another limitation was the lack of temporal correspondence between data relating to commercial establishments and the IDH-M. That said, at the time of this investigation, there were no reliable data with temporal correspondence for such analysis, since it was only in 2021 that a new demographic census started in the country, which is still ongoing.

A strength of this study is that it characterizes the food environment of the community related to the acquisition of ready-to-consume foods in the territories of all units of PAS in a Brazilian metropolis, which is unprecedented in the Brazilian literature. The characterization of the food environment in PAS territory can assist with the implementation of health promotion, as well as food and nutrition policies, that aim to advance health-friendly food environments, in addition to food and nutrition education for the community that uses these health services. Furthermore, carrying out this investigation has the potential to help monitor strategies that foster adequate and healthy eating and combat NCDs, such as obesity[48,49].

Conclusion

Mapping establishments that sell ready-to-consume foods around the PAS units in Belo Horizonte-MG made it possible to verify socio-economic inequality in their distribution. The densities of establishments were higher in areas with higher IDH-M; however, concentrations were also observed in less affluent regions. These results reinforce the need for more equitable food and health regulation and supply policies, which consider the singularities of the development of each part of the city. Therefore, actions should promote access to healthy food for all and protect the population against excessive exposure to UPFs, especially in the city's central zones and peripheral areas with consolidated subcenters.

Collaborations

MS Lopes worked on conception, analysis and data interpretation; writing of the article and relevant critical review of the intellectual content; final approval of the version to be published. MO Martiniano worked on conception and data interpretation; writing of the article; final approval of the version to be published. PP Freitas worked on data interpretation; writing of the article and relevant critical review of the intellectual content; final approval of the version to be published. MCR Carvalho worked on data interpretation; relevant critical review of intellectual content; final approval of the version to be published. DM Sales worked on conception, analysis and data interpretation; critical review of the intellectual content; final approval of the version to be published. ACS Lopes worked on conception and data interpretation; relevant critical review of intellectual content; final approval of the version to be published.

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