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Availability of food stores around Brazilian schools

Disponibilidade de estabelecimentos de venda de alimentos no entorno de escolas brasileiras

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Abstract *The aim of this study was to analyze the availability of food stores in the territory of schools. Ecological study conducted in Viçosa, Minas Gerais, Brazil, with all schools (N=42) and food stores (N=656). Data were collected through the objective evaluation of the environment, and the stores were categorized into healthy, unhealthy, mixed and supermarkets. Bivariate Ripley´s K function assessed the existence of clustering of categories of stores in the territory of schools. All the schools had at least one food store in their territory. Unhealthy stores were the most common and closest to the schools. There were more stores around private schools, offering high school education, located in the central region and in the highest per capita income tercile. The bivariate Ripley´s K function showed evidence of clustering of stores at all analyzed distances (400 to 1.5 km) with up to 3 times more establishments than would be expected if they were randomly distributed. Therefore, schoolchildren were likely exposed to unhealthy food environments, regardless of neighborhood income and location, which may contribute to inadequate food choices.*

Key words *Child health, Adolescent health, Schools, Food environment, Spatial analysis*

Resumo *O objetivo deste estudo foi analisar a disponibilidade de estabelecimentos de venda de alimentos no território das escolas. Estudo ecológico conduzido em Viçosa, Minas Gerais, Brasil, com todas as escolas (N=42) e estabelecimentos de venda de alimentos (N=656). Dados foram coletados através de avaliação objetiva do ambiente, e estabelecimentos foram categorizados em saudáveis, não saudáveis, mistos e supermercados. Função K de Ripley bivariada avaliou a existência de agrupamento das categorias de estabelecimentos no território das escolas. Todas as escolas tinham no mínimo um estabelecimento de venda de alimentos em seu território. Estabelecimentos não saudáveis foram mais frequentes e próximos das escolas. Havia mais estabelecimentos no entorno de escolas particulares com ensino médio, localizadas na região central e de maior tercil de renda per capita. A função K de Ripley bivariada evidenciou o agrupamento de estabelecimentos em todas as distâncias analisadas (400 a 1,5 km), com três vezes mais estabelecimentos do que o esperado em uma distribuição aleatória. Portanto, escolares provavelmente estavam expostos a um ambiente alimentar não saudável, independentemente da renda da vizinhança e da localização das escolas, o que pode contribuir para escolhas alimentares inadequadas.*

Palavras-chave *Saúde da criança, Saúde do adolescente, Escolas, Ambiente alimentar, Análise espacial*

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Introduction

Food consumption has a great influence on the health profile of individuals. Healthy diets are known to be composed essentially of *in natura* and minimally processed foods, prepared and consumed with respect to local culture and tradition[1,2]. Despite this fact, the contribution of ultra-processed foods – such as soft drinks, filled cookies, processed snacks, sweets and sandwiches – in the diet of developed and developing countries is gradually increasing[1,2]. These food products are related to excessive weight gain and increased risk for various non-communicable diseases (NCD). In this context, the high consumption of ultra-processed foods by children and adolescents has been pointed out as one of the leading causes of high early incidence of these diseases in the world´s population[3,4].

Since the 1990s, studies have shown the influence of the environment (where people live, study and work) on non-communicable diseases[5], in that political, individual, behavioral and environmental factors influence dietary patterns, and consequently can affect the risk of developing many chronic diseases[6]. The food environment is inserted among the environment components and can be defined as "collective physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status"[7]. And the food environment of schools "involves all the spaces, infrastructure and conditions within and beyond the school premises where food is available, obtained, purchased and consumed. It also involves the information about food and nutrition and the promotion and pricing of foods"[8].

The food environment of schools is recognized as an important influence on the food consumption[9,10] and nutritional status[11] of children and adolescents, since the availability and access to food stores can be a positive or negative influence depending on the foods marketed[12]. Studies indicate that children who study near fast food restaurants, convenience stores, and unhealthy food stores are more prone to inadequate food intake[10,11,13,14]. The same occurs in territories of schools located in low-income neighborhoods, noted for the lack of healthy food stores and high exposure to unhealthy food[15-17]. In the same way, systematic review of 26 cross-sectional studies, 3 longitudinal and 2 ecological studies found a direct association between the density or proximity of unhealthy food establishments with overweight or obesity[18].

Studies on the food environment in the school territory are extremely important for the development of policies aimed at promoting healthy eating and the regulation of commerce in the school territory through zoning policies (with municipal competence). For example, the development of new "hot food takeaways" was limited above a defined concentration and within a defined distance of schools in United Kingdom[19] and the zone ordinance of Detroit, United States, requires fast food restaurants maintain a minimum distance of 150 meters between elementary, junior high, or senior high school site and restaurants, including fast food and drive-through restaurants[18,20].

Nevertheless, few Brazilian municipalities have implemented policies restricting sales in and around schools, and are mostly concentrated in state capitals, in general, bigger municipalities where greater information is made available[21]. In the Federal District, the Decree No. 36,900/2015 prohibits to sell a series of foods, such as artificial drinks, sweets and industrialized snacks, in the school environment and in the vicinity of schools (a 50-meter radius around the school)[21]. The Bill No. 9/2017 provides for the obligation for soft drink labels to contain warning text about the harmful effects of abusive consumption of soft drink, as well as the prohibition of its sale in elementary schools[22]. In the state of Bahia, the Law No. 13,582/2016 regulates children's food advertising, prohibiting advertising aimed at children about foods and beverages poor in nutrients and high in sugar, saturated fat or sodium[23].

Furthermore, Brazilian studies on this topic are scarce. Thus, little is known about the territory of schools in small and medium-sized municipalities, where approximately two-thirds of the population live, and whose urban and commercial organization is distinct from that of large municipalities.

In this regard, the objective of this study was to analyze the availability of food stores in the territory of urban schools in a medium – sized Brazilian city.

Material and methods

Study design and setting

Ecological study carried out with all urban public and private schools and all food stores of the school territories of Viçosa, Minas Gerais, Brazil. The research was approved by the Human

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Viçosa has a higher number of urban economic activities compared to agricultural activities, highlighting the important role of the tertiary sector on its economy. Consequently, the city´s main economic activities are commerce and services[24]. It is also home to a large Federal University (enrolling more than 20 thousand students).

According to the 2010 census of the Brazilian Institute of Geography and Statistics (IBGE), Viçosa had an area of 299.42 km² and 72,220 inhabitants, of which 20,813 were under 20 years and 16,232 were enrolled between preschool and high school. The estimated population in 2016 was 77,863 inhabitants, being 93.2% of the population living in urban areas[25].

The municipality is composed of 110 census tracts, of which 99 are urban. The study covered all the census tracts of the urban area of Viçosa-MG.

Unit of analysis

The neighborhood unit employed in the evaluation of the food environment in the school territory was buffer. Taking the central point of each school, circular buffers of 400 and 800 meters were constructed, which correspond to 5 and 10 minutes walking time, respectively[15,26-28].

Data collection

Food environment

Data on the food stores were collected through an objective evaluation of the food environment throughout the urban area of Viçosa-MG between December 2015 to July 2016. Prior to data collection, a pilot study was conducted in the central region of the city to observe the dynamics surrounding data acquisition and the feasibility of applying the questionnaires.

The researchers (11 undergraduate and graduate students) were duly trained for data collection, and to obtain easy access to standardized information, a manual was developed. In possession of urban census tract maps, the researchers traversed all the streets of each sector in pairs, identifying food stores and collecting information of complete address and type of food store through observation. The typology of food stores was proposed based on adaptations of an instrument developed by Duran *et al.*[29], focused on the reality of Brazil, through a study conducted in São Paulo city.

All objective assessment questionnaires of food stores were used in printed format and checked by field supervisors (graduate students). Independent double data entry was performed in Microsoft Excel software, followed by consistency analysis in Excel Diff software.

Based on recommendations of the Dietary Guidelines for the Brazilian Population[30] and the grouping of establishments proposed by Duran *et al.*[29], the food stores were grouped into four categories considering the products they usually sell, degree of processing and association between type of store and food consumption. The categories consist of healthy, unhealthy, mixed and supermarkets.

Stores that sold mostly *in natura* or minimally processed foods were classified as healthy stores; food stores that sold mainly ultra-processed foods were classified as unhealthy[31]; mixed stores sold both healthy and unhealthy foods[32]. Supermarkets were classified under a separate category because they commercialized a wide variety of foods and there was no consensus in the literature on their influence on the food consumption of individuals[33] (Chart 1).

Schools

Data of all urban public and private schools in Viçosa-MG, in 2016 (N=42 schools, with about 16,000 students), were provided by the Municipal Department of Education and consisted of name, full address, type (federal, state, municipal, philanthropic or private) and levels of education (kindergarten, elementary school and high school).

Census data on neighborhood income

Neighborhood income was evaluated based on the mean monthly *per capita* income of the census tract. Information about the income of the neighborhood and population was obtained from the 2010 Brazilian Demographic Census database of the Brazilian Institute of Geography and Statistics[25], with reference to the geographical boundaries of the urban census tracts of Viçosa-MG. The mean monthly *per capita* income was calculated based on the income of the neighborhood divided by the population in each census area, and was subsequently categorized into terciles for data analysis.

Geocoding of data

Geographic coordinates (latitude and longitude) of the schools and food stores were ob-

Chart 1. Categories of food stores according to predominantly commercialized foods. Viçosa, Minas Gerais, Brazil. 2016.

Categories	Types of food stores
Healthy food stores	Farmers market; butchery and fish market; delicatessen (dairy and cold cuts); natural food store; street hawker of fruits and vegetables and open-air market
Mixed food stores	Bakery and restaurant
Unhealthy food stores	Convenience store; Grocery store; bar; bonbon store; beverage distributors; snack bar; ice cream shop and street hawker of fast food
Supermarkets	Supermarket

Source: Brasil, 2014[30]; Duran *et al.*, 2015[29]; Cetateanu and Jones, 2014[31]; Fiechtner *et al.*, 2015[32]; Larsen *et al.*, 2015[33].

tained from their addresses using the Google Maps online search service (https://www.google.com.br/maps?hl=pt-BR). The data were collected in the WGS 84 Geographic Coordinate System configuration and were later transformed into the Projected Coordinate System, Universal Transverse Mercator Coordinated System (UTM), spindle 23S, and SIRGAS 2000 datum.

Data analysis

From the buffers created, it was possible to account for each type of food store around the schools and, subsequently, compare the food environment between public and private schools; located in the central region or not (defined according to division by neighborhoods, being central region located in the downtown neighborhood and non-central region located outside downtown); offering high school education or not (identified according to data provided by the Municipal Department of Education) and the economic level of the neighborhood (three levels based on the *per capita* income distribution of the regions).

It is worth noting that sampling data of the schools and food stores were not used, but rather census data. In view of this, the use of hypothesis tests to verify the difference in density of food stores in the territory of the schools is not necessary or appropriate[26].

In order to evaluate the proximity of each type of store to the schools, Euclidean distance (meters) between school and nearest food store was calculated.

The bivariate Ripley´s K function was used to assess the existence of clustering (spatial dependency) of each category of food stores in the territory of the schools, stratified according to type of school (public or private), educational levels (schools offering high school education and only kindergarten and/or elementary education), location (central or non-central) and *per capita* income of neighborhood (in terciles). For all the analyses, the territory of the schools from a distance of 0 to 1.5 km was observed[15,26,27].

The magnitude of clustering was measured using ratio of observed value (K function curve) to expected value (K function curve), calculated by the distance from the schools for each category of food store. Values close to 1.0 indicate a small difference between the observed spatial pattern of the food stores and the expected value. On the other hand, values greater than 1.0 indicate spatial dependence and represent how many times the value is exceeded in relation to what would be expected if the stores were randomly distributed. Evidence of significant clustering was assessed by graphical analysis.

The descriptive analyses were performed in the SPSS software (version 20.0) and for the spatial analysis, the QGis 2.14.4 software and the Spatstat Package of the Statistical Program R (version 3.3.2) were used.

Results

Six hundred and fifty-six (656) food stores were visited and after classifying the stores according to the predominant items sold, it was found that stores that predominantly sold unhealthy foods were present at a higher frequency (71.3%), followed by mixed (13.0%), healthy (12.7%) and supermarkets (3.0%).

In parallel, 42 schools were identified in the municipality, mostly public schools (59.5%), especially municipal schools (31.0%). Regarding education levels, one third of the schools offered only kindergarten (33.3%), a proportion similar to that of schools offering high school (31.0%).

All schools had at least one food store in their territory, regardless of category, as well as at least one unhealthy store in buffers of 400 and 800 meters. The distance from school to the nearest unhealthy store was almost 3 times lower compared to a healthy store (176.4 m vs. 64.3 m) (Table 1).

Private schools, offering high school education, located in the central region and in the higher income tercile, had more food stores in

Table 1. Distribution of food stores according to categories in the territory of schools. Viçosa, Minas Gerais, Brazil, 2016.

	Healthy	Mixed	Unhealthy	Supermarket	Total
400 meters buffer					
Mean (SD)	6.5 (6.9)	6.2 (7.9)	22.4 (17.9)	1.7 (2.1)	36.9 (33.4)
Median	4.0	3.0	18.5	1.0	25.5
Amplitude	0-24	0-32	1-77	0-6	1-136
% at least one store	83.3	81.0	100.0	59.5	100.0
800 meters buffer					
Mean (SD)	16.5 (15.1)	17.5 (17.5)	64.2 (44.8)	3.9 (3.7)	102.1 (79.6)
Median	12.0	8.0	58.0	2.0	83.0
Amplitude	0-45	0-51	6-142	0-10	7-228
% at least one store	95.2	97.6	100.0	85.7	100.0
Median distance from the nearest store (m)	176.4	198.2	64.3	308.9	52.2

Source: Authors.

their territory, in buffers of 400 meters and 800 meters (Table 2), as well as greater clustering (Table 3) for all categories of stores.

Table 3 shows the results derived from the bivariate Ripley's K function and the ratio between the observed and expected value for the densities of food stores in the territory of the schools. There was evidence of clustering of food stores at all distances (400 to 1.5 km), with up to 3 times more stores than would be expected if the stores were randomly distributed. From all observations, the ratio between the observed and expected value decreased with increasing distance, indicating that clustering of stores was more evident at lower school distances (400 meters) (Table 3).

In assessing the clustering of food stores according to *per capita* income of neighborhood, it can be seen that healthy, unhealthy, mixed stores and supermarkets were concentrated in school territories within the highest income tercile. The clustering of stores of all categories in the school territories increased according to increase in the *per capita* income of neighborhood (Table 3).

Unhealthy food stores were concentrated in the territory of the schools at all distances and in all income categories, with statistical significance. In the first tercile of income, there was no evidence of significant clustering for all distances from healthy, mixed and supermarket stores. In the second tercile, only supermarkets (400 to 1200 meters away) did not present significant clustering, as well as mixed stores (400 meters).

Discussion

The present study is the first to investigate the complete set of food stores in a medium-sized municipality in Brazil and its relationship with public and private schools, whose unprecedented results elucidate the food environment in the country. Of the 656 stores visited, the frequency of stores selling predominantly ultra-processed foods stands out.

All the 42 schools in the municipality had at least one food store in their territory, regardless of category, and at least one unhealthy store even at a small amplitude buffer (400 m). Private schools, offering high school education, located in the central region and in the upper tercile of income, had a greater quantity and clustering of food stores in their territory.

A study that analyzed the temporality of the spatial clustering of food stores in Christchurch, New Zealand, between 1966 and 2006, indicated a reduction in the density of convenience stores (characterized by the sale of limited quantities of food, including the sale of dairies and small fruit and vegetable stores), supermarkets and grocery stores in the territory of schools, in addition to an increase in the density of fast-food restaurants, especially in the territory of high schools[16]. Other studies also observed that food stores were concentrated in the territory of schools that offer high school education[27,34-36], since adolescents have greater autonomy in the purchase of food, as well as greater mobility to travel more distances in the school territory, such as the path between home and school[34].

Table 2. Distribution of food stores according to categories and characteristics of schools. Viçosa, Minas Gerais, Brazil, 2016.

Variable	Healthy	Mixed	Unhealthy	Supermarkets	All categories
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
400 meters buffer					
Type of school					
Public	4.1 (5.2)	3.8 (5.7)	16.7 (11.5)	1.1 (1.6)	25.7 (22.4)
Private	10.2 (7.6)	9.6 (9.6)	30.8 (22.4)	2.7 (2.4)	53.3 (40.3)
Offers high school education					
No	6.4 (6.5)	5.0 (5.9)	21.1 (14.8)	1.8 (2.2)	34.2 (28.0)
Yes	6.8 (7.9)	8.8 (11.1)	25.5 (24.0)	1.7 (1.9)	42.7 (43.8)
Location					
Central	13.7 (5.9)	12.6 (8.8)	37.6 (17.5)	3.9 (1.8)	67.7 (32.5)
Non-central	2.1 (2.1)	2.2 (3.7)	13.1 (10.4)	0.4 (0.6)	17.9 (14.6)
Neighborhood *per capita* income					
1st tercile (R$219.73 -| 487.47)	1.9 (2.8)	1.1 (1.4)	12.2 (5.4)	0.4 (0.5)	15.7 (8.7)
2nd tercile (R$487.47 -| 878.46)	3.5 (2.5)	2.1 (1.6)	14.9 (10.3)	0.8 (0.9)	21.3 (13.6)
3rd tercile (R$878.46 -| 3.327.37)	10.2 (7.8)	10.7 (9.1)	31.1 (20.7)	1.8 (2.4)	54.9 (38.3)
800 meters buffer					
Type of school					
Public	11.5 (13.8)	11.8 (15.6)	48.5 (41.6)	2.8 (3.2)	74.6 (72.8)
Private	23.8 (14.3)	25.8 (17.1)	87.2 (39.9)	5.5 (3.8)	142.4 (73.3)
Offers high school education					
No	15.9 (15.2)	16.2 (16.8)	63.4 (44.3)	3.8 (3.7)	99.3 (78.6)
Yes	17.7 (15.4)	20.3 (19.3)	65.9 (47.6)	4.2 (3.7)	108.1 (84.6)
Location					
Central	32.6 (9.1)	34.0 (14.2)	111.3 (27.0)	8.1 (2.3)	185.9 (50.3)
Non-central	6.5 (7.5)	7.4 (9.9)	35.2 (23.7)	1.3 (1.1)	50.4 (39.9)
Neighborhood *per capita* income					
1st tercile (R$219.73 -| 487.47)	5.0 (8.2)	4.4 (9.2)	31.2 (22.9)	1.6 (1.6)	42.2 (40.6)
2nd tercile (R$487.47 -| 878.46)	7.6 (6.4)	7.1 (6.0)	39.6 (25.0)	1.5 (1.8)	55.8 (37.5)
3rd tercile (R$878.46 -| 3.327.37)	26.5 (14.4)	29.1 (17.1)	92.4 (43.2)	6.2 (3.7)	154.1 (76.2)

SD - standard deviation.

Source: Authors.

Regarding the location of schools, Brazilian studies also found a greater number and clustering of commerce in the central region of the city, explained by the greater economic importance of the region[9,37]. On the other hand, in the study conducted in Chicago, USA, statistically significant clusters of stores were present in the non-central regions, and the authors argue that although the number of stores was higher in the downtown of the city, such stores did not appear to focus on the school territory[26].

The higher number of food stores in the central region of Viçosa can be explained by the intense concentration of people in this area of the city, and also attributed to the presence of the Federal University of Viçosa[38]. The greater circulation of people also explains the clustering of food stores in the territory of the schools, such that commercial stores are attracted to this territory in order to attend to students as well as their parents or guardians.

As regards the availability of food stores according to neighborhood *per capita* income, the results indicated that the clustering of stores of all categories in the school territory was larger according to increase in income, the same was also demonstrated in the regions of the private schools.

Studies report that the food environment may be influenced by the socioeconomic characteristics of the neighborhood, since commer-

Table 3. Ratio between observed and expected value (Ripley´s K function) for the densities of food stores around schools. Viçosa, Minas Gerais, Brazil, 2016.

	Distance from schools			
	400 m	**800 m**	**1200 m**	**1500 m**
Type of school				
Public	1.87	1.60	1.38	1.36
Private	2.68	2.18	1.90	1.70
Offers high school education				
No	2.15	1.83	1.61	1.51
Yes	2.42	1.91	1.63	1.50
Location of school				
Central	3.02	2.49	2.09	1.85
Non- central	1.56	1.32	1.23	1.25
Neighborhood *per capita* income				
1st tercile (R$219,73 -| 487,47)	1.50	1.24	1.12	1.11
2nd tercile (R$487,47 -| 878,46)	1.69	1.37	1.30	1.33
3rd tercile (R$878,46 -| 3.327,37)	2.72	2.27	1.93	1.73
Healthy				
1st tercile	1.46*	1.16*	1.11*	1.14*
2nd tercile	1.91	1.42	1.32	1.44
3rd tercile	3.30	2.64	2.23	1.98
Mixed				
1st tercile	1.13*	1.08*	1.07*	1.07*
2nd tercile	1.48*	1.37	1.37	1.45
3rd tercile	3.33	2.73	2.28	2.00
Unhealthy				
1st tercile	1.56	1.28	1.13	1.11
2nd tercile	1.68	1.37	1.28	1.29
3rd tercile	2.42	2.08	1.79	1.62
Supermarket				
1st tercile	1.49*	1.33*	1.22*	1.18*
2nd tercile	1.80*	1.27*	1.23*	1.34
3rd tercile	3.54	2.62	2.06	1.80

* From the graphical analysis (data not shown), there was no evidence of significant clustering.

Source: Authors.

cial stores tend to be more frequent in places with higher income. Thus, lower income regions tend to have less availability and variety of food stores, with more limited access to healthy foods and greater exposure to the sale of unhealthy foods[39,40].

A clustering pattern according to neighborhood income was also found in a similar study carried out in Glasgow – United Kingdom – evaluated the community food environment in public school territories and observed a higher clustering of food stores within 400 meters from less deprived regions, but at distances of 800 meters, these clusters were observed in areas located in the second quartile of the economically disadvantaged[15].

In a Brazilian study, a higher frequency of the sale of ultra-processed foods, as well as greater proximity and clustering was found in regions with higher socioeconomic level[9]. Higher densities of food stores (healthy, unhealthy, mixed and supermarkets) were found in regions of lower vulnerability in a municipality in Brazil[37]. In addition, an exploratory study conducted in 1,292 schools and 613 fast-food restaurants in Chicago, USA found a greater clustering of such stores in the territory of schools in the highest income tercile[26].

In the highest income tercile, the largest clusters of all types of food stores were found, but it is important to note that in the lower income ter-

cile, significant statistical clustering was observed only for unhealthy stores, confirming the results of other studies that observed greater proximity and clustering of these stores in economically disadvantaged regions[16,17,27,34-36,41].

Changes that have occurred over the years have facilitated the access of schoolchildren to ultra-processed foods of low nutritional value, since the number of stores selling healthy foods in schools has declined over the years, while there has been an increase in availability of stores selling unhealthy foods[16]. In this context, the availability of unhealthy food stores may contribute to the access to an unhealthy diet between schoolchildren and adolescents in the evaluated city.

Supermarkets seem to be between the unhealthy food stores. Although there is no consensus in the literature on influence of supermarkets on the food consumption of individuals[33], a Brazilian population-based study indicated that the share of ultra-processed foods and beverages in purchases made at supermarkets was 25% higher than at other food stores and low price was an important factor that explains the acquisition of these products[42]. As a result, we evidence a scenario in which children and adolescents from private schools in higher-income areas, potentially with greater purchasing power, are significantly more exposed to supermarkets and, consequently, have greater access to ultra-processed foods.

The present study is similar to several studies that evaluated the availability of food stores near schools, with a greater exposure of students to an unhealthy food environment, such as fast-food restaurants and convenience stores[9,13,17,43]. However, there are strengths that make our research methodologically relevant and therefore contribute to the internal validity of our study. We conducted an objective evaluation of the environment with an investigation of the real food environment of the school territory. The majority of studies that evaluated the availability of food stores in the school territory used secondary data, however it is worth noting that when secondary data are used to obtain information about food stores, the validity of such information may be compromised, in terms of informality and quality of records, which does not occur when primary data are used.

This study has some limitations. First, the use of buffer to define the school territory determines boundaries that are arbitrary, that is, the routes actually used to access the schools are not taken into consideration. Despite that, 400-m radius and 800-m radius buffers have been widely used in studies that evaluate the food environment in the school territory[15,26-28]. Furthermore, they seem to correspond to the distance of the actual walking and cycling routes between home and school, which is potentially used for food acquisition[44]. Second, no information was collected on the food environment inside the schools, which is also important for understanding the dynamics of the food environment in the school territory. Finally, the presence of the Federal University of Viçosa may influence clustering in the central business district due to the high number of university students.

Despite these limitations, the present study indicates that there is a greater concentration of food stores around schools, especially those considered unhealthy. This scenario justifies the development of legislation that regulates the sale of unhealthy foods around Brazilian schools, since there is a scarcity of this type of regulation in the country.

Conclusions

It is concluded that schools are potentially exposed to unhealthy food environment at short distances from the urban schools of Viçosa-MG, regardless of income and location, which may favor inadequate eating habits and overweight in children. In view of this, it is necessary to reflect on actions aimed at modifying and promoting a healthy food environment in the school territory, such as the store of healthy stores and at a smaller distance from schools, combined with the regulation of the sale of ultra-processed foods; as well as interventions aimed at promoting adequate and healthy food for this public.

Collaborations

TG Novaes, LFF Almeida, AQ Ribeiro and MC Pessoa worked on concept and design of the study. TG Novaes and LFF Almeida worked on carrying it out. TG Novaes worked on analysis of data and drafting of the manuscript. TG Novaes, AQ Ribeiro, LL Mendes, RM Claro and MC Pessoa worked on interpretation of data. All authors participated in the review of the manuscript and approved the final version.

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