Disparities in Food Availability around Schools in a Large Brazilian City

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Abstract

The food environment around schools may influence the food consumption and health outcomes of children and adolescents. We conducted a cross-sectional exploratory census study in Juiz de Fora, Minas Gerais, Brazil, to investigate the food environment in the neighborhoods of schools. Schools were classified according to administration (public/private), location (central/peripheral), and neighborhood socioeconomic vulnerability. The density of food stores around schools was divided into four categories: i) only or mainly selling unprocessed or minimally processed food, ii) mixed, iii) only or mainly selling ultra-processed food, and iv) supermarkets and hypermarkets. We calculated the Euclidian distances (m) from schools to each nearest establishment category and plotted circular buffers of

250, 500, and 1000 m radius around schools to evaluate the density of food stores inside the circular areas. A total of 316 schools and 4,690 establishments were included in the study. We found that the closest establishment category around schools was those selling only or mainly ultra-processed food. Schools were situated where there was a concentration of food stores; being in the central district was the most influential factor with regard to their presence around schools. Moreover, the density of food stores around schools decreased as the district's vulnerability increased. To fight against an obesogenic environment around schools, public policies are needed to regulate the commodities being sold nearby.

Keywords: food environment, geographical variations, schools, socio-economic inequalities, ultra-processed food

Background

Traditional efforts toward obesity prevention and treatment focus on changes in individual behavior; more specifically, attitudes toward energy intake and expenditure (Reed, Viola, & Lynch, 2014). However, the increasing prevalence of obesity and other chronic non-communicable diseases worldwide indicates an association with other determinants beyond genetics and individual choices, such as social and environmental factors (Penney, Almiron-Roig, Shearer, McIsaac, & Kirk, 2014).

More than two decades ago, Egger and Swinburn developed an ecological model to better understand the determinants of obesity. They realized that the traditional view of obesity as a personal disorder that requires treatment was not containing the obesity pandemic and a shift was needed (Egger & Swinburn, 1997). This broad perspective resulted in the concept of "obesogenic environments" in which the sum of the surroundings, opportunities, or conditions of life promote obesity in individuals or populations. This paradigm helped in developing theoretical models that consider the characteristics of built environment, culture, and socioeconomic factors as population health determinants (Swinburn, Egger, & Raza, 1999).

Today it is known that environmental or contextual characteristics, such as urban infrastructure, location of food-related establishments, traffic, crime, and others, influence dietary and physical activity patterns. Boclin, Faerstein, and Ponce de Leon (2014) found that residents in neighborhoods with higher social development indices have more leisure-time physical activity, showing that the environment influences the promotion or prevention of obesity in several ways. It is important to note that some social vulnerability markers, such as race and ethnicity, must be considered in analyzing the role of the environment in health outcomes. Kumanyika and colleagues suggested that high-risk populations, such as African American communities, are understudied and need target interventions to have a greater impact on preventing obesity and promoting health (Kumanyika, Swank, Stachecki, Whitt-Glover, & Brennan, 2014).

Children and adolescents worldwide spend a significant part of their time in and around schools, often consuming one to three meals a day during school hours. Thus, the quality of food available within and surrounding schools can significantly influence the health outcomes of this population (O'Toole, Anderson, Miller, & Guthrie, 2007; Story, Nanney, & Schwartz, 2009). Recognizing the prevention of childhood obesity as a global priority, Penney and colleagues (2014) argue that interventions in this area, including social marketing campaigns with a focus on environment and policy changes, can show promising results.

In Brazil, there are public and private schools. The municipality, state, or federation manages the public schools. In all public schools, the most important policy for protecting children and adolescents' eating is the National School Feeding Program (Programa Nacional de Alimentação Escolar), which has existed since 1955 and consists of food supply and food and nutritional education for students at all stages of basic education (Ministério da Educação do Brasil, 2008).

The regulation of food sales at school canteens and at establishments around schools, however, is incipient in Brazil. The first law prohibiting the sale of unhealthy food in school canteens was passed in 2001 (São Paulo, 2001). There are some laws spread across Brazilian states and municipalities prohibiting certain food sales inside schools (Gabriel et al., 2012) and a few regulations on food sales in the neighborhoods of schools.

Few studies have been conducted in Brazil or other Latin American countries concerning the characteristics and distribution of food stores around schools. Therefore, this study aimed to investigate the community food environment in school neighborhoods in urban districts in a large Brazilian city, evaluating the differences in the food environment according to school characteristics and location.

Methods

Study Design and Setting

This is a cross-sectional exploratory census study, whose analysis unit is the territory around public and private schools in Juiz de Fora in 2016.[1]

Juiz de Fora is a large city located in the Zona da Mata Mineira, in the southeastern part of the state of Minas Gerais. In 2010, it had a Municipal Human Development Index (MHDI) of 0.778, placing it among Brazilian cities with high levels of development (MHDI between 0.700 and 0.799) (IBGE, 2010). However, its Gini index of 0.58 (Atlas do Desenvolvimento Humano no Brasil, 2013) shows high intra-urban social inequality.

According to the 2010 census data released by the Brazilian National Institute of Geography and Statistics (IBGE, 2010), the municipality had a population of 516,247 inhabitants, with 98.86% of the residents in urban areas. Sidewalks are present in 88.38% of the urban area, closed sewage in 99.16%, public lighting in 99.24%, and 56.03% of the urban area is green space (IBGE, 2010).

Data

Considering school territories as units of analysis, we evaluated environmental variables concerning the food environment and the health vulnerability index.

We extracted the complete list with data of all schools in Juiz de Fora in 2016 from the open-access website of the Secretary of State for Education, Government of Minas Gerais. The relevant information for the study was as follows: name (for identification), full address, administration (federal, state, municipal, or private), and education level provided by the school. The inclusion criterion was urban schools that offered at least one of the following levels of education: preschool, elementary school, or high school.

[1] This study is part of the project, "Built and Social Environments: Relationship with Overweight, Obesity, and Food Consumption by Children and Adolescents of Juiz de Fora, Minas Gerais," developed by Universidade Federal de Juiz de Fora and approved by the Research Ethics Committee (protocol number 522.694/ 2014).

From the complete addresses of the schools, their geographical coordinates (latitude and longitude) were obtained through the Find Latitude and Longitude website. We used the Geographic Information System QGIS 2.8.6 for the school georeferencing.

In order to characterize the community food environment around Juiz de Fora schools, we utilized a secondary database containing the full addresses of all establishments in the food retail sector in Juiz de Fora in 2016. We obtained this database from the Minas Gerais State Secretariat of Finance. The Secretariat is a governmental body that has information on the location of commercial establishments described according to the National Classification of Economic Activities. This is comparable to a label that describes and categorizes the different types of commercial establishments according to their main economic activity (IBGE, 2016). We obtained data on street food vendors and farmers' food markets from the Secretariat of Urban Activities of Juiz de Fora (Juiz de Fora, 2019). The food establishments were georeferenced following the same methodology used for schools. Because of incomplete addresses, we lost 139 food stores from the study.

We grouped the establishments according to their main economic activity and the nature, purpose, and degree of processing of the predominant food sold, based on the NOVA food classification[2] (Monteiro et al., 2019; Table 1). Supermarkets and hypermarkets (i.e., "superstores") were analyzed separately from other establishments, considering their large sizes and the lack of consensus in the literature regarding the influence of buying food from supermarkets on consumer attitudes because of the wide range of food available in these spaces (Machado, Claro, Canella, Sarti, & Levy, 2017; Larson, Story, & Nelson, 2009).

Table 1. Classification of food establishments according to the main activity and types of food sold

A. Only or mainly selling unprocessed or minimally processed food: Butchers, vegetable and fruit stores, farmers' markets, fish markets, dairy markets, and street vendors mainly selling unprocessed and minimally processed food*
B. Mixed: Restaurants and bakeries
C. Only or mainly selling ultra-processed food: Candy shops, snack bars, mini-markets, street vendors selling solely or mainly ultra-processed food**
D. Supermarkets and hypermarkets

* Coconut water, garlic, spices, fruits, cane juice, raw beans, pineapple, green corn, and/or honey

** Biscuits, hot dogs, burgers, fried savories, pastries, popsicles, industrialized potato chips, confectionery, and/or chocolate

[2] The NOVA food framework has been proposed as an approach to classify all foods and beverages into four groups according to the nature, extent, and purpose of their processing: (i) unprocessed or minimally processed foods; (ii) processed culinary ingredients; (iii) processed foods; and (iv) ultra-processed foods.

We used the health vulnerability index to categorize the various districts within the urban area according to socioeconomic deprivation levels. For Juiz de Fora, this index was constructed using data from the 2010 Census (IBGE, 2010) following the methodology elaborated by the Municipal Health Secretariat of Belo Horizonte (Belo Horizonte, 2013). This is a synthetic indicator that associates different socioeconomic and environmental variables and is useful for analyzing health events. It allows us to analyze the characteristics of population groups living in certain geographic areas, identify inequalities in the epidemiological profile of social groups, and point out intra-urban socioeconomic differences (Friche, 2011; Barbosa, 2011). The index comprises eight indicators grouped into two dimensions (sanitation and socioeconomic conditions).[3]

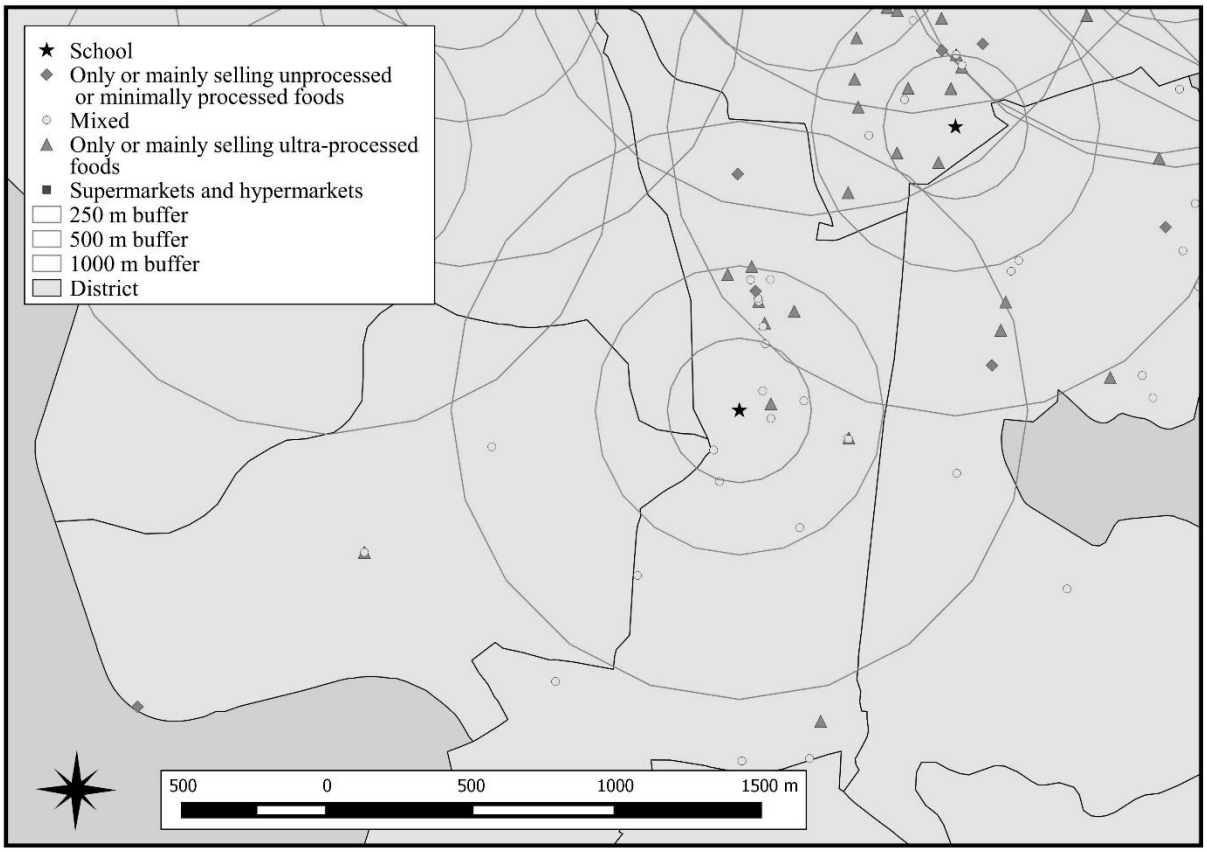
By applying the vulnerability index to the districts of the urban area, we classified the districts, as well as the school and food establishments within them, as low, medium, high, or very high risk (Belo Horizonte, 2013).

Data Analysis

In order to explore the food environment in school neighborhoods, we calculated the Euclidian distances (meters) from schools to each nearest food establishment category using ArcGIS 10.5. We also plotted circular buffers of 250, 500, and 1000 m radius—equivalent to 5, 10, and 20 minutes of walking around each school (Chiang et al., 2011)—and evaluated the density of food stores inside the circular areas using QGIS 2.8.6. We performed all descriptive analyses using the Statistical Software for Professionals (STATA), version 14.1. The planimetric reference system used in spatial data manipulation was the Geocentric Reference System for Americas (SIRGAS 2000), which is a geodetic reference system officially adopted in Brazil. We categorized the schools according to administration (public or private), location (central or peripheral), and neighborhood socioeconomic vulnerability. No statistical tests were conducted to compare the descriptive characteristics of schools or buffers because this is a census study. Figure 1 is an illustration of the food environment around two of the schools studied.

[3] More information about this index is available at https://prefeitura.pbh.gov.br/sites/default/files/estrutura-de-governo/saude/2018/publicacaoes-da-vigilancia-em-saude/indice_vulnerabilidade2012.pdf

Figure 1. Visualizing the food environment in the neighborhoods around two of the schools studied



Source: Authors (2020), based on data from Minas Gerais (2016), and Juiz de Fora (2016).

Results

The study included 316 schools attended by children aged 4 to 17 years. Of the total studied schools, 179 (56.64%) were private. Most schools were in peripheral locations (91.14%) in medium vulnerability (44.94%) districts. The study included 4,690 food establishments (Table 2).

Table 2. Average distance from schools to food establishments in meters in Juiz de Fora, Minas Gerais, Brazil (2016)

School types	N (%)	Average distance (m) from food establishments:			
		Only or mainly selling unprocessed or minimally processed food	Mixed	Only or mainly selling ultra-processed food	Supermarkets and hypermarkets
		Mean (SD)			
All schools	316 (100.00)	205.47m (244.55)	96.60m (108.59)	76.11m (99.69)	569.66m (634.28)
Separated by administration					
Public	137 (43.35)	231.81m (292.75)	111.61m (119.02)	85.32m (122.34)	681.44m (763.50)
Private	179 (56.65)	185.30m (198.53)	85.11m (98.69)	69.07m (77.70)	484.11m (499.59)
Separated by address					
Downtown	28 (8.86)	94.18m (53.73)	57.31m (47.20)	40.92m (39.13)	201.79m (126.37)
Peripheral districts	288 (91.14)	216.29m (253.07)	100.42m (112.11)	79.54m (103.11)	605.43m (652.36)
Separated by socioeconomic vulnerability of district					
Low vulnerability	107 (33.86)	144.19m (114.24)	67.84m (56.86)	58.78m (60.47)	321.82m (206.69)
Medium vulnerability	142 (44.94)	218.67m (216.56)	92.09m (73.86)	71.04m (56.18)	493.78m (361.12)
High vulnerability	67 (21.20)	275.35m (390.99)	152.07m (186.89)	114.56m (181.04)	1,126.20m (1,070.70)

* SD = standard deviation

Table 2 shows that the establishments closest to schools sold only or mainly ultra-processed food. Smaller distances to all food stores were noted for private schools and those located downtown and in low-vulnerability districts. Food stores only or mainly selling unprocessed or minimally processed food as well as supermarkets and hypermarkets were more distant from schools than other types of establishments. The higher the district vulnerability, the greater the distance from schools to all types of food stores.

Table 3. Mean density of food establishments by category (number per km²) in school neighborhoods in Juiz de Fora, Minas Gerais, Brazil (2016)

School types	Establishments only or mainly selling unprocessed or minimally processed food			Mixed establishments			Establishments only or mainly selling ultra-processed food			Supermarkets and hypermarkets		
	distance from the school:			distance from the school:			distance from the school:			distance from the school:		
	250 m	500 m	1,000 m	250 m	500 m	1,000 m	250 m	500 m	1,000 m	250 m	500 m	1,000 m
	Mean (SD)											
All schools	19.3 (31.63)	14.23 (19.77)	10.53 (11.56)	45.33 (49.05)	37.87 (37.59)	29.67 (27.17)	72.93 (97.89)	58.68 (69.89)	46.56 (46.74)	2.39 (4.48)	1.87 (2.24)	1.25 (1.27)
Separated by administration												
Public	19.67 (41.30)	13.71 (23.57)	8.59 (10.58)	39.63 (58.20)	31.66 (38.97)	24.02 (24.83)	73.49 (133.22)	53.93 (79.61)	38.10 (43.06)	2.19 (4.61)	1.63 (2.10)	1.02 (1.23)
Private	19.03 (21.56)	14.63 (16.35)	12.01 (12.08)	49.68 (40.26)	42.62 (35.89)	34.00 (28.13)	72.52 (58.34)	62.33 (61.41)	53.03 (48.5)	2.59 (4.36)	2.06 (2.33)	1.43 (1.28)
Separated by address												
Downtown	68.03 (76.33)	56.61 (41.21)	39.42 (5.82)	125.32 (92.20)	113.09 (42.82)	88.33 (15.10)	245.55 (237.28)	219.18 (121.88)	161.44 (25.07)	6.91 (7.23)	6.28 (2.77)	4.42 (0.71)
Peripheral	14.57 (17.16)	10.11 (8.79)	7.72 (7.36)	37.54 (33.95)	30.56 (27.8)	23.97 (20.50)	56.16 (45.12)	43.09 (34.73)	35.39 (30.43)	1.98 (3.86)	1.45 (1.65)	0.94 (0.80)
Separated by vulnerability index of district												
Low vulnerability	29.9 (46.91)	25.22 (29.13)	20.21 (13.99)	77.62 (67.38)	71.30 (45.51)	57.07 (27.88)	121.21 (149.22)	109.37 (98.42)	89.34 (53.76)	3.41 (5.30)	3.00 (2.84)	2.38 (1.46)
Medium vulnerability	15.89 (19.66)	10.13 (9.10)	6.57 (6.13)	33.41 (23.89)	24.87 (15.29)	18.50 (12.35)	53.48 (39.27)	37.27 (23.21)	28.50 (22.67)	2.24 (4.33)	1.64 (1.72)	0.82 (0.60)
High vulnerability	9.68 (10.29)	5.33 (3.92)	3.44 (2.64)	18.95 (15.89)	12.04 (8.19)	9.60 (7.31)	37.08 (28.21)	23.16 (13.06)	16.50 (10.05)	1.12 (2.65)	0.57 (0.94)	0.37 (0.45)

* SD = standard deviation

Table 3 shows that the predominant type of food establishment around all schools was that which sold only or mainly ultra-processed food. Higher densities of all food stores were noted for private schools and those located in downtown and in low-vulnerability districts. Furthermore, the density of food stores around schools decreased as the district's vulnerability increased. As the size of the analyzed area increased, the density of establishments decreased, indicating that there is a concentration of food establishments closer to schools.

Location appeared to more strongly influence the food environment in the school neighborhood than whether the school was public or private. Specifically, being

located in the central district, among the analyzed characteristics, was the factor that most influenced the presence of food establishments around schools. Supermarkets and hypermarkets were the establishments least frequently found around schools and the most distant to them.

Discussion

This study sought to provide some answers about the community food environment surrounding schools in a large Brazilian city. The food environments vary according to the schools' administration, location, and district socioeconomic vulnerability.

As socioeconomic vulnerability increases, there is a decrease in the density of all types of food establishments in school neighborhoods. Therefore, students at schools located in less-fortunate districts have fewer choices about where to eat or buy food (Ford & Dzewaltowski, 2008; Beaulac, Kristjansson, & Cummins, 2009). This might happen because higher-vulnerability districts are less attractive for operating food establishments because of precarious infrastructure, higher crime rates, and lower purchasing power of consumers (Sharifi et al., 2017; Duran, Diez Roux, Latorre, & Jaime, 2013). Consequently, students might have different relationships with the food environment around their school, depending on the school neighborhood's level of vulnerability. While those who studied in the poorest regions might have fewer options of where to eat, the ones who studied in richer regions—and especially downtown—are hyper-exposed to a wide range of food stores, although these do not necessarily provide many options for healthy food. However, studies show that a lack of options for where to buy and eat healthy food can be associated with negative health outcomes (Dubowitz et al., 2012; Courtemanche & Carden, 2011; Prince et al., 2012).

It is not new that socioeconomic inequities related to the individual and their context interfere with food consumption and nutritional status (Black, Macinko, Dixon, & Fryer, 2010). According to the "deprivation amplification" hypothesis, socially disadvantaged individuals experience a further contextual disadvantage regarding their access to health-promoting resources due to their coexisting place characteristics (Macintyre, 2007). People who live, work, and study in deprived urban areas are disproportionately affected by stress and risk factors for obesity, such as higher crime rates, discrimination, social vulnerability, reduced access to healthcare resources, lower access to healthy food establishments, and limited opportunities to practice safe physical activity (Garasky, Stewart, Gundersen, Lohman, & Eisenmann, 2009; Dawson-McClure et al., 2019). The distribution of food establishments can reinforce community inequities in relation to access to healthy food and limited food choices (Day & Pearce, 2011).

It is noteworthy that low-income people, at all ages, have many more barriers to access healthy food, either because of lower purchasing power or limited access to healthy food in the neighborhood where they live, study, and work (Duran et al., 2013). In addition, other factors, such as less time available to devote to practices related to food preparation and consumption, lower access to information regarding healthy eating, and greater stress, also have an effect (Drewnowski, 2009).

The most abundant establishments in school neighborhoods in Juiz de Fora are those selling only or mainly ultra-processed food. Proximity to unhealthy food establishments is considered a risk factor for weight gain in this population (Fiechtner et al., 2015; Macintyre, McKay, Cummins, & Burns, 2005). Our findings are in agreement with other results reported in the literature that show that the low quality of food sold around schools exposes children and adolescents to a low-quality food environment (Day & Pearce, 2011; Austin et al., 2005; Kipke et al., 2007; Engler-Stringer, Shah, Bell, & Muhajarine, 2014; Morin, Demers, Robitaille, Lebel, & Bisset, 2015; Leite et al., 2012; Missbach, Pachschwöll, Kuchling, & König, 2017; Day, Pearce, & Pearson, 2015). Studies conducted in the U.S. and Brazil showed that children and adolescents had easy access to establishments that offer fast food or ultra-processed food at a short distance from schools and were exposed to low-quality food environments (Austin et al., 2005; Kipke et al., 2007). In New Zealand and Canada, this exposure was more intense in regions with lower socioeconomic levels (Day & Pearce, 2011; Engler-Stringer et al., 2014; Morin et al., 2015).

Schools are located in places where there is a concentration of food stores. The schools may have been a magnet for the attraction of different food establishments to their neighborhoods, or perhaps schools are built in places where this concentration already exists. Defending the first hypothesis, due to the high circulation of children, adolescents, and parents or guardians around schools, these areas might be perceived as interesting niches for operating food establishments (Day & Pearce, 2011; Austin et al., 2005; Gilliland et al., 2012).

People tend to consume what is easier to reach (Bucher et al., 2016), and if ultra-processed foods are more easily available, it is easier to choose these foods. For example, in Quebec, Canada, researchers found that greater access to fast-food restaurants around high schools was associated with a higher consumption of junk food during lunch after controlling for variables related to the student (e.g., age, gender, and health perception), their family (parents' level of education), and school characteristics (urban/rural and area deprivation) (Cutumisu et al., 2017). Usually, ultra-processed products are more convenient to transport to establishments located in distant and less affluent urban areas because they are standardized formulations with long-term stability and often do not require special transportation, storage or marketing (Monteiro et al., 2019).

It is important to note that establishments in the category "only or mainly selling unprocessed or minimally processed food" (such as butchers, vegetable and fruit stores, fish markets, and dairy markets) will not usually be frequented by children and adolescents, especially to buy food to be consumed during school hours. However, as noted above, the school neighborhood is a live territory where children and adolescents' guardians also circulate and buy food that will be part of the family diet. A systematic review by Karpyn and colleagues showed that increasing access to healthy food products in stores, particularly while utilizing promotion strategies, increases healthy food sales and purchase and improves dietary outcomes (Karpyn, McCalllops, Wolgast, & Glanz, 2020).

The findings of this study can be extrapolated to cities similar to Juiz de Fora and help to explain the food environment scenario in school neighborhoods in Brazil and other low- and mid-income countries. To fight against an obesogenic environment around schools, public policies are needed to regulate what is being sold around these institutions. A possible intervention could encourage healthier food retail to be set up a short distance from schools. Other interventions such as ultra-processed food taxation, limitations on marketing strategies, especially those targeting children and adolescents, warning labeling on the front of packages, and food and nutritional education are also important in inhibiting the consumption of ultra-processed food by young people.

Our study methodology raises possible limitations. Using secondary data sources may have led to inaccurate results. However, we audited a sample of food establishments and tested the database quality. We found the data of 78.6% of establishments to be consistent. In addition, we used Euclidian distance and buffers to determine paths and school territory, which are virtual boundaries in the school neighborhood. The choice of this territorial cut was based on previous studies already conducted and published in peer-reviewed scientific journals (Austin et al., 2005; Kipke et al., 2007; Laska, Hearst, Forsyth, Pasch, & Lytle, 2010).

Despite these limitations, this census study considers all schools in the city and gives us a macro view of the territory.

Conclusions

The findings demonstrate that schools and food establishments seem to have spatial correlation; socioeconomic vulnerability is inversely proportional to food establishments' density in the school neighborhoods, and the closest and densest establishments in school neighborhoods are those selling only or mainly ultra-processed food.

This poor-quality food environment around schools exposes children and adolescents to risk factors for the overconsumption of ultra-processed food and, consequently, obesity and other negative health outcomes. Students' experiences with the food environment around schools differ according to school characteristics, such as administration, location, and neighborhood socioeconomic vulnerability. Public policies are needed to regulate the food environments in school neighborhoods and ensure equitable access to healthy food.

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