

## Availability of processed foods in the perimeter of public schools in urban areas

Fernanda Helena Marrocos Leite,<sup>1</sup> Maria Aparecida de Oliveira,<sup>2</sup> Elena de Carvalho Cremm,<sup>1</sup>  
Débora Silva Costa de Abreu,<sup>1</sup> Luana Rieffe Maron,<sup>3</sup> Paula Andrea Martins<sup>4</sup>

### Abstract

**Objective:** To assess the availability of food in relation to their degree of industrial processing and the types of food stores in the perimeters of elementary schools.

**Method:** This is a cross-sectional study. 82 food stores located within a 500 m radius buffer of three public schools located in three distinct regions with different socioeconomic levels in the municipality of Santos, state of São Paulo, Brazil, were assessed. All streets within a 500-meter radius of the schools were covered, geographic coordinates were recorded and information about the stores and food items available were collected by direct observation and interview with store managers. Available food items were classified in relation to their degree of industrial processing as ultra-processed foods and minimally processed foods. Kernel's density maps were used to assess the degree of agglomeration of stores near the schools.

**Results:** The stores that offered mostly ultra-processed foods were significantly closer to schools than those who offered mostly minimally processed foods. There was a significant difference between the availability of processed food in different types of stores and between the three regions assessed.

**Conclusions:** The data found by this work evidences that children who attend the three public schools assessed are exposed to an environment that encourages the consumption of ultra-processed foods through easier access of these products in the studied stores.

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### Introduction

Studies have shown that the health and behavior of individuals are influenced by the physical and social environment they inhabit. Many studies have focused on the characteristics of the neighborhood environment as determinants of socioeconomic differences in individuals' diet and physical activity.<sup>1,2</sup>

The prevalence rates of obesity and non-transmissible chronic diseases associated with diet have been rising at an accelerated pace. This epidemiological picture is marked by a contemporary urban environment that leads to an increased intake of energy,<sup>3</sup> while physical activity is limited due to, among other factors, the environmental

1. MSc in Sciences. Ciências do Movimento Humano, Instituto Saúde e Sociedade, Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil.

2. PhD in Public Health. Saúde Ambiental, Faculdade de Saúde Pública, Universidade de São Paulo (USP), São Paulo, SP, Brazil.

3. Specialist in Public Health. Ciências do Movimento Humano, Instituto Saúde e Sociedade, UNIFESP, São Paulo, SP, Brazil.

4. PhD in Sciences. Ciências do Movimento Humano, Instituto Saúde e Sociedade, UNIFESP, São Paulo, SP, Brazil.

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characteristics of neighborhoods that often have no place (bike lanes, parks and sports courts) where these activities can be performed.<sup>4</sup>

Moreover, although many studies stress the importance of nutrients and foods in achieving a healthy diet, very little is discussed – in the guidelines, information on nutrition and health and in public policy – about the industrial processing these products undergo.<sup>5</sup>

Generally, processed foods have a high energy density, an excess of fats (especially saturated fats), sugar and additives (colorants, preservatives) and lack or have a shortage of fibers and micronutrients.<sup>6</sup>

Taking into account that the consumption of processed foods by the Brazilian population has increased in recent decades, access to adequate nutrition in childhood has become the focus of discussion, since this is strongly conditioned by the purchasing power of households, which depends on the availability, quality and quantity of food consumed.<sup>7</sup>

In addition to the actions of parents to provide food for their children, the school environment is an especially suitable space for the development of actions to improve the health condition and nutritional status of children.<sup>8</sup>

However, students are not always faced with an environment conducive to the consumption of nutritional foods that promote a healthy diet. The school food environment has undergone numerous changes in recent years, since there is a large supply of high-fat food – like crackers, snack chips, ice cream and soda – in canteens or in vending machines in schools, prompting many students to not consume the school program meal.<sup>9</sup>

This study aimed to evaluate the supply of ultra-processed foods (UPF) and minimally processed foods (MPF) at food outlets classified as food stores, located in the perimeters of three public schools in the municipality of Santos, state of São Paulo, Brazil.

## Methods

### **Study design and sample**

This study had a cross-sectional observational design. The data were collected from December, 2008, to October, 2009, in the municipality of Santos. The research focused on characteristics related to food availability and access in areas close to three municipal schools (kindergarten and elementary school), located in three distinct regions of Santos (Regions 1, 2 and 3) and representing different socioeconomic levels. Regions 1 and 2 are located at the Orla (Waterside) and Ponta da Praia areas in Santos and are characterized by higher population density and higher socioeconomic level.<sup>10</sup> Region 3 is located in the downtown area and has a lower socioeconomic level.<sup>10</sup> Schools were selected through a lot stratified by region, proportionally to the population living in the municipality.

The sample was composed of 82 outlets classified as stores included in the vicinity of assessed schools, comprising 12% of the insular area of the municipality. Every street in the perimeters of the schools was covered, assuming a radius of 500 meters for the delimitation of the area. The geographic coordinates were registered and information about the stores and on foods sold was collected through observation and interview with those responsible for the store.

The study was approved by the Research Ethics Committee of Universidade Federal de São Paulo (CEP n. 2058/08).

### **Register and characterization of geographic points of interest**

The measurement of geographic coordinates was conducted by the field staff with a Global Positioning System (GPS) unit. All stores located at the perimeter of the schools included in the study were measured. The characterization of these stores was also performed.

The researchers stood at one meter from the store and read the information recorded in the GPS (latitude and longitude). The data were entered into a geographic information system.

### **Assessment of food stores**

The characterization of stores was made from information supplied by those responsible for them and observation, using an instrument validated by the research group.<sup>11</sup> The questionnaire was developed with based on the study of the Glanz et al.<sup>12</sup> Through this instrument, issues relating to the characteristics of stores were investigated, such as: more frequent public – children ( $\geq 0$  and  $< 10$  years) with or without guardians, adolescents ( $\geq 10$  and  $\leq 19$  years) with or without guardians, adults ( $> 19$  and  $< 60$  years) and elderly ( $\geq 60$  years)<sup>13</sup>; physical structure – closed environment (when the space/place where meals are prepared has walls) or in the open air; number of food outlets (two or more stores, one immediately next to each other, with the same ultimate purpose, i.e., serve meals, regardless of type) or isolated; fixed or mobile outlet; and category – butcher, poultry and fishmonger shop; candy store; fresh food stand; food retailing; grocery store/shop; bakery; “sacolão” (a type of bargain grocery store); supermarket; convenience store; mini bomboniere and fresh pasta store.

The questionnaire also included an inventory of foods sold, which assessed the availability of food according to the groups described in the Harvard Guide<sup>14</sup> and to the different degrees of industrial processing.<sup>15,16</sup>

### **Classification of stores and foods available**

This study focused on stores classified as food stores, that is, those that offered food for purchase but not for consumption on site. These comprised supermarkets, butcher shops, bakeries, grocery stores and shops, candy stores, among others.<sup>17</sup> All visited stores had as their main activity the sale of food and were open during the day.

The existing foods in these stores were classified in three groups, according to the degree of industrial processing: UPF, processed foods as ingredients for culinary preparations (PFCP) and MPF.<sup>18</sup>

The first group (MPF) was composed of unprocessed foods or foods that underwent minimal industrial processing – mostly physical – in order to make them more available, accessible and safe, such as fresh meats and milk, grains, legumes, oilseeds, fruits and vegetables, roots and tubers, tea, coffee, herbal infusions and bottled waters. In the second group (PFCP) were inserted MPFs characterized by being used as culinary and/or industrial ingredients: oils, fats, flour, pasta, starches and sugars, corn syrup, lactose and soy and milk protein. In the third group (UPF) were included foods produced from various foodstuffs, including foods from group 1 and ingredients from group 2. Foods part of this group were: bread, cereal bar, biscuits, chips, cakes, candies, ice cream and soda, frozen pasta and pizzas, sausages, breaded chicken, fish strips, canned or dehydrated soups, infant formulas and baby foods. In the analysis, second group foods (PFCP) were grouped with MPF, as there were no trades that offered more foods from this group in comparison with the others.

Later, stores were classified as having greater availability of UPF or greater availability of MPF (MPF + PFCP), according to what types of food were predominantly offered.

### **Analyses**

A descriptive analysis of the stores was conducted, to verify their frequency in the regions, physical structure, categories, more frequent public and food groups offered in the different categories. The analyses of the offer of UPF and MPF in the different categories of stores in the three regions of the municipality of Santos, as well as the analysis of the mean distances of the stores in relation to the schools, were performed using the nonparametric Kruskal-Wallis statistical test. The post-hoc Tukey's test was performed when there was at least a statistically significant difference between the averages of the variables. The analysis of the distance of stores with a smaller or larger predominance of UPFs to the schools was performed by the nonparametric Mann-Whitney test. A significance level of 5% was used.

To assess the degree of agglomeration of the stores in the perimeters of schools maps of spatial distribution of points collected by GPS were prepared, using the Kernel density map. In this analysis, the stronger (dark) colors

represent a larger agglomeration of points in relation to the centroid (school) of the buffer.

The database was developed with the software Epi-Info version 3.4 and the statistical analyzes with Statistical Package for Social Sciences version 16. For the modeling of geographic information systems and the spatial analyses, the softwares Terraview 3.1.4 and ArcView 9.2 were used.

### **Results**

The study sample consisted of 82 stores in the vicinity of three public schools (kindergarten and elementary school). These food outlets were present in three regions assessed in the study. A higher percentage of stores were in Region 3 (51.2%) – which represents the central region of the municipality – than in other regions (Region 1 = 18.3%, Region 2 = 30.5 %). Regarding the physical properties of the stores, most of them had closed environment (81.7%) and were located at isolated (72%) and fixed points (85.4%). The public most often consisted of adults (78%) and elderly (37.8%), while children with and without guardians and adolescents with and without guardians represented, respectively, 8.5, 13.4, 8.5 and 13.4% of the public. The main categories of stores existing in the three assessed regions were the fresh food stands (30.5%), bakeries (15.9%) and butcher, fishmonger and poultry shops (14.6%). The categories candy store (6.1%), food retailing (9.8%), grocery store/shop (9.8%), supermarkets (6.1%), fresh pasta stores (1.2%), mini bombonieres (0%), convenience stores (2.4%) and "sacolão" (3.7%) were less present in the perimeters.

The food groups that made up the questionnaire are distributed in relation to the different types of stores in Table 1. The first type (butcher, fishmonger and poultry stores) had a higher availability of groups: unprocessed meats, processed meats, canned goods and eggs. As for the type 2 (candy store, fresh pasta store, food retailing, mini bombonieres, convenience stores) offered mostly the groups: beverages, biscuits with or without stuffing, chips and sweets. In contrast, the groups most prevalent in the type 3 stores (fresh food stands, "sacolão") were: fruits, roots and tubers, vegetables, cereal starches, eggs and other foods. Since type 4 groups food retailing, grocery stores/shops, bakeries and supermarkets, they offered most of the food groups, especially: beverages, biscuits with or without stuffing, cereal starches, sweets, canned foods.

In order to assess the degree of processing in the food available in the stores classified as food stores every UPF and MPF was counted. The aim was to see which group was more present and to assess the availability of food in areas close to schools.

The main types of stores assessed differ significantly ( $p < 0.001$ ) in relation to the offer of UPF and MPF (Table

2). Type 3 stores had a larger supply of MPF than type 1 ( $p < 0.05$ ), 2 ( $p < 0.001$ ) and 4 ( $p < 0.001$ ), since these were composed of fresh food stalls and "sacolão". UPFs were more present in type 4 stores ( $p < 0.001$ ), i.e., food retailing, grocery stores/shops, bakery and supermarkets, and in all type 2 stores.

In assessing the distribution of food in the three regions of the municipality it was found that region 3, despite having a lower socioeconomic level, showed a significantly higher ( $p < 0.01$ ) availability of MPF in comparison to region 2, that has a higher socioeconomic status. This result was due to the presence of a municipal market which had a large number of fresh food stands. UPFs were found more

frequently ( $p < 0.01$ ) in region 2. Region 1 also showed a significant frequency of UPF ( $p = 0.052$ ) when compared to MPF.

To assess students' access to food outlets, their distances in relation to the selected schools were measured. Food outlets located in Region 3 were significantly more distant from schools than those in region 1 ( $p < 0.001$ ) and region 2 ( $p < 0.05$ ) (Table 3). Moreover, outlets which offered mostly UPFs were significantly closer to the schools ( $p < 0.01$ ) than those who offered mostly less processed foods.

Although buffers around schools have a 500 meters radius, some stores were more distant, probably because

**Table 1 -** Offer of food groups in the different stores categories (municipality of Santos, Brazil, 2012)

Groups	Store types*			
	Type 1 n (%)	Type 2 n (%)	Type 3 n (%)	Type 4 n (%)
Beverages	4 (33.33)	7 (87.5)	2 (7.40)	32 (91.42)
Biscuits without stuffing	2 (16.66)	6 (75)	1 (3.70)	31 (88.57)
Biscuits with stuffing	2 (16.66)	6 (75)	1 (3.70)	28 (80)
Cakes	3 (25)	2 (25)	4 (7.40)	16 (45.71)
Cereals (ready)	1 (8.33)	0 (0)	0 (0)	18 (51.42)
Cereal starches	4 (33.33)	2 (25)	7 (25.92)	30 (85.71)
Cereal (whole grains)	2 (16.66)	2 (25)	3 (11.11)	23 (65.71)
Chips	3 (25)	7 (87.5)	1 (3.70)	23 (65.71)
Sweets	2 (16.66)	7 (87.5)	2 (7.40)	31 (88.57)
Processed desserts	0 (0)	3 (37.5)	1 (3.70)	23 (65.71)
Canned foods	7 (58.33)	3 (37.5)	5 (18.51)	31 (88.57)
Fruits	1 (8.33)	0 (0)	16 (59.25)	17 (48.57)
Vegetables	2 (16.66)	0 (0)	9 (33.33)	16 (45.71)
Legumes	3 (25)	1 (12.5)	3 (11.11)	25 (71.42)
Milk and dairy products	2 (16.66)	1 (12.5)	4 (7.40)	25 (71.42)
Pasta (ingredients)	4 (33.33)	2 (25)	4 (7.40)	28 (80)
Pasta (ready)	4 (33.33)	2 (25)	1 (3.70)	11 (31.42)
Oils and fats	5 (41.66)	1 (12.5)	3 (11.11)	19 (54.28)
Oilseeds and seeds	2 (16.66)	3 (37.5)	3 (11.11)	24 (68.57)
Eggs	6 (50)	1 (12.5)	5 (18.51)	26 (74.28)
Bread	1 (8.33)	1 (12.5)	1 (3.70)	24 (68.57)
Roots and tubers	2 (16.6)	1 (12.5)	10 (37.03)	17 (48.57)
Salty snacks (baked)	0 (0)	3 (37.5)	1 (3.70)	19 (54.28)
Salty snacks (fried)	0 (0)	2 (25)	1 (3.70)	15 (42.85)
Sandwiches	0 (0)	2 (25)	0 (0)	14 (40)
Other processed foods	6 (50)	3 (37.5)	7 (25.92)	30 (85.71)
Meats (unprocessed)	11 (91.66)	0 (0)	0 (0)	12 (34.28)
Meats (processed)	9 (75)	0 (0)	0 (0)	26 (74.28)
Fish (unprocessed)	1 (8.33)	0 (0)	4 (7.40)	9 (25.71)
Fish (processed)	3 (25)	1 (12.5)	2 (7.40)	18 (51.42)
Cheese (unprocessed)	5 (41.66)	0 (0)	2 (7.40)	25 (71.42)
Cheese (processed)	3 (25)	0 (0)	1 (8.33)	20 (57.14)

\* Type 1: butcher, fishmonger and poultry stores; type 2: candy store, fresh pasta store, food retailing, mini bombonieres, convenience stores; type 3: fresh food stand, "sacolão"; type 4: food retailing, grocery store/shop, bakery, supermarket.

**Table 2** - Offer of ultra processed foods and minimally processed foods in the different store categories and in the three assessed regions of the municipality of Santos (Santos, Brazil, 2012)

Variables	UPF n (%)	MPF n (%)	Total (%)
Types of store*			
1	4 (33.3)	8 (66.7) <sup>a</sup>	12 (100)
2	8 (100)	0 (0) <sup>b</sup>	8 (100)
3	1 (3.7)	26 (96.3) <sup>c</sup>	27 (100)
4	30 (85.7)	5 (14.3) <sup>b d</sup>	35 (100)
Regions of Santos			
1	10 (66.7)	5 <sup>a</sup> (33.3)	15 (100)
2	19 (76)	6 <sup>a</sup> (24)	25 (100)
3	14 (33.3)	28 <sup>b</sup> (66.7)	42 (100)
Total	43 (52.4)	39 (47.6)	82 (100)

UPF = ultra processed foods; MPF = minimally processed foods. Different letters represent significant differences ( $p < 0.001$ ; except type 1 x type 3,  $p < 0.05$ ).

\* Type 1: butcher, fishmonger and poultry stores; type 2: candy store, fresh pasta store, food retailing, mini bombonieres, convenience stores; type 3: fresh food stand, "sacolão"; type 4: food retailing, grocery store/shop, bakery, supermarket.

of some degree of inaccuracy in the data collection instrument (Table 3).

In relation to the intensity of stores around schools located in region 1 and region 3 of the municipality of Santos, it was noticeable that, although the latter has a larger number of stores that offer MPF, these were not much aggregated around the school (Figure 1). In region 1 and region 2, despite the higher aggregation of stores around schools, the degree of agglomeration for the UPF group was higher compared to the minimally processed group.

## Discussion

There was a higher number of stores in the central region of the municipality (region 3) of Santos, Brazil, when compared to regions 1 and 2. This fact can be explained by the commercial importance of the region. Although there is a higher supply of MPF in Region 3 due to the presence of a municipal market, it was noticeable that stores that offered mostly MPF were less agglomerated around schools than those that offered mostly UPF. In regions 1 and 2 there was a greater aggregation of stores that offered most of their food classified as ultra processed closer and around the school.

Although the cost of food is an important barrier to food consumption, the location of stores can prevent individuals from having a healthy nutrition.<sup>19</sup> This analysis is consistent with what was observed in the present study, since it was found a different percentage of stores that offered more or less UPF in the three assessed regions.

Most research on childhood obesity has focused on investigating the school environment, assessing the availability of food in canteens and in the meals provided by the school. However, one must consider the students' exposure to the food environment around schools during periods of arrival and departure, because many children go to school by foot or driving bicycles.<sup>20</sup>

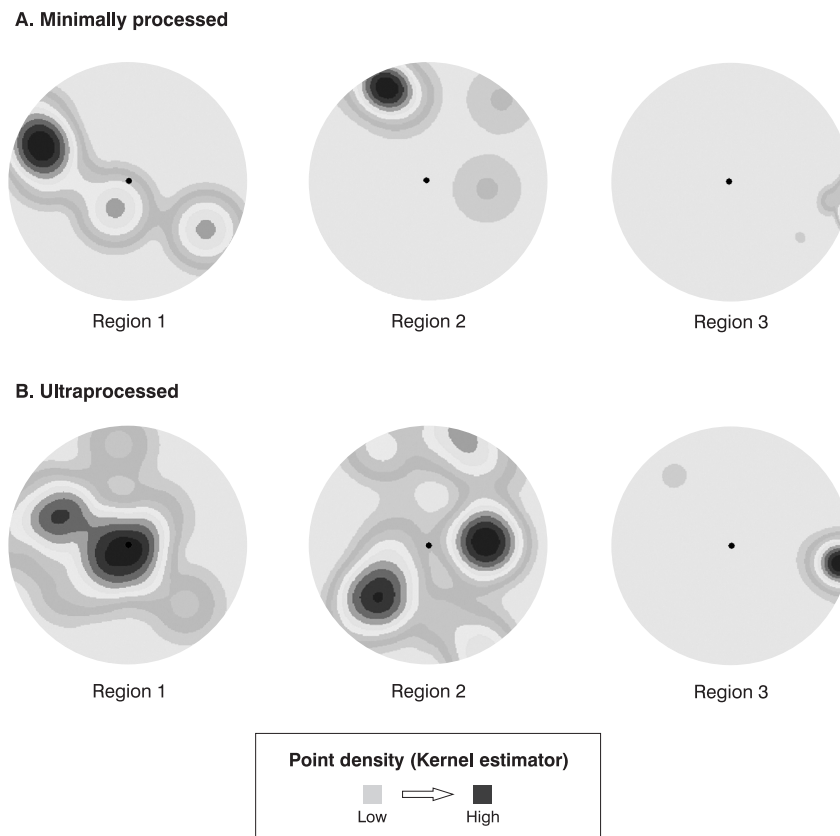
A study that assessed the provision of snack options at corner stores located around three public schools in Philadelphia, United States, found that the majority of options (over 95%) was composed of highly processed foods and that they differed greatly between the regions investigated. The authors point out as important factors for this difference the preferences of local consumers – which can differ from one area to another – and the business priorities of the food industries, which are located strategically in certain regions.<sup>21</sup> A similar result was observed in Chicago, where a study showed a great concentration of fast food restaurants in areas close to

**Table 3** - Analysis of stores distance in relation to the schools in the three regions of the municipality of Santos (Santos, Brazil, 2012)

Distance (m)	Average	Median	SD	Minimum	Maximum
Region					
1	288.03 <sup>b</sup>	295.18	133.10	69.52	495.04
2	369.65 <sup>b</sup>	373.20	125.80	118.48	587.91
3	445.66 <sup>a</sup>	487.87	94.17	58.35	517.36
Stores					
Higher UPF availability	345.33 <sup>a</sup>	367.65	142.44	58.35	587.91
Higher MPF availability	437.15 <sup>b</sup>	468.29	87.02	207.29	517.36

SD = standard deviation; UPF = ultra processed foods; MPF = minimally processed foods.

Different letters represent significant differences ( $p < 0.05$  for distances between regions and  $p < 0.01$  for distances between stores more or less processed).



**Figure 1 -** Assessment of the agglomeration of stores with a predominance of ultraprocessed and minimally processed foods in the three regions of the municipality of Santos (Santos, Brazil, 2012)

schools, with 78% of schools having at least one such store at a distance of 800 meters.<sup>22</sup>

Although the majority of stores in this study have a fixed physical structure, approximately 15% of the assessed stores were mobile. A study that assessed the number of such stores around primary and secondary schools in Oakland showed the presence of about five vendors (mobile food stores) around each school, which offered foods like ice cream, fruit and vegetables, scratch, tacos, hot dogs, churros and roasted corn.<sup>20</sup> Researching type of outlet is important, since they typically are very close to schools and offer mostly high energy density foods low in nutrients.

A study of the vicinity of 10 schools in Philadelphia assessed the contribution of corner shop purchases in energy intake among children from the 4th to 6th grade. The results showed that children who participated in the study

acquired an average of 356 kcal per purchase, reaching 712 kcal/day and 3,560 kcal/week for children who bought items in these shops twice daily for 5 days a week. The most popular foods were low cost ones, with high energy density and low nutrition value.<sup>23</sup>

The main limitations of this study are the assessment of only three school perimeters – due, among other factors, to some adjustments that had to be performed on the instrument used for field data collection – and the classification of stores based on the predominance of food classified as ultra processed or minimally processed, though often both groups exist on the store. Moreover, it is possible that the number of stores with a mobile physical structure is underestimated, because it was not always possible to collect data in the periods of arrival and departure of children from school, when the concentration of this type of trade is higher.



The data in this study show that children who attend the three assessed public schools are exposed to an environment that encourages the consumption of highly processed foods through easier access in the investigated stores.

This shows the importance of developing interventions targeted directly to children through nutrition education in schools, of encouraging store owners to offer healthier food items, and of government policies that promote the location of stores that offer healthier foods in the vicinity of schools.

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### Correspondence:

Paula Andrea Martins  
Av. Ana Costa, 95  
CEP 11060-001 - Santos, SP - Brazil  
Tel.: +55 (13) 3787.3700, ramal 3796  
E-mail: paula.andrea.martins@gmail.com