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Food environment at subway stations: a study in the municipality of São Paulo, Brazil

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Abstract *This study aimed to characterize the food environment within subway stations in São Paulo and describe the availability of food and drinks according to the social vulnerability of the area where the stations are located. A cross-sectional study was carried out involving 19 subway stations, and checklist instruments were used to audit outlets and vending machines. The São Paulo Social Vulnerability Index was adopted to characterize the location of the stations. Sixty-six outlets were found. The median of outlets per station was the same in all categories of the territory's social vulnerability (median=2 establishments/station). The most frequent types of food sold were convenience foods, present in all of the outlets. The territory's vulnerability did not result in a difference in the availability of healthy and unhealthy marker foods. The food environment at subway stations is marked by the high availability of ultra-processed food and drinks at all outlets.*

Key words *Food Supply, Social vulnerability, Nutritional Policy, Diet, food and nutrition, Environment*

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Introduction

In the 1980s, the onset of an intense development of food processing and increased supply and access to "practical" foods (the so-called ultra-processed foods) evidenced that the urban environment leads to higher energy intake and individual diet and lifestyle change[1-4].

In Brazil, food outside the home is increasingly frequent. The first results of the 2017 Household Budget Survey (POF) show that almost a third (32.8%) of the total food expenses of Brazilian households are exclusively geared to meals outside the home. This result points to an increase of 8.7 percentage points in the weight of this expenditure, between 2002-2003 and 2017-2018. The types of food most consumed in this latest survey have not yet been disclosed, but the previous POF (2008-2009) pointed out that, despite an expected growing trend, the quality of food consumed outside the home is of concern, especially among the population that resides in urban areas. The most consumed items are those commonly characterized by high energy density and reduced nutritional content, such as snacks, pizza, soft drinks, and sandwiches[5,6].

The right to access adequate food is among the social rights, included in Article 6 of the Brazilian Constitution, and is a basic human right[7]. The full realization of this right and, consequently, assurance of Food and Nutrition Security for the Brazilian population, is required under Law N° 11.346 of September 15, 2006[8]:

[...] regular and permanent access to quality food, in sufficient quantity, without compromising access to other essential needs, based on health-promoting food practices that respect cultural diversity and are environmentally, culturally, economically, and socially sustainable[8](p.01).

This concept gathers issues related to the production and availability of food, access, and commitment to health promotion, connecting the socioeconomic focus with health and nutrition[9]. Although efforts to reduce hunger and misery deserve to be highlighted, issues related to the quality of food consumed by the Brazilians still require special attention. Data from national surveys show the continuous advance of household availability of ultra-processed foods[10]. This finding is of concern since the increased share of these foods results in worse quality eating, with a more significant amount of saturated fat, trans fat, sugar and a lower supply of micronutrients[11].

In this context, it is crucial to understand how the food environment can affect people's food and health, as it refers to the "physical, economic, political, and sociocultural context in which consumers interact with the food system to acquire, prepare and consume food"[12].

It is known that adherence to healthy eating practices is harder in unfavorable environments – where healthy foods, such as fresh or minimally processed foods and preparations based on them are not sold, or the availability of these foods occurs on a smaller scale compared to the availability unhealthy foods, such as ultra-processed foods, the so-called "obesogenic" environments[13]. Thus, the environment encourages the consumption of ultra-processed and low-nutritious foods and discourages the consumption of foods considered healthy by combining aspects related to the availability and cost of these foods[14]. Recently, the term "food marshes" has also been used in the literature to describe urban areas with an excess of establishments selling unhealthy foods compared to those selling healthy foods[15]. Evidence shows that socioeconomically most impoverished regions have lower availability of healthy foods, such as fruits and vegetables[16,17].

The impact of the food environment on food is not restricted to what is available around the homes and workplaces of individuals[18-21] and the traveling routes adopted daily, which started to be considered a few years ago[22,23]. A study carried out in São Paulo found that areas with higher people flow, such as bus terminals, train and subway stations, have a higher density of restaurants, bars, and snack bars[24]. Despite this, studies addressing the relationship between food outside the home and the food environment of bus, train and subway stations and terminals[25,26] are still scarce.

The flow of people in several means of public transport is on the rise in the metropolitan region of São Paulo. These means, mainly subway stations, contribute to people traveling to different city regions, even the remotest ones. Approximately 4 million people travel on them every day. Their profile reveals that the use of long-distance transport means (with a mean duration of one hour), at peak hours (in the morning, between 5 am and 8 am, mid-day at around noon, and evening, between 4 pm and 7 pm), and users' final destination is work or school/university[27].

Sizeable commercial food exploitation is known to occur in these spaces, such as kiosks, snack bars, stores, and vending machines, so users of this equipment can employ the time spent commuting to eat. Thus, it is necessary to carry out studies that assess what is available in this

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scenario not yet explored by the Brazilian literature on the food environment to identify possible impacts on people's health.

In this sense, this study aimed to characterize the food environment within subway stations in São Paulo and describe the availability of food and drinks according to the social vulnerability of the territory where the stations are located.

Methods

This is a cross-sectional study on 19 subway stations located in the municipality of São Paulo, administered exclusively by the Government of the State of São Paulo, distributed between lines 1-Blue (Tucuruvi, Jabaquara, Luz, Sé, Paraíso and Ana Rosa), 2-Green (Vila Madalena, Vila Prudente, Consolação, Paraíso, Ana Rosa and Tamanduateí), 3-Red (Palmeiras-Barra Funda, Corinthians-Itaquera, República, Sé, Brás and Tatuapé), 5-Lilac (Capão Redondo, Adolfo Pinheiro and Santo Amaro) and 15-Silver (Vila Prudente and Oratório). The criterion for selecting the stations was to consider the busiest in São Paulo, which are: 1) the terminal stations of each line (first and last) or 2) the stations interconnecting with other lines of the São Paulo Metropolitan Company (Subway) or trains of the São Paulo Metropolitan Trains Company (CPTM).

Data were collected by three trained researchers in the first semester of 2017. Worth noting is that the stations launched after the data collection period were not included in the study.

We employed the instrument developed by the Collaborative Group for Studies on the University Food Environment (CALU)[28] to analyze of the food environment, which is a checklist addressing the following domains: characterization of the establishment (type, location, opening hours, peak visiting hours, payment method), availability, variety (brand, type of packaging, volume, weight) and price of food and beverages, nutritional information and advertisements referring to healthy and unhealthy food markers, based on foods commonly found at universities (where the instrument was developed). The definition of these markers by CALU was based on evidence about the association between food consumption and the protection against or occurrence of chronic diseases already mentioned in the literature[11,29,30], collecting, for example, a vast list of ultra-processed items. The instrument's reliability was assessed, and, considering the adjusted kappa, the interobserver and test-retest tests showed that 93% of the items showed substantial or almost perfect agreement. All of the items evaluated through percentage agreement show substantial or almost perfect agreement for the interobserver test and the test-retest tests[28].

While this instrument was developed to assess the university food environment, it contains some items that can be sold in snack bars, coffee shops and sweet stores at subway stations, such as sandwiches, salty pastry, sandwich cookies, snacks, soft drinks, among others, besides those found at restaurants.

In dialogue with the Brazilian Population Food Guide[29], considering the food items of the instrument[28] and those available in the stations studied, the following were considered healthy markers in this study: fresh fruits, mineral water and natural fruit juice (fresh food or drinks). The unhealthy markers were convenience items (such as sweet and savory cookies without filling, sandwich cookies, snacks, chocolates, sugary drinks), sandwiches, fried or baked salty pastry, and sweetened refreshments in containers (ultra-processed foods or drinks).

Vending machines were also found at the stations, and the instrument previously presented does not include the assessment of this food trade category. Thus, the vending machines were analyzed through the use of a checklist prepared by the authors of this study, which included mainly the sweets stores' items found in the instrument developed by the CALU. Vending machine data were presented descriptively (characteristics of the machines), by type (healthy or unhealthy), variety (brand, type of packaging, volume, weight) and price of food and beverages sold, as well as payment method available and presence of advertisements and discounts.

All stations selected for the study were visited [paid area of the station (after the turnstile and on the transfer paths); unpaid area of the station (before the turnstile and in free spaces), and boarding area (platforms)]. All formal outlets in areas belonging to the São Paulo Subway were audited. Outlets in the territories of Via Quatro, CPTM, Bus Stations, Municipal and Intermunicipal Bus Terminals, and informal trade (carried out by street vendors inside train cars) were not audited.

The food outlets audited were grouped into the following categories, established in the instrument used[28], per type of food predominantly sold: snack bar (primarily snacks (sandwiches and fried and baked salty pastry) and candy items

(treats, sweets, ultra-processed drinks)), coffee shop (coffees and other drinks and, eventually, quick-consumption foods), sweet store (sweets, candies, chewing gum, chocolates, soft drinks, juices, treats in general, and ice cream). Besides these, the vending machine category (food and drink self-service vending machines) was created for this study.

A territorial social vulnerability indicator, namely the São Paulo Social Vulnerability Index (IPVS), was created by the SEADE Foundation based on data from the census sectors from the 2010 São Paulo Census[31] and used to characterize the geographical areas of subway stations, which consists of types of situations of exposure to vulnerability, aggregating income, education, and demographic variable indicators. The categories employed were "extremely low vulnerability" (IPVS 1), "very low vulnerability" (IPVS 2), and "low vulnerability" (IPVS 3). The IPVS of the territories where stations were located were obtained by calculating the mean IPVS of the census tracts underpinning each district[32].

As for data analysis, the distribution of the types of outlets in the evaluated subway stations (absolute and relative frequency and density of establishments – number of establishments/1,000 users) and their characteristics (location, day/opening hours, peak hours, payment method, on-site consumption structure), and availability and price indicators for food and beverages, nutritional information and advertisements were described. Moreover, the availability of food and beverage considered markers of healthy and unhealthy food was described as per the IPVS. Thus, the relative and absolute frequencies, means, and medians were calculated. The comparison of food and beverage availability according to the territory's social vulnerability was evaluated using the Kruskal-Wallis test.

The collected data were entered using the Epi InfoTM 7 program (Centers for Disease Control and Prevention, Atlanta, USA). The database was then transferred to the SPSS statistical package (IBM, New York, USA) for data editing. The software Stata SE 14.2 was used in the data analysis.

Results

Sixty-six outlets were found in the 19 subway stations evaluated, and Brás and Sé stations had the most significant number of establishments. Vila Madalena and Tucuruvi had the lowest number of establishments among the stations with outlets. Adolfo Pinheiro, Capão Redondo, Oratório, Santo Amaro, and Vila Prudente stations did not have any food or beverage outlets.

The sweet store category had the highest proportion (n=32; 48.5%), followed by vending machine (n=21; 31.8%). Most sweet stores and snack bars were found at Brás station (28.1% and 50.0%, respectively), vending machines at Sé station (28.6%) and coffee shops distributed at Brás, Luz and República stations (33.3% each). Considering the distribution of establishments as per the IPVS, we observed that the median of outlets per station was the same in all IPVS categories. The number of outlets at the stations is not apparently related to the number of passengers transiting through them (Table 1).

Regarding the location of outlets at stations, 77.3% (23 sweet stores, 18 vending machines, eight snack bars, and two coffee shops) were found in the station's paid/transfer area. In the case of interconnected stations (after the turnstile), 22.7% (9 sweet stores, three vending machines, two snack bars, and one coffee shop) were in the station's unpaid area (before the turnstile or free area) and 6.1% (3 sweet stores and one vending machine) in the boarding area (platform).

All food outlets were open from Monday through Friday. Weekends and holidays had different dynamics (but at least one in each station worked). Thus, the distribution of opening hours was: 74.2% worked every day, 19.7% Monday through Saturday, 4.5% Monday through Friday, and 1.5% Sunday through Friday. We clarify that the opening hours of the stations studied are Sunday through Friday from 04:40 to 00:00 and on Saturdays from 04:40 to 1:00 of Sunday. The opening hours of food outlets found are from 06:00 to 23:00, and staff affirmed that they were more visited in the late afternoon/early evening.

As for the payment methods available to customers at the food outlets found, cash was accepted in full (100%), followed by debit (69.7%) and credit card (60.6%). Meal vouchers were the least frequent (18.2%), but the acceptance of this payment method stands out, including in two sweet stores.

Only 10 establishments offered a structure such as a table and counter for on-site food consumption, representing 22.2% of the total establishments (n=45, excluding vending machines). When considering each type of establishment alone, all coffee shops (n=3), 60% (n=6) of snack bars, and 3.1% (n=1) of sweet stores also had that same structure.

Table 1. Absolute and relative frequency (%) of the types of outlets available at subway stations in São Paulo. São Paulo, Brazil, 2017.

Mean district IPVS groups/ Station	Total	Type of outlet				Mean N of daily users[a]	Density (Number of establishments /1000 users)
		Sweets store	Vending machine	Snack bar	Coffee shop		
	N	N (%)	N (%)	N (%)	N (%)		
Group of stations located in the IPVS districts 1[b]							
Ana Rosa	5	2 (40.0)	3 (60.0)	0 (0.0)	0 (0.0)	45,000	0.11
Barra Funda	4	4 (100.0)	0 (00.0)	0 (0.0)	0 (0.0)	204,000	0.02
Consolação	4	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)	134,000	0.03
Paraíso	2	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	44,000	0.05
Vila Madalena	1	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	27,000	0.04
Adolfo Pinheiro	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10,000	0.00
Santo Amaro	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	86,000	0.00
Total	16	9 (56.2)	7 (43.8)	0 (0.0)	0 (0.0)	550,000	0.03
Mean	2.3	1.3	1.0	0.0	0.0	78,571	0.04
Median	2.0	1.0	0.0	0.0	0.0	45,000	0.03
Group of stations located in the IPVS districts 2[c]							
Brás	16	9 (56.3)	1 (6.3)	5 (31.3)	1 (6.3)	96,000	0.17
Luz	6	1 (16.7)	3 (50.0)	1 (16.7)	1 (16.7)	169,000	0.04
República	4	2 (50.0)	1 (25.0)	0 (0.0)	1 (25.0)	157,000	0.03
Tatuapé	3	0 (0.0)	2 (66.7)	1 (33.3)	0 (0.0)	93,000	0.03
Jabaquara	2	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	92,000	0.02
Tamanduateí	2	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	59,000	0.03
Tucuruvi	1	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	70,000	0.01
Oratório	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4,000	0.00
Vila Prudente	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	44,000	0.00
Total	34	16 (47.1)	8 (23.5)	7 (20.1)	3 (8.8)	740,000	0.05
Mean	3.8	1.8	0.9	0.8	0.3	87,111	0.04
Median	2.0	1.0	1.0	0.0	0.0	92,000	0.03
Group of stations located in the IPVS districts 3[d]							
Sé	14	5 (35.7)	6 (42.9)	3 (21.4)	0 (00.0)	78,000	0.18
Itaquera	2	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	96,000	0.02
Capão Redondo	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	74,000	0.00
Total	16	7 (43.8)	6 (37.5)	3 (18.8)	0 (0.0)	248,000	0.06
Mean	5.3	2.3	2.0	1.0	0.0	82,667	0.07
Median	2.0	2.0	0.0	0.0	0.0	78,000	0.02
Total	66	32 (48.5)	21 (31.8)	10 (15.1)	3 (4.5)	1,582,000	0.04

[a]Mean number of entries of passengers on weekdays in 2016 (year in which the stations for data collection were chosen), with rounding (source: http://www.metro.sp.gov.br/metro/numeros-pesquisa/demanda.aspx, access in January 2017); bGroup 1: extremely low vulnerability, [c]Group 2: very low vulnerability, [d]Group 3: low vulnerability.

Source: Elaborated by the authors.

The information available to customers at food outlets were prices and menus. Prices were shown individually (in the product itself) or in Banner/Totem/TV. Only one sweet store and one snack bar did not provide this type of information. The menus presented in Banner/Totem/TV were found in 70% of snack bars and all coffee shops. No nutritional information was found in any of the 66 outlets.

The most frequent food type sold were convenience foods. It is noteworthy that their presence was not attributed only to sweet stores but also in all vending machines, snack bars, and coffee shops. Thus, this type of product was found in

all (n=66) the food outlets studied. In most cases (75.6%), these foods were displayed close to the payment counter.

As for the convenience items sold, there was a wide variety of candies and chocolate bars, with up to 134 types found in the same establishment and representing a mean of 24.1 types/establishment. Concerning packaged snacks or crackers without filling, up to 55 different types were found in the same establishment, with a mean of 15.1 types/establishment.

Regarding ultra-processed drinks, soft drinks can be highlighted, with 24 types found in a single establishment and a mean of 8.1 types/establishment. Packaged snacks or crackers without filling, candies and chocolate bars, and soft drinks were available at more than half of the food outlets found (51.5%, 53.0%, and 60.6%, respectively). It is noteworthy that alcoholic beverages cannot be sold within stations, and thus were not found.

When observing the convenience items sold concerning the social vulnerability of the stations' territory, more than 80% of the establishments sold at least one type of unhealthy food and at least 50% of the establishments sold ultra-processed drinks, without statistically significant difference concerning the IPVS (Table 2).

While the availability of convenience items is the most frequent in stations, other foods and beverages are also sold. As healthy markers, fruits (Brás and Tatuapé stations) were found in 10% of snack bars and 4.8% of vending machines. Vegetables were only available as part of preparations. In this case, sandwiches (which in this study were considered unhealthy markers) were found in 50% of snack bars (Brás, Tatuapé, and Sé stations). Among the healthy drinks' options, only mineral water (in all stations, except in Tucuruvi) and natural fruit juice (in Brás station) were found. Mineral water was found in all coffee shops, 85.7% of vending machines, 80% of snack bars, and 40.6% of sweet stores. Natural fruit juices were found in 20% of snack bars. Sandwiches (Sé, Luz, Tatuapé, Brás, and República stations), fried and baked salty pastry (Sé, Luz, Tatuapé, Brás, and República stations) and sweetened refreshments in containers (located at Luz and Tatuapé, Brás, Sé, and República stations) were found as unhealthy markers. Sandwiches were present in 70% of snack bars, 66.7% of coffee shops and 9.5% of vending machines; fried and baked salty pastry were found in all of the coffee shops and 90.0% of snack bars; and refreshments were found in all of the coffee shops and 60% of snack bars.

The vulnerability of the territory did not result in a difference in the availability of healthy and unhealthy markers. However, it is worth mentioning the stations located in districts with IPVS of group 1 with extremely low vulnerability (Ana Rosa, Barra Funda, Consolação, Paraíso, Vila Madalena, Adolfo Pinheiro, and Santo Amaro) which, sold only one (mineral water) of all markers of healthy and unhealthy food and drinks (Table 3).

Regarding the prices charged by the establishments, the lowest price of the food items found was recorded. Noteworthy are the 20-50 g bags of sweet treats (candies, bonbons or chocolate bars, chocolate truffle, cake, and gingerbread) sold for R$ 0.10 (found in a sweet store at Jabaquara station); 15-30 g bags of sandwich cookies sold for R$ 0.75 (found in a sweet store at Paraíso station); energy drinks sold for R$ 3.50 (found in a sweet store at Barra Funda station); and 350 ml soft drinks sold for R$ 2.00 (found in six vending machines distributed at Barra Funda, Brás Luz, República and Sé stations). Among healthy foods and drinks found, the 150-200 g fruit or fruit salad sold for R$ 2.00 (found in a vending machine at the Tatuapé station); 300 ml natural fruit and pulp juice sold for R$ 3.00 (found in a snack bar at Brás station); and 510 ml mineral water sold for R$ 2.00 (found in four sweet stores distributed in Brás, Itaquera, and República stations; in four snack bars distributed in Brás, Sé and Tatuapé stations, and in five vending machines distributed in Brás, Luz, República and Sé stations) stand out.

Discussion

This study stands out for being the first to characterize the food environment within a means of public transportation in a Brazilian metropolis. The results revealed the low nutritional quality of foods most sold at the stations, regardless of their territory's social vulnerability, and alert to a potentially adverse effect on the food quality of people using this service.

The new daily life consumption patterns resulting from the process of increasing urbanization, which reduces the time dedicated to meals and how they take place, arouse interest in the use of other city spaces, in this case, subway stations, as places that provide an edge to consumers over the metropolis time: food is available right there, there is no need to go out to access it, and they can be consumed in transit. This is

Table 2. Absolute and relative frequency (%) of convenience items available at outlets in subway stations in the city of São Paulo, according to the social vulnerability of the territory. São Paulo, Brazil, 2017.

Convenience items (including sweets store)	Frequency of outlets						P-value[d]
	Stations located in group 1 of IPVS[a]		Stations located in group 2 of IPVS[b]		Stations located in group 3 of IPVS[c]		
	N	%	N	%	N	%	
Foods							
Candy and chocolate bar	9	50.0	18	50.0	8	47.1	0.940
Packet snack or cracker without filling	10	55.6	17	47.2	7	41.2	0.556
Sandwich cookies	10	55.6	17	47.2	5	29.4	0.208
Other sweets*	10	55.6	15	41.7	5	29.4	0.207
Candy	4	22.2	14	38.9	4	23.5	0.385
Other items**	7	38.9	11	30.6	3	17.6	0.320
Cereal bars	5	27.8	10	27.8	4	23.5	0.922
Cookies without filling	7	38.9	9	25.0	2	11.8	0.142
Whole Grain Crackers and Cookies	4	22.2	7	19.4	2	11.8	0.666
Breakfast cereal	0	0.0	2	5.6	0	0.0	0.385
Beverages							
Soft drinks	8	44.4	23	63.9	9	52.9	0.458
Flavored milk/milk drink/mixed milk and fruit drink	7	38.9	18	50.0	4	23.5	0.183
Fruit juice or fruit nectar-based drinks	6	33.3	16	44.4	6	35.3	0.738
Guarana refreshment	3	16.7	13	36.1	2	11.8	0.114
Isotonic drinks	1	5.6	7	19.4	0	0.0	0.085
Ready-to-drink tea	0	0.0	6	16.7	1	5.9	0.140
Energy drinks	0	0.0	6	16.7	0	0.0	0.047
Soy-based beverages	1	5.6	3	8.3	0	0.0	0.480
Alcoholic beverages	0	0.0	0	0.0	0	0.0	-

*Gingerbread, cake, chocolate truffle; **Other unhealthy marker foods found: panettone, protein bar, dried banana bar with chocolate. [a]Group 1: extremely low vulnerability; [b]Group 2: very low vulnerability; [c]Group 3: low vulnerability; [d] P-value according to the Kruskal-Wallis test.

Source: Elaborated by the authors.

due to the commuting time, averaging one hour, between home and work (or activities outside the home in general), of São Paulo city residents[27].

A study carried out in a metropolitan public transport company in the city of Lima, Peru, evaluated the types of food sold by street vendors and showed that ultra-processed foods were offered by 75.0% of them and, among these foods, sweets had a higher frequency (49.3%)[33].

Concerning vending machines, at the train stations in Sydney, Australia, 206 vending machines were identified and 84% of them were supplied with ultra-processed food and beverages, the most frequent items being snacks (33.0%), soft drinks (18.0%), chocolate (12.0%) and other sweets (10.0%). Also, this study found that stations in low and medium socioeconomic status areas had a higher number of vending machines than stations in higher-income areas, but the latter had a higher number of unhealthy items per machine[26].

The widespread availability of unhealthy foods in Lima and Sydney was the same as found in our study. However, the social vulnerability of the territory in which the metro stations were located did not result in a difference in the types of food and drinks sold at the stations. Notwithstanding this, differences in the availability of healthy and unhealthy foods will likely be found around the stations.

In São Paulo, a study on the community food environment shows that areas of higher socioeconomic status had greater availability of establishments selling healthy foods, while those that were poorer had greater availability of fast-food type restaurants[16]. In this sense, considering that

Table 3. Absolute and relative frequency (%) of food and beverages not considered as convenience items available at outlets in subway stations in the city of São Paulo, according to the social vulnerability of the territory. São Paulo, Brazil, 2017.

Food items not considered as convenience	Frequency at outlets						p-value[d]
	Stations located in group 1 of IPVS[a]		Stations located in group 2 of IPVS[b]		Stations located in group 3 of IPVS[c]		
	N	%	N	%	N	%	
Healthy food and beverage markers							
Fresh fruits	0	0.0	2	5.6	0	0.0	0.385
Mineral water	9	50.0	22	61.1	10	58.8	0.849
Natural fruit juice	0	0.0	2	5.6	0	0.0	0.385
Unhealthy food and beverage markers							
Sandwiches	0	0.0	9	25.0	2	11.8	0.080
Fried or baked salty pastry	0	0.0	9	25.0	3	17.6	0.059
Sweetened refreshments in containers	0	0.0	[8e]	22.2	[1b]	5.9	0.049

[a]Group 1: extremely low vulnerability; [b]Group 2: very low vulnerability, [c]Group 3: low vulnerability; [d]P-value according to the Kruskal-Wallis test; [e]Total n=45 (excluding vending machines).

Source: Elaborated by the authors.

the low-income population is already more exposed to unhealthy food in the territory, it would be even more relevant to regulate what is being sold at stations to promote healthy eating.

However, it is up to the merchant to define what will be sold at the stations' outlets, with no interference from the São Paulo Metropolitan Company. The contract and the concession of the internal areas of the stations for the installation of food stores only require the Municipal Health Surveillance Register to ensure the hygiene and health food quality, but it does not mention the quality from the viewpoint of what types of food should be sold or what kind of environment users should be exposed to[34].

Concerning prices, unhealthy foods had a better possibility of purchase due to their low cost. Therefore, besides greater physical access to these products, due to greater availability at stations, subway users also had greater financial access to them. The low cost of ultra-processed foods, with high energy density (high levels of fats and sugars) and low in nutrients and fibers, is a consequence of a combination of factors, such as technological improvement, the food industry's expanded production capacity, the use of food ingredients and additives that generate negligible costs and people increased demand for these types of foods[1,35-37].

It is also important to argue that the highest purchase frequency was during the period when workers generally have completed their commitments or night shift students are going to schools and colleges. Although few commercial outlets provide an on-site consumption structure, there is a "convenience" of not having to leave the station to purchase the food offered, since most food outlets were present in the area beyond the turnstile, allowing users to make their purchases throughout their journey, even in their possible transfers to other lines of the Subway Company and CPTM.

We also highlight the possibility of using meal vouchers in coffee shops, snack bars, and sweet stores located in the stations. Meal vouchers are a benefit given to employees, per the legislation that regulates the Workers' Food Program (PAT)[38,39], and this benefit allows small companies to participate in the PAT, even when they are unable to have complex structures such as restaurants within the work environment.

It is crucial to have greater control over the food types sold at outlets that accept these benefits to ensure at least one healthy meal (considering the days worked in the month) and the adequate coverage of the portion of more impoverished and rural workers[40]. While this payment method is used in only 18.2% of the outlets found, the fact that the sweet stores accept meal vouchers further contributes to the high consumption of ultra-processed foods, mainly due to high availability and low cost.

Some limitations must be considered despite the innovative character of this study. Because it is a convenience sample, restricted to a city in the country, its external validity is bounded. Moreover, while one of the instruments used includes dimensions of the food environment and food and beverage markers available at subway stations, this tool was developed for the university context. Data concerning the informal sale of food within wagons were not collected.

The development of the checklist was necessary to accurately evaluate the vending machines, as no specific Brazilian instruments were found for their audit, and the instruments found in the international literature did not meet what this study aimed to investigate[26,41]. An American instrument[41], for example, considers ultra-processed diet soda as a healthy option, and an Australian instrument[25] classifies foods/drinks as healthy or unhealthy just using the calorie per serving criterion, which was also not aligned with the reference used in this study.

No details on the ingredients of sandwiches and fried or baked salty pastry were collected. These could be fresh food-based culinary preparations, but they were classified as ultra-processed in this study because they often use ultra-processed foods and ingredients not available in domestic kitchens in their preparation.

The last question concerns data collection that took place in one of the semesters of the year. The availability of items at different times is not known. However, considering the massive availability of ultra-processed foods, it is believed that there is no seasonal variation.

The government can use our results to formulate interventions, public policies, and regulations, which consider the realization of the human right to adequate food for the population using this public service-providing equipment.

Conclusion

This study revealed that subway stations' food environment is marked by the availability and greater financial accessibility to ultra-processed foods, which may have an unfavorable influence on the daily diet of millions of people in the greater São Paulo. The most prevalent establishments were sweet stores and vending machines, whose characteristic is the almost exclusive sale of ultra-processed foods and drinks. The widespread presence of these types of foods and beverages was also observed in all outlets found, with a low presence of healthier items, such as fresh or minimally processed foods, without variation according to the IPVS.

The excessive availability of low-priced ultra-processed foods in closed spaces and the constant traffic of people could be an essential obstacle to the autonomy for healthy food choices and the assurance of Food and Nutrition Security for subway users, adversely interfering in the consumer's health.

Collaborations

All authors contributed to the study design, data analysis, paper writing, and final review. All authors approved the final version of the paper.

References

1. Monteiro CA, Moubarac J-C, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obes Rev* 2013; 14(2):21-28.
2. Ortigoza SAG. *O tempo e o espaço da alimentação no centro da metrópole paulista* [tese]. Rio Claro: Universidade Estadual Paulista; 2001.
3. Popkin BM. Global nutrition dynamics: the world is shifiting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006; 84(2):289-298.
4. Swinburn BA, Sacks G, Hall KD, McPherson K, Finegood DT, Moodie ML, Gortmaker SL. The global obesity pandemic: shaped by global drivers and local environments. *Lancet* 2011; 378(9793):804-814.
5. Instituto Brasileiro de Geografia e Estatística (IBGE). *POF 2017-2018: Primeiros Resultados*. Rio de Janeiro: IBGE; 2019.
6. Instituto Brasileiro de Geografia e Estatística (IBGE). *POF 2008-2009: Análise do Consumo Alimentar Pessoal no Brasil*. Rio de Janeiro: IBGE; 2011.
7. Brasil. Emenda Constitucional nº 64, de 4 de fevereiro de 2010. Altera o art. 6º da Constituição Federal, para introduzir a alimentação como direito social. *Diário Oficial da União* 2010; 4 fev.
8. Brasil. Lei nº 11.346, de 15 de Setembro de 2006. Cria o Sistema Nacional de Segurança Alimentar e Nutricional – SISAN com vistas a assegurar o direito humano à alimentação adequada, institui a Política Nacional de Segurança Alimentar e Nutricional – PNSAN, estabelece os parâmetros para a elaboração do Plano Nacional de Segurança Alimentar e Nutricional, e dá outras providências. *Diário Oficial da União* 2006; 18 set.
9. Brasil. Ministério da Saúde (MS). *Política Nacional de Alimentação e Nutrição*. Brasília: MS; 2012.
10. Martins APB, Levy RB, Claro RM, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). *Rev Saude Publica* 2013; 47(4):656-665.
11. Louzada MLC, Baraldi LG, Steele EM, Martins AP, Canella DS, Moubarac JC, Levy RB, Cannon G, Afshin A, Imamura F, Mozaffarian D. Consumption of ultra -processed foods and obesity in Brazilian adolescents and adults. *Prev Med* 2015; 81:9-15.
12. High Level Panel of Experts (HLPE). *Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*. Rome: HLPE; 2017.
13. Franco M, Roux AVD, Glass TA, Caballero B, Brancati FL. Neighborhood Characteristics and Availability of Healthy Foods in Baltimore. *Am J Prev Med* 2008; 35(6):561-567.
14. Swinburn BA, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med* 1999; 29(1):563-570.
15. Castro Junior PCP. *Ambiente alimentar comunitário medido e percebido: descrição e associação com Índice de Massa Corporal de adultos brasileiros* [tese]. Rio de Janeiro: Escola Nacional de Saúde Pública, Fiocruz; 2018.
16. Duran AC, Diez Roux AV, Latorre MRDO, Jaime PC. Neighborhood socioeconomic characteristics and differences in the availability of healthy food stores and restaurants in Sao Paulo, Brazil. *Health Place* 2013; 23:39-47.
17. Jaime PC, Duran AC, Sarti FM, Lock K. Investigating Environmental Determinants of Diet, Physical Activity, and Overweight among Adults in Sao Paulo, Brazil. *J Urban Health* 2011; 88(3):567-581.
18. Gittelsohn J, Kim EM, He S, Pardilla M. A Food Store–Based Environmental Intervention Is Associated with Reduced BMI and Improved Psychosocial Factors and Food-Related Behaviors on the Navajo Nation. *J Nutr* 2013; 143(9):1494-1500.
19. D'angelo H, Suratkar S, Song HJ, Stauffer E, Gittelsohn. Access to food source and food source use are associated with healthy and unhealthy foodpurchasing behaviours among low-income African-American adults in Baltimore City. *Public Health Nutr* 2011; 14(9):1632-1639.
20. Holsten JE. Obesity and the community food environment: a systematic review. *Public Health Nutr* 2009; 12(3):397-405.
21. Glanz K, Sallis JF, Saelens BE, Frank LD. Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. *Am J Prev Med* 2007; 32(4):282-289.
22. Burgoine T, Monsivais P. Characterising food environment exposure at home, at work, and along commuting journeys using data on adults in the UK. *Int J BehavNutr Phys Act* 2013; 10:85.
23. Moore K, Diez-Roux AV, Auchincloss A, Evenson KR, Kaufman J, Mujahid M, Williams K. Home and Work Neighborhood Environments in Relation to Body Mass Index: the Multi-Ethnic Study of Atherosclerosis (MESA). *J Epidemiol Community Health* 2013; 67(10):846-853.
24. Canella DS, Duran ACFL, Tavares TF, Jaime PC. A circulação de pessoas influencia a disponibilidade de restaurantes, bares e lanchonetes? Um estudo no município de São Paulo. *Demetra* 2015; 10(1):109-118.
25. Settle PJ, Cameron AJ, Thornton LE. Socioeconomic differences in outdoor food advertising at public transit stops across Melbourne suburbs. *Aust N Z J Public Health* 2014; 38(5):414-418.
26. Kelly YB, Floof VM, Bicego C, Yeatman NH. Derailing healthy choices: an audit of vending machines at train stations in NSW. *Health Promot J Austr* 2012; 23(1):73-75.
27. Secretaria Estadual dos Transportes Metropolitanos. *Pesquisa Origem Destino 2017 – 50 anos: A mobilidade urbana da região metropolitana de São Paulo em detalhes* [Internet]. 2019 [acessado 2020 abr 06]. Disponível em: http://www.metro.sp.gov.br/pesquisa-od/arquivos/Ebook%20Pesquisa%20OD%202017_final_240719_versao_4.pdf.
28. Franco AS. *Ambiente alimentar universitário: Caracterização, qualidade da medida e mudança no tempo* [tese]. Rio de Janeiro: Instituto de Nutrição, Universidade do Estado do Rio de Janeiro; 2016.

29. Brasil. Ministério da Saúde (MS). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. *Guia alimentar para a população brasileira*. 2ª ed. Brasília: MS; 2014.
30. World Health Organization (WHO). Diet, nutrition and the prevention of chronic diseases. Geneva: WHO; 2003.
31. Instituto Brasileiro de Geografia e Estatística (IBGE). *Censo Demográfico 2010: Famílias e domicílios*. Rio de Janeiro: IBGE; 2010.
32. São Paulo. Assembleia Legislativa do Estado de São Paulo. *Índice Paulista de Vulnerabilidade Social - IPVS: versão 2010* [Internet]. 2010 [acessado 2020 abr 6]. Disponível em: http://ipvs.seade.gov.br/view/index.php.
33. Alejo RP. *Alimentos ofrecidos ambulatoriamente características del comprador en vehículos de una empresa de transporte público, Lima-2015* [tesis]. Lima: Facultad De Medicina, Universidad Nacional Mayor De San Marcos; 2016.
34. Franco JV, Bógus CM. Avaliação das políticas para instalação de pontos comerciais de alimentos no interior das estações de metrô da cidade de São Paulo. *Segur Alimentar Nutr* 2019; 26:e019010.
35. Monteiro CA, Levy RB, Claro RM, Castro IRR, Cannon G. A new classification of foods based on the extent and purpose of food processing. *Cad Saude Publica* 2010; 26(11):2039-2049.
36. Popkin BM, Adair LS, NG SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev* 2012; 70(1):3-21.
37. Yuba TY, Sarti FM, Campino ACC, Carmo HCE. Evoluções dos preços relativos de grupos alimentares entre 1939 e 2010, em São Paulo, SP. *Rev Saude Publica* 2013; 47(3):549-559.
38. Brasil. Lei nº 6.321, de 14 de abril de 1976. Dispõe sobre a dedução, do lucro tributável para fins de imposto sobre a renda das pessoas jurídicas, do dobro das despesas realizadas em programas de alimentação do trabalhador. *Diário Oficial da União* 1976 19 abr.
39. Brasil. Decreto nº 5, de 14 de janeiro de 1991. Regulamenta a Lei nº 6.321, de 14 de abril de 1976, que trata do Programa de Alimentação do Trabalhador, revoga o Decreto nº 78.676, de 8 de novembro de 1976 e dá outras providências. *Diário Oficial da União* 1991; 15 jan.
40. Canella DS, Martins APB, Bandoni DH. Iniquidades no acesso aos benefícios alimentação e refeição no Brasil: uma análise da Pesquisa de Orçamentos Familiares 2008-2009. *Cad Saude Publica* 2016; 32:e00037815.
41. Voss C, Klein S, Glanz K, Clawson M. Nutrition environment measures survey-vending: development, dissemination, and reliability. *Health Promot Pract* 2012; 13(4):425-430.

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