Development of a Healthy Meal-Restaurant Index and a Healthy Retail Food Store Index: Obesogenic Environment Brazilian Study (ESAO)

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Abstract

Introduction: The food environment has been associated with food choices and obesity however tools to measure the food environment in middle-income countries are yet unavailable. **Objectives:** To propose two indexes to evaluate the food environment: Healthy Meal-Restaurant Index (HM-RI) and Healthy Retail Food Store Index (HRSI). **Methods:** All restaurants and retail food stores located in 52 census tracts across 13 districts of São Paulo city were audited. ANOVA analyses were performed according to SES and store types. **Results:** In total, 472 restaurants and 313 retail food stores were found. Mean HM-RI score was 2.66 (Standard deviation - SD=0.96), 50.2% of stores scored up to 2. Higher mean scores were found in high SES areas ($p<0.001$) and among full service restaurants ($p<0.001$). Mean HRFI score was 3.15 (SD=2.36). Fruits and vegetable markets and supermarkets scored higher ($p<0.001$). **Conclusion:** The proposed tools and indexes have evidence of being able to discriminate retail food stores and restaurant types and can be used in research and practice to characterize establishments and evaluate food environment interventions.

Keywords: food environment, index, restaurants, food stores, retail

Introduction

The rising prevalence of overweight and obesity worldwide is currently a major public health concern (WHO, 2003). In many contexts, increasing obesity appears to be linked to increasing rates of chronic non-communicable diseases (NCDs) (Jones-Smith et al., 2011) and the rates of overweight and obesity have been increasing both in developed and developing countries (Popkin et al., 2012). This increase has been especially pronounced in some developing countries and may be linked to society-wide changes in diet and physical activity associated with economic growth as some Latin American countries (Fleischer et al. 2008). In Brazil the prevalence of adult overweight (body mass index $\geq$ 25 kg/m^2) increased from 18 to 50% between 1975 and 2009 in men and from 29 to 49% in women (IBGE, 2010). Moreover, obesity appears to be associated with lower education and unemployment in women, (Moura, Claro, 2011) and may thus be an important contributor to health inequities (Monteiro et at, 2009).

Several studies have shown that rates of physical activity, dietary patterns, and obesity vary across neighborhoods. The most consistent evidence available on associations of obesity and dietary patterns with neighborhood-level Powell et al., 2007; Franco et al., 2008; characteristics comes from several US studies (Moore, Diez-Roux, 2006; Hickson et al., 2011). These studies have generally shown that access to healthy foods is associated with better diets and lower obesity rates (Moore et al. 2008; Auchincloss et al. 2011). However, it is not clear whether these results are generalizable to other countries, as mixed results have been reported elsewhere (Ball et al., 2009, Cummins et al., 2010; Smith et al., 2010). A previous study from our group has shown that fruit and vegetables consumption was higher in more affluent areas of the city of Sao Paulo, Brazil, and was associated with a higher density of fruits and vegetables specialized markets (Jaime et al., 2011). Contradictory findings on the availability and accessibility of healthy foods across neighborhoods of different socioeconomic status may reflect real cultural and geographical differences (Cumming et al, 2006). Methodological factors may also contribute to such discrepancies. For example, much of the existing literature uses the presence of different types of stores as proxies for healthy foods (Moore, Diez-Roux, 2006, Powell et al., 2007), rather than directly measuring the food environment, and those that directly measure the food environment, come primarily from high income countries such as the United States (Glanz et al., 2007; Saelens et al., 2007; Franco et al., 2008; Hickson et al., 2011), Australia (Ball et al., 2009) and Scotland (Cummins et al., 2010) Thus far, no data on this question is available from middle income countries. Lack of evidence in such countries, especially those undergoing rapid nutrition and socioeconomic transitions like Brazil, may lead to erroneous interventions and policy-making.

The goal of the present study was to investigate whether the availability, accessibility, and advertisement of healthy and unhealthy foods vary across different types of stores and neighborhoods of different socioeconomic statuses in Sao Paulo city, Brazil.

Methods

Geographic coverage and census tracts sampling

As part of the *"Obesogenic" Environment Study in Sao Paulo, Brazil (ESAO-SP*), we conducted a cross-sectional survey in the city of Sao Paulo, Brazil from November 2010 to February 2011 in order to directly measure the local food environment of neighborhoods in Sao Paulo city. The area included in the study encompassed 52 census tracts (CT) (areas established by the Brazilian Census with an average of 300 households) (IBGE, 2011).

Sao Paulo is the largest city of Brazil with a population of 11.2 million inhabitants, 99% living in urban areas, and with a total of 3.933.448 households (IBGE, 2011).

Tracts were sampled by using food environment and neighborhood socioeconomic characteristics from secondary datasets aggregated within the 96 districts which constitute the administrative divisions of the city. A purposive sampling methodology, which consists in choosing sample units based on the researcher´s knowledge of the subject matter and the nature of the research, was used. In this approach, the rationale of selecting sample units is not to select a sample that is representative of all city districts, but to ensure representation of socioeconomic and food environment diversity (Ritchie et al., 2003). The inner city neighborhoods are wealthier whereas those located in the outskirts of the city offer worse living conditions to their residents (PMSP, 2007). Similar methods have been used previously to study urban food environments (Glanz et al.,2007; Saelens et al.,2007; Ball et al., 2009).

First, the 96 districts of the city were ranked according to the Human Development Index modified for use in the city of Sao Paulo (HDI-M). This index includes information regarding life expectancy, per capita household income and education (illiteracy rates in the population over 15 years of age (1/3) and mean schooling years of the person with the highest income in the household (2/3)) using data from the 2000 Brazilian Census (PMSP, 2007). Then, the districts were divided into three groups according to HDI-M tertiles.

Second, three food environment variables, which have been previously associated with obesity and/or a healthier food intake (Ball et al., 2009; Morland et al, 2009), were aggregated to the district level from the most recently available secondary datasets.

Data on grocery stores, supermarkets, and specialized fruit and vegetable (F&V) markets were collected from the available City Council datasets in 2010 and data on fast food establishments was obtained from commercial lists of the 5 largest fast food restaurants chains in the city of Sao Paulo (Bob´s, Burger King, McDonald´s, Pizza Hut and Habib´s). In order to improve the information on fast food density, we added data of the location of all shopping malls in the city of Sao Paulo in 2010 as they usually hold at least one fast food court with large and local chains fast food restaurants on its premises. Data on food stores and fast food restaurants were aggregated to the district-level (Secretaria Municipal de Planejamento do Estado de São Paulo, 2009). We calculated densities per 1,000 inhabitants in 2010 for the following indicators: a) local grocery stores and supermarkets, b) fruits and vegetables specialized markets, and c) fast food restaurants.

We then selected 4 city districts in each HDI-M tertile that had data on the three food environment indicators. Within each tertile we selected 2 districts above the median for each food environment measure and 2 districts below the median randomly. An extra district within the highest tertile of HDI-M was randomly selected in order to offset potential data loss. As no data were lost, we decided to retain the 13th district in the analyses.

Finally, 8 CTs in each of the selected districts were randomly selected. The field coordinator went to each of these tracts in order to check whether they would have a sufficiently large number of food stores and/or fast food restaurants, in accordance with its food environment density strata, for instance whether the census tract which was originally selected for a large density of restaurants had or not a selection of establishments. Of the 104 tracts initially selected, 18 were excluded, as no stores could be found within their area and they were all located in districts chosen for their high density food environment indicators. In each of these districts, the remaining tracts were chosen.

Then, 4 CTs were randomly selected from the other districts where no problems were found. The final number of selected tracts was 52 (4 in each one of the 13 districts). A list of the selected districts and CTs is available with the authors upon request.

Socioeconomic measures

A neighborhood socioeconomic characteristic was investigated: mean education of the sampled CT, collected in the Brazilian Census year 2000, as more recent data on education or income was not available. Mean education was chosen over household income as it explained better the variations within retail food stores, however no differences when the restaurants were analyzed.

Both neighborhood variables were categorized into tertiles.

Types of stores

Trained research assistants visited all food stores they found within the selected CTs and categorized them into the following categories for retail food stores, adapted from Glanz et al. 2007. 1) convenience stores, 2) public-owned specialized F&V markets, 3) privately-owned specialized F&V markets, 4) farmer´s markets, 5) corner stores, 6) local grocery stores, 7) large chain grocery stores, 8)large chain supermarkets, and 9) delis. They were then collapsed into 4 categories for the analyses: a) large chain supermarkets and grocery stores, b) specialized F&V markets and farmer´s markets, c) local grocery stores, and d) delis and convenience stores.

In the case of restaurants, trained research assistants categorized business into the following categories adapted from Saelens et al 2007: 1) A la carte full service restaurants, 2) All-you-eat buffet restaurants, 3) Restaurants where foods were sold by weight, 4) Large chain fast food restaurants, 5) Local chain or chainless fast food restaurants, 6) Bars and establishments where alcohol was sold in large quantities, 6) Bakeries, 7) Coffee shops, and 7) Ice cream shops. These categories were then collapsed for analyses into: a) Full service restaurants, b) Fast food restaurants, c) bars, d) bakeries and coffee shops.

To assess inter-rater reliability, two trained raters independently visited food outlets to complete the same set of assessments within 15 days since the first visit. And to assess test–retest reliability, outlets were reassessed again within 1 month after the initial observations by one of the same raters.

Population density for each census tract was calculated using data from Brazilian Census year 2010 and was used a covariate in the analyses.

Food environment measuring indexes

New tools to assess healthy food availability in food retail stores, farmer's market and other specialized F&V markets and restaurants were developed based on existing food environment assessment tools tested and validated in the United States (COHEN et al., 2007; Glanz et al., 2007; Franco et al., 2008), Europe (Teo et al., 2009) and Australia (Ball et al., 2009). These are: 1. Retail food stores such as supermarkets and grocery stores; 2. All types of restaurants; and 3. Specialized F&V markets.

After pilot-testing the tools in 4 different census tracts in both high and low SES neighborhoods of the city, a final version of the tools was used in the data collection that was conducted from November 2010 through February 2011. Trained research assistants visited all retail food stores, specialized fruits and vegetables farmer's markets, and restaurants found within the sampled CTs. Inter-rater reliability and test-retest reliability of availability were medium to high in all tools..

Two healthy food availability scores were calculated from the objective measures of food environment: healthy food store index (HFSI) and healthy meal restaurant index (HMRI).

The HFSI measures availability, variety and advertisement of foods in a food store. Healthy foods were rated with a positive score and unhealthy foods were reverse coded, with the range in the total possible score of 0 to 15 points. The score is based on data on the availability and variety of the 10 most commonly purchased fruits and vegetables in the metropolitan area of Sao Paulo city, as well as advertisements of fruits and vegetables. It also includes analogous measures for selected snack items (sugar-sweetened beverages, chocolate filled cookies, and processed corn chips) which are the most commonly consumed snack processed items in Brazil (IBGE, 2010; Fundação Seade, 2010) (Table 1).

The HMRI ranges from 0 to 8 points and includes data on the availability, facilitators, and supports for healthful eating, barriers to healthful eating, and signage/promotion of selected healthy (fruits and vegetables) and unhealthy foods (sugar-sweetened beverages, French fries and sugar-rich deserts). As in the case of the HFSI, items referring to availability of unhealthy items were reverse coded (Table 2).

Statistical analyses

The goal of the analysis was to estimate the associations of neighborhood education levels (low, mid and high) with healthy food availability, variety, and advertisement, as assessed by the mean HMRI and HFSI for all stores within the CT. The distribution of types of stores and the HMRI and HFSI was compared across categories of neighborhood education level using chi-square tests and ANOVA. Mean HMRI and HFSI scores for different types of food stores and for food stores of a similar type located in different neighborhoods were compared, using ANOVA.

All analyses were performed on Stata 11.0 (StataCorp LP, College Station).

RESULTS

Of the 52 sampled CTs, data on restaurants (n=472) were available from 50 tracts, and data on retail food stores (n=313) were available in 48 CTs. Research assistants were able to access all food stores and restaurants in the sampled areas but one large supermarket, one grocery store, 2 bars and 2 fast food restaurants as they were not given permission by the owners or managers of the establishments.

Of a total of over 14,000 census tracts in the city of Sao Paulo, the 52 sampled census tracts covered a total area of 4.96 km^2. Mean population density was 14,311 inhabitants, with a mean number of residents per household of 3.22. Mean years of education was 9.17, Standard deviation (SD) = 2.67.

Retail food store densities ranged from 0.0 to 466.7/10,000 inhabitants. The majority (80.8%) were classified as local grocery stores, and 15 (4.8%) were classified as specialized F&V markets or farmer´s markets. Restaurant densities ranged from 0.0 to 155.7/10,000 inhabitants per tract. One-third of restaurants were fast food restaurants, and another third were classified as bars or places were alcohol was sold.

Compared with affluent areas, disadvantaged areas had a larger number of total retail food stores per 10,000 inhabitants in each census tract ($p= 0.002$) (data not shown). However, when different types of food stores were compared, they were all more prevalent in areas within the second tertile of educational level, except for convenience stores, which were mostly found in the CT in the third tertile.

The percent distribution of store types varied across neighborhoods within different levels of education ($p<0.001$). More convenience stores (26.5%) were found in CT in the third tertile of education, compared to the other two levels of education (1.0% and 7.3%, in the first and the second tertiles, respectively) and more local grocery stores in the poorest areas: 94.1% of the total retail food stores found at the CT within the first tertile of education ($p<0.001$). However, more specialized F&V markets were found in the second tertile of education ($p<0.001$).

Among restaurants, no neighborhood differences were found when total number of stores per 1,000 inhabitants was compared (data not found), however more full service restaurants, as compared to fast food restaurants and bars, were found in the census tracts with the highest levels of education. Furthermore, more bars (41.8% of total restaurants found) and fast food restaurants (37.3%) were found in the CT in the first tertile of education ($p<0.001$) (Table 3).

Restaurants were evaluated in 2-10 minutes and retail food stores in 5-40 minutes, according to the size of the establishment and the amount of types of foods it carried.

Mean HFSI was 3.70 (SD=3.44), and 50.2 % of the assessed stores reached up to 2 points in the score. Mean HMRI was 2.6 (SD=0.96), and similarly only 50.2 % of the assessed stores reached up to 2 points in the score and only 5.7% ≥ 5.

Regarding food produce, only a quarter (24.6%) of all the retail food stores held any type or quantity of fruits or vegetables, whereas 81% presented soft drinks, 61% had processed or powder sugar-sweetened juices, 66% had chocolate sandwich cookies and corn chips were found in 79% of the stores.

Among the restaurants, fast food outlets, bars, bakeries and coffee shops, even less (17%) served fresh and season fruits for desert or had freshly squeezed fruit juices. A salad bar or salad available on the menu was found in only 16% of the establishments.

Table 3 shows mean HFSI and HMRI by neighborhood education level and store type. The mean HMRI in areas in the first tertile for education was lower (2.43), compared to those areas in the second (2.66) and the third tertile of education (2.90) ($p<0.001$). Fast food stores in the middle and higher education tertiles areas had higher mean scores (2.82 and 2.78, respectively) than those in the lowest tertile (2.39) ($p<0.001$).

Among grocery stores and supermarkets, mean HFSI score was higher in more highly educated census tracts (4.11), compared to those of lower (2.95) levels of education ($p=0.016$). Moreover, scores for local grocery stores were greater in the higher SES areas (3.81), compared to both low (2.57) and medium SES areas (3.04) ($p<0.001$) (Table 3).

DISCUSSION

Both food environment measures developed and evaluated in this study had middle to high inter-rater and test–retest reliabilities and were able to discriminate food stores both according to store type and the neighborhood SES and therefore were shown to be able to provide support for the construct validity of the measures. Because the indicator foods were carefully selected based on guidelines and recommendations, actual overall purchase of the Brazilian population and the population residing in the metropolitan area of Sao Paulo, as well as previous tools developed for other countries (Cohen et al., 2007; Glanz et al., 2007; Teo et al., 2009), validity of the measures is also affirmed. These measures provide an evaluation of food stores available in specific location and the unique contribution of these measures is the assessment of the availability, price, and quality of foods available within stores, reflecting the environment confronted by consumers making food choices.

Moreover, no studies assessing the food environment in middle income countries, to our knowledge, have yet been published, thus our study sought to fill a gap and explore cross-country differences in the food environment as previous results in countries outside the United States have shown mixed results (Ball et al., 2009, Cummins et al., 2010; Smith et al., 2010).

In order for the scores to be constructed, we had to drop the questions regarding the absolute and relative prices of F&V and consequently all the variables on prices of the other types of foods as only 24% of all the retail food stores sold any type of fruits or vegetables and when these questions were included, the HFSI was not as able to discriminate the differences found in the stores. The same happened for the HMRI, as again less than 20% of all fast food and full service restaurants, bars, coffee shops and bakeries found hold any type of freshly squeezed juices or fruit or fruit salads as deserts. In order for a better estimate, it is recommended to compare the relative prices of healthy foods to unhealthy foods (POWELL et al., 2007). Therefore data on food prices could not be included in the score.

Although it can be a limitation of the present score, we recommend that as the availability of fruits and vegetables increase, the score should be revised and such information included.

Previous studies have shown healthful foods are less available in low-income or minority neighborhoods (Powell et al., 2007; Franco et al., 2008; Moore et al. 2008; Auchincloss et al. 2011) and replication of those findings in the present study, even in a different context, support the ability of the new measures to discriminate between high- and low-income neighborhoods. Because it is hypothesized that healthful foods will be more available, lower in price, and higher in quality in grocery stores than in convenience stores (Glanz et al., 2007; Franco et al., 2008), present findings indicate that the new measures are sensitive enough to detect those expected differences.

The differences found in the HFSI scores when supermarkets, grocery stores and convenience stores were large and alike previous studies, these findings suggest that differences in food store environments may be large enough to have substantial effects on healthy food access, favoring those living in richer areas, ultimately contributing to widen healthy inequalities already presented (Monteiro et at, 2009; Auchincloss et al. 2011).

An important limitation of the food store environment measures is the cost of personnel time. However, after an extensive yet necessary training, our tools were easily and quickly applied by the team of research assistants. Despite the complexity of the research area, such measures are imperative to drive public health policies as not all grocery stores or restaurants are alike. For instance, we found important differences not only across store types, but within the same type of store located in different neighborhoods. Wealthier areas had groceries stores and fast foods scoring higher than those same types of stores located in poor areas.

Lytle (2009) suggested that authors studying the food environment should care about the parsimony in data collection, be transparent with regard to data reduction, and report psychometric properties of the instruments used. Although our tool may still demand personnel and time, we were able to include fewer questions than previous tools (Glanz et al., 2007; Saelens et al., 2007) and we encourage the use of tools by public health professionals with the help of members of the local community when assessing the food environment after an adequate training. Involving the community has been previously suggested in order for changes in the food environment and interventions to be more sustainable (Gittelsohn et al. 2010).

Another limitation of the present evaluation was that it was conducted within a single large metropolitan area. However, the selected neighborhoods provided variation in education status, with mean education levels varying from 5.6 to 14.0 years. Further application of the present tools are encouraged in other areas and cities of Brazil and countries in order for the feasibility of the tool to be tested in other settings.

Finally, the tools developed to measure the food environment in retail stores are feasible, reliable, and seem to have good support for construct validity. Both scores included information in the availability, variety and advertisement for both healthy and unhealthy foods and were able to discriminate different types of retail food stores and differences across high- versus low-income neighborhoods. Thus, the measures reported here can be used to test associations between the food environment, eating behavior and obesity/chronic diseases in multilevel studies. Although needing further and thorough testing, we encourage the use of our measures in intervention studies and evaluations of changing in food environments, along with updates in the scoring system as the quality and availability of healthier foods improve.

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Table 1. Scoring system for the Healthy Retail Food Store Index (HFSI).

Variable	Score
Fresh fruits and vegetable availability	0 points if not available; 1 point if available
Fresh fruits and vegetable located near the entrance of the store	0 points if not located near the entrance of the store; 1 point if located
Number of fruits type	0 points if not available; 1 point if 1-7 types of the 10 most consumed fruits are available; 2 points if 8-10 of the 10 most purchased fruits are available
Fruits variety	0 points if not even 1 fruit variety is available; 1 point if up to 14 varieties; 2 points if 15 or more varieties are available
Number of vegetables type	0 points if not available; 1 point if 1-7 types of the 10 most consumed vegetables are available; 2 points if 8-10 of the 10 most purchased vegetables are available
Vegetables variety	0 points if not even 1 vegetable variety is available; 1 point if up to 14 varieties; 2 points if 15 or more varieties are available
Fruits and vegetables adverstisements	0 points if not available; 1 point if available
Soft drinks availability	0 points if available; 1 point if not available
Sugary juices availability	0 points if available; 1 point if not available
Chocolate filled cookies availability	0 points if available; 1 point if not available
Corn chips availability	0 points if available; 1 point if not available
Highly processed foods adverstisements	0 points if available; 1 point if not available

Table 2. Scoring system for the Healthy Meal - Restaurant Index (HMRI)

Variable	**Score**
Salad bar availability	0 points if not available; 1 point if available
Fresh fruits availability	0 points if not available; 1 point if available
Fresh fruit juices availaibility	0 points if not available; 1 point if available
Fruits and vegetable adverstisements	0 points if not available; 1 point if available
Highly processed foods advertisements	0 points if available; 1 point if not available
All-you-can-eat buffet only	0 points if available; 1 point if not available
Nutrition facts available in the menu	0 points if not available; 1 point if available
Nutrition facts available in other store locations	0 points if not available; 1 point if available

Table 3. Distribution (%) of type of stores in a neighborhood and mean (SD) of HMRI and HFSI scores Indexes by neighborhood characteristics and store type.

	Census tract education level								
	Total		Lower		Medium		High		
HMRI (n=472)	%	mean(SD)	%	mean(SD)	%	mean(SD)	%	mean(SD)	ANOVA
Full service restaurants	24.2	3.34 (1.05)	13.3	3.33 (1.15)	26.0	3.28 (1.04)	33.1	3.40 (1.02)	<0.001
Fast food restaurants	30.3	2.63 (0.87)	37.3	2.39 (0.69)	24.7	2.82 (1.06)	28.8	2.78 (0.84)	<0.001
Bakeries and coffee shops	12.7	2.58 (0.81)	7.6	2.67 (0.65)	14.3	2.36 (0.73)	16.3	2.73 (0.92)	<0.001
Bars	32.8	2.23 (0.73)	41.8	2.14 (0.80)	35.1	2.20 (0.63)	21.9	2.43 (0.70)	<0.001
Total	100.0	2.66 (0.96)	100.0	2.43 (0.89)	100.0	2.66 (0.97)	100.0	2.90 (0.96)	<0.001
HFSI (n=313)	%	mean(SD)	%	mean(SD)	%	mean(SD)	%	mean(SD)	ANOVA
Fruits and vegetable markets	2.9	13.13 (2.69)	2.9	11.00 (3.61)	7.3	13.88 (1.64)	3.9	13.25 (3.59)	<0.001
Supermarkets	4.8	10.33 (2.87)	2.0	8.50 (3.54)	3.7	9.25 (2.50)	2.9	13.00 (1.00)	<0.001
Local grocery stores	80.8	3.07 (2.50)	94.1	2.57 (1.92)	81.7	3.04 (2.64)	66.7	3.81 (2.87)	<0.001
Delies and convinience stores	11.5	2.53 (1.46)	1.0	4.00 -	7.3	2.38 (1.41)	26.5	2.52 (1.50)	<0.001
Total	100.0	3.70 (3.44)	100.0	2.95 (2.56)	100.0	4.02 (3.92)	100.0	4.11 (3.59)	<0.001

SD=Standard deviation